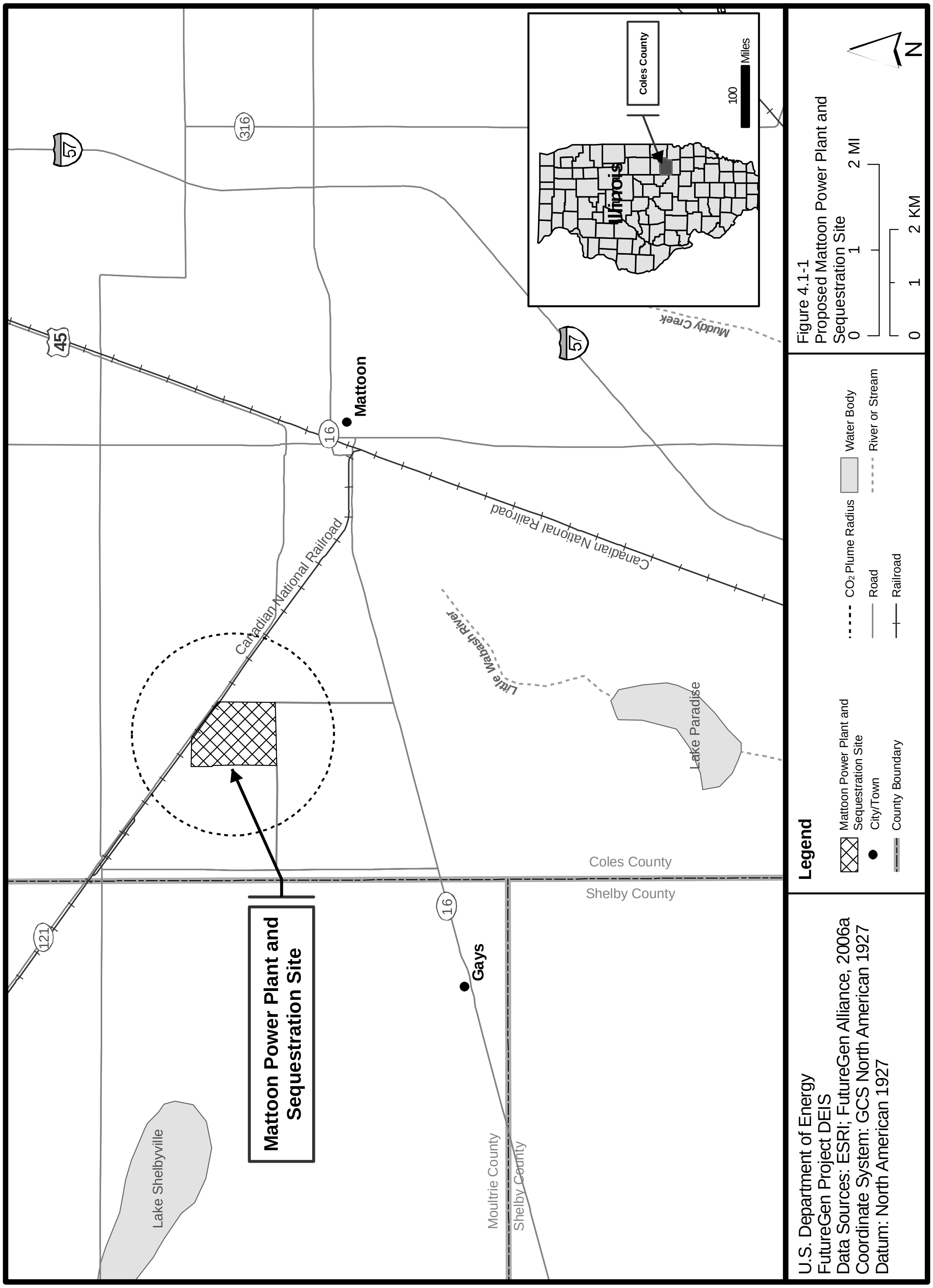
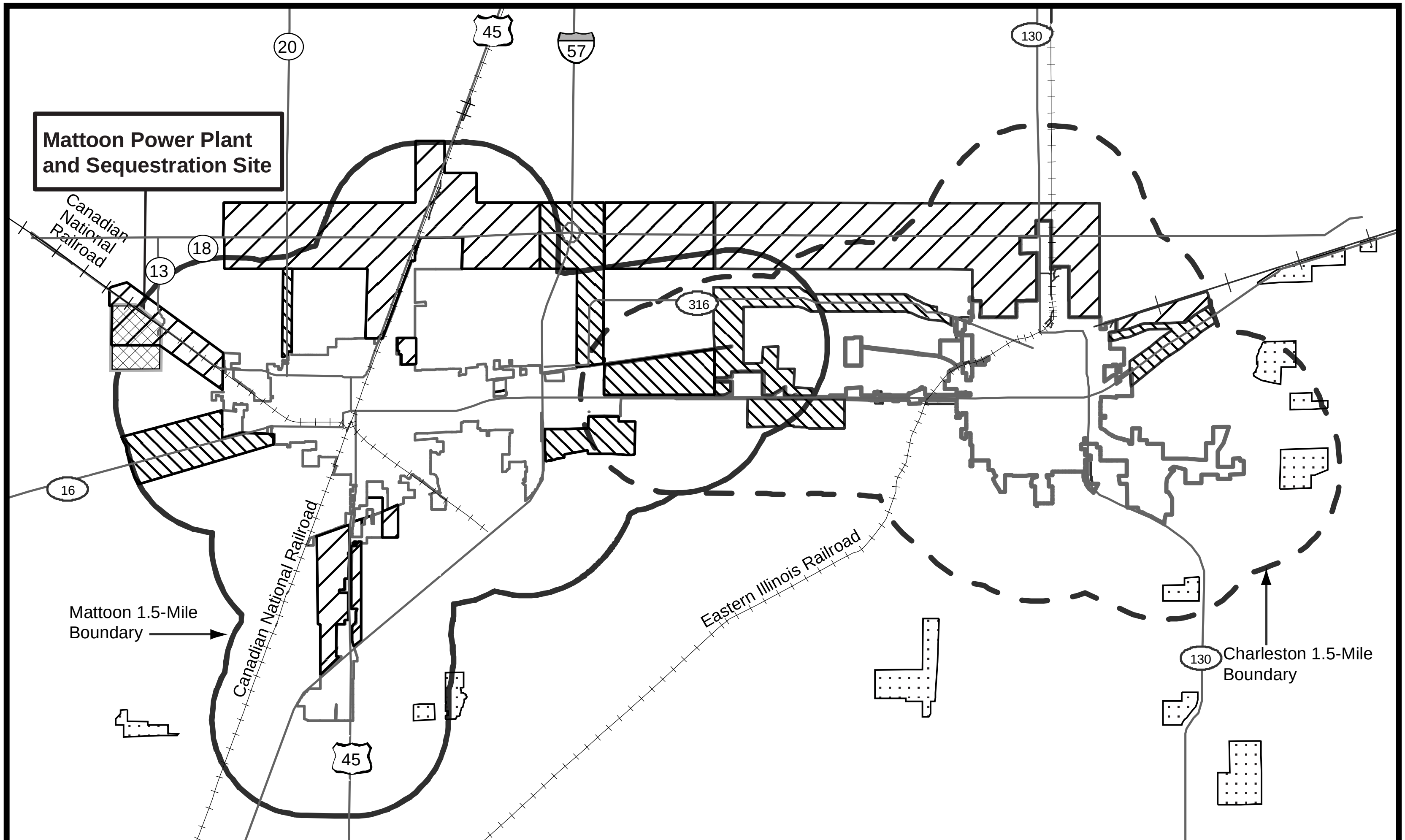


Figure 4.1-1
Proposed Mattoon Power Plant and Sequestration Site



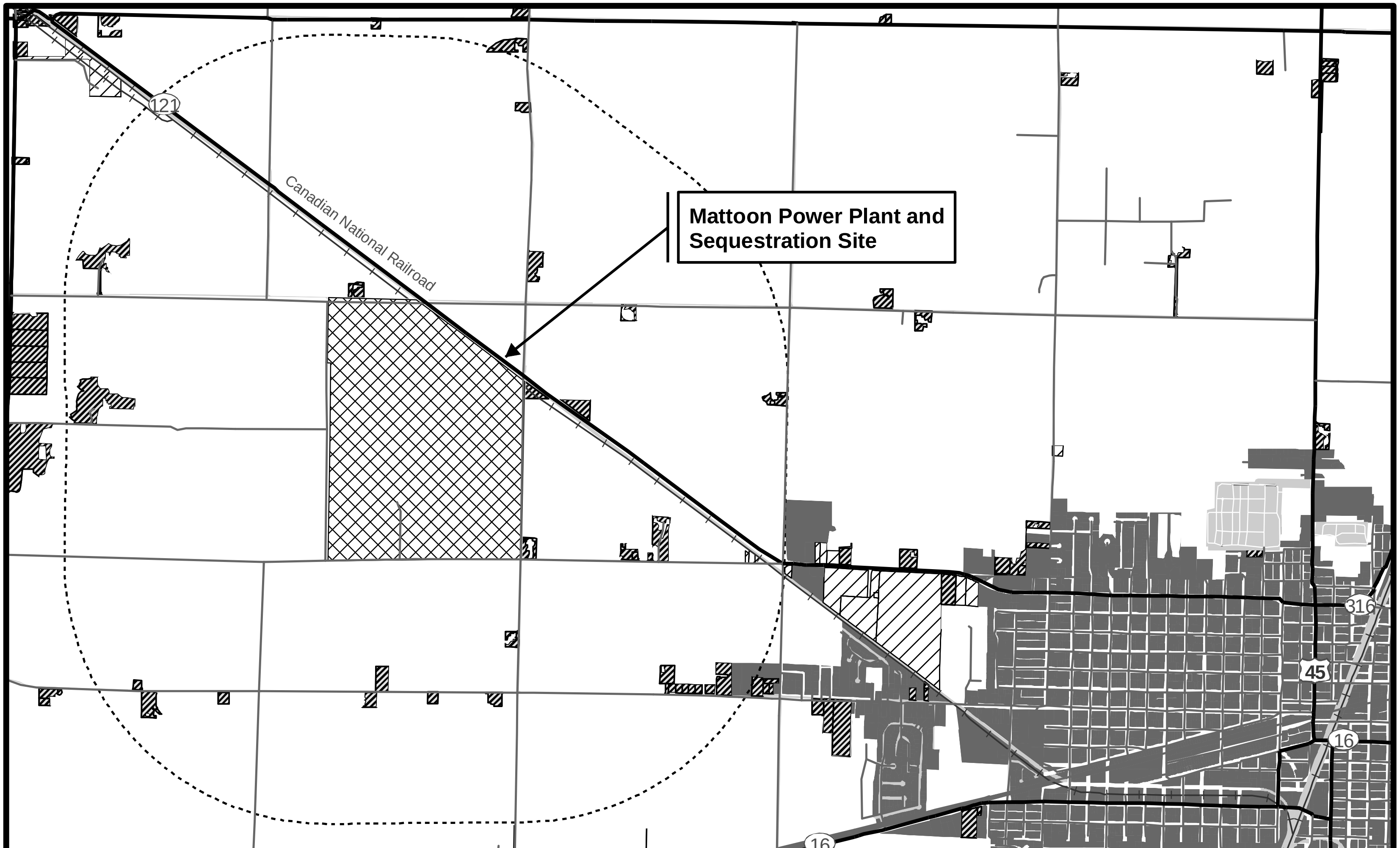
U.S. Department of Energy
FutureGen Project DEIS
Data Source: FutureGen Alliance, 2006a
Datum: North American 1927

Legend

- Proposed Mattoon Power Plant and Sequestration Site
- Mattoon 1.5 Mile Boundary
- Charleston 1.5 Mile Boundary
- Urban Facilities Development Area
- Industrial Devolpment Area
- Retail Development Area
- Rural Residential Growth Development Area
- Railroads

Figure 4.11-1
Future Land Use Classification Map and the City of Mattoon Extraterritorial Bounday

0 2 4 MI
0 2 5 KM
N



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: ESRI; FutureGen Alliance, 2006a
Coordinate System: NAD 1983 UTM Zone 16N
Datum: North American

Legend

- Mattoon Power Plant and Sequestration Site
- 1-Mile ROI
- Major Road
- Minor Road
- Railroad
- Local, State, Federal Ownership
- Agriculture, Forestry, Fishing and Hunting
- Municipal
- Commerical
- Residential

Figure 4.11-2
Land Use Classification for the Proposed Mattoon Power Plant and Sequestration Site

0 0.25 0.5 MI
0 0.25 0.5 KM
N

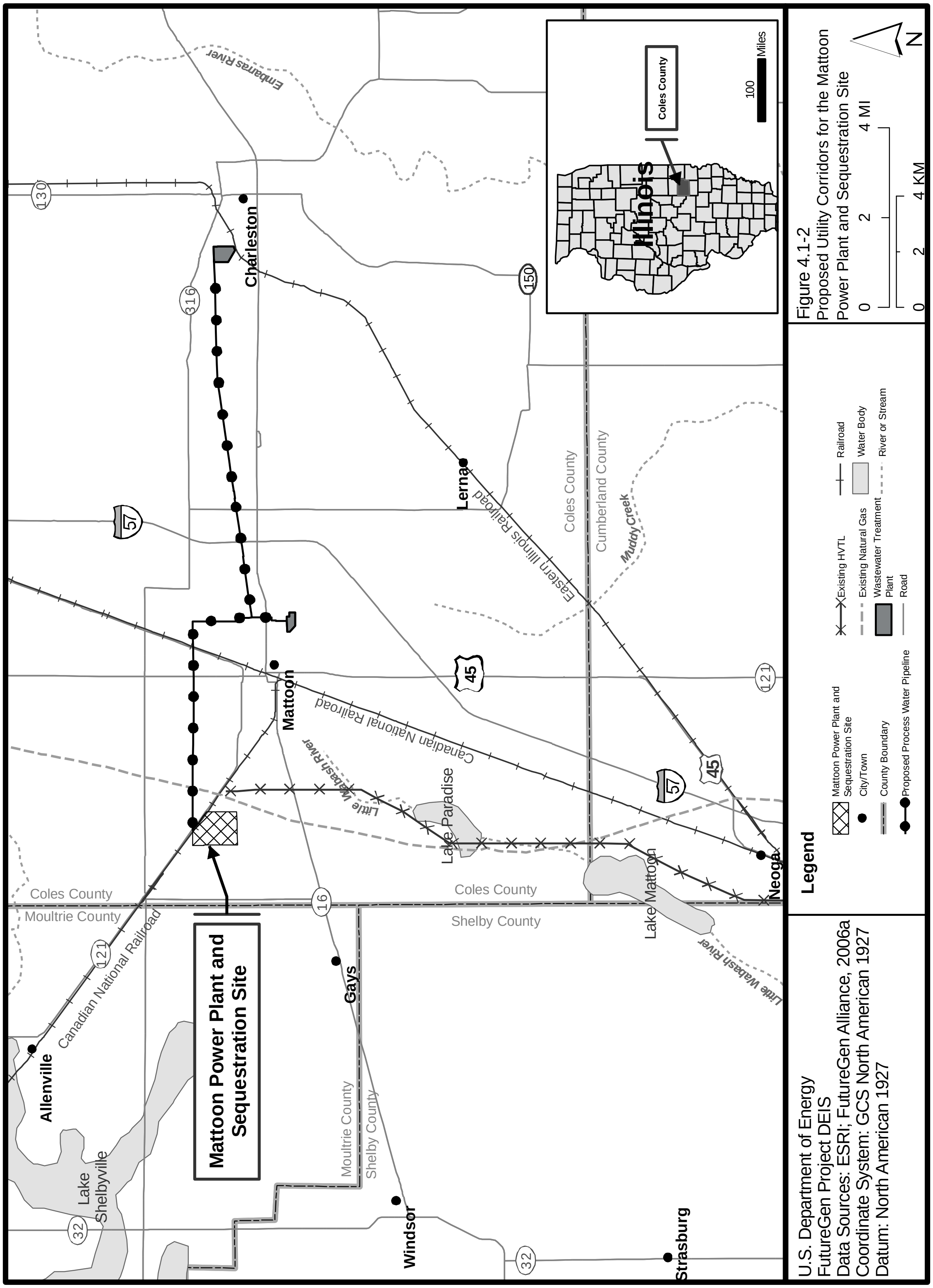


Figure 4.1-2
Proposed Utility Corridors for the Mattoon Power Plant and Sequestration Site

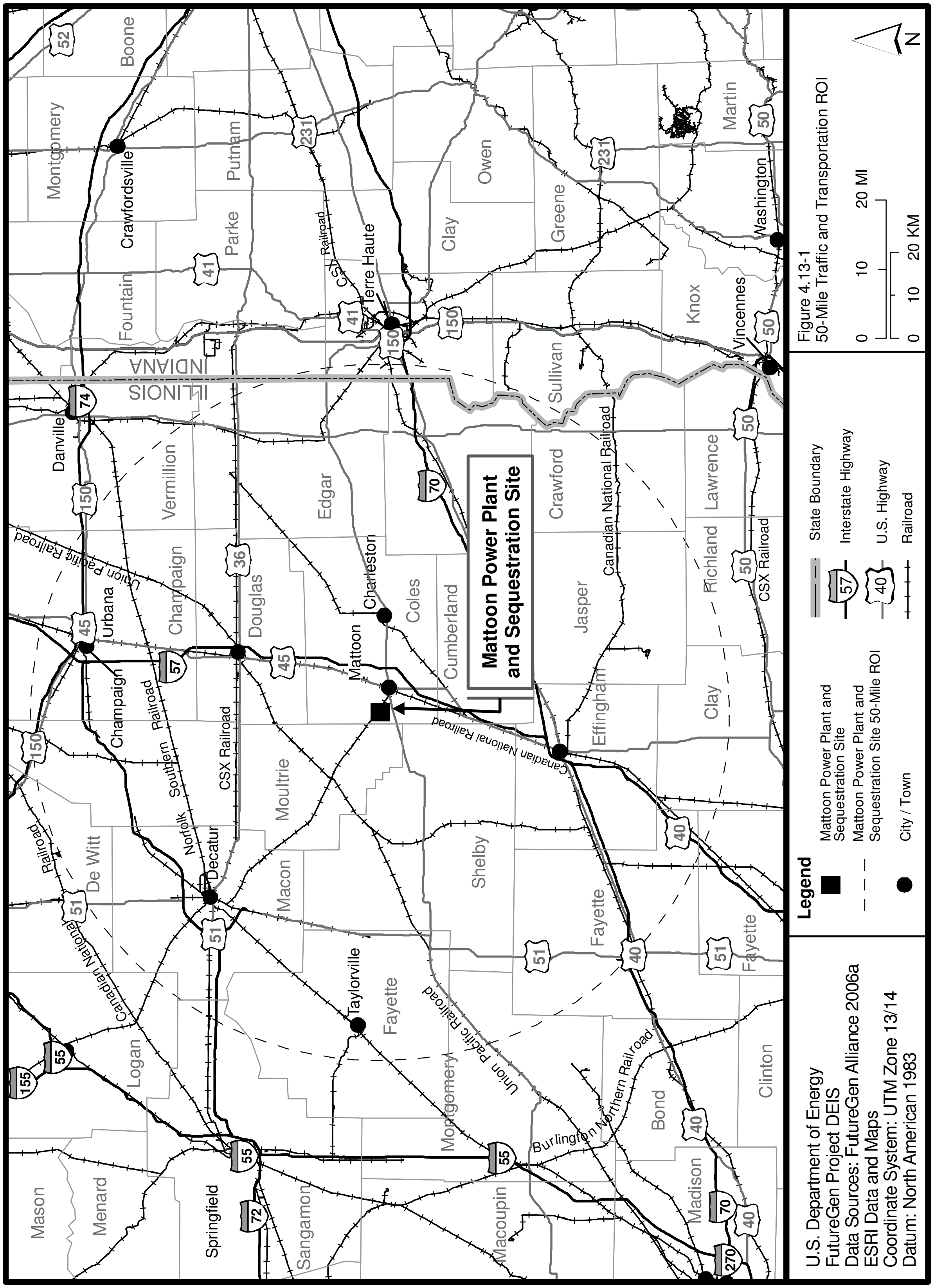


Figure 4.13-1
50-Mile Traffic and Transportation ROI

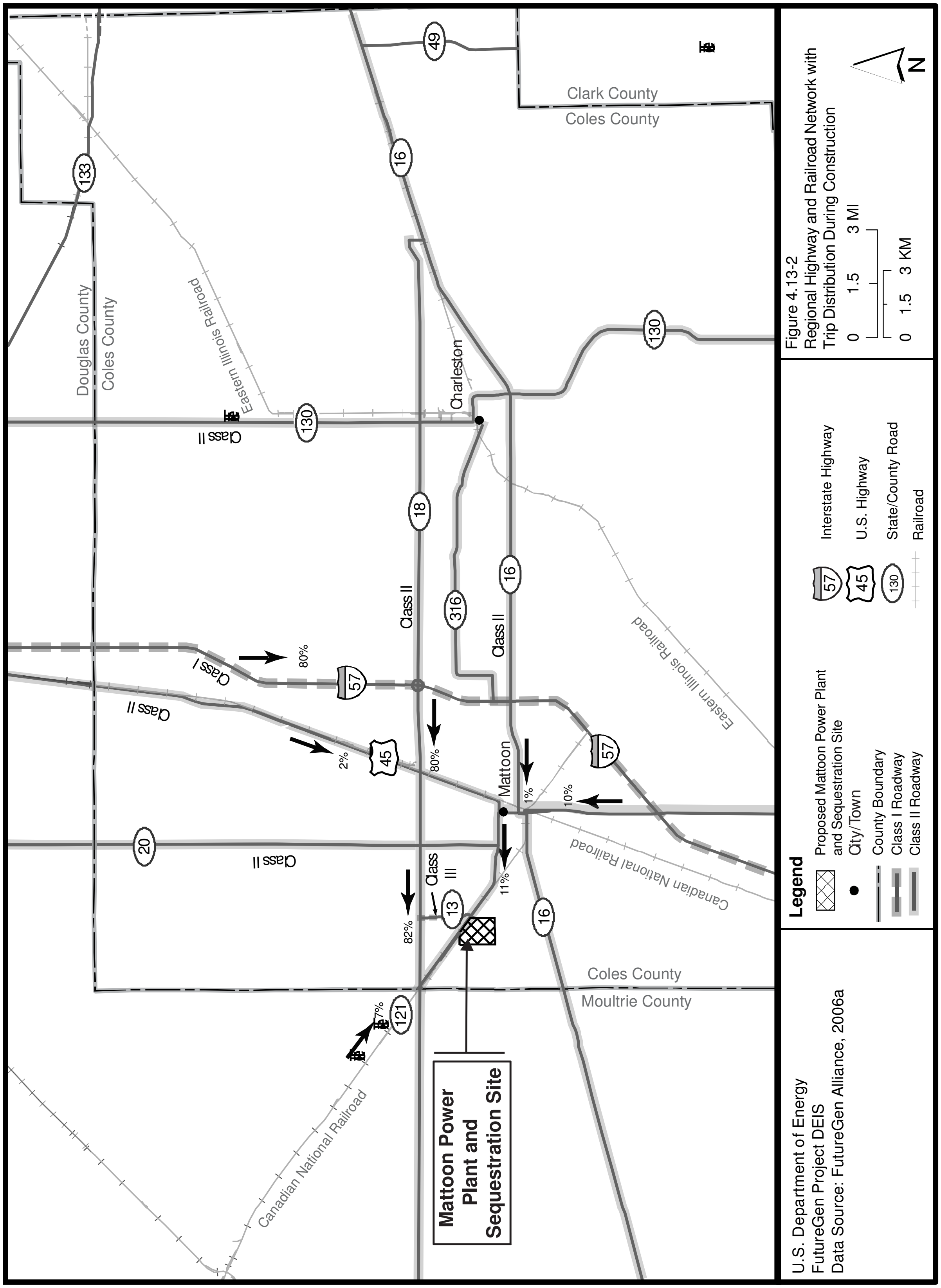


Figure 4.13-2
Regional Highway and Railroad Network with Trip Distribution During Construction

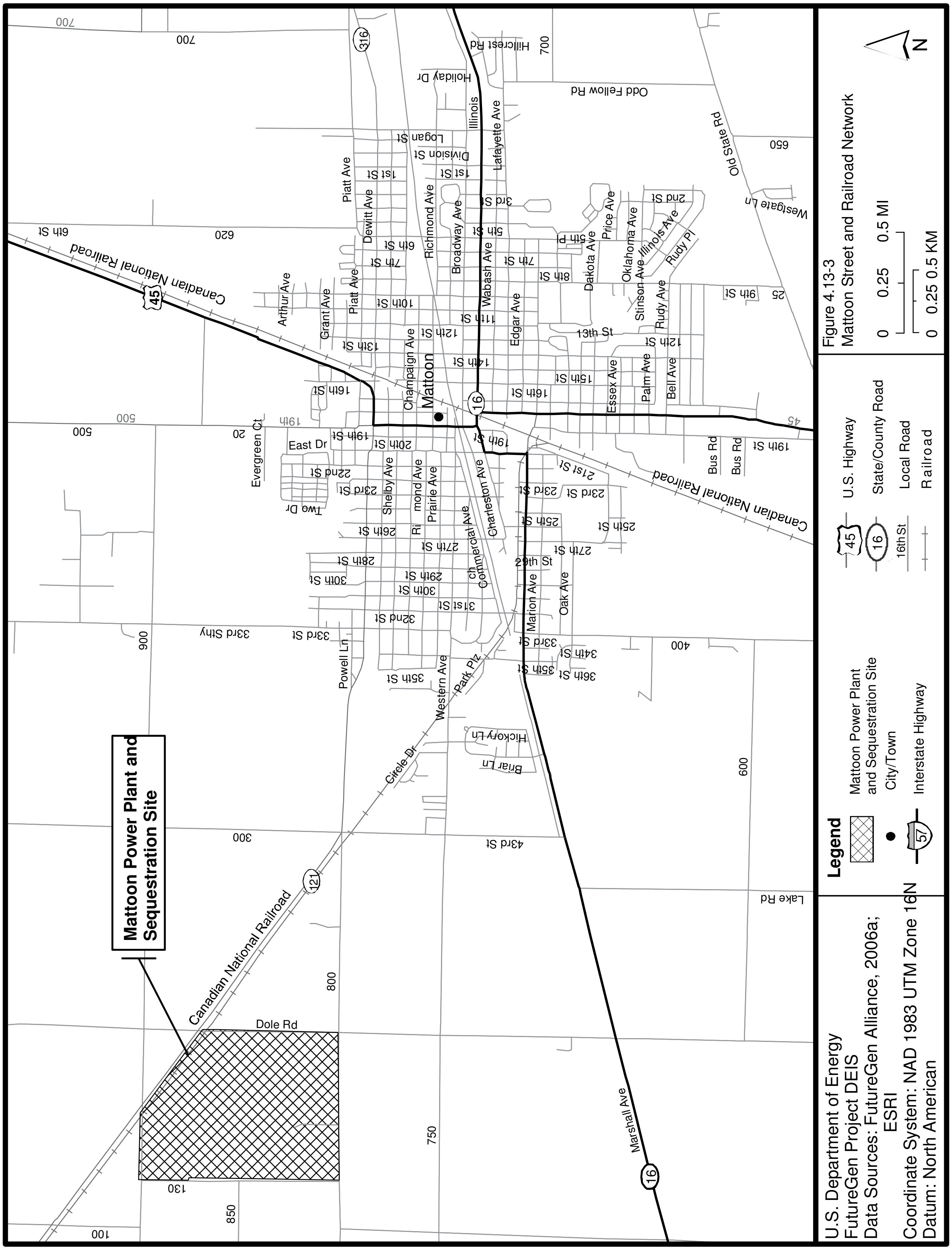


Figure 4.13-3
Mattoon Street and Railroad Network

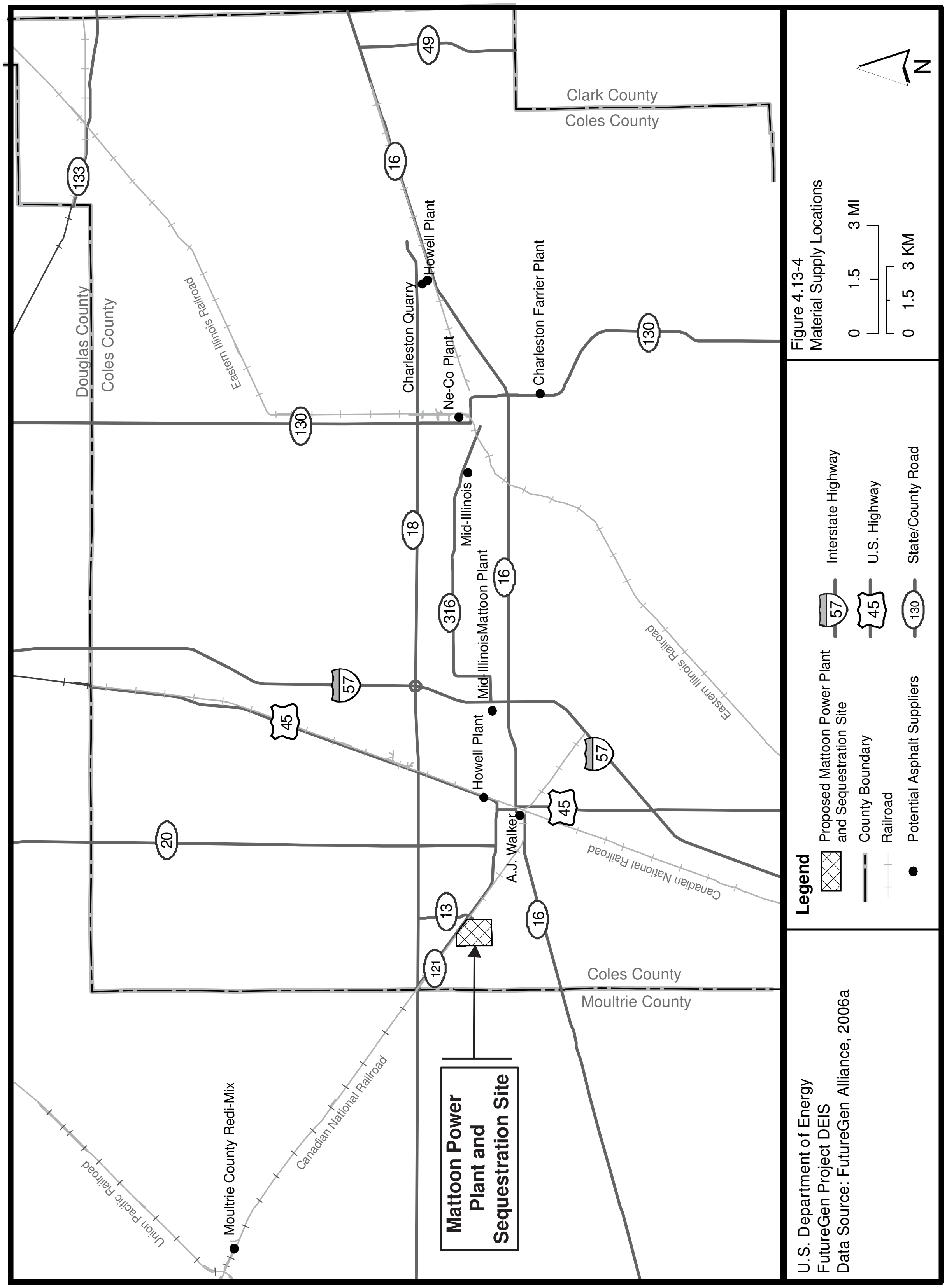
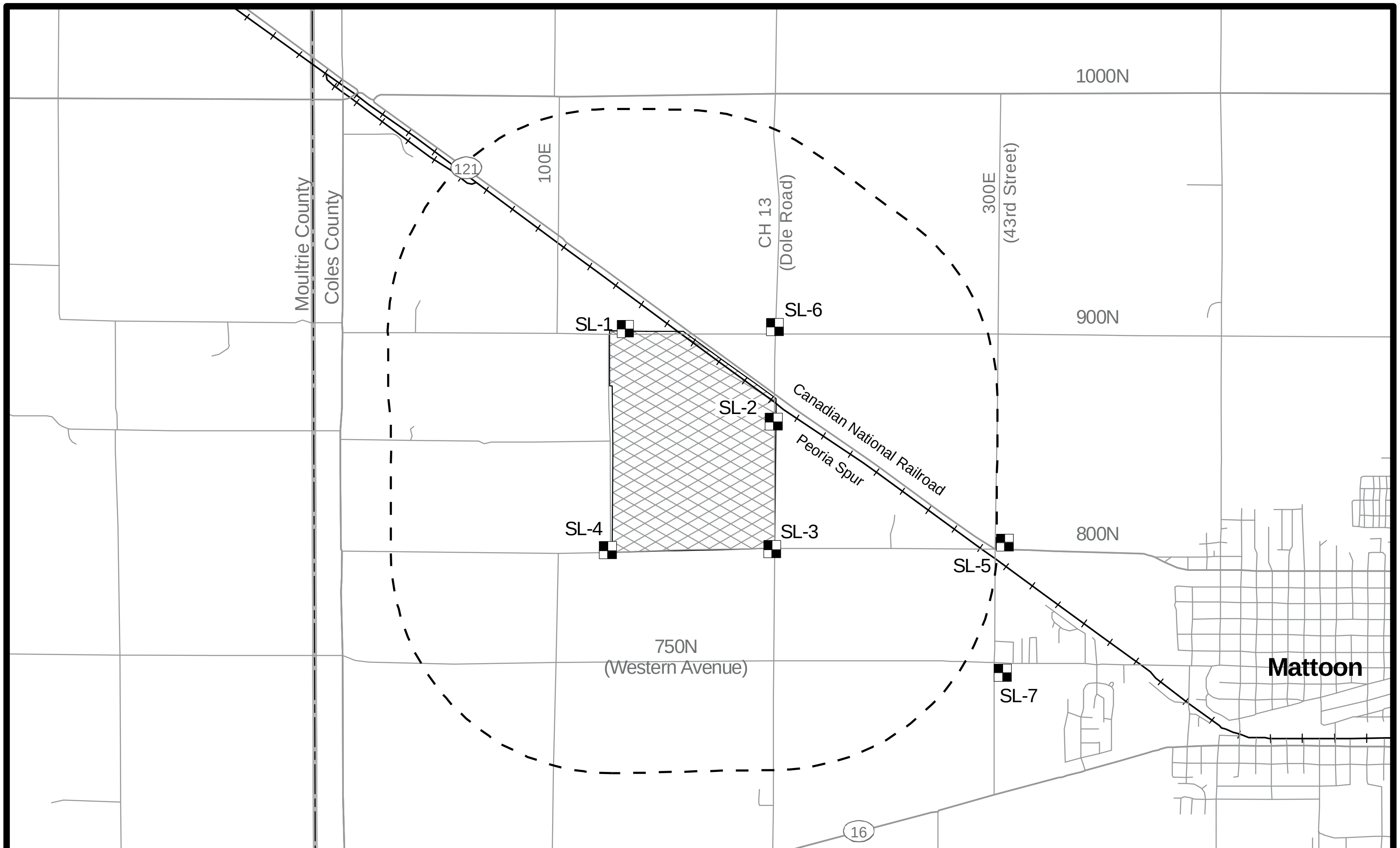


Figure 4.13-4
Material Supply Locations



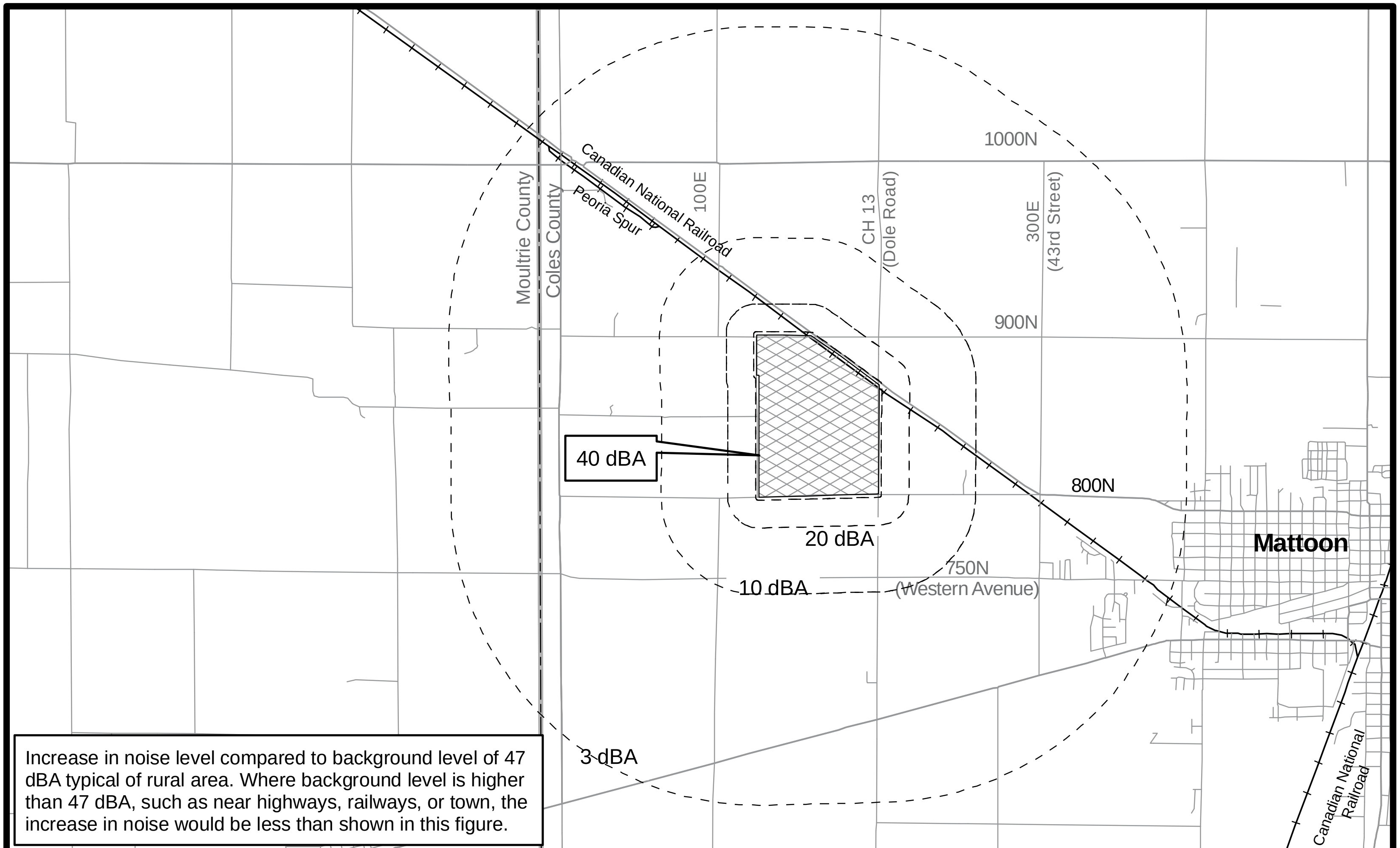
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006a
ESRI Data and Maps
Coordinate System: UTM Zone 13/14
Datum: North American 1983

Legend

- Mattoon Power Plant and Sequestration Site
- 1-Mile ROI Boundary
- SL-X Ambient Noise Level Measurement Points
- County Boundary
- State / County Road
- Railroad

Figure 4.14-2
Noise Measurement Locations near the Proposed Mattoon Power Plant Site

0 0.4 0.8 MI
0 0.4 0.8 KM
N



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006a
ESRI Data and Maps
Coordinate System: UTM Zone 13/14
Datum: North American 1983

Legend

- Mattoon Power Plant and Sequestration Site
- Increase in noise level compared to background level of 47 dBA typical of rural area
- County Boundary
- State / County Road
- Railroad

Figure 4.14-3
Change in Noise Level During Construction at the Proposed Mattoon Power Plant and Sequestration Site

0 0.5 1 MI
0 0.5 1 KM
N

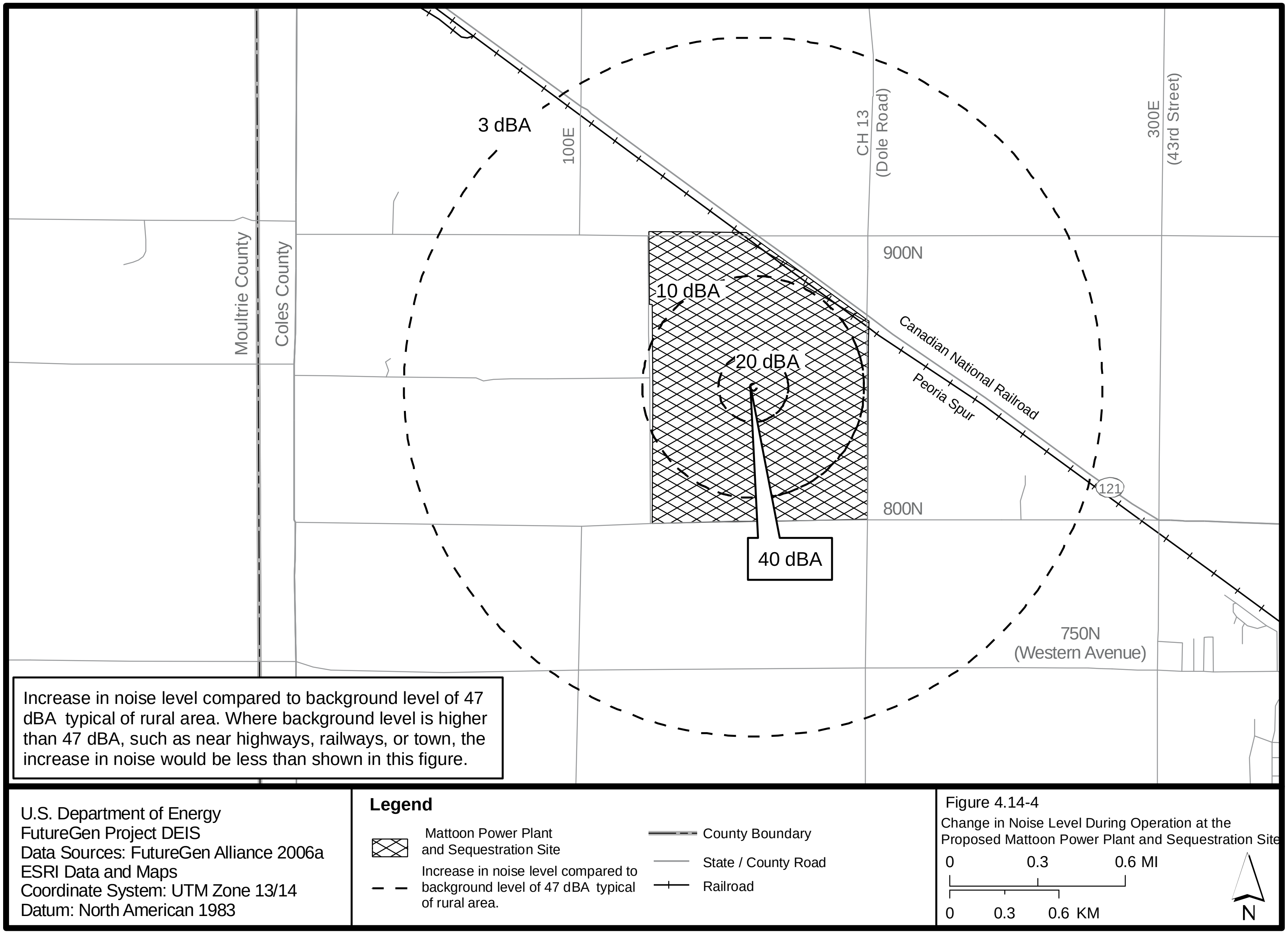


Figure 4.14-4
Change in Noise Level During Operation at the Proposed Mattoon Power Plant and Sequestration Site

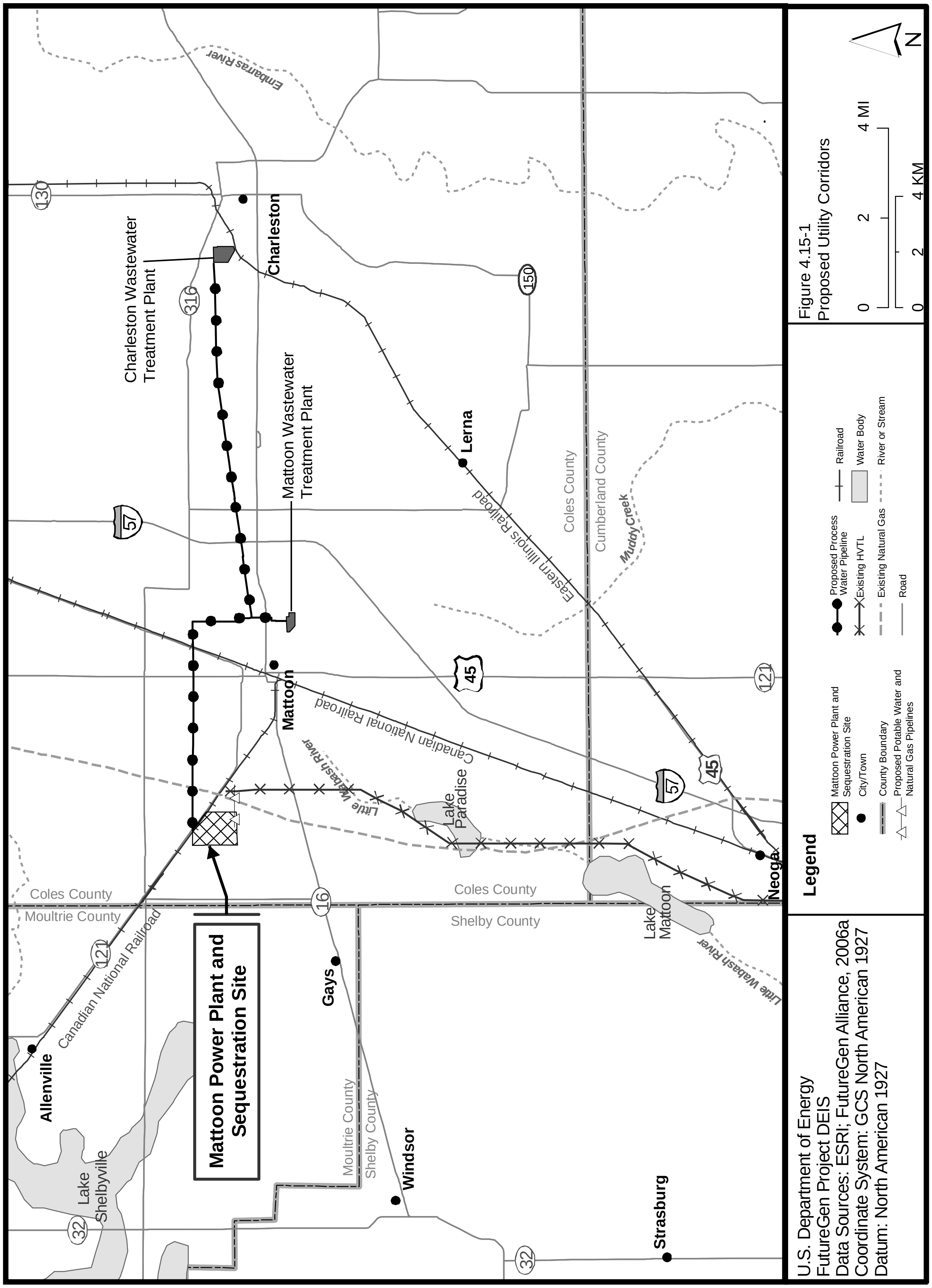
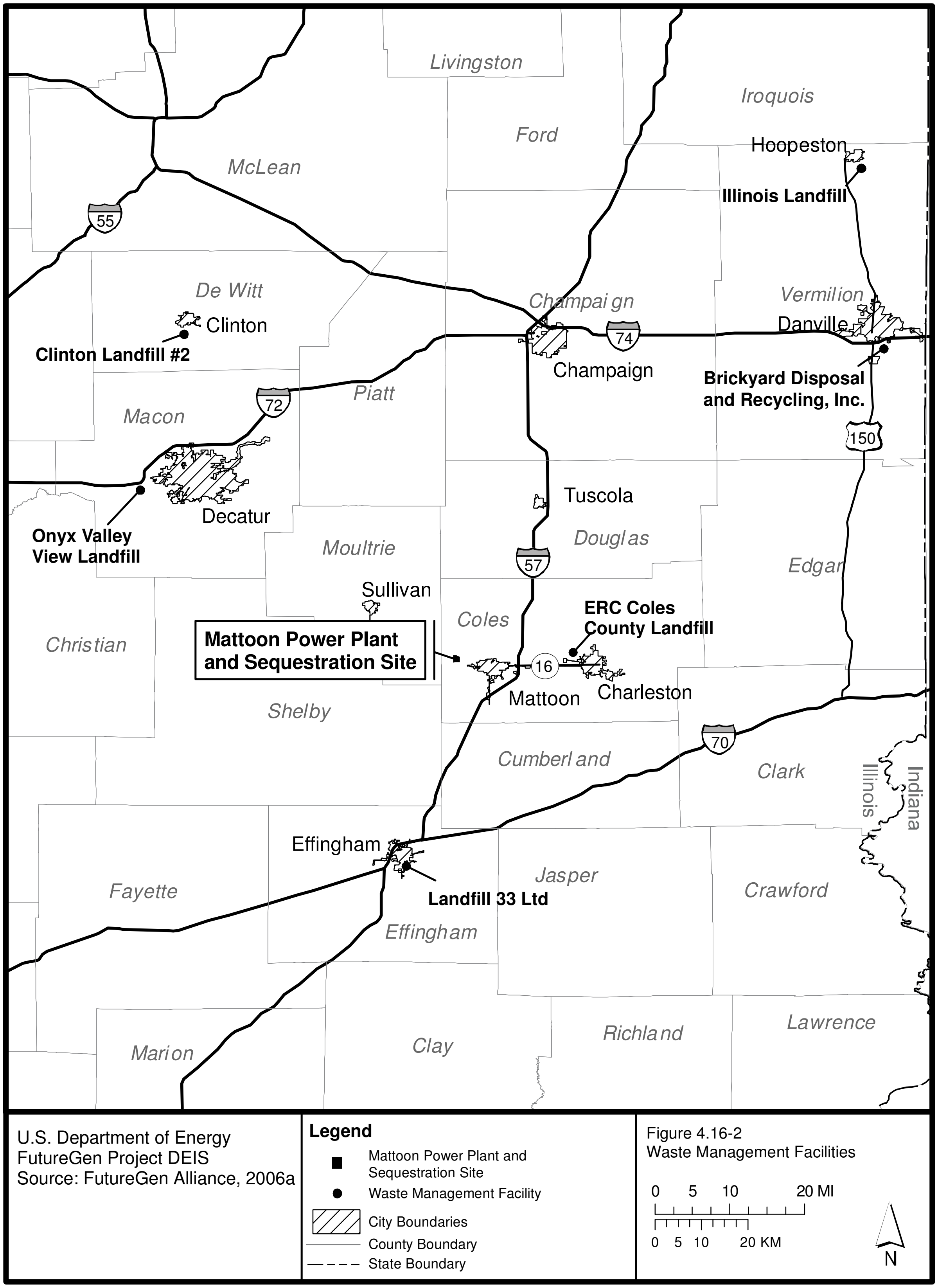


Figure 4.15-1
Proposed Utility Corridors

Figure 4.16-1 Coal Resources



U.S. Department of Energy
FutureGen Project DEIS
Source: FutureGen Alliance, 2006a

Figure 4.16-2
Waste Management Facilities

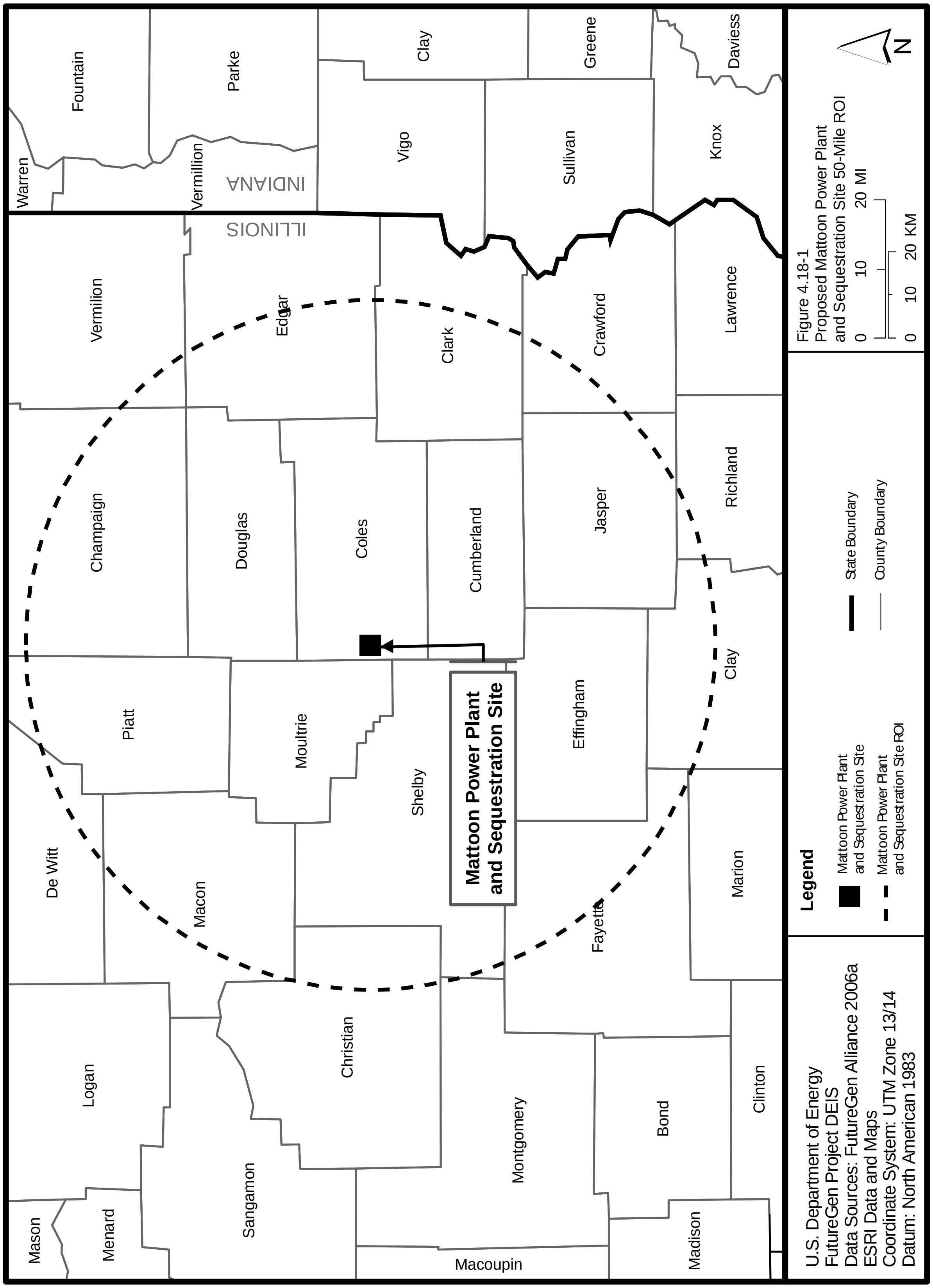


Figure 4.18-1
Proposed Mattoon Power Plant and Sequestration Site 50-Mile ROI

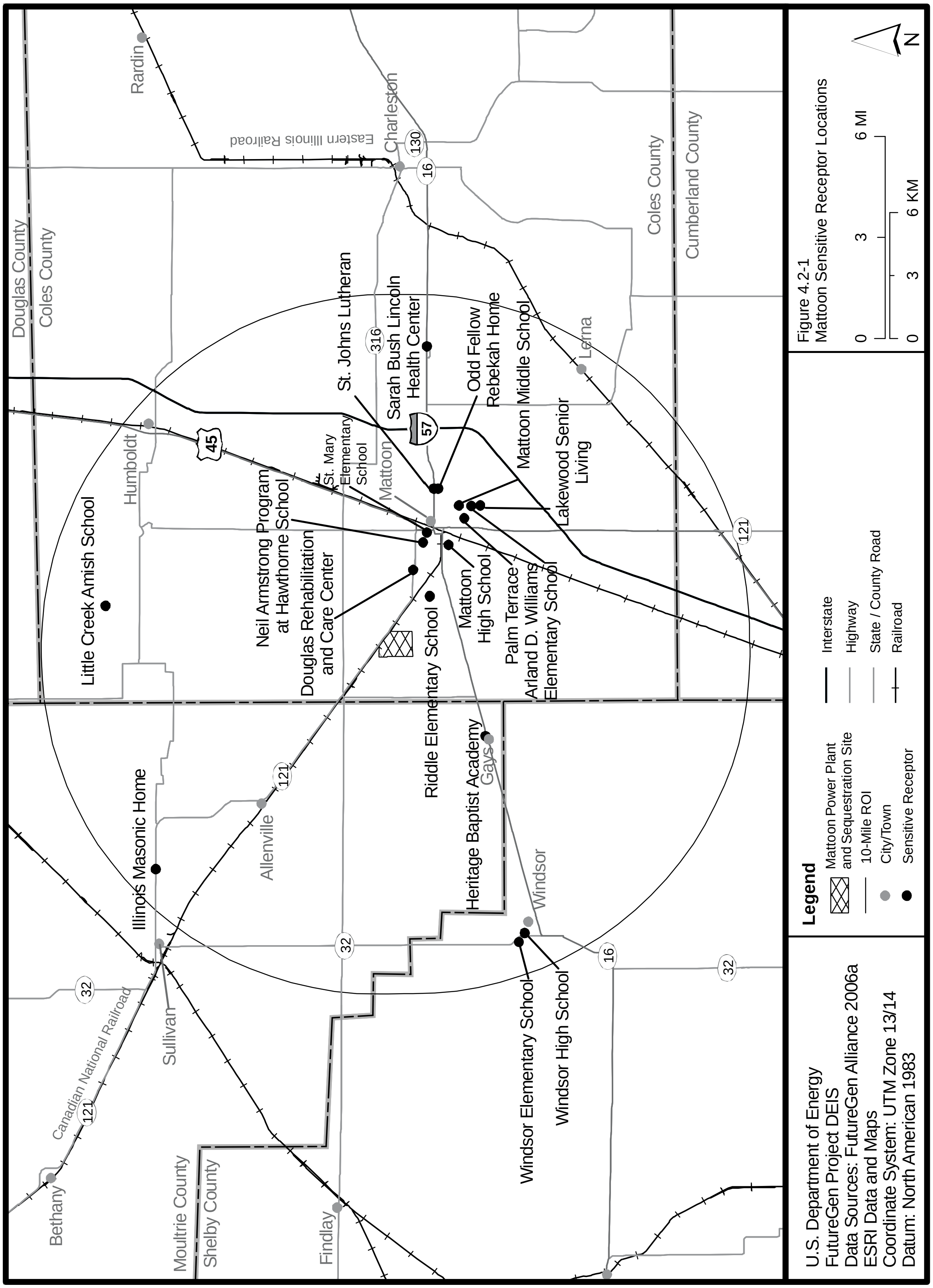


Figure 4.2-1
Mattoon Sensitive Receptor Locations

U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006a
ESRI Data and Maps
Coordinate System: UTM Zone 13/14
Datum: North American 1983

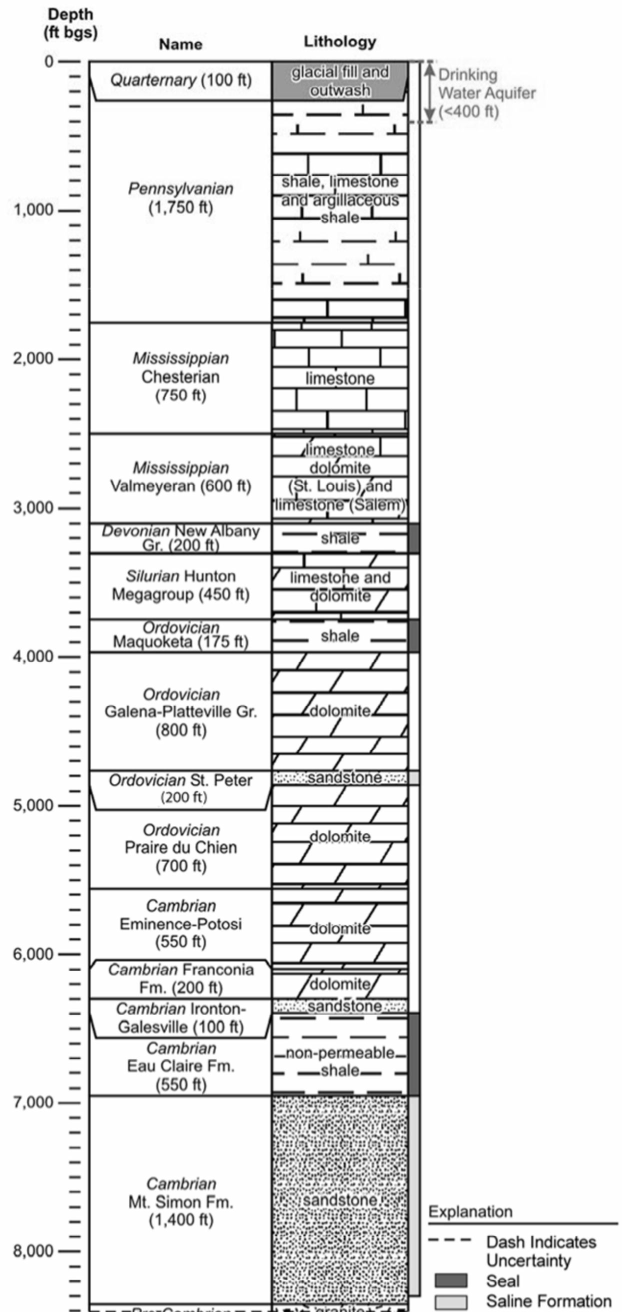
Legend

- Mattoon Sequestration Site
- Existing Wells Penetrating New Albany Shale (Active or Shut-In)
- Existing Wells Penetrating New Albany Shale (Plugged and Abandoned)
- 50-Year plume at 1 MMT/year (1.2-Mile radius)
- City/Town
- Interstate
- Highway
- State/County Road
- Railroad

Figure 4.4-1
Plan View of the Lateral Extent of the Subsurface ROI

0 2 4 MI
0 2 4 KM

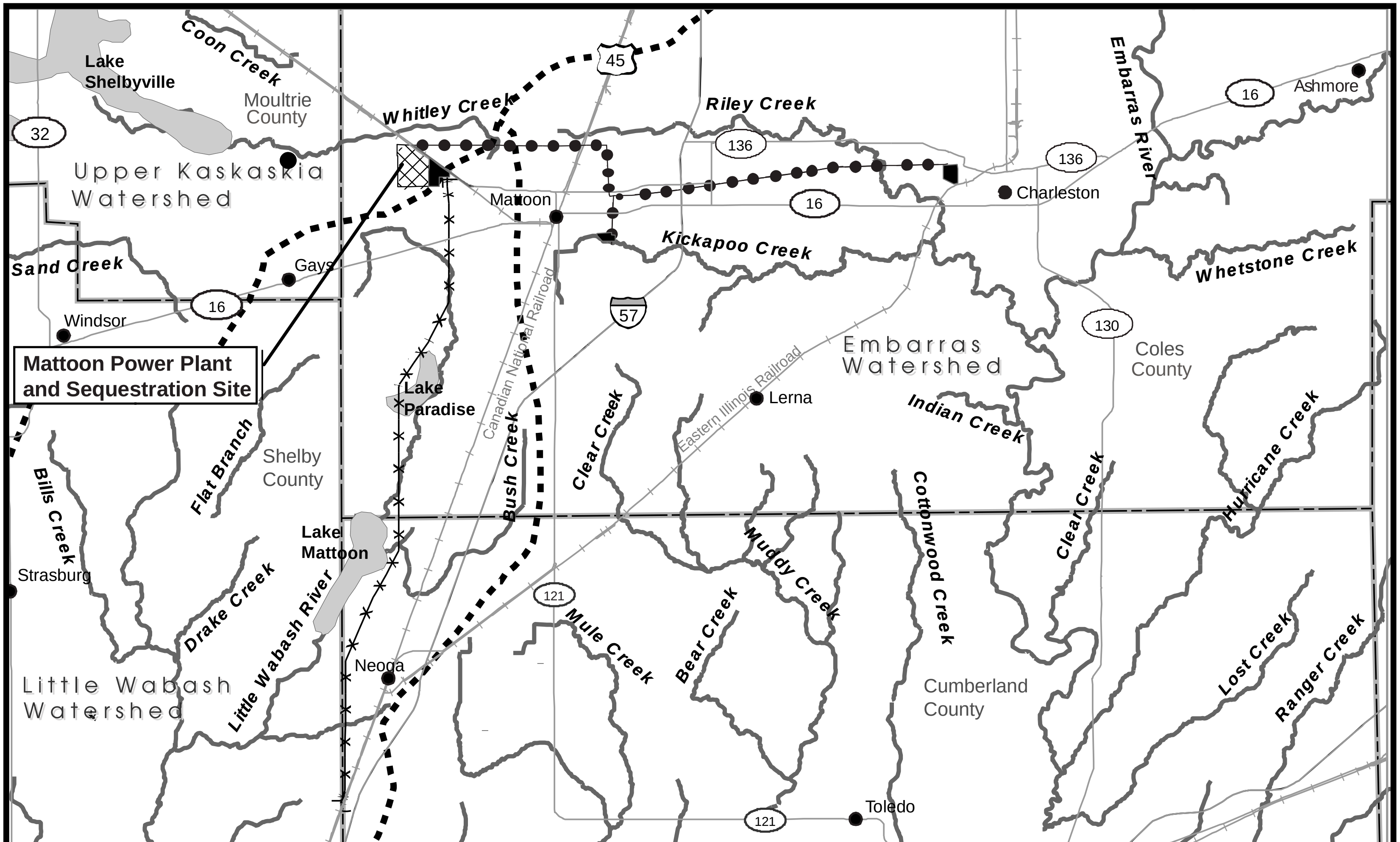
N



ft bgs= feet below ground surface

Source: FG Alliance, 2006a

Figure 4.4-2. Stratigraphy of the Mattoon Injection Area



U.S. Department of Energy
FutureGen Project DEIS
Data Source: FutureGen Alliance, 2006a
Coordinate System: GCS North American, 1927
Datum: North American 1927

Legend

- Mattoon Power Plant and Sequestration Site
- City/Town
- County Boundary
- Proposed Process Water
- Proposed HVTL
- Road
- Railroad
- Water Body
- Stream
- Watershed Divide

Figure 4.7-1
Mattoon Surface Water Resources

0 2.5 5 MI
0 2.5 5 KM
N

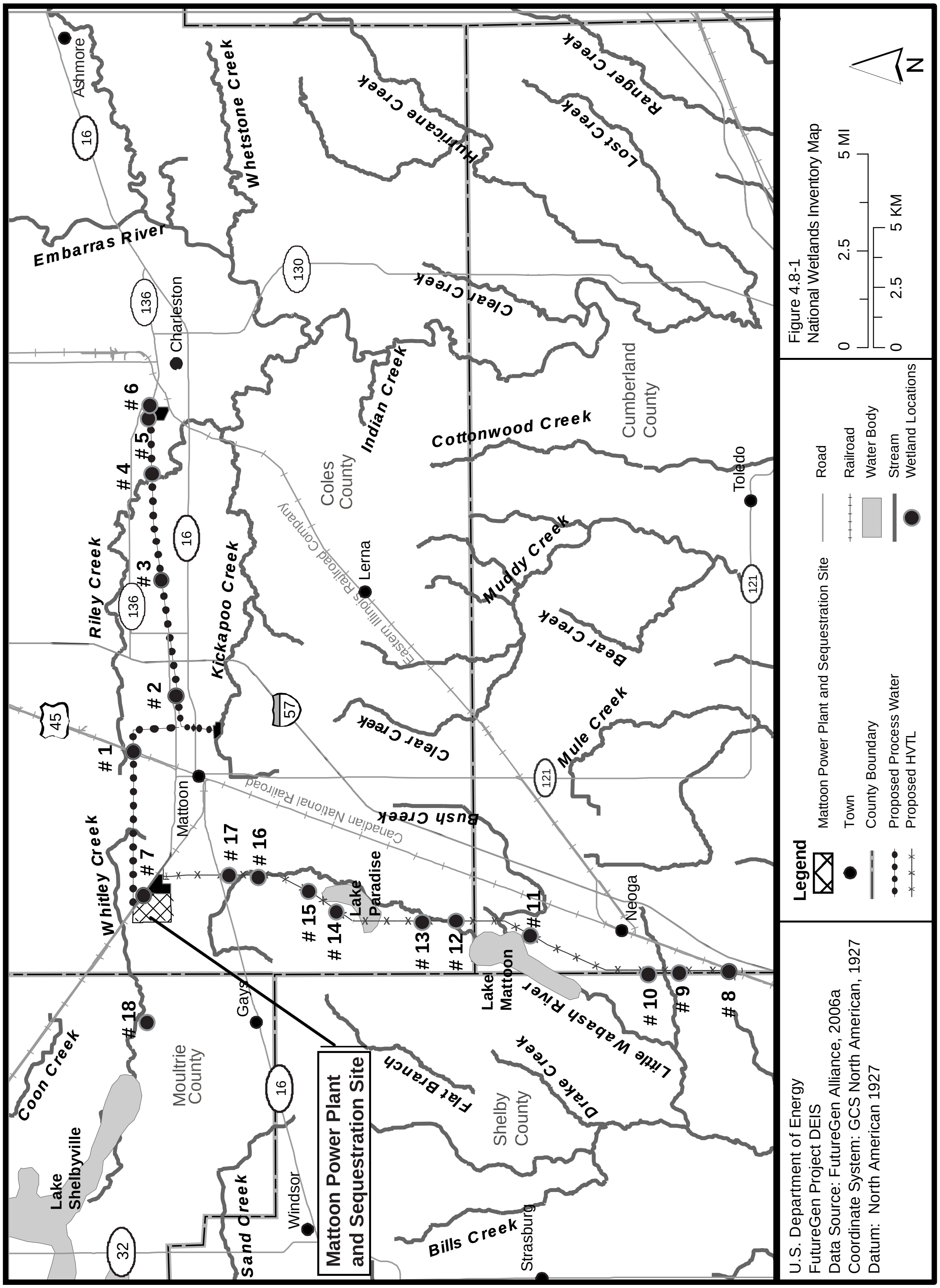


Figure 4.8-1
National Wetlands Inventory Map

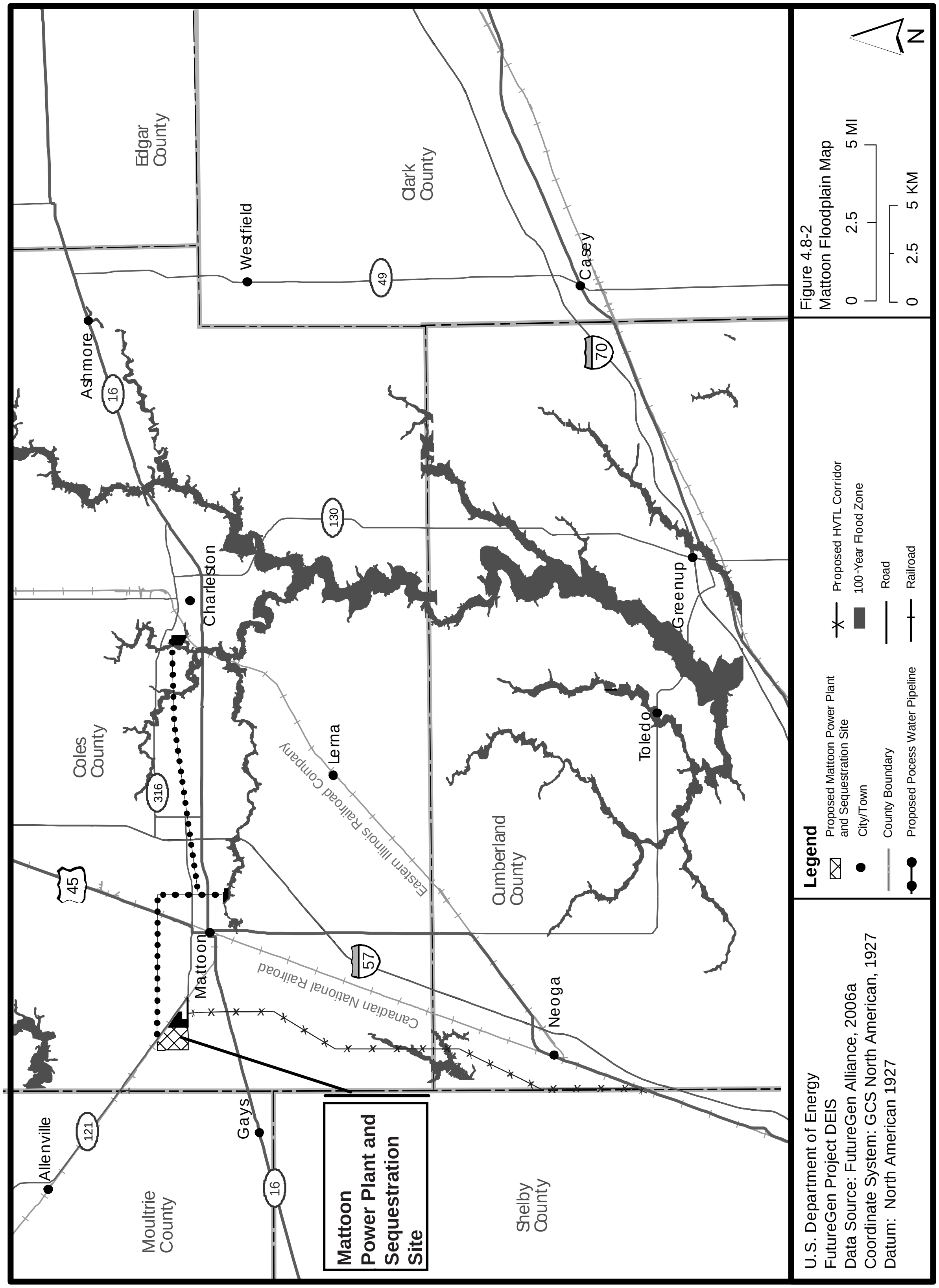


Figure 4.8-2
Mattoon Floodplain Map

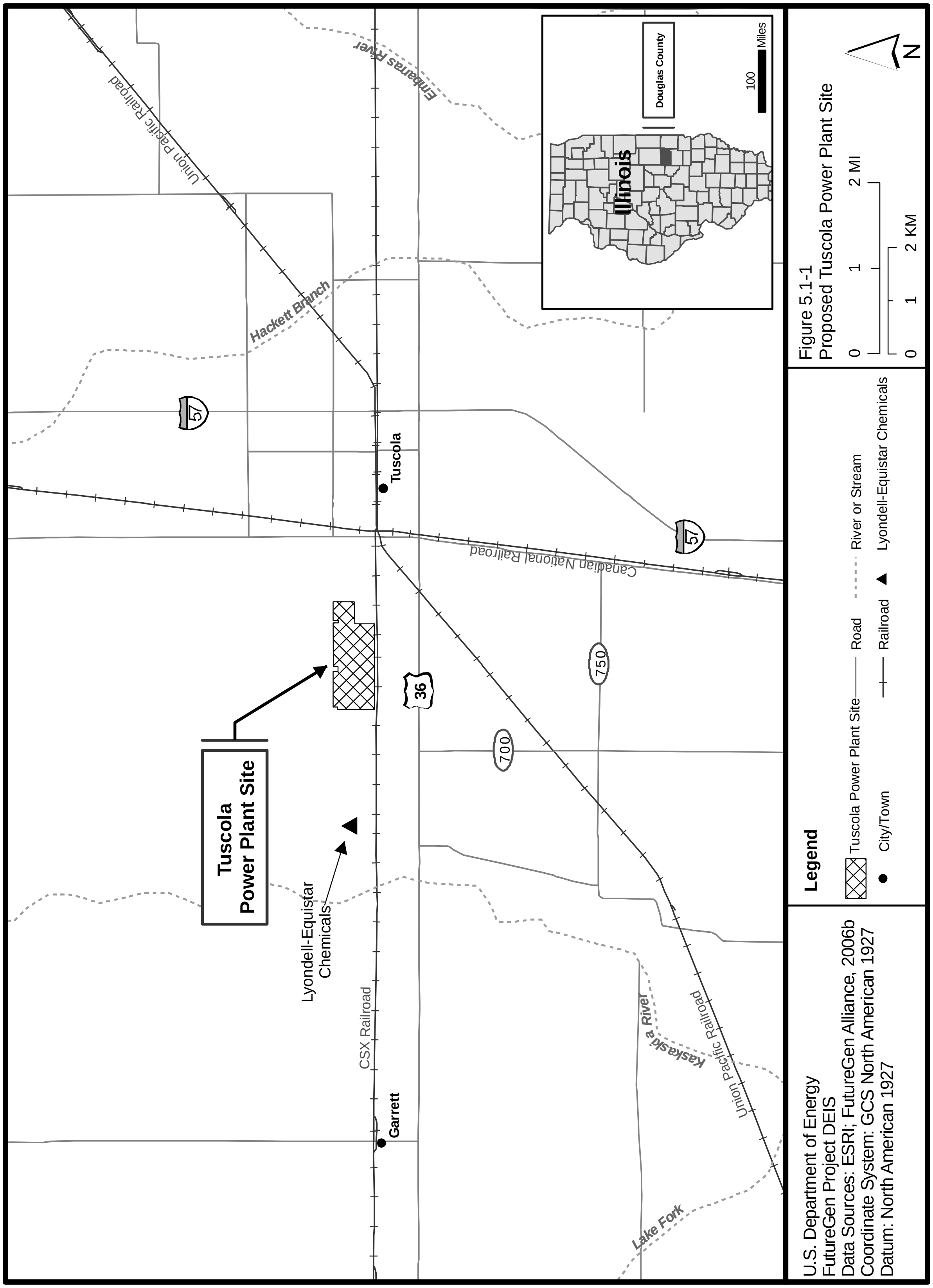


Figure 5.1-1
Proposed Tuscola Power Plant Site

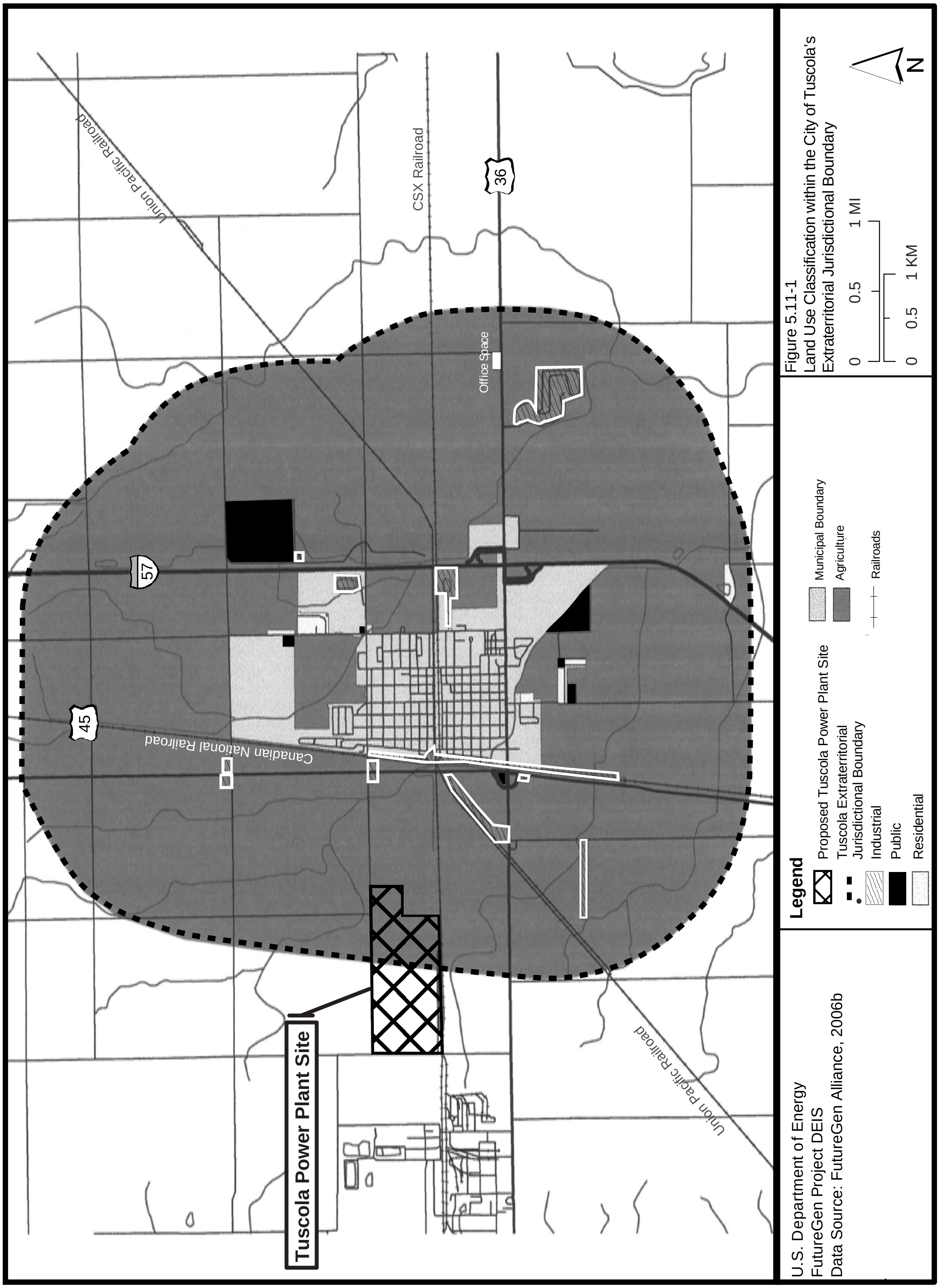
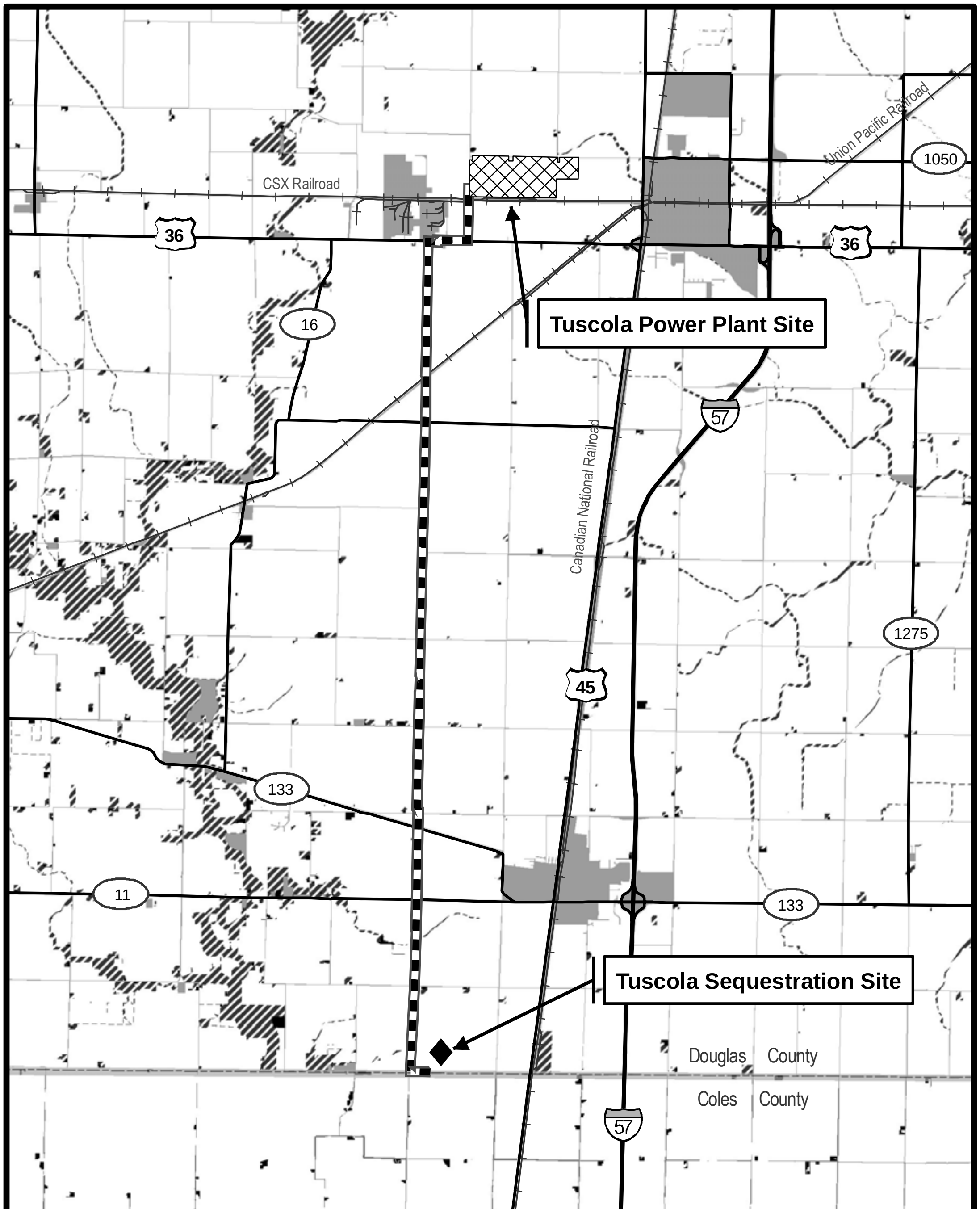


Figure 5.11-1
Land Use Classification within the City of Tuscola's Extraterritorial Jurisdictional Boundary



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: ESRI; FutureGen Alliance, 2006b
Coordinate System: NAD 1983 UTM Zone 16N
Datum: North American

Figure 5.11-2
Land Use Classification for the Proposed Tuscola Power Plant Site, CO_2 Corridor and Proposed Sequestration Site

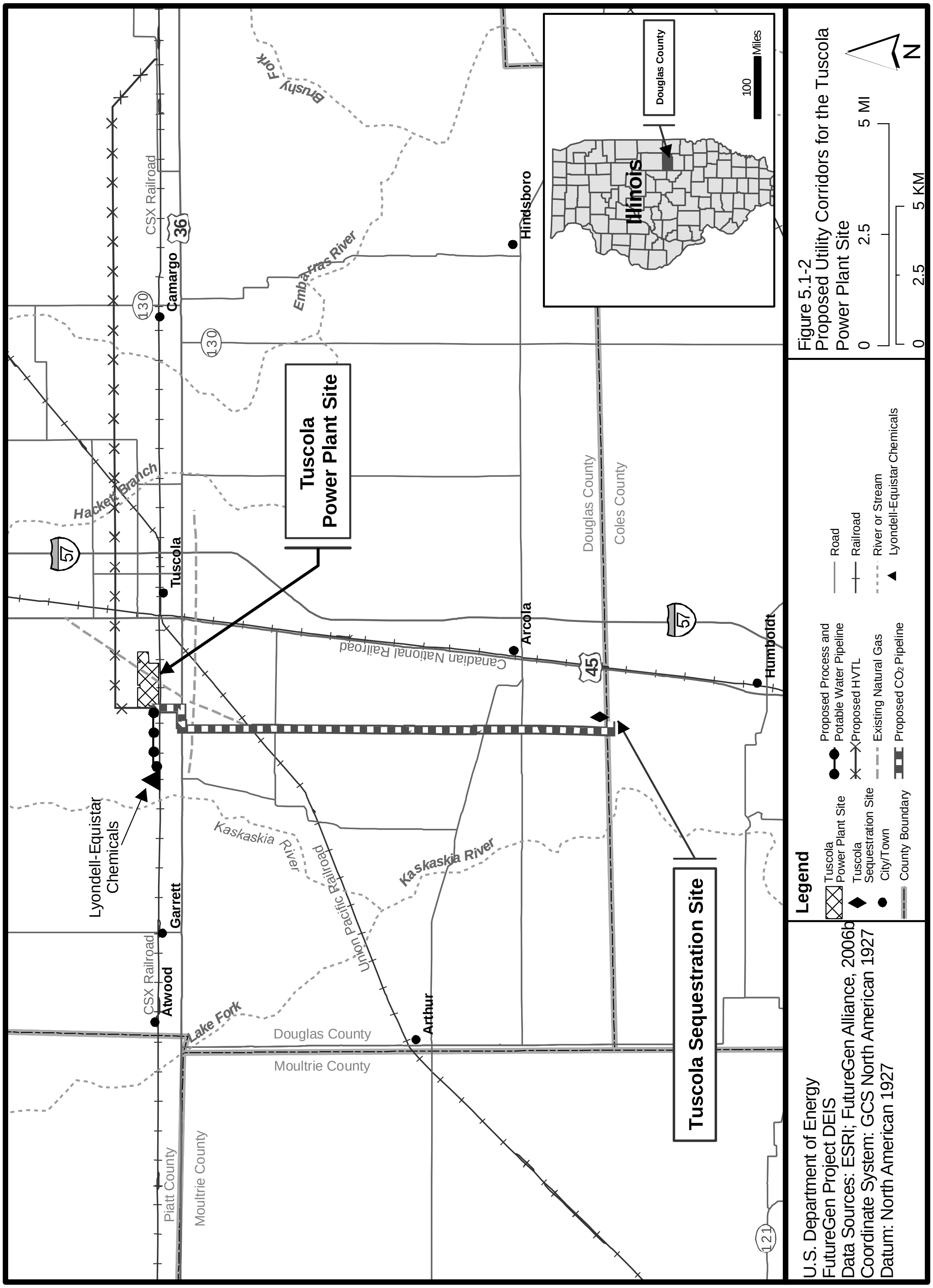


Figure 5.1-2
Proposed Utility Corridors for the Tuscola Power Plant Site

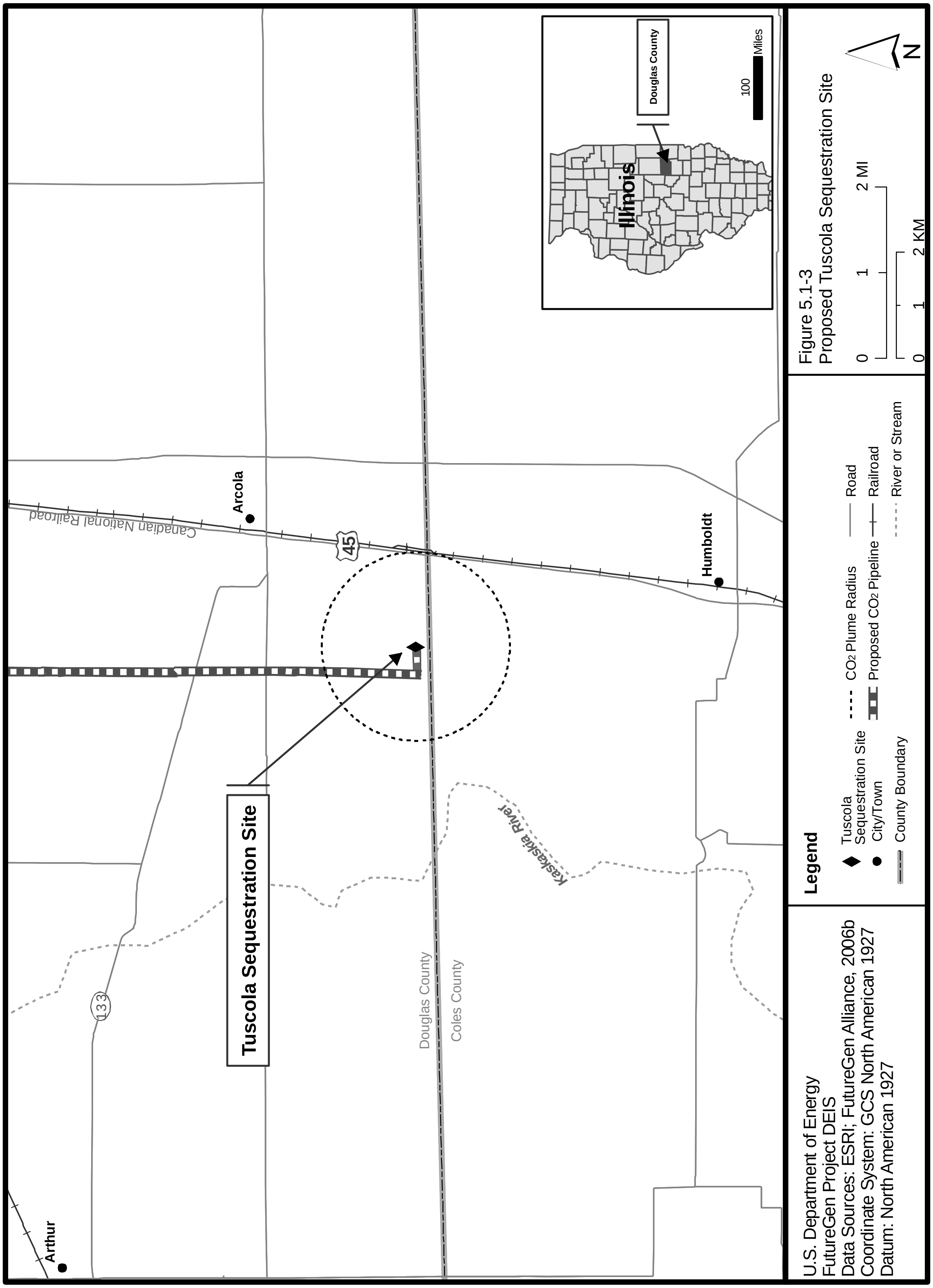


Figure 5.1-3
Proposed Tuscola Sequestration Site

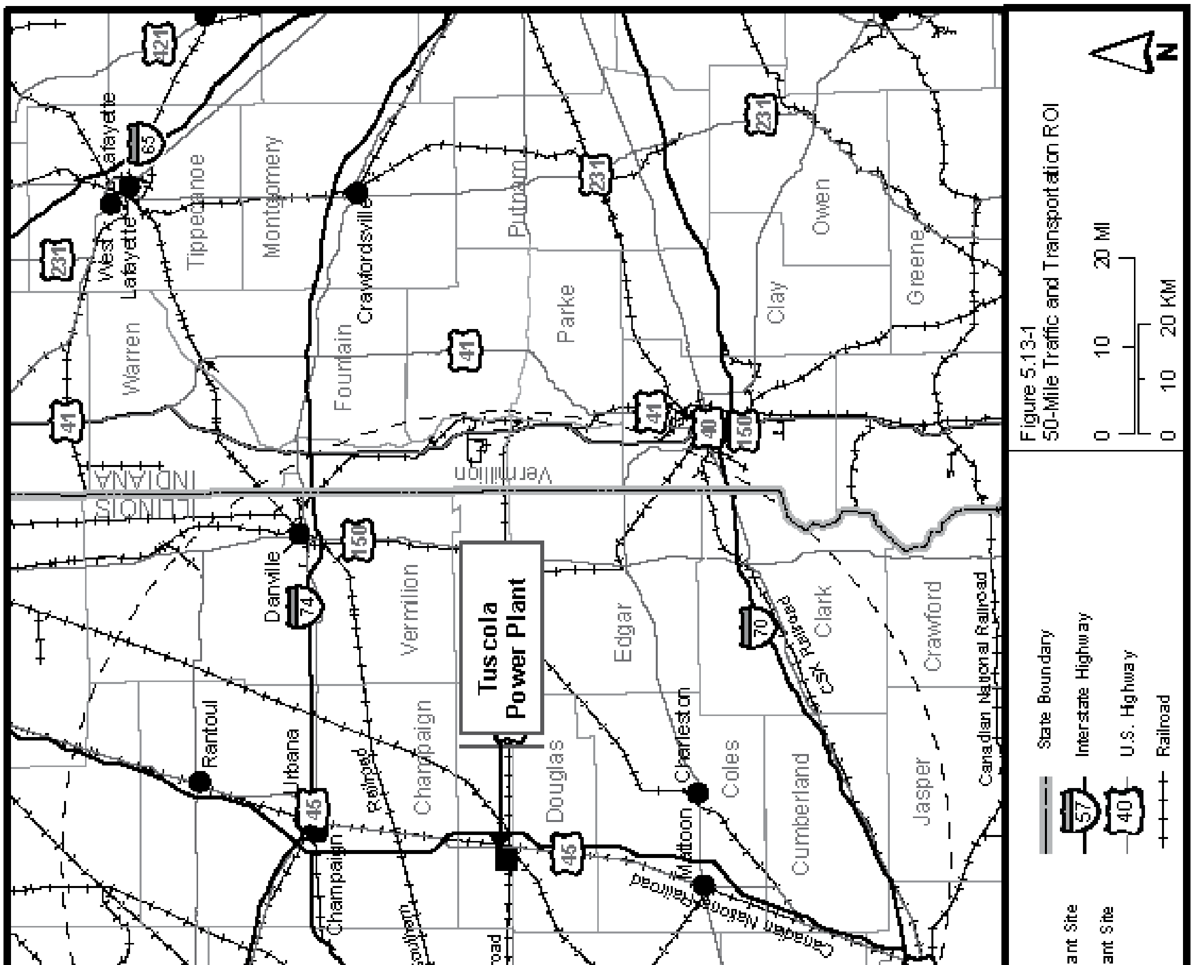


Figure 5.13-1
50-Mile Traffic and Transportation ROI

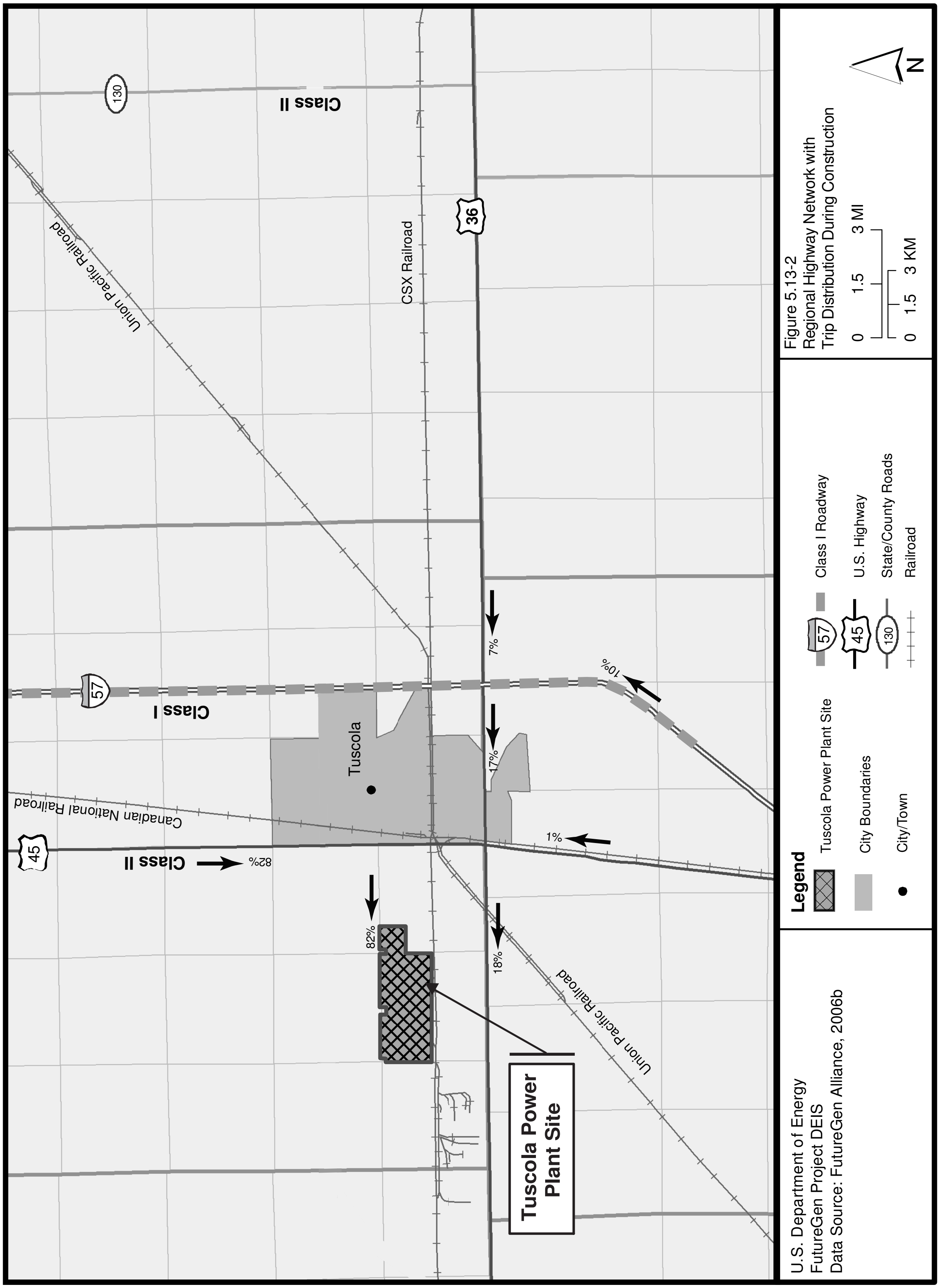


Figure 5.13-2
Regional Highway Network with
Trip Distribution During Construction

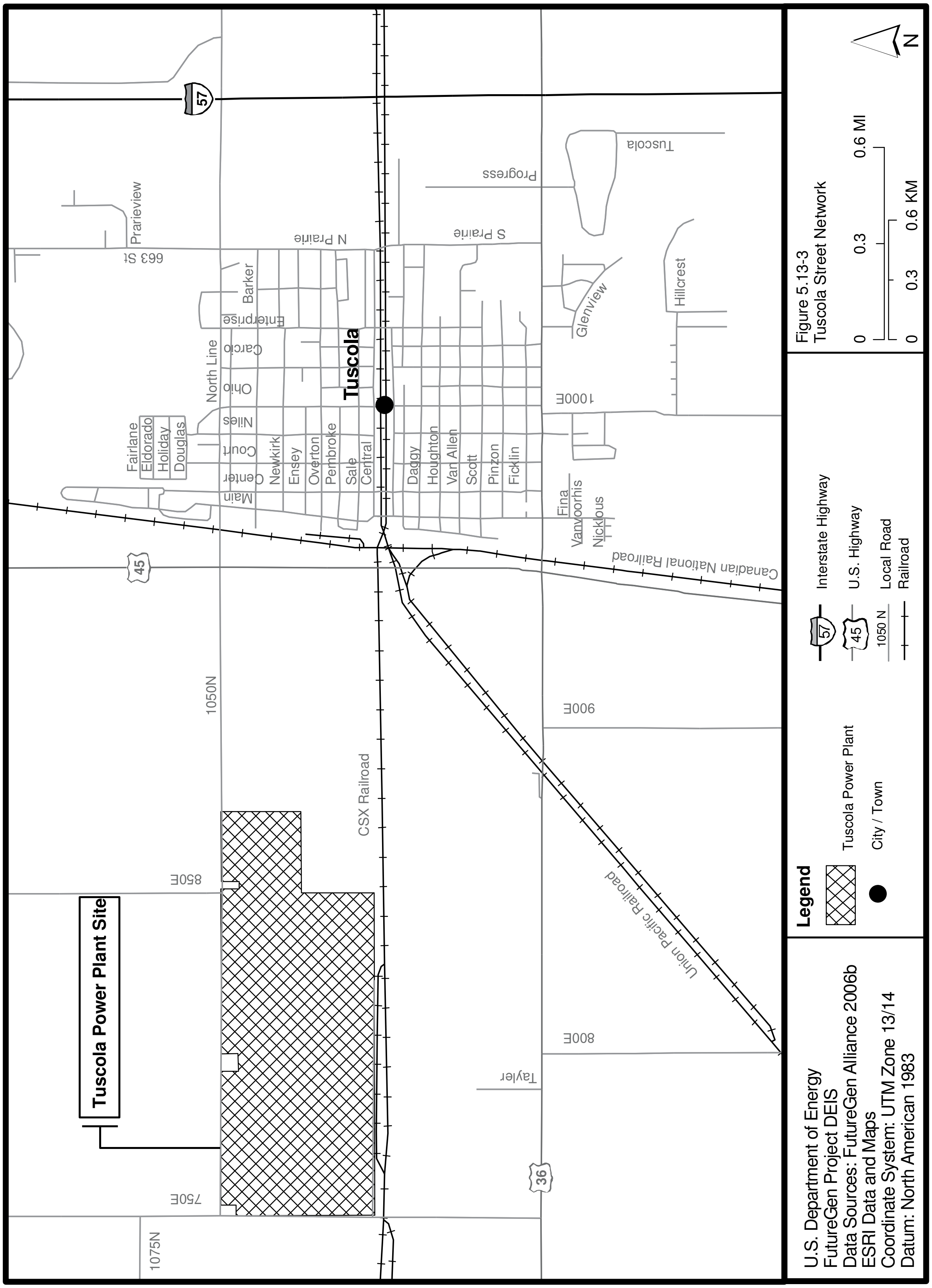
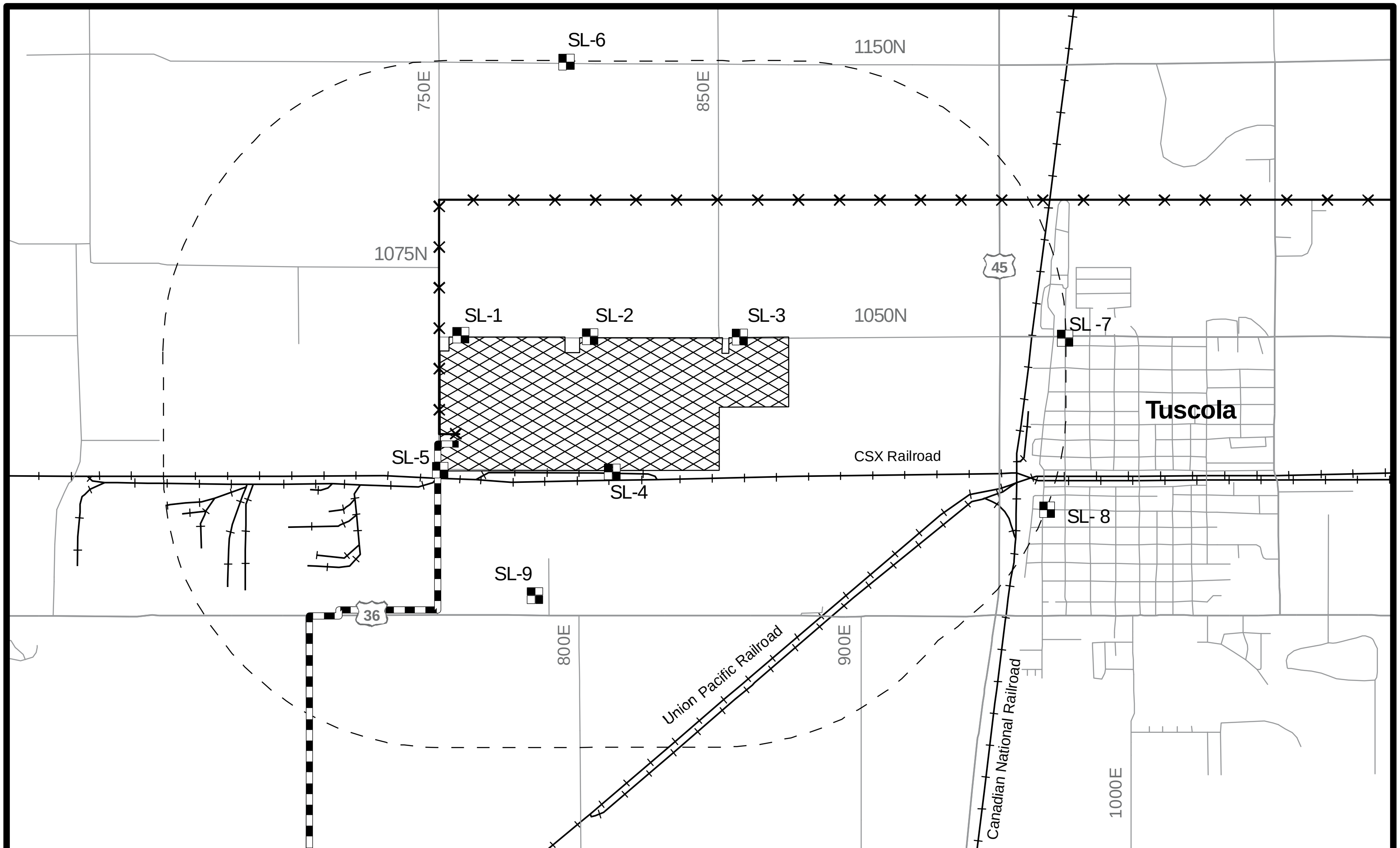


Figure 5.13-3
Tuscola Street Network



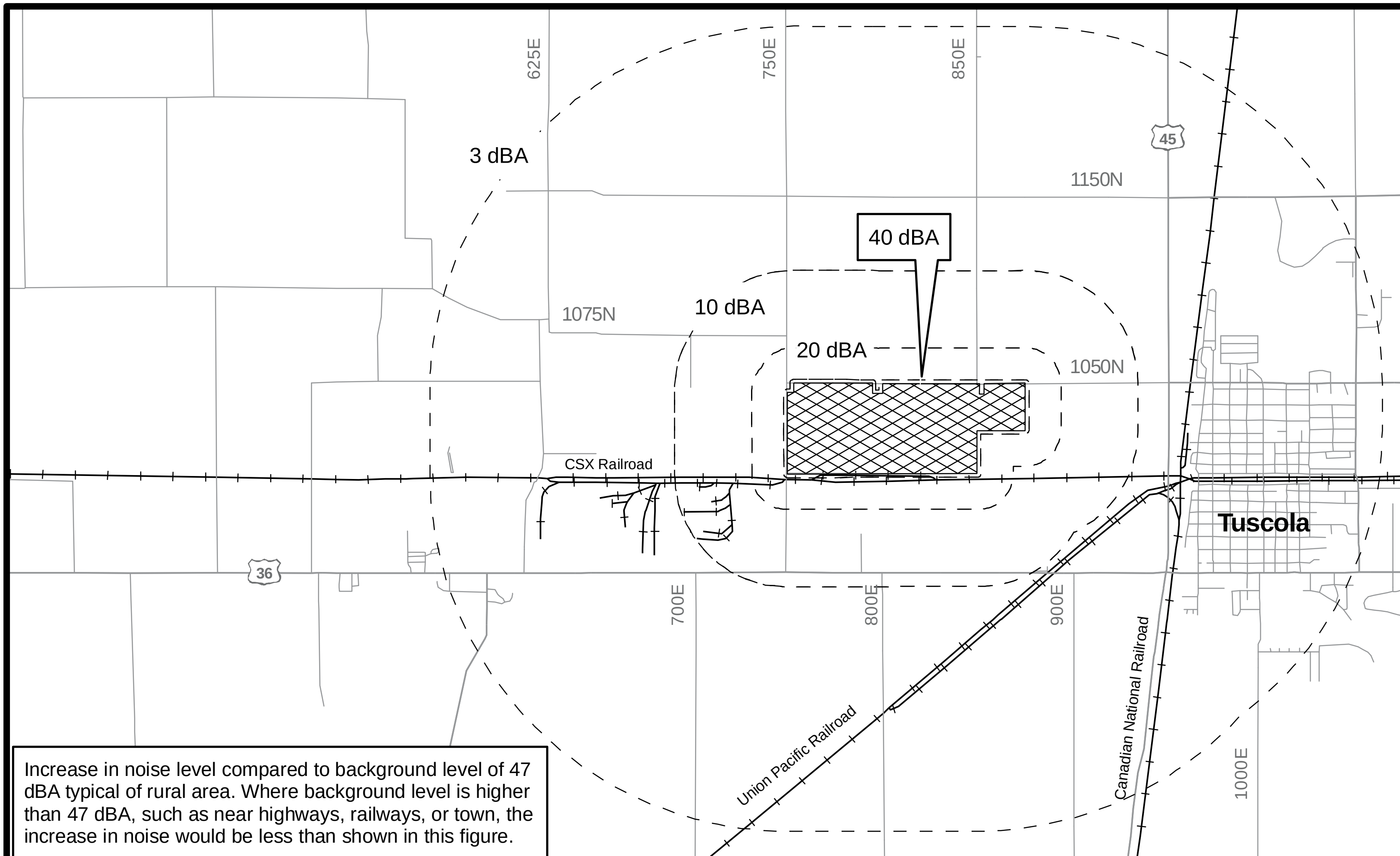
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006b
ESRI Data and Maps
Coordinate System: UTM Zone 16
Datum: North American 1983

Legend

- Tuscola Power Plant Site
- 1-Mile ROI Boundary
- Proposed HVTL
- Proposed CO2 Pipeline
- SL-X Ambient Noise Level Measurement Points
- U.S. Highway
- State / County Road
- Railroad

Figure 5.14-2
Noise Measurement Locations near the Proposed Tuscola Power Plant Site

0 0.4 0.8 MI
0 0.4 0.8 KM
N



Increase in noise level compared to background level of 47 dBA typical of rural area. Where background level is higher than 47 dBA, such as near highways, railways, or town, the increase in noise would be less than shown in this figure.

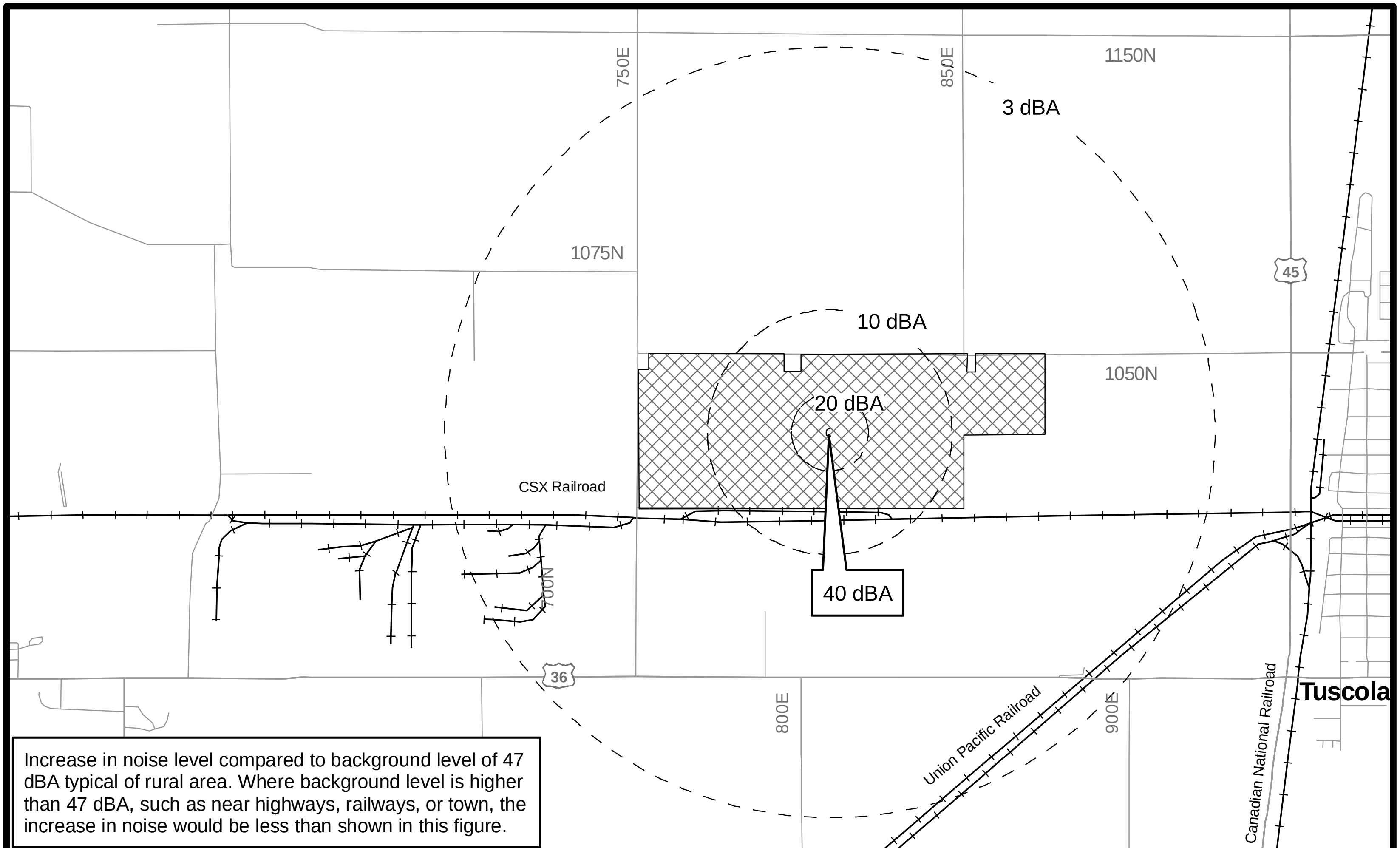
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006b
ESRI Data and Maps
Coordinate System: UTM Zone 16
Datum: North American 1983

Legend

- Tuscola Power Plant Site
- Increase in noise level compared to background level of 47 dBA typical of rural area
- U.S.Highway
- State / County Road
- Railroad

Figure 5.14-3
Change in Noise Level During Construction at the Proposed Tuscola Power Plant Site

0 0.5 1 MI
0 0.5 1 KM
N



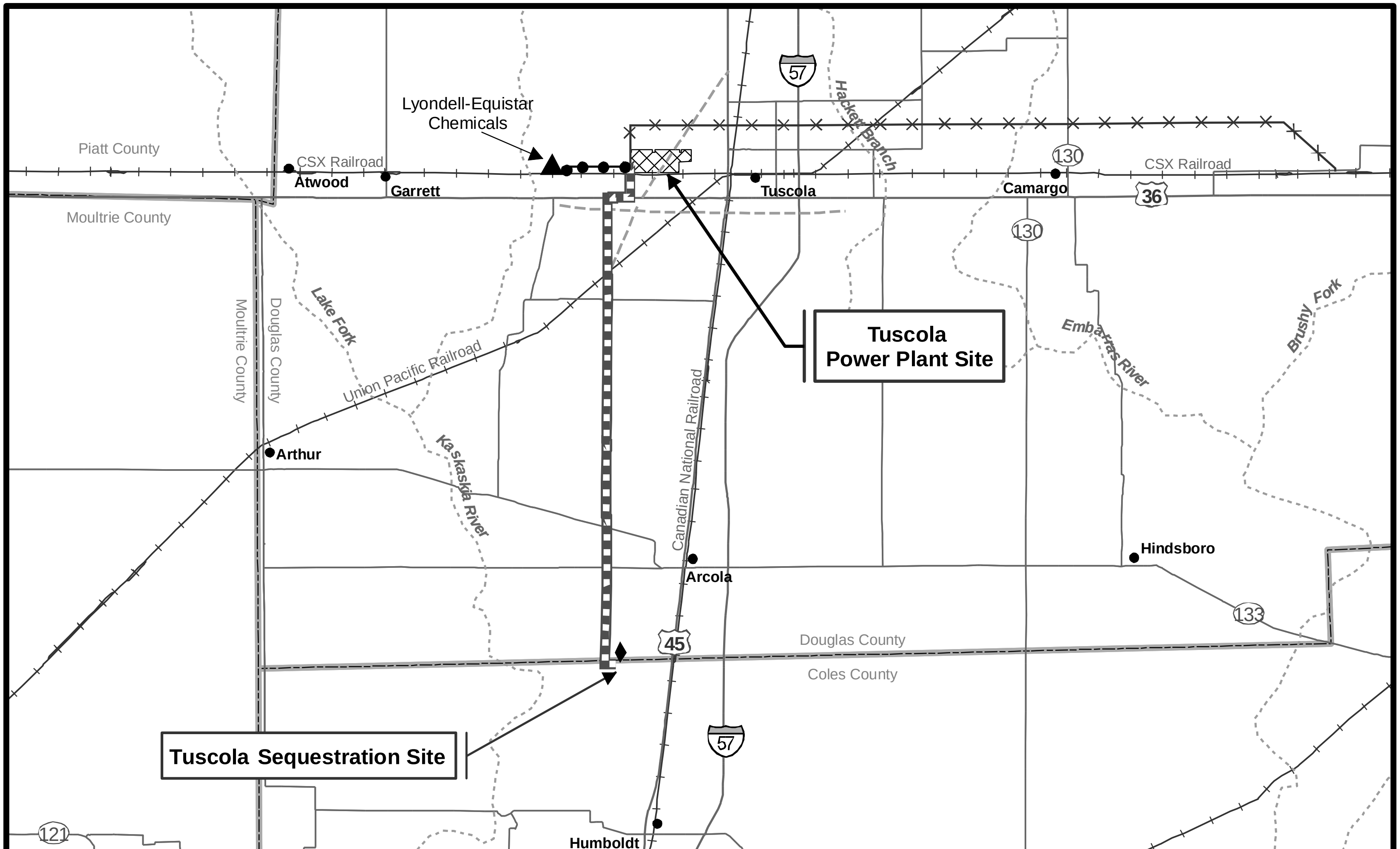
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006b
ESRI Data and Maps
Coordinate System: UTM Zone 16
Datum: North American 1983

Legend

Tuscola Power Plant Site
Increase in noise level compared to background level of 47 dBA typical of rural area
U.S. Highway
State / County Road
Railroad

Figure 5.14-4
Change in Noise Level During Operation at the Proposed Tuscola Power Plant Site

0 0.3 0.6 MI
0 0.3 0.6 KM
N



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: ESRI; FutureGen Alliance, 2006b
Coordinate System: GCS North American 1927
Datum: North American 1927

Legend

- Tuscola Power Plant Site
- Tuscola Sequestration Site
- City/Town
- County Boundary
- Proposed Process and Potable Water Pipeline
- Proposed HVTL
- Existing Natural Gas
- Proposed CO_2 Pipeline
- Road
- Railroad
- River or Stream
- Lyondell-Equistar Chemicals

Figure 5.15-1
Proposed Utility Corridors

0 2.5 5 MI
0 2.5 5 KM
N

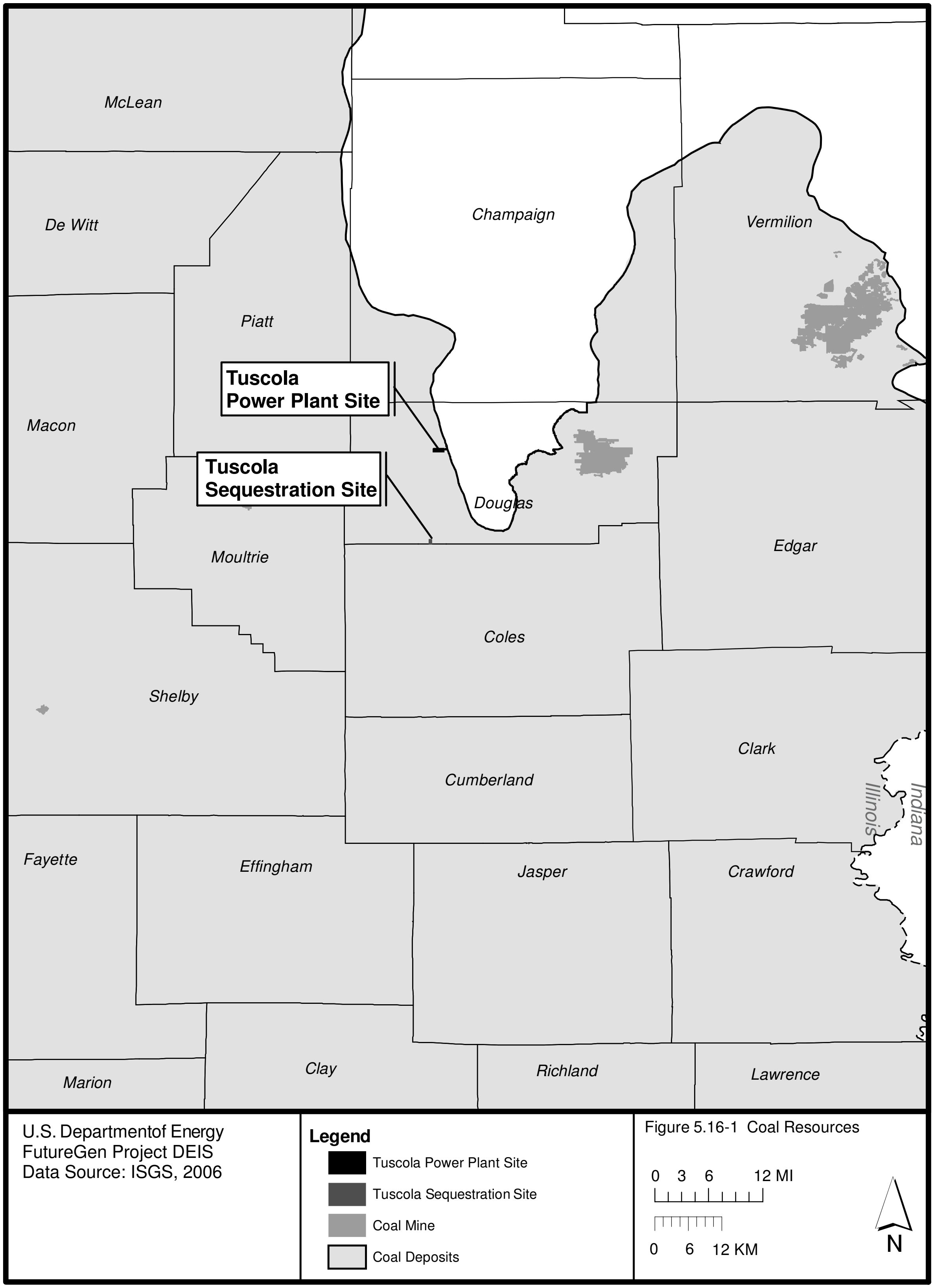
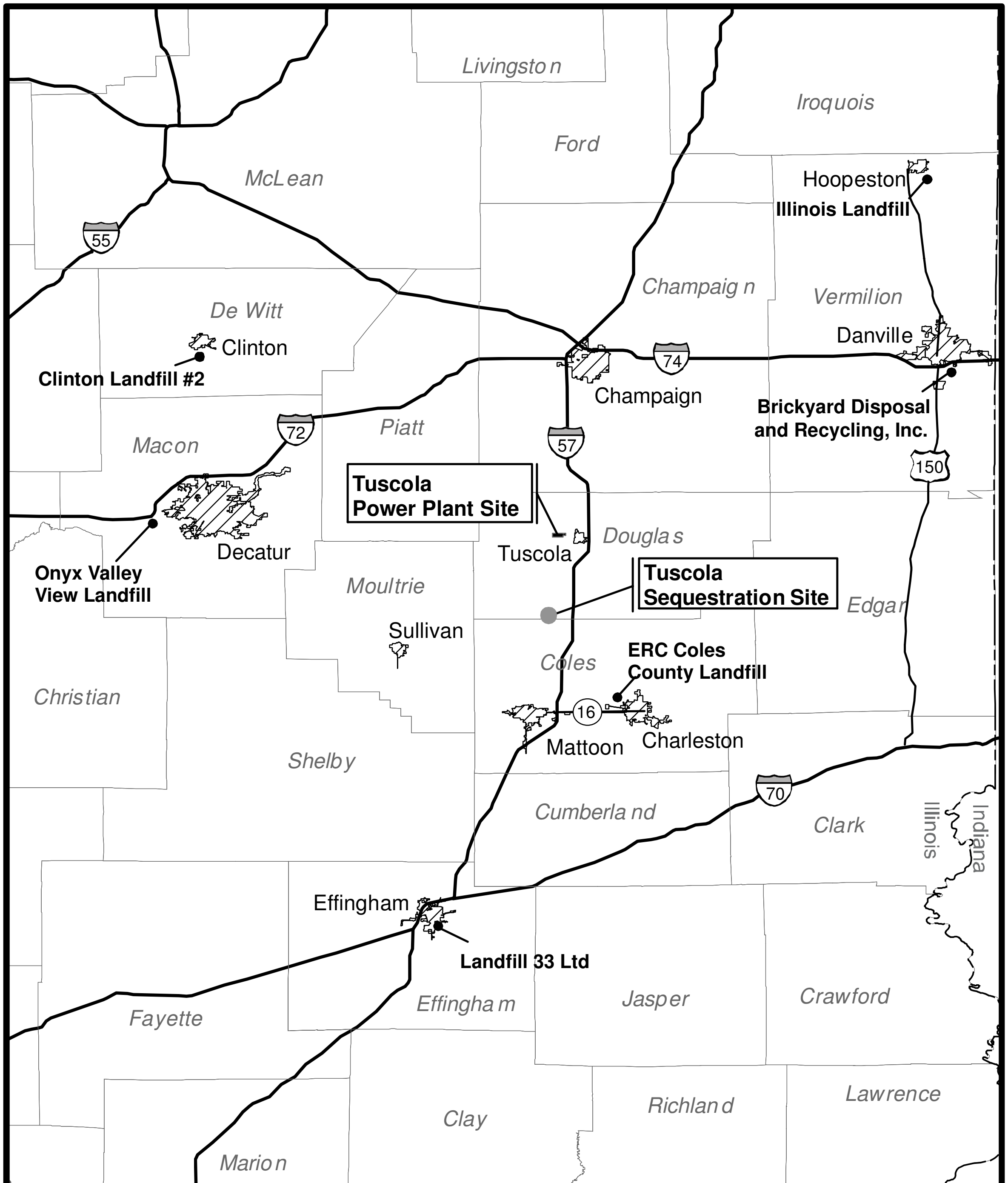


Figure 5.16-1 Coal Resources



U.S. Department of Energy
FutureGen Project DEIS
Source: FutureGen Alliance, 2006b

Legend

- ■ Tuscola Power Plant Site
- ● (grey) Tuscola Sequestration Site
- ● Waste Management Facility
- City Boundaries
- County Boundary
- State Boundary

0 5 10 20 MI
0 5 10 20 KM
N

Figure 5.16-2
Waste Management Facilities

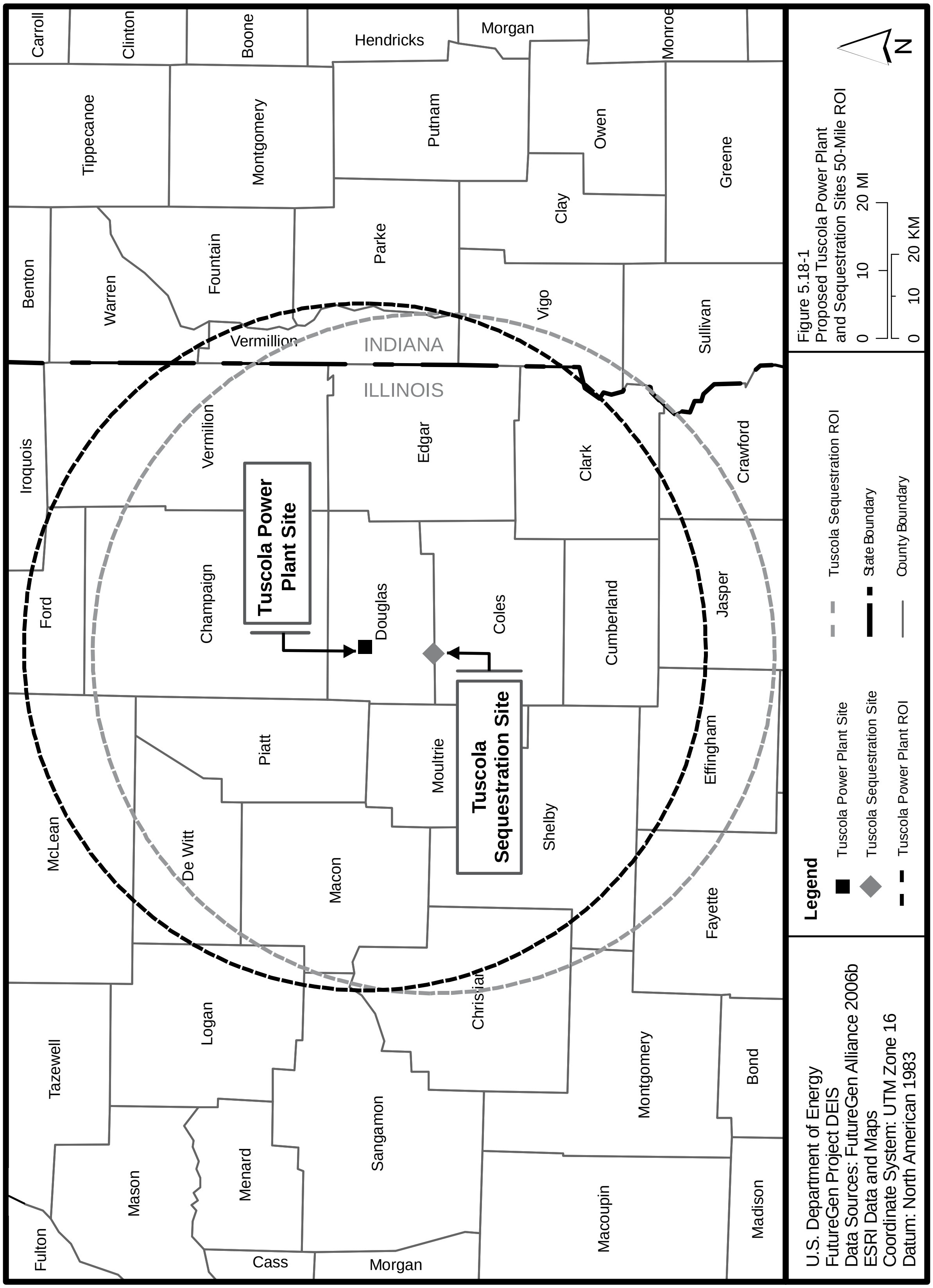


Figure 5.18-1
Proposed Tuscola Power Plant and Sequestration Sites 50-Mile ROI

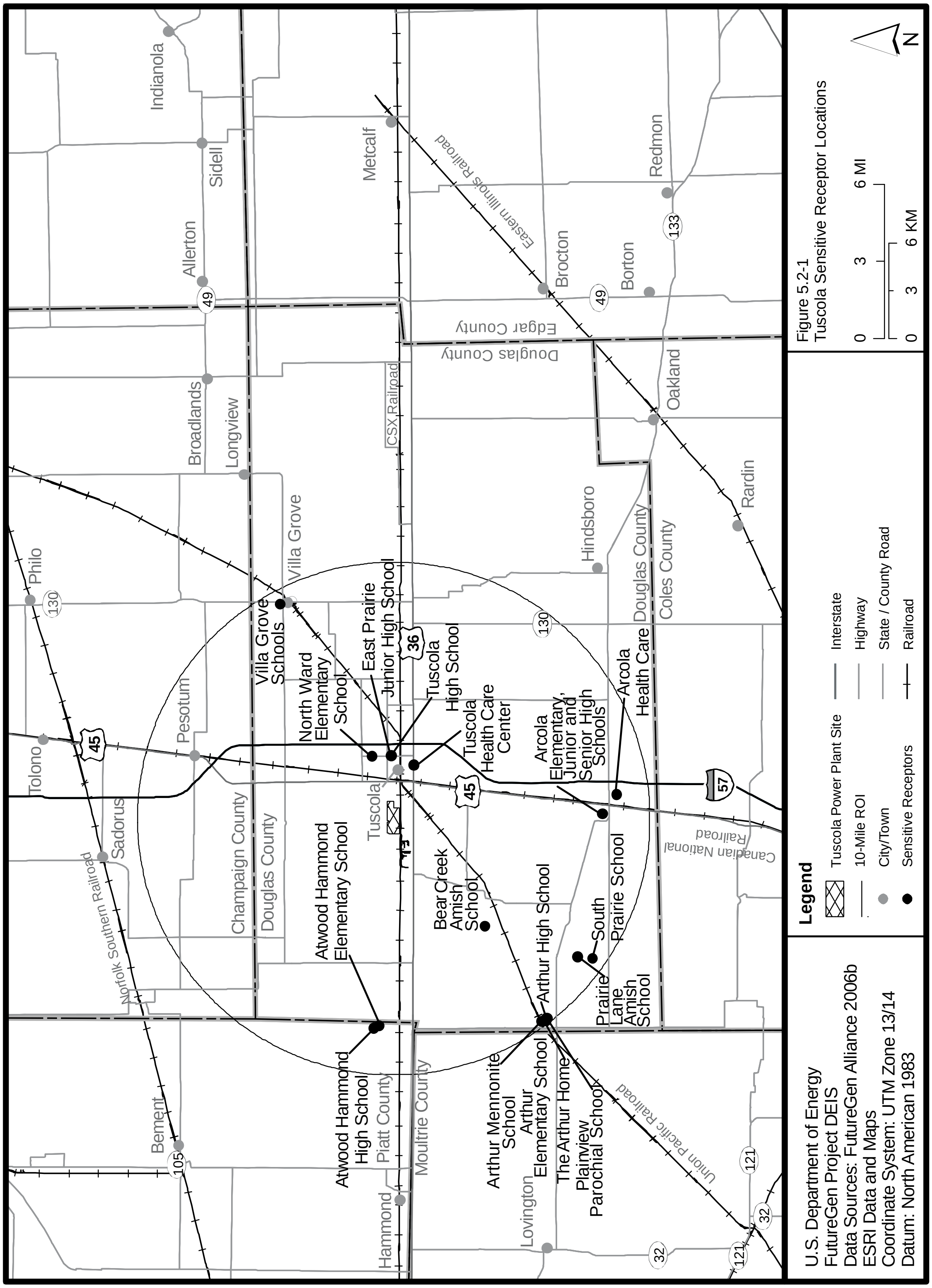


Figure 5.2-1
Tuscola Sensitive Receptor Locations

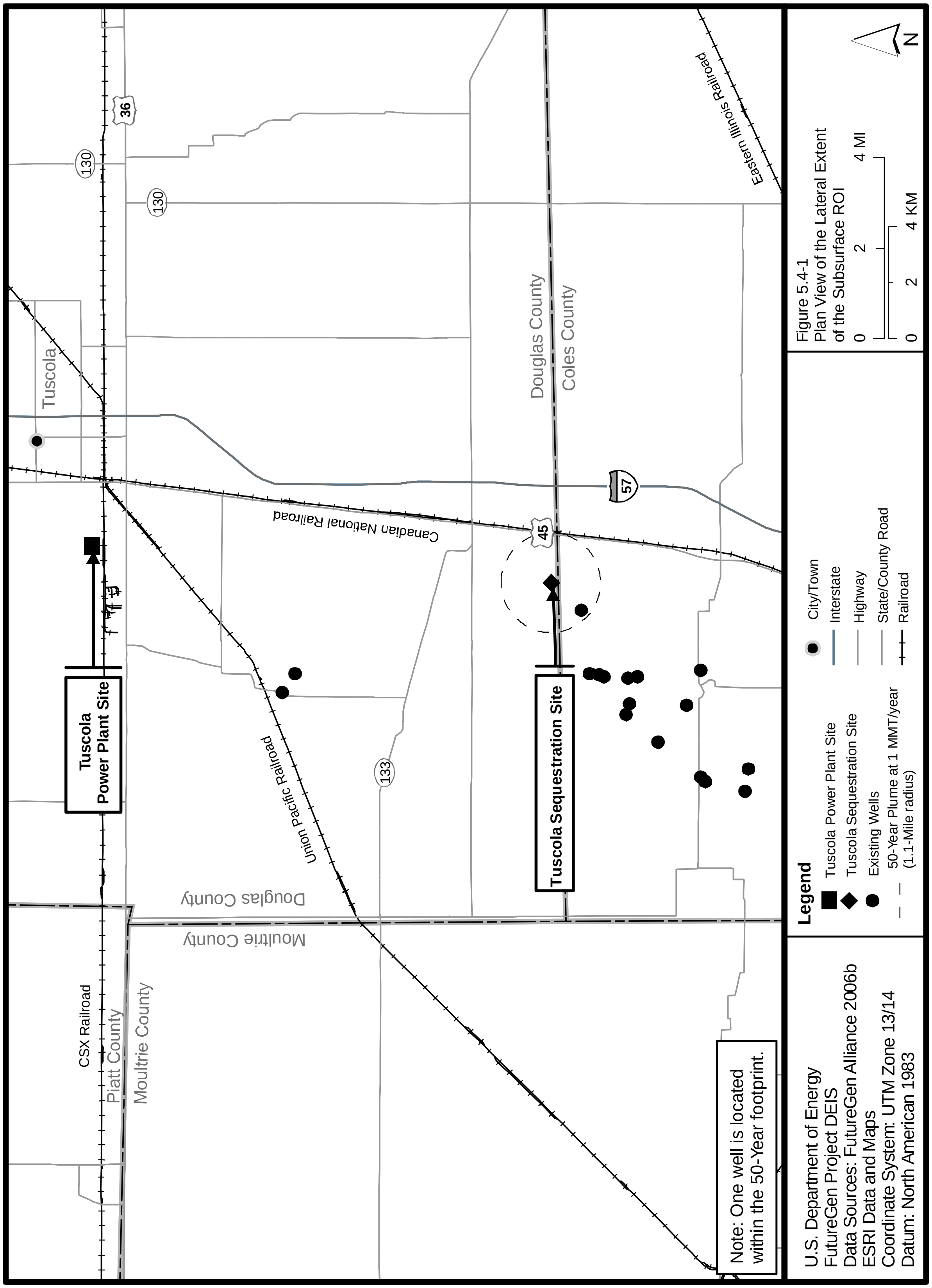


Figure 5.4-1
Plan View of the Lateral Extent of the Subsurface ROI

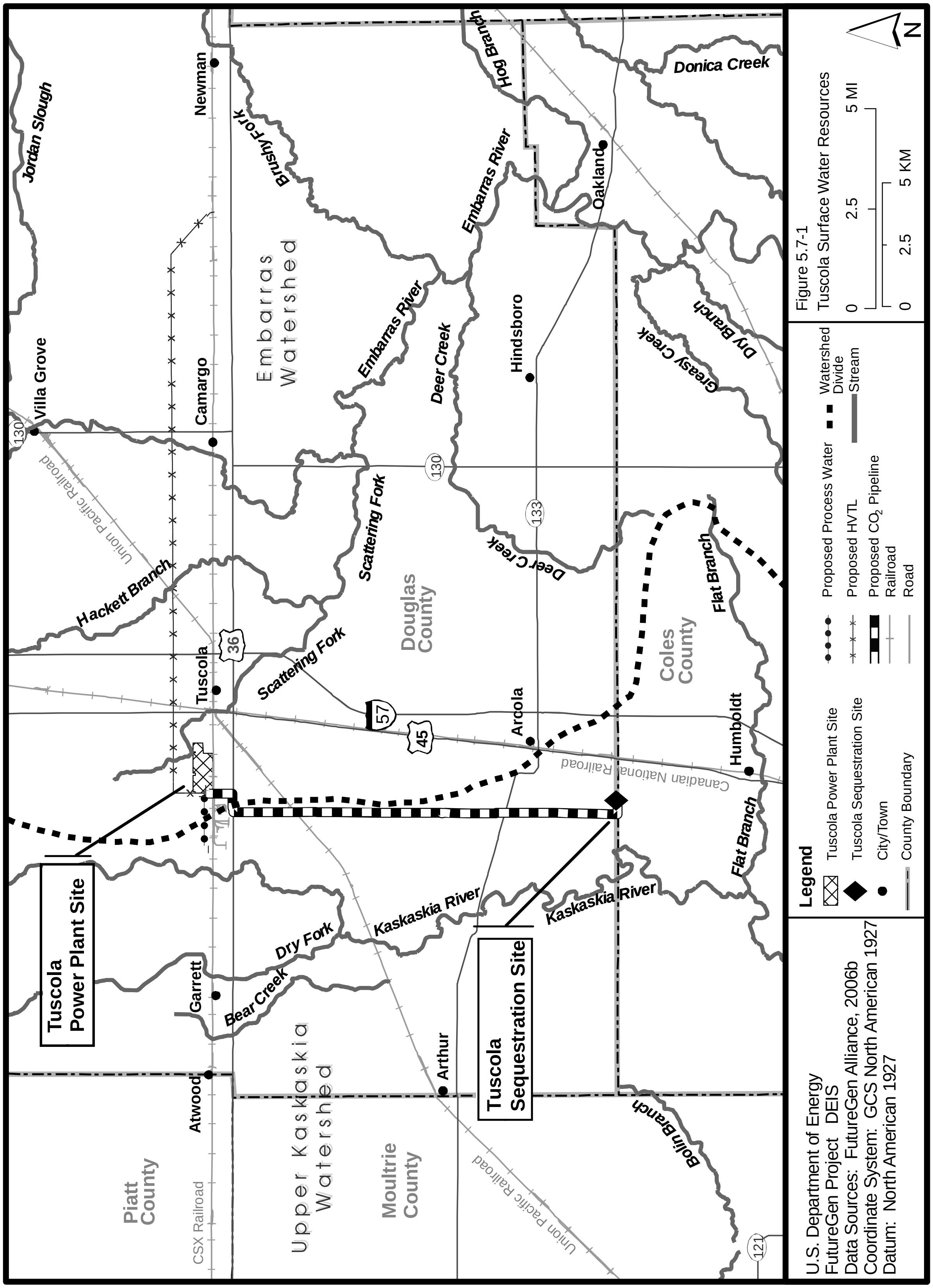


Figure 5.7-1
Tuscola Surface Water Resources

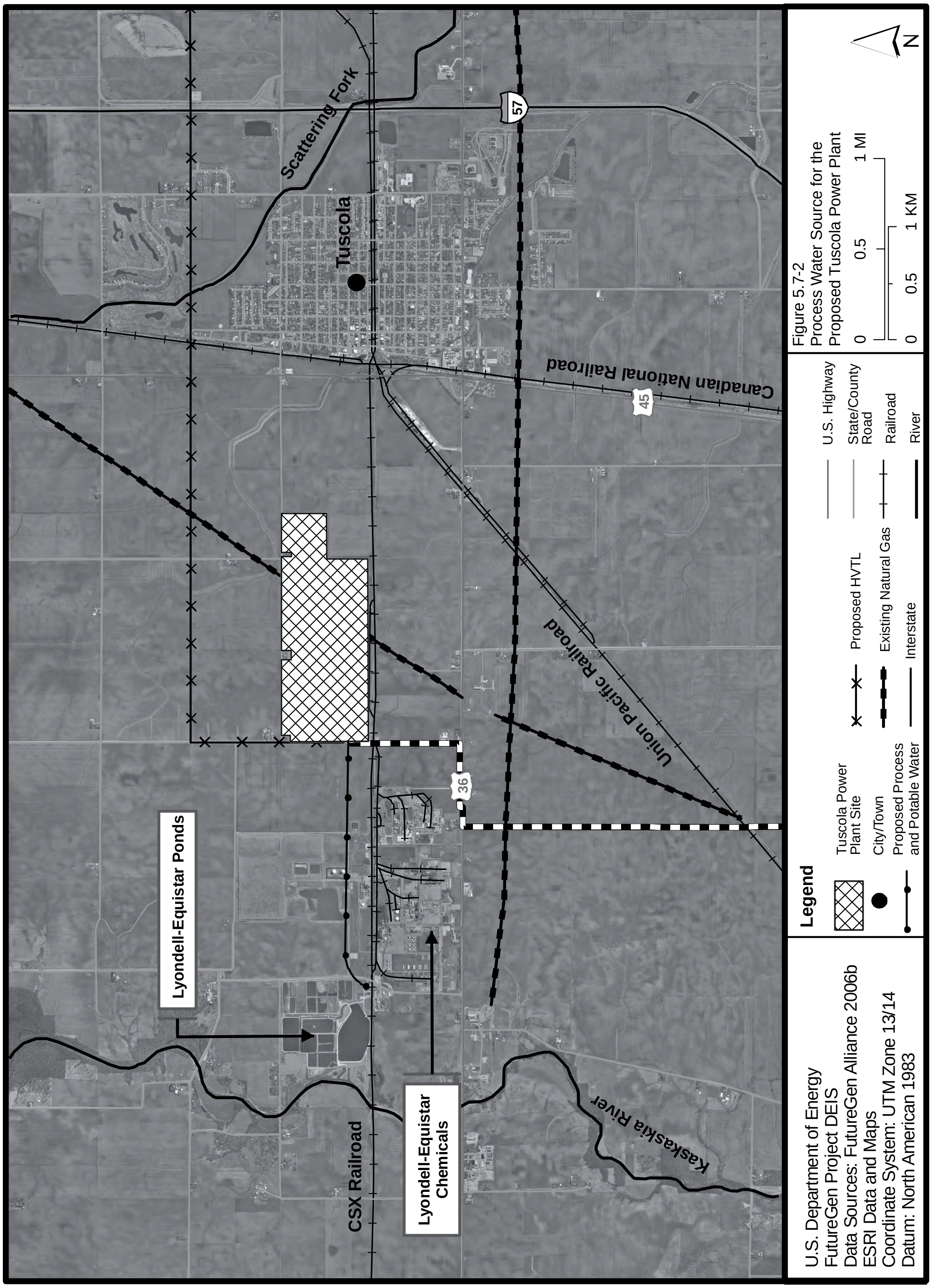


Figure 5.7-2
Process Water Source for the Proposed Tuscola Power Plant

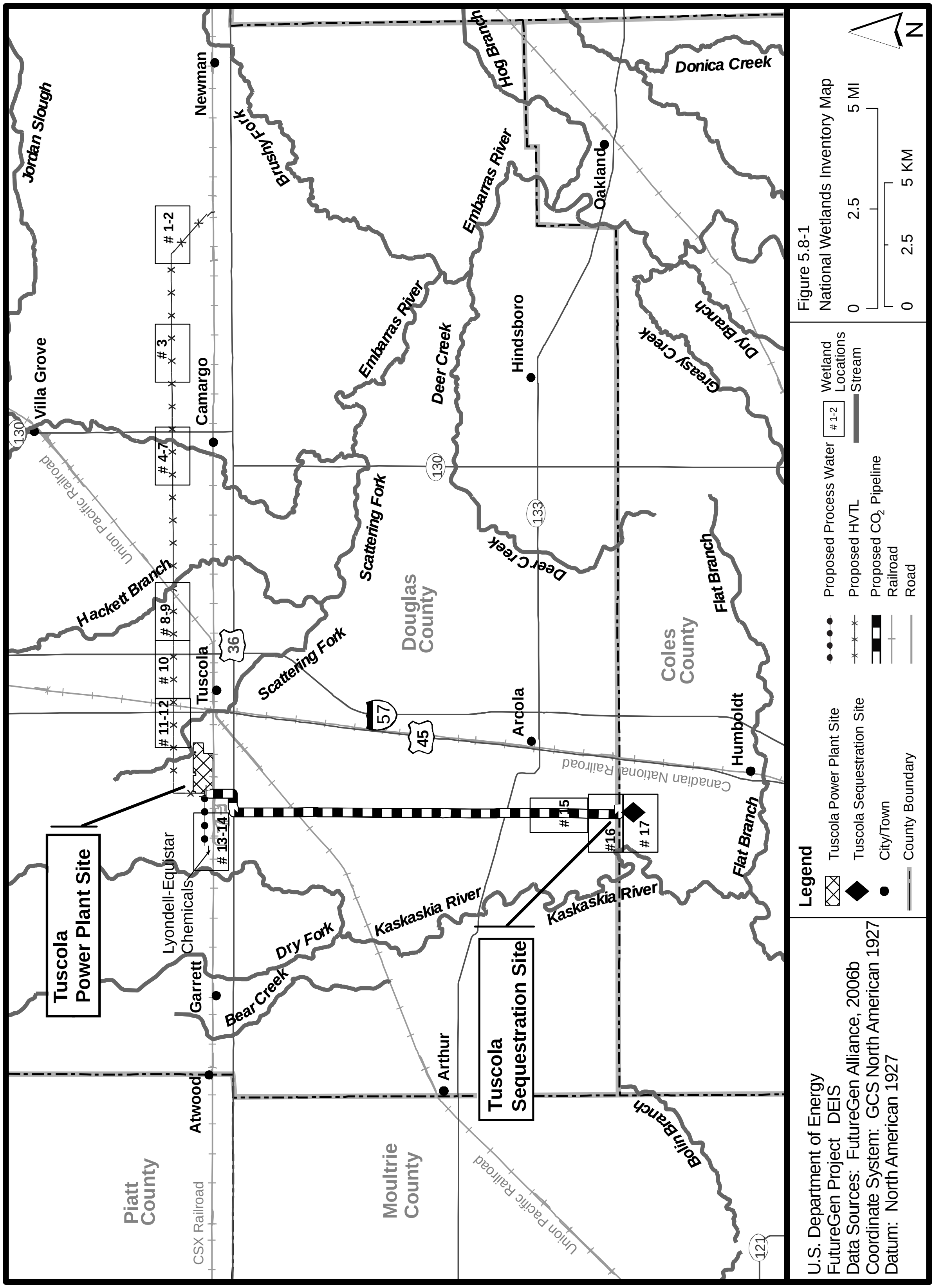


Figure 5.8-1
National Wetlands Inventory Map
0 2.5 5 MI
0 2.5 5 KM
N
Legend
Tuscola Power Plant Site
Tuscola Sequestration Site
City/Town
County Boundary
Proposed Process Water
Proposed HVTL
Proposed CO2 Pipeline
Railroad
Road
Wetland Locations
Stream
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance, 2006b
Coordinate System: GCS North American 1927
Datum: North American 1927
Tuscola Power Plant Site
Tuscola Sequestration Site
Lyondell-Equistar Chemicals
Douglas County
Coles County
Piatt County
Moultrie County
Tuscola
Newman
Villa Grove
Camargo
Hindsboro
Oakland
Ardola
Humboldt
Garrett
Atwood
Arthur
Jordan Slough
Brushy Fork
Embarras River
Deer Creek
Hog Branch
Donica Creek
Dry Branch
Greasy Creek
Scattering Fork
Hackett Branch
Flat Branch
Kaskaskia River
Dry Fork
Bear Creek
Bolin Branch
Union Pacific Railroad
Canadian National Railroad
CSX Railroad

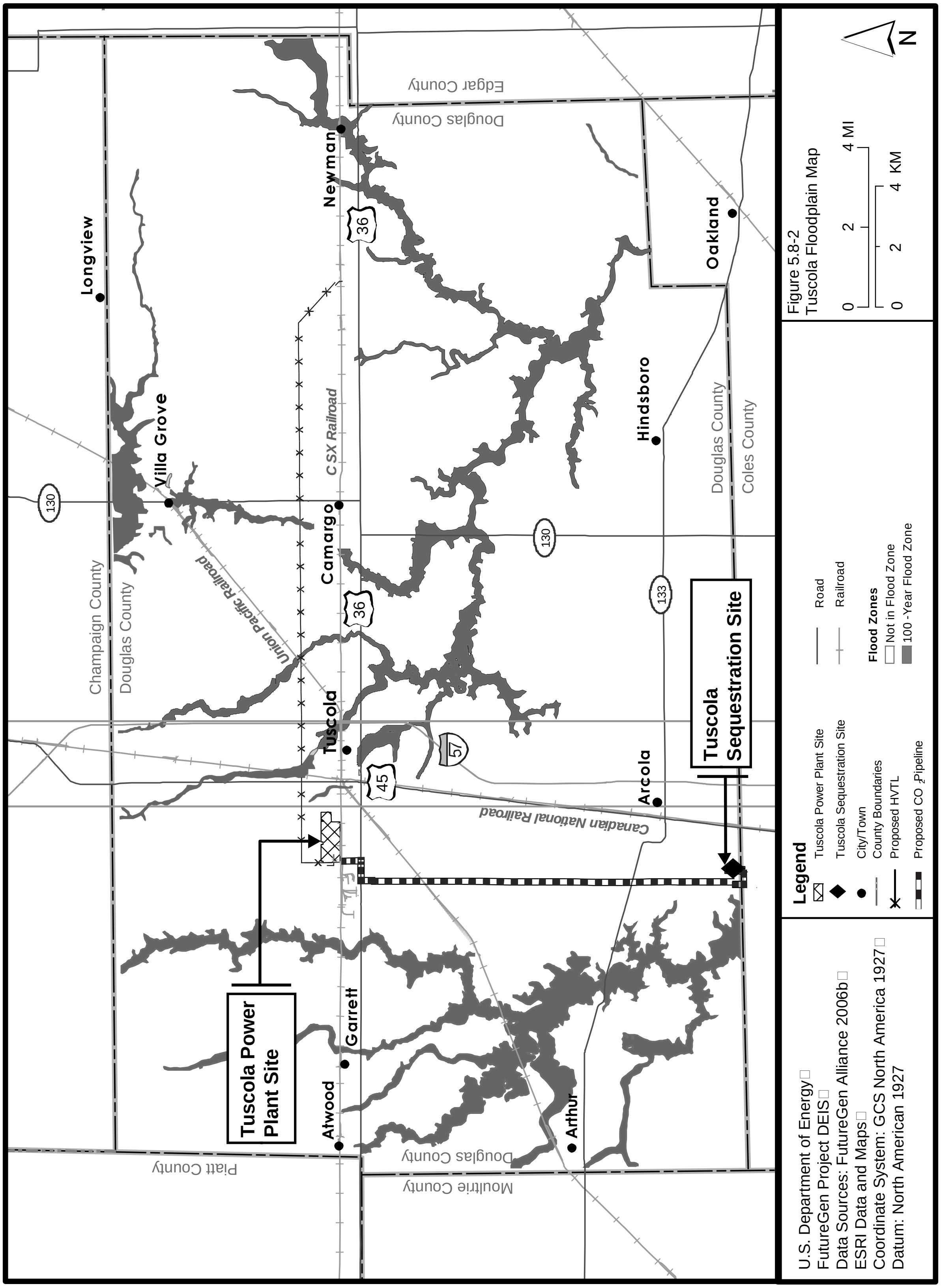


Figure 5.8-2
Tuscola Floodplain Map

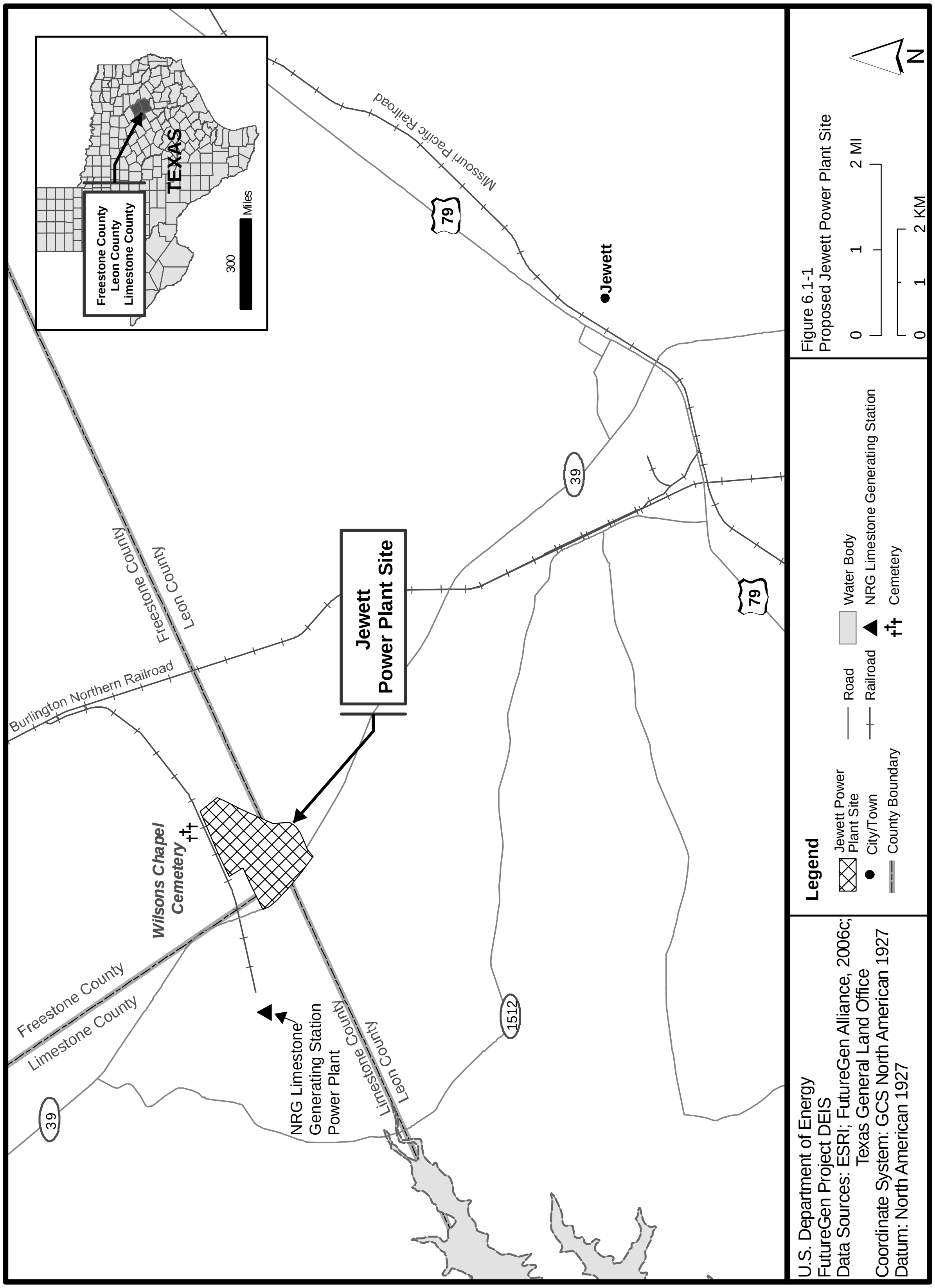
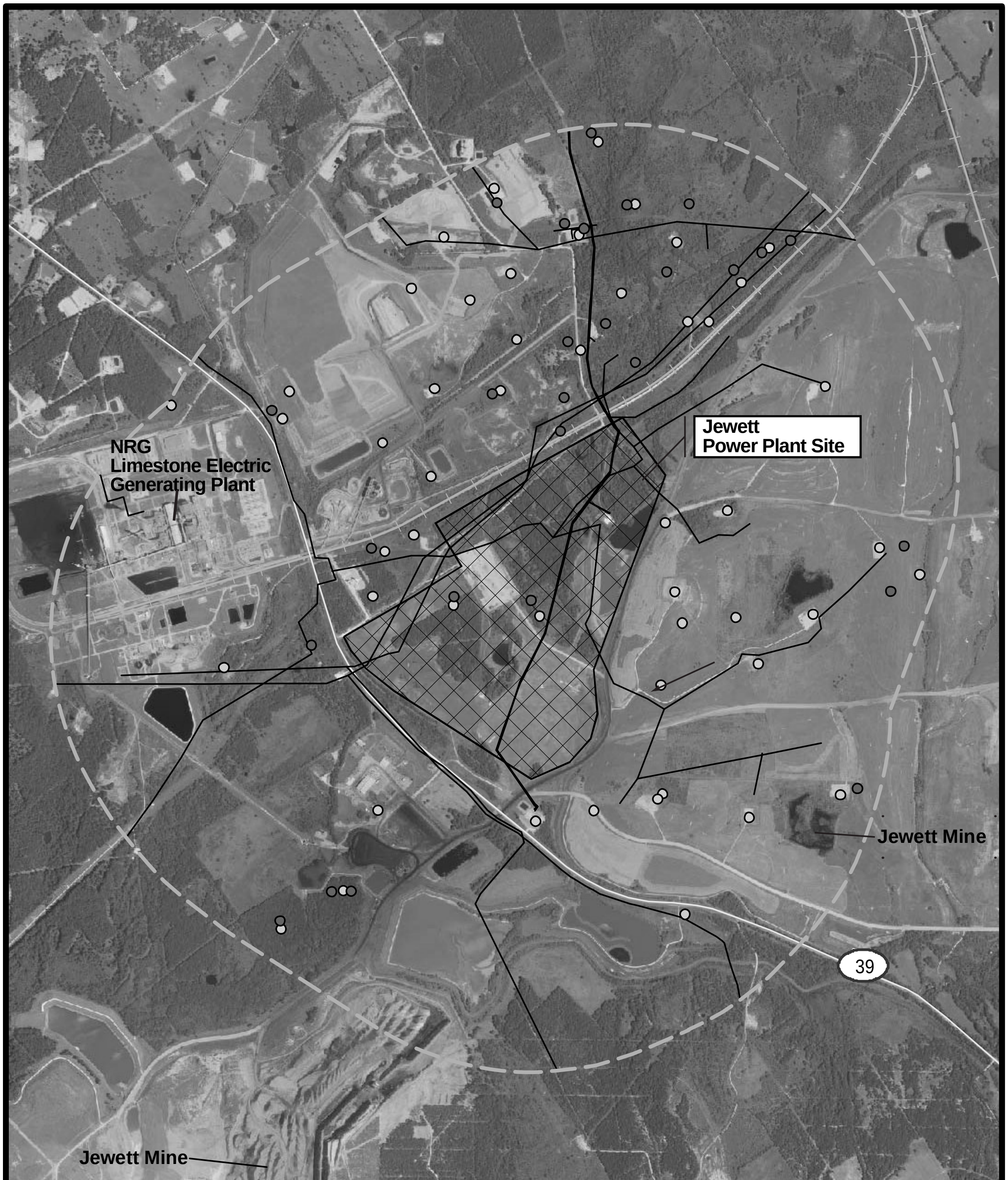


Figure 6.1-1
Proposed Jewett Power Plant Site



U.S. Department of Energy
FutureGen Project DEIS
Data Source: FutureGen Alliance, 2006c
USDA FSA APFO 2004;
RCT 2005, BEG 2006

Legend
Jewett Power Plant Site
Water Wells
Oil/Gas Wells
Existing Oil/Gas Pipelines
1-Mile ROI
Railroad

All land within the ROI is owned by NRG or Texas Westmorleand Coal Company

Figure 6.11-1
Aerial Photo of the Proposed Jewett Power Plant Land Use ROI

0 0.25 0.5 MI
0 0.25 0.5 KM
N

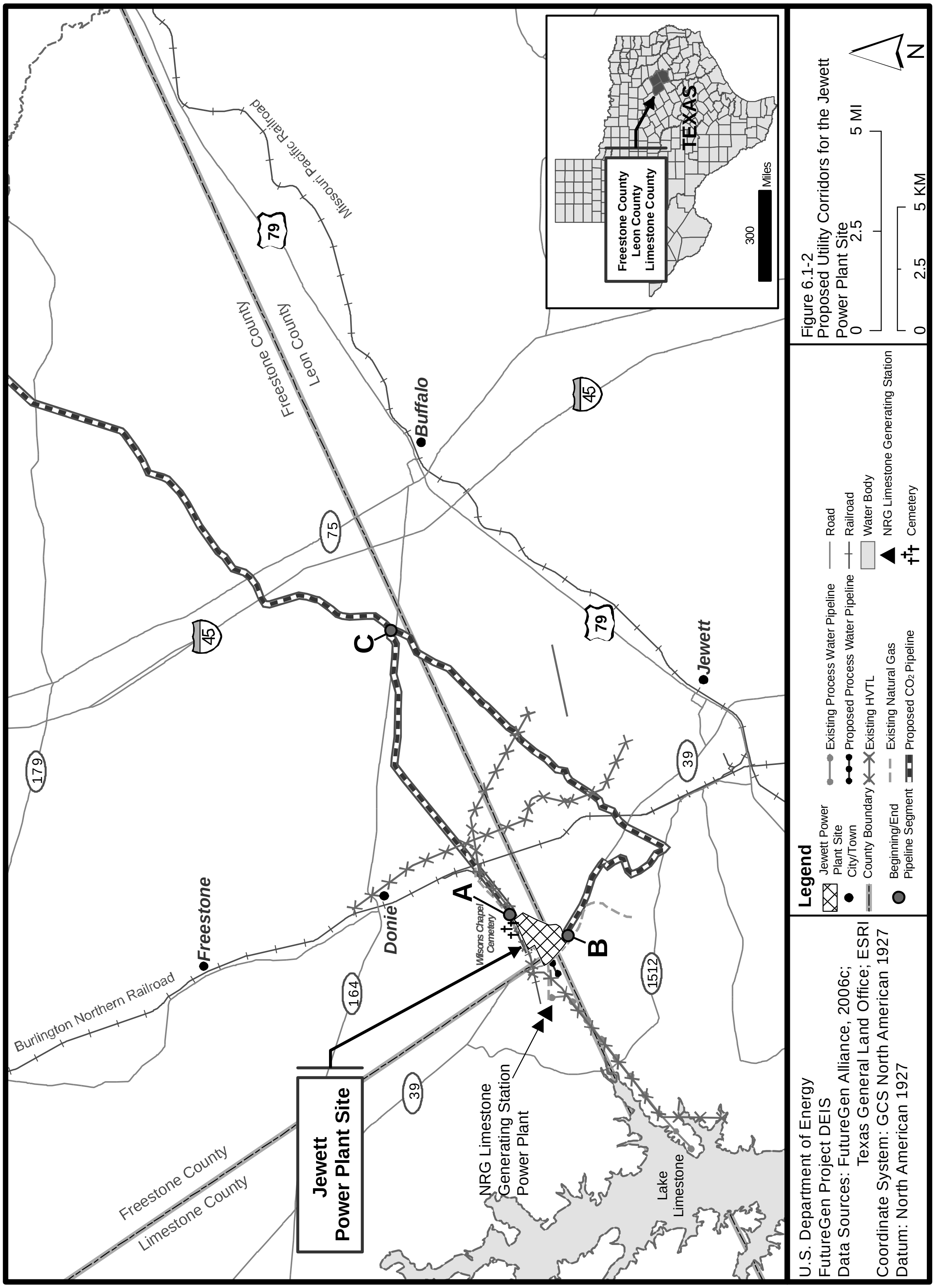
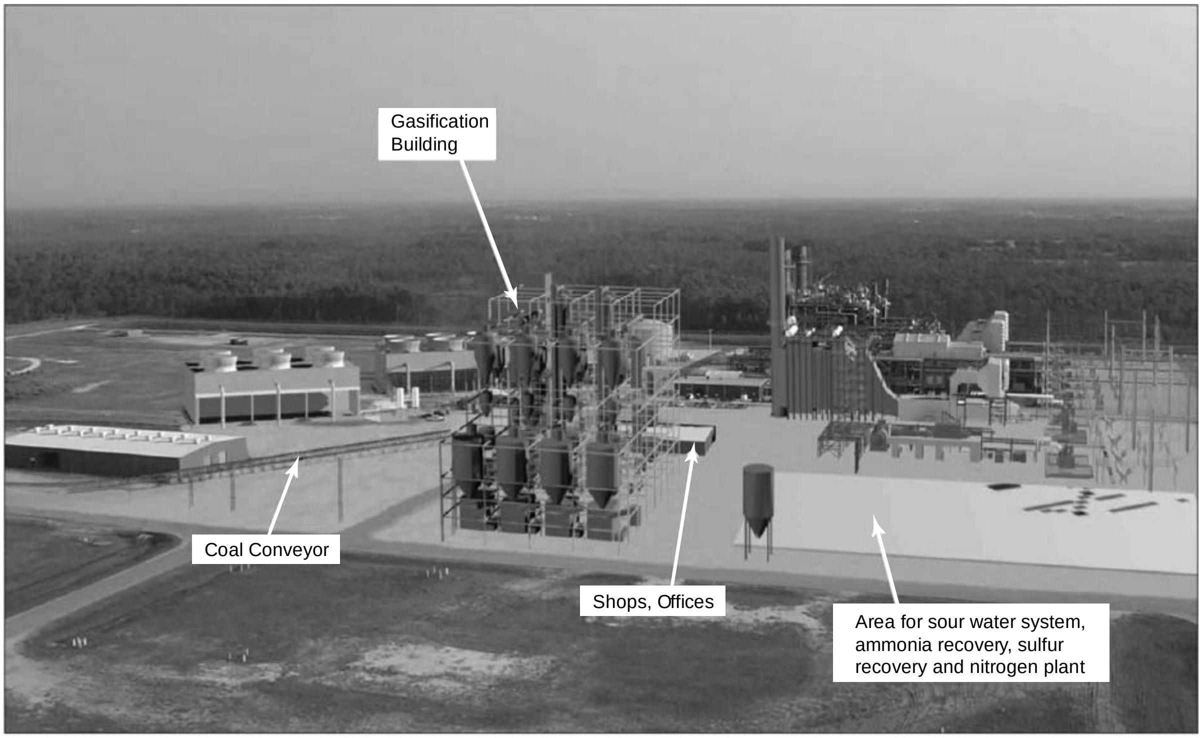


Figure 6.1-2
Proposed Utility Corridors for the Jewett Power Plant Site



Source: DOE, 2006a

Figure 6.12-3. Artist's Rendering of an IGCC Plant with Minimal Screening and Architectural Design Elements

Source: DOE, 2006

Figure 6.12-4. Artist's Rendering of an IGCC Plant with Extensive Screening and Architectural Design Elements

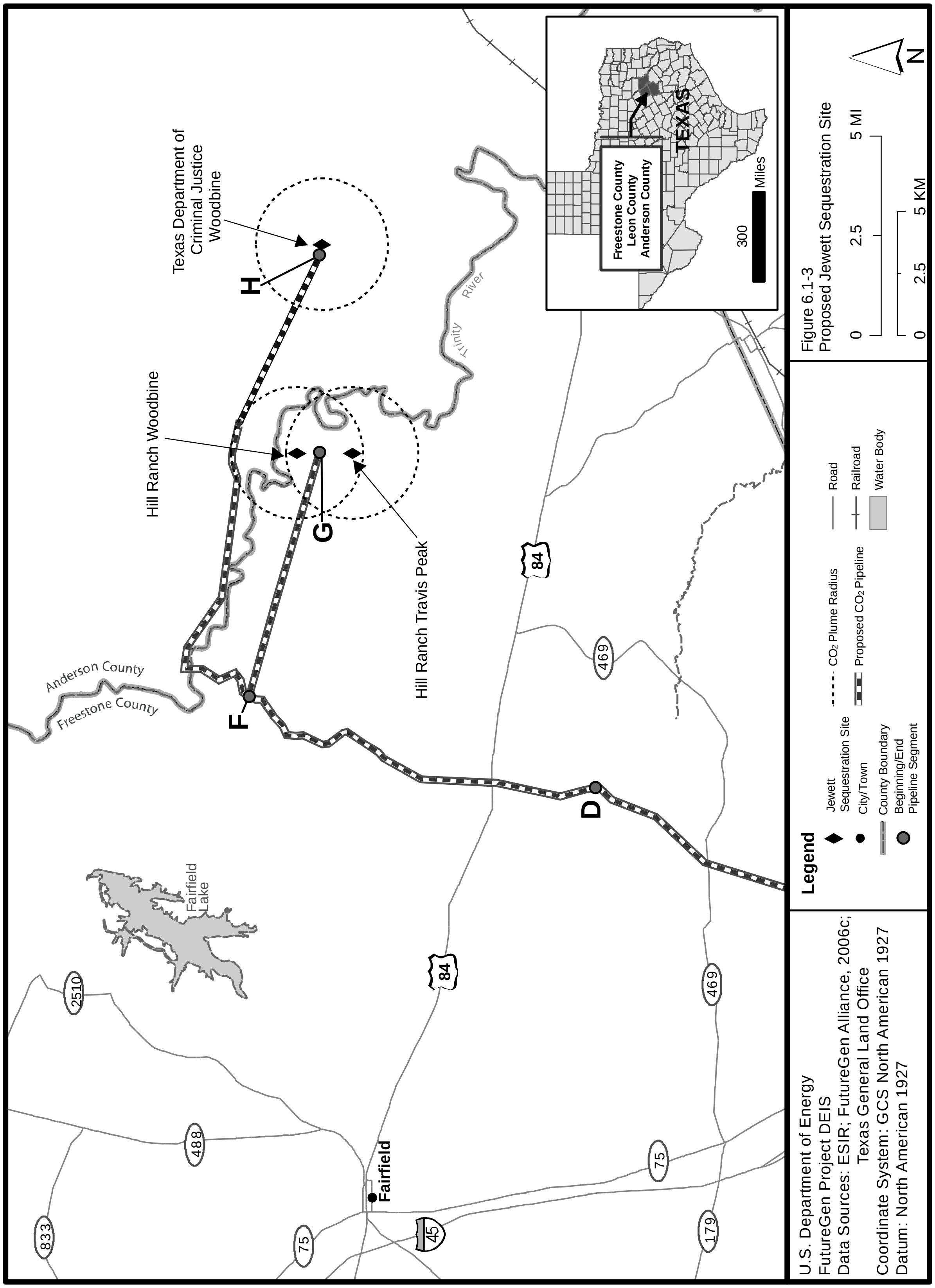


Figure 6.1-3
Proposed Jewett Sequestration Site

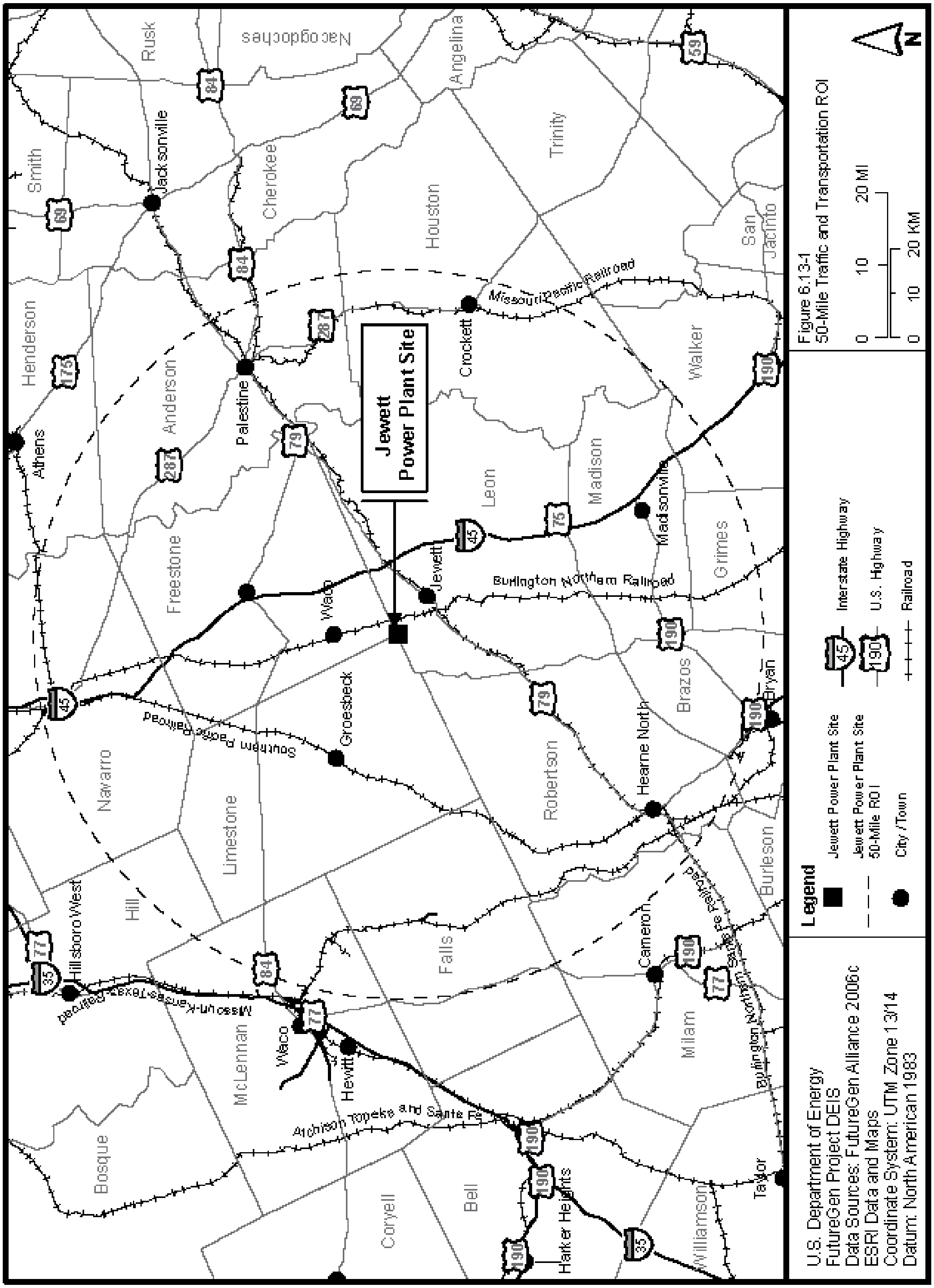


Figure 6.13-1
50-Mile Traffic and Transportation ROI

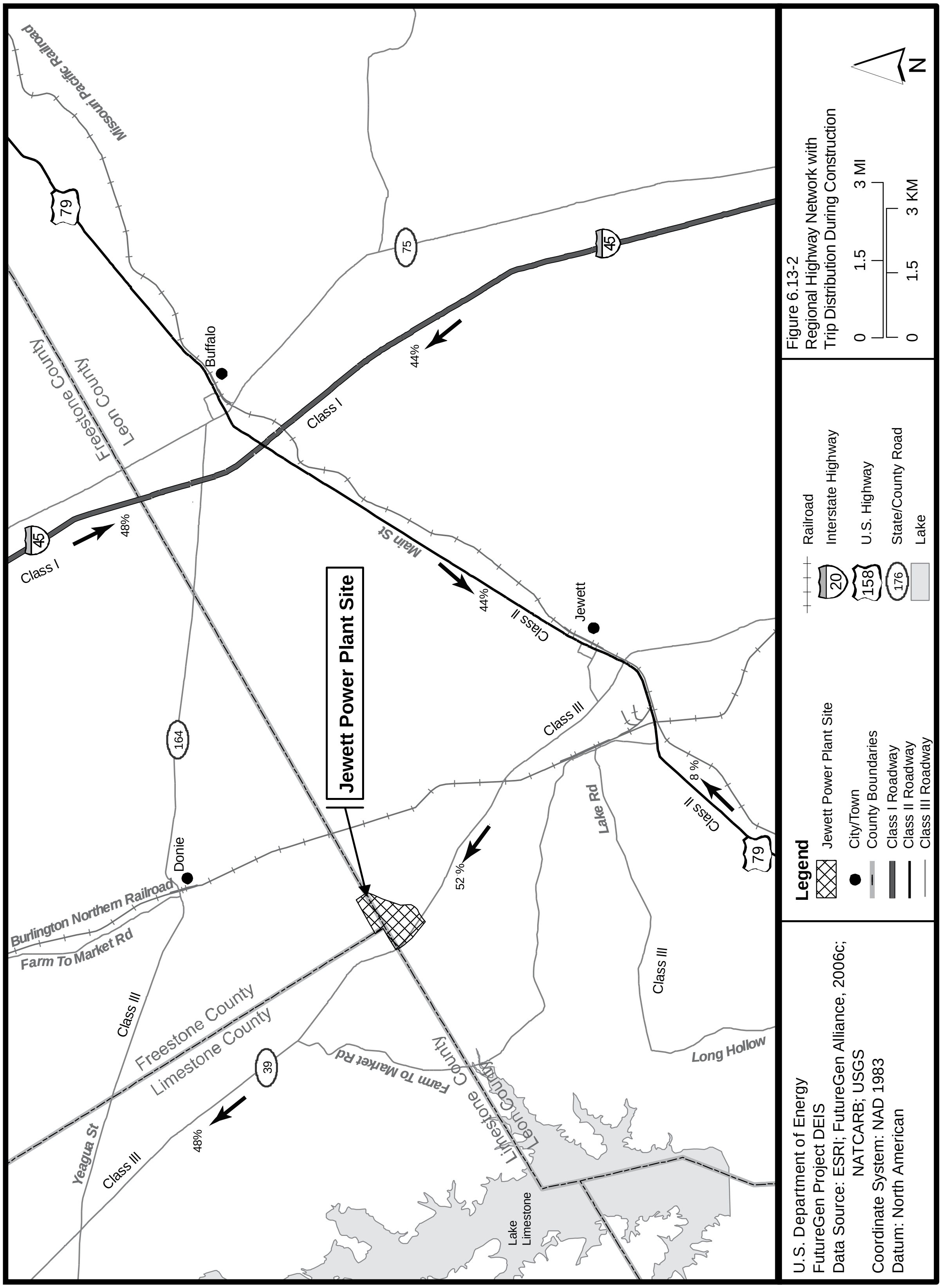
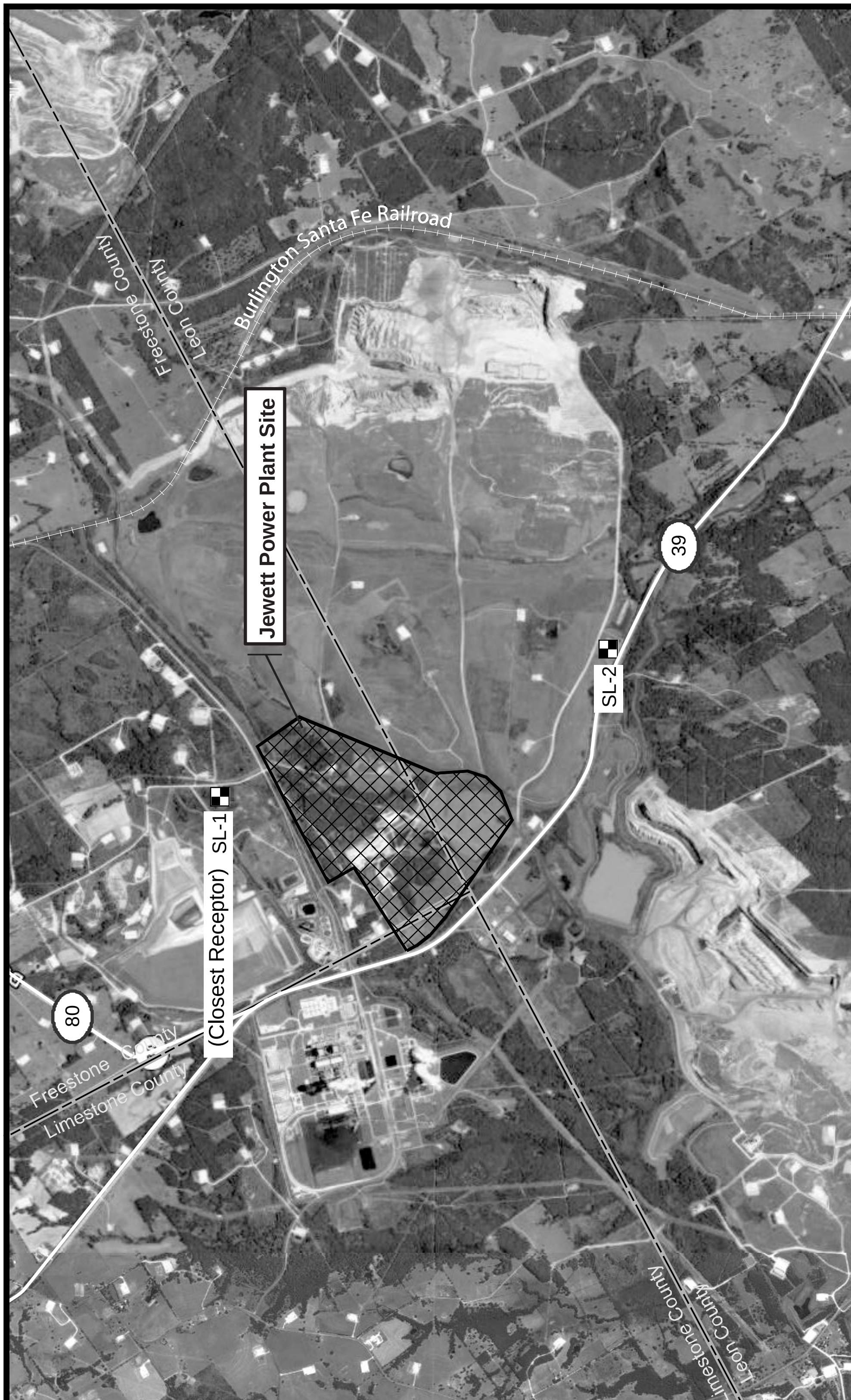


Figure 6.13-2
Regional Highway Network with
Trip Distribution During Construction
0 1.5 3 MI
0 1.5 3 KM
N
Legend
Jewett Power Plant Site
City/Town
County Boundaries
Class I Roadway
Class II Roadway
Class III Roadway
Railroad
Interstate Highway
U.S. Highway
State/County Road
Lake
U.S. Department of Energy
FutureGen Project DEIS
Data Source: ESRI; FutureGen Alliance, 2006c; NATCARB; USGS
Coordinate System: NAD 1983
Datum: North American
Jewett Power Plant Site
Missouri Pacific Railroad
Burlington Northern Railroad
Farm To Market Rd
Main St
Lake Rd
Long Hollow
Yeagua St
Buffalo
Jewett
Donie
Freestone County
Leon County
Limestone County
Lake Limestone
Class I
Class II
Class III
44%
48%
52 %
8 %



Legend

Jewett Power Plant Site
SL-X Sensitive Receptor Locations
County Boundary
State/County Road
Railroad

Figure 6.14-2
Noise Measurement Locations near the Proposed Jewett Power Plant Site

0 .5 1 MI
0 0.5 1 KM

N

U.S. Department of Energy
FutureGen Project DEIS
Data Source: FutureGen Alliance, 2006c
Datum: WGS84

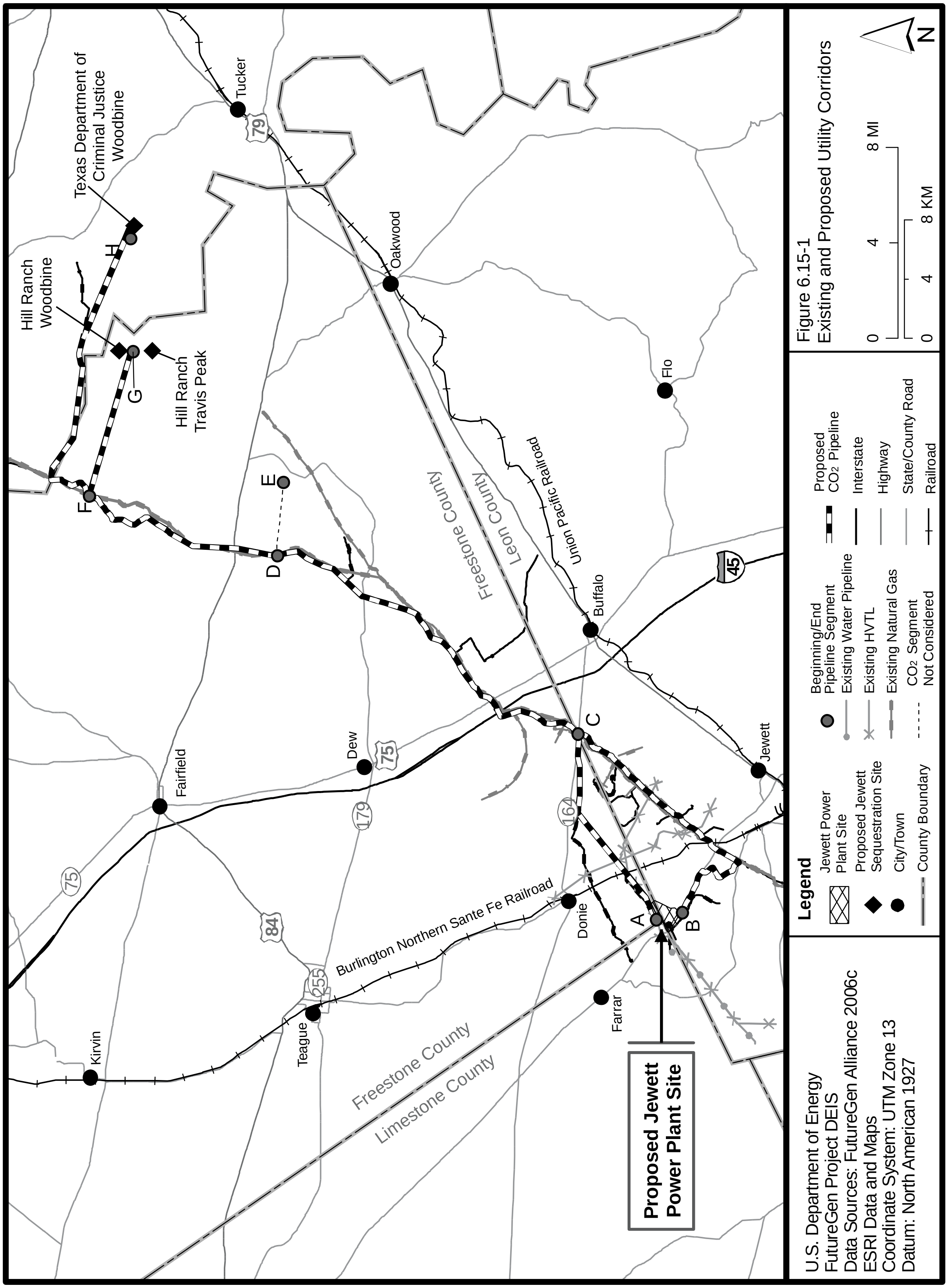
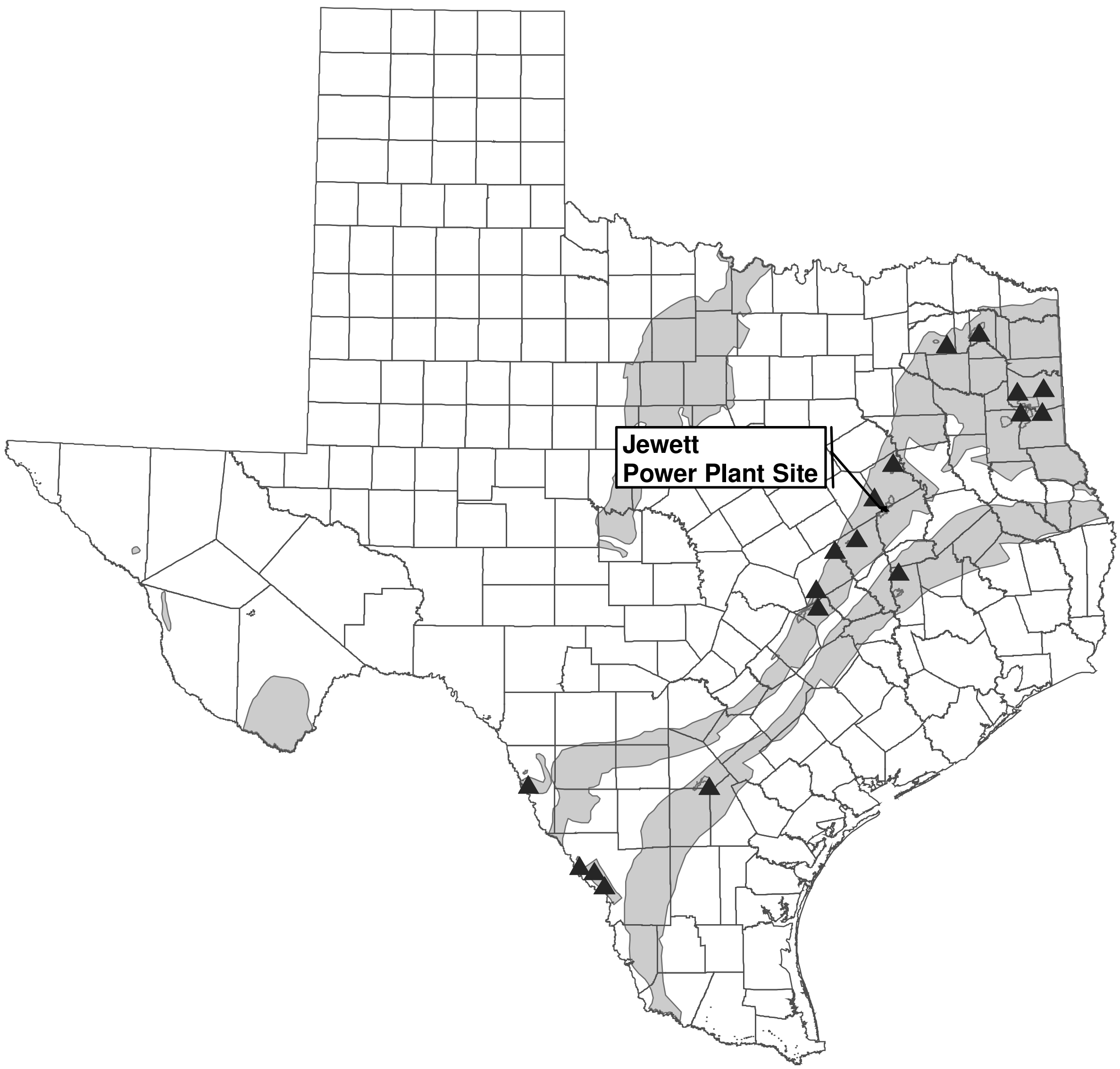


Figure 6.15-1
Existing and Proposed Utility Corridors
0 4 8 MI
0 4 8 KM
N
Legend
Jewett Power Plant Site
Proposed Jewett Sequestration Site
City/Town
County Boundary
Beginning/End Pipeline Segment
Existing Water Pipeline
Existing HVTL
Existing Natural Gas
CO2 Segment Not Considered
Proposed CO2 Pipeline
Interstate
Highway
State/County Road
Railroad
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006c
ESRI Data and Maps
Coordinate System: UTM Zone 13
Datum: North American 1927
Proposed Jewett Power Plant Site
Texas Department of Criminal Justice Woodbine
Hill Ranch Woodbine
Hill Ranch Travis Peak
Tucker
Oakwood
Flo
Buffalo
Jewett
Fairfield
Dew
Kirvin
Teague
Donie
Farrar
Freestone County
Leon County
Limestone County
Union Pacific Railroad
Burlington Northern Sante Fe Railroad
A
B
C
D
E
F
G
H
79
45
75
179
164
84
255



U.S. Department of Energy
FutureGen Project DEIS
Source: FutureGen Alliance, 2006c

Legend

Jewett Power Plant Site
Coal Deposits
Coal Mines

Figure 6.16-1
Coal Resources

0 50 100 MI
0 50 100 KM
N

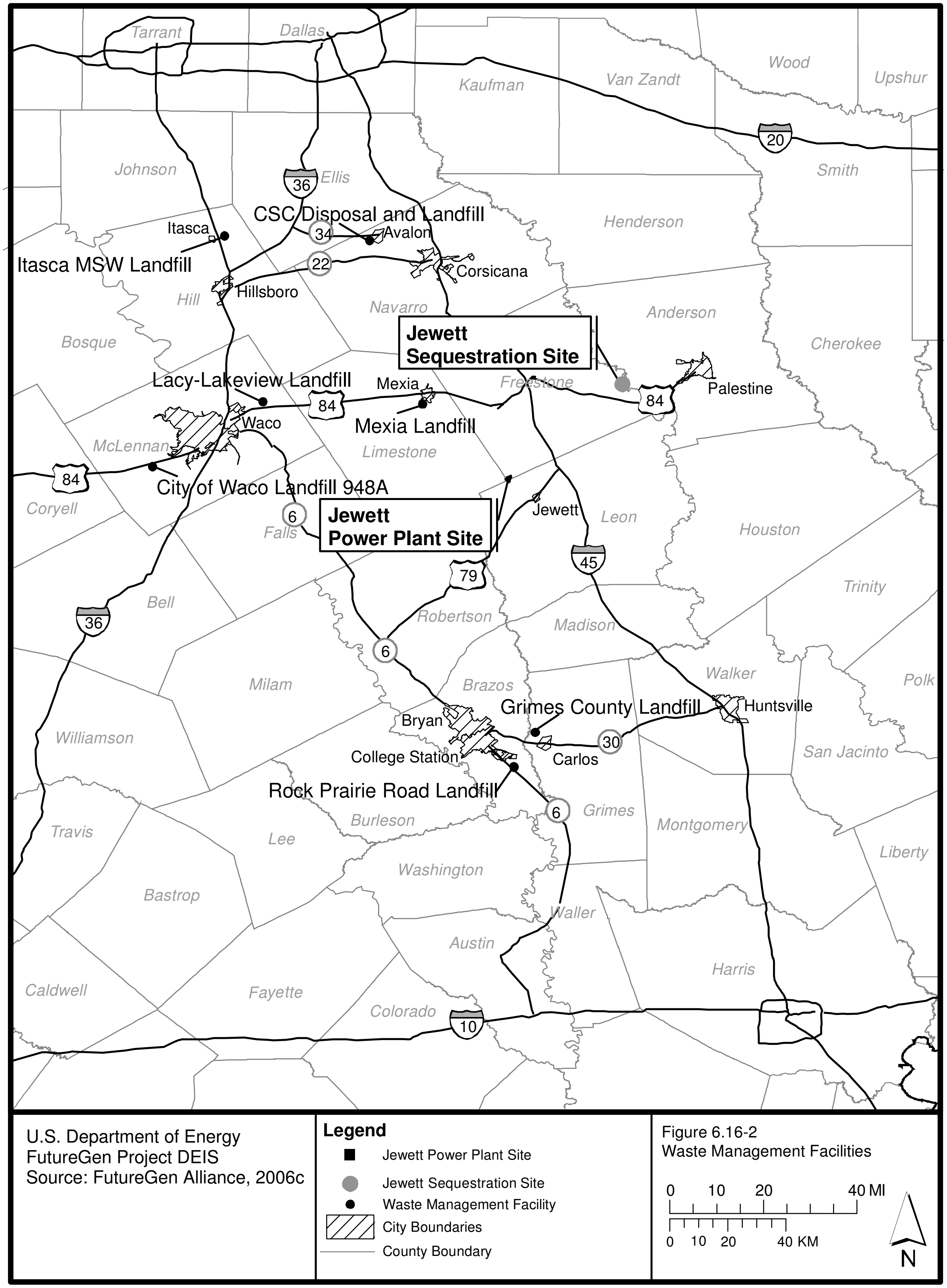


Figure 6.16-2
Waste Management Facilities

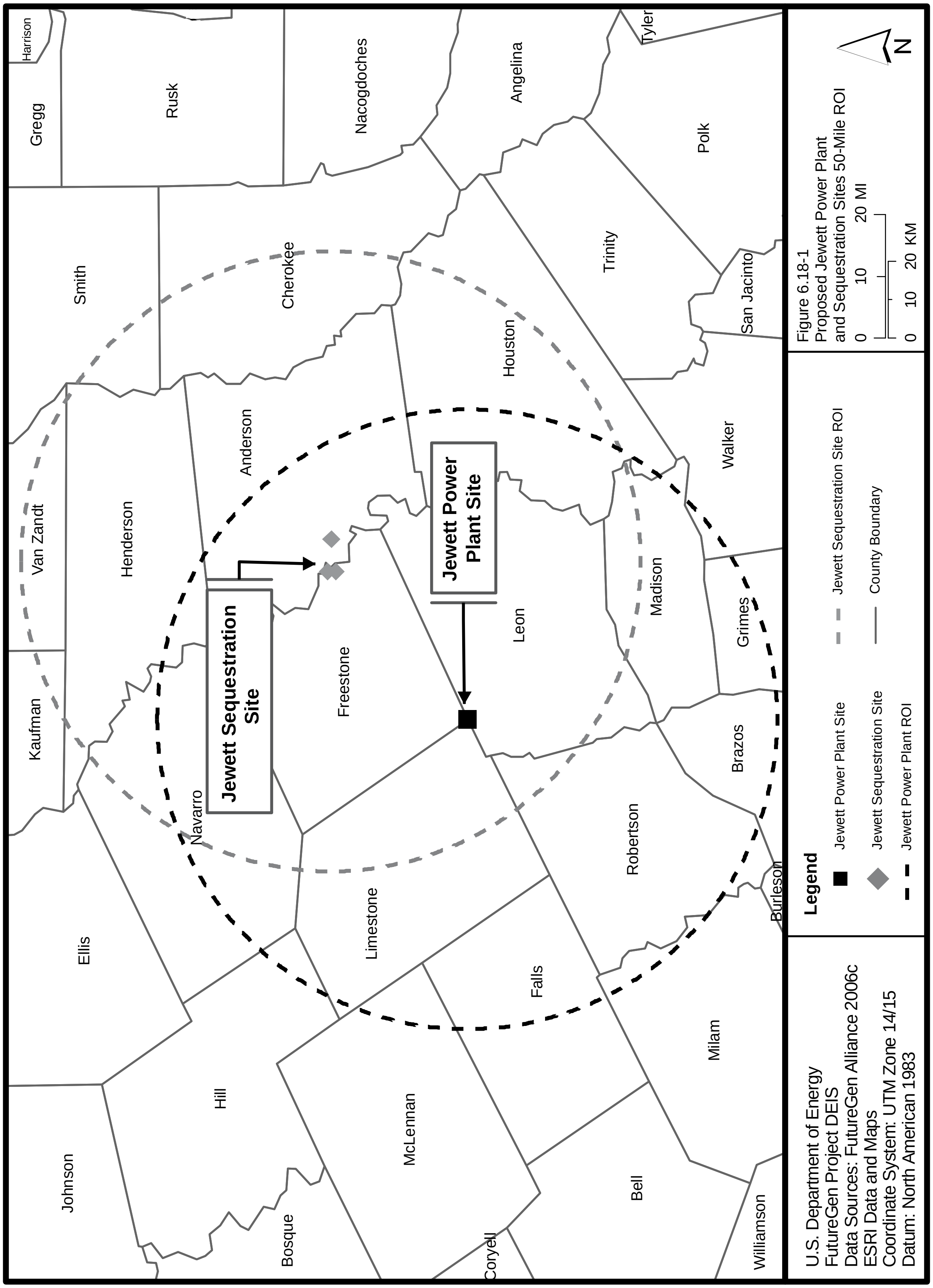


Figure 6.18-1
Proposed Jewett Power Plant and Sequestration Sites 50-Mile ROI

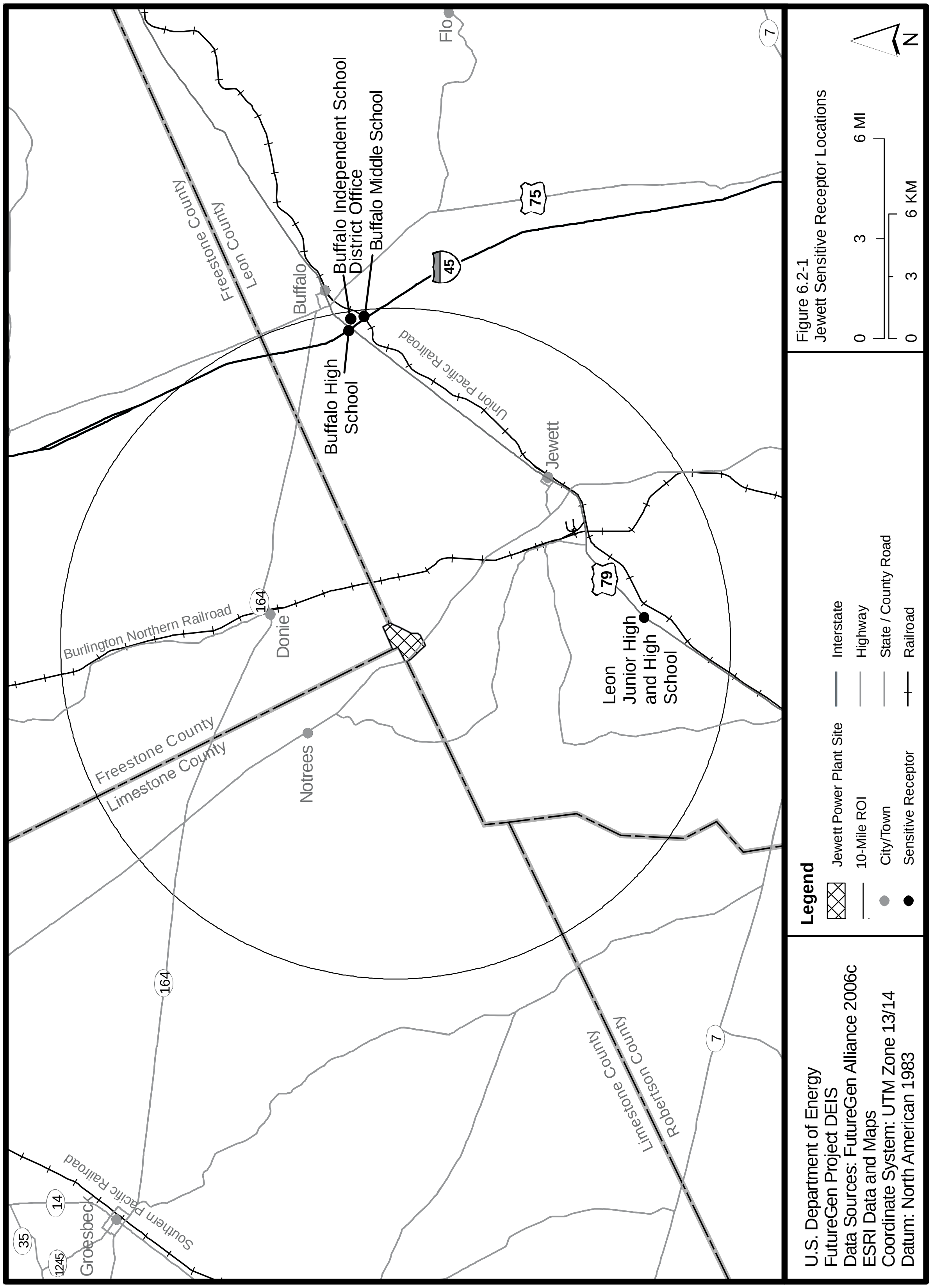
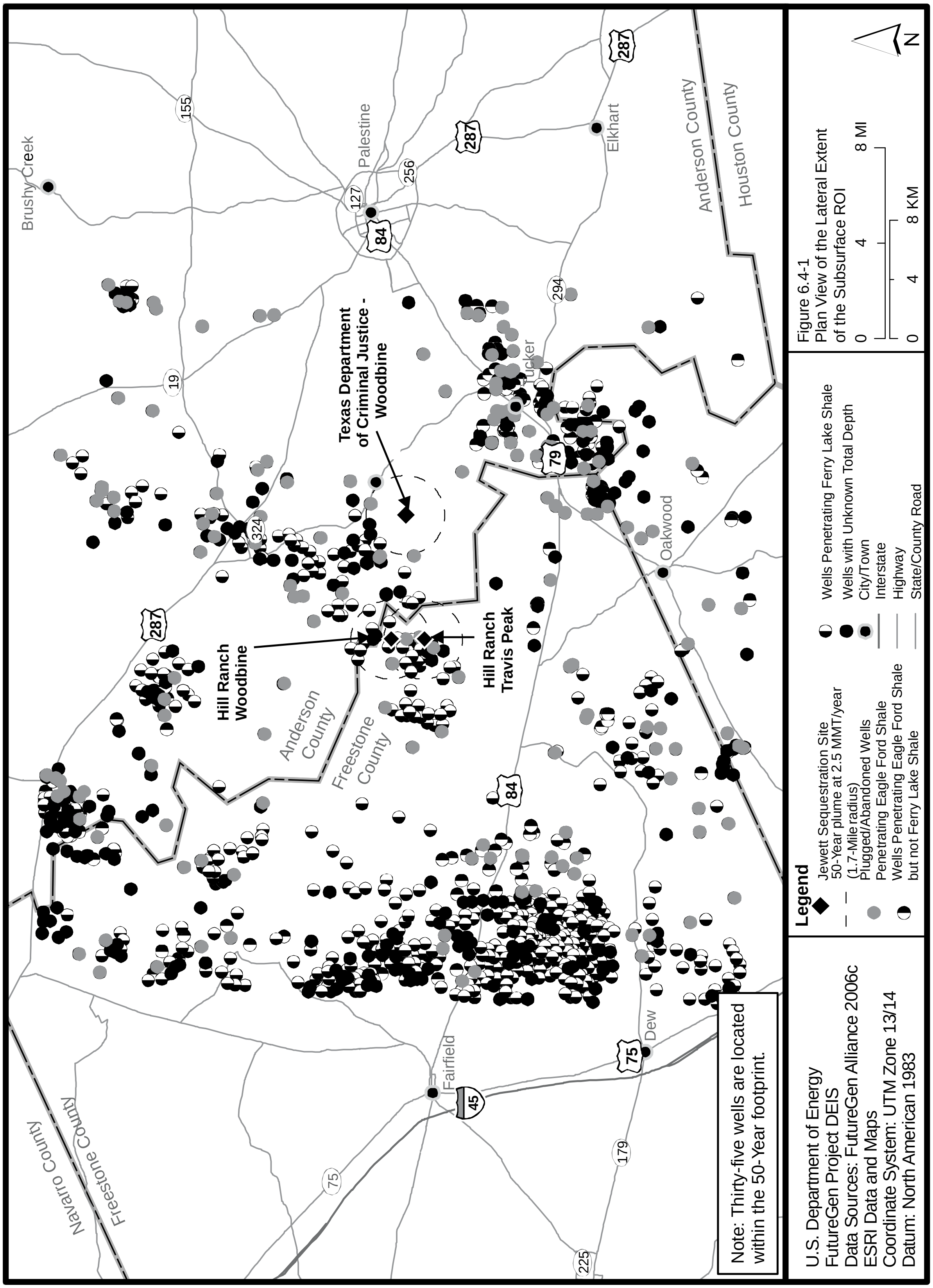


Figure 6.2-1
Jewett Sensitive Receptor Locations



Note: Thirty-five wells are located within the 50-Year footprint.

Figure 6.4-1
Plan View of the Lateral Extent of the Subsurface ROI

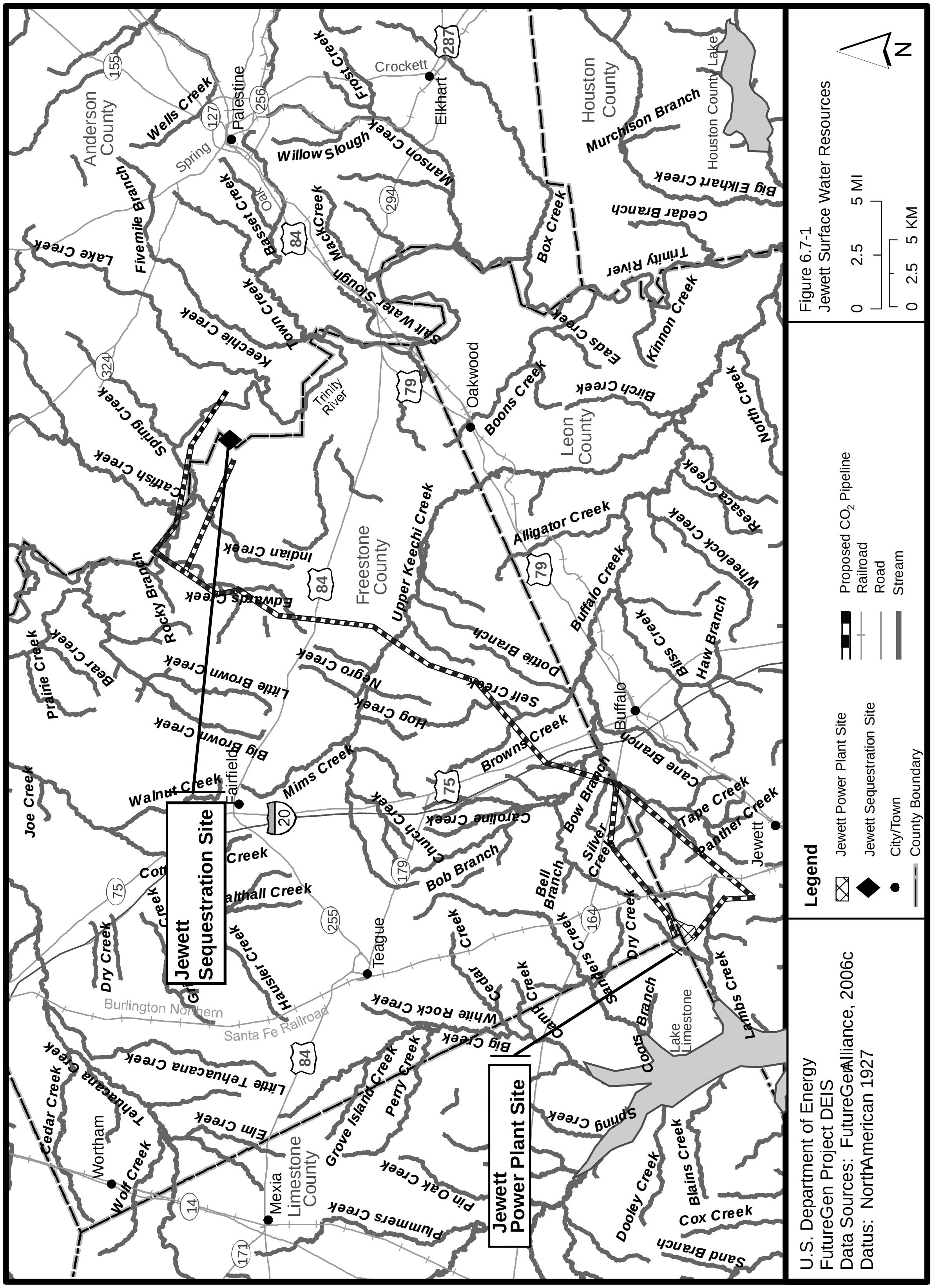


Figure 6.7-1
Jewett Surface Water Resources

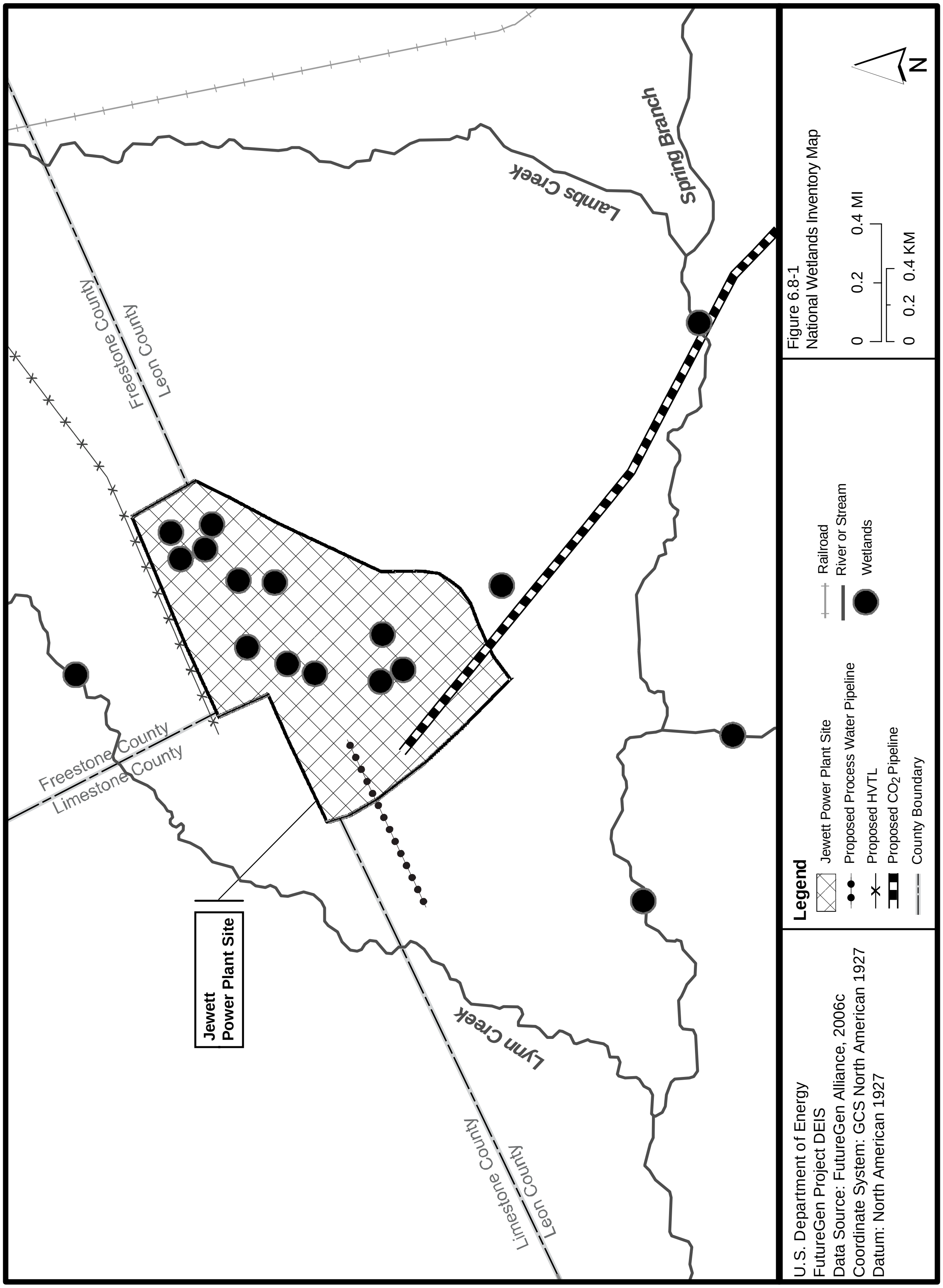
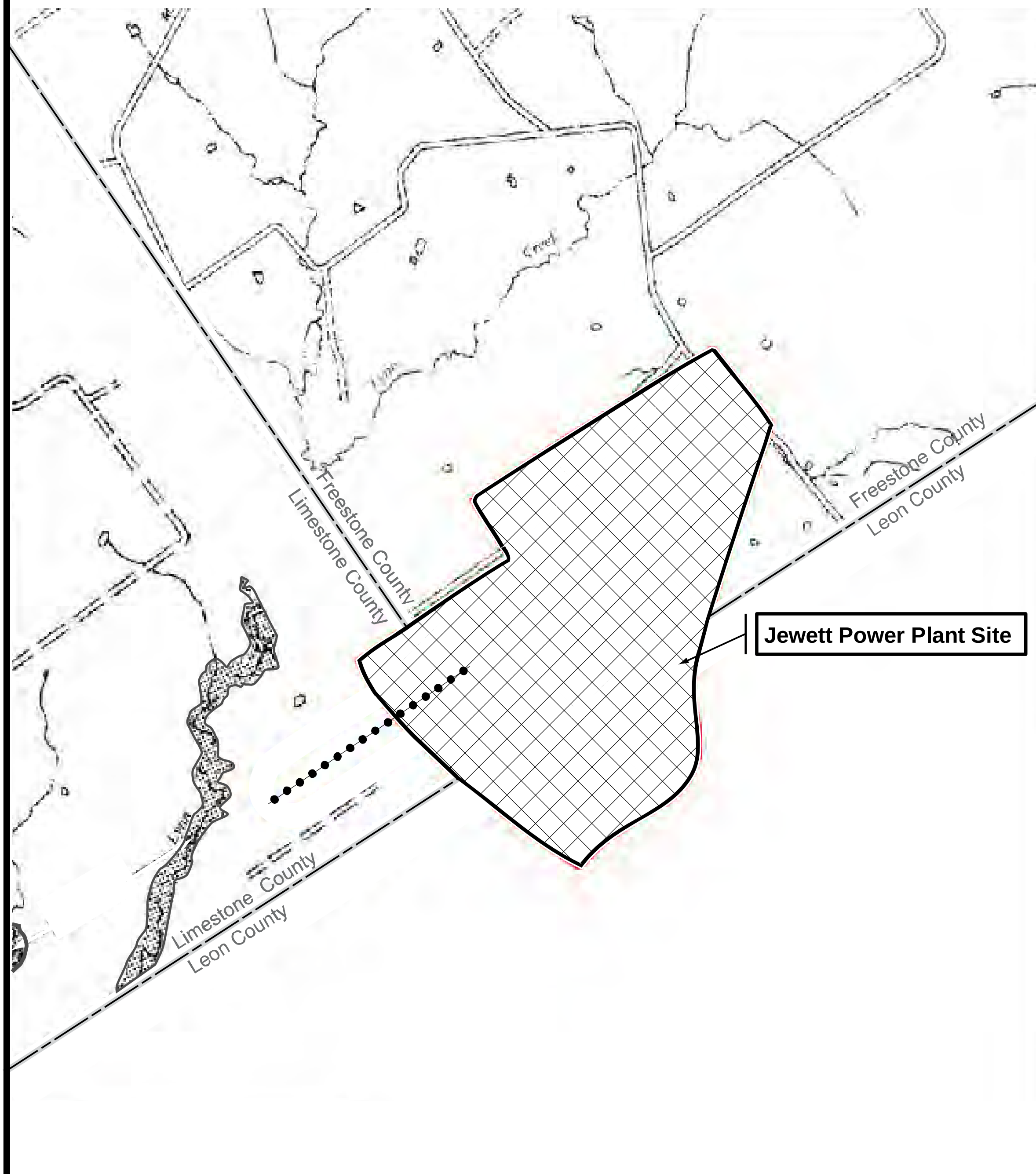


Figure 6.8-1
National Wetlands Inventory Map



U.S. Department of Energy
FutureGen Project DEIS
Data Source: FutureGen Alliance, 2006c

Legend

- Jewett Power Plant Site
- Proposed Process Water Pipeline
- 100-Year Flood Zone (Zone A) No base flood elevations
- Paved Road/Highway
- Unpaved Road

FEMA floodplain data is not available for Leon County

Figure 6.8-2
Jewett Floodplain Map

0 1,000 2,000 ft

0 200 m

N

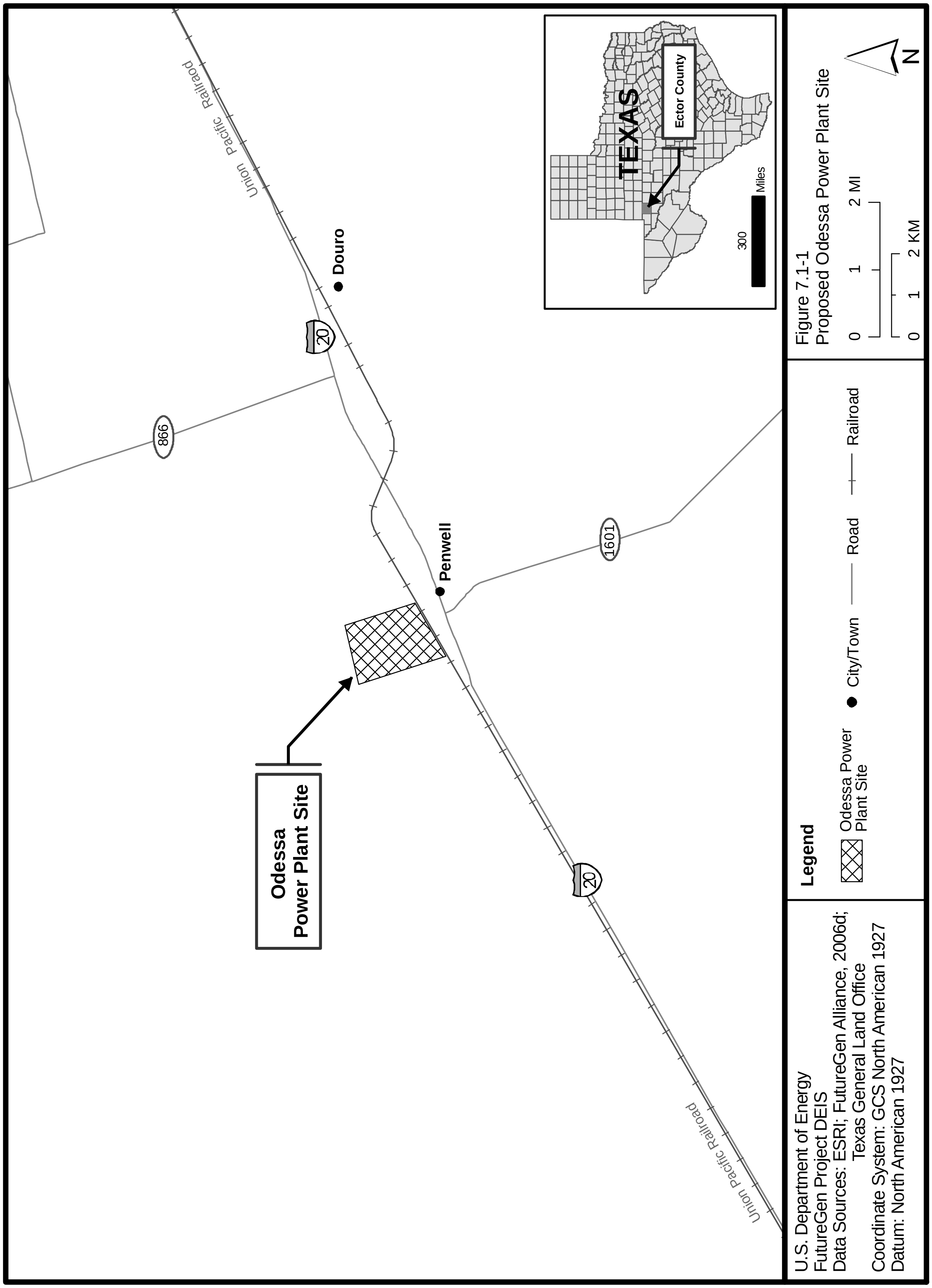
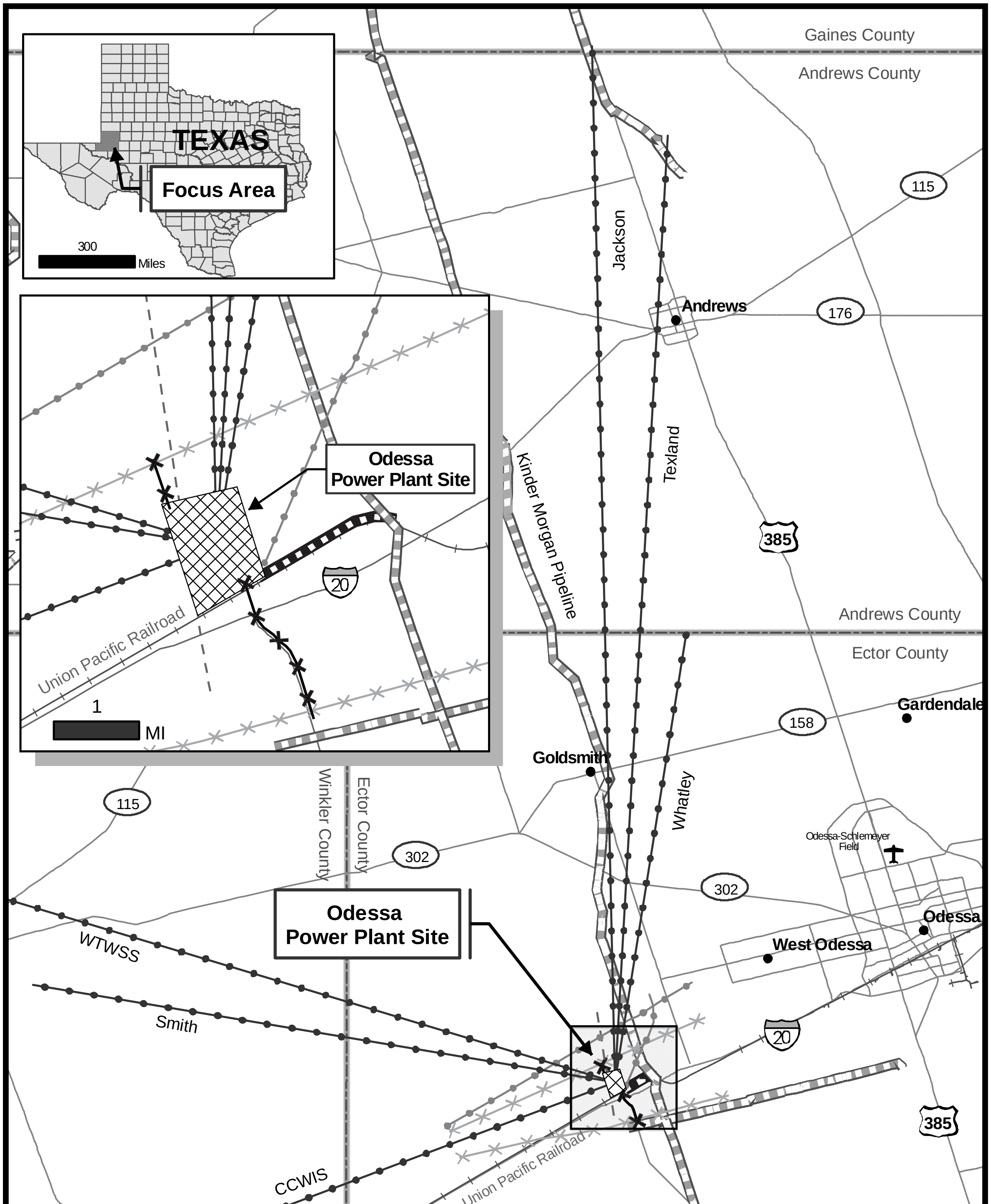


Figure 7.1-1
Proposed Odessa Power Plant Site

Figure 7.11-1
Aerial Photo of the Proposed Odessa Power Plant Land Use ROI



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: ESRI; FutureGen Alliance, 2006d; Texas General Land Office
Coordinate System: GCS North American 1927
Datum: North American 1927

Legend

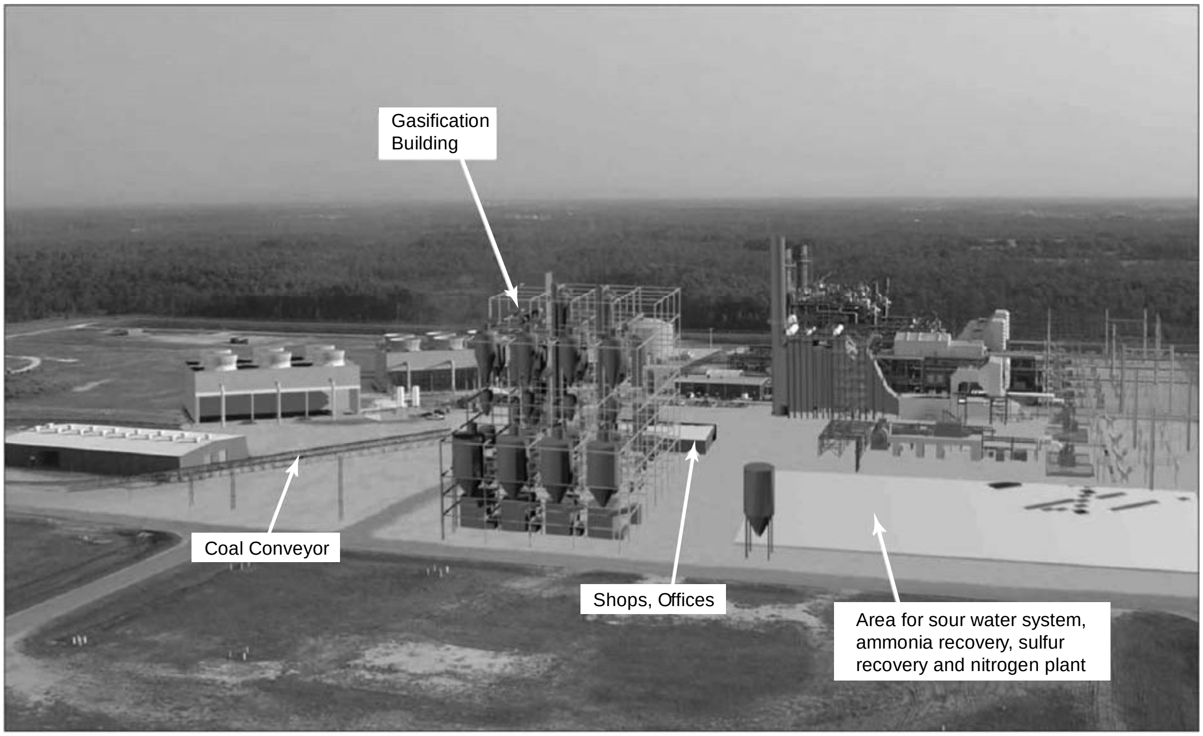
- Odessa Power Plant Site
- City/Town
- County Boundary
- Existing Potable and Process Water Pipeline
- Proposed Potable and Process Water Pipeline
- Existing HVTL
- Proposed HVTL
- Existing CO_2 Pipeline
- Proposed CO_2 Pipeline
- Existing Natural Gas
- Road
- Railroad
- Airport
- Location of Inset

Figure 7.1-2
Proposed Utility Corridors for the Odessa Power Plant Site

0 2.5 5 MI

0 2.5 5 KM

N



Source: DOE, 2006a

Figure 7.12-4. Artist's Rendering of an IGCC Plant with Minimal Screening and Architectural Design Elements

Source: DOE, 2006b

Figure 7.12-5. Artist's Rendering of an IGCC Plant with Extensive Screening and Architectural Design Elements

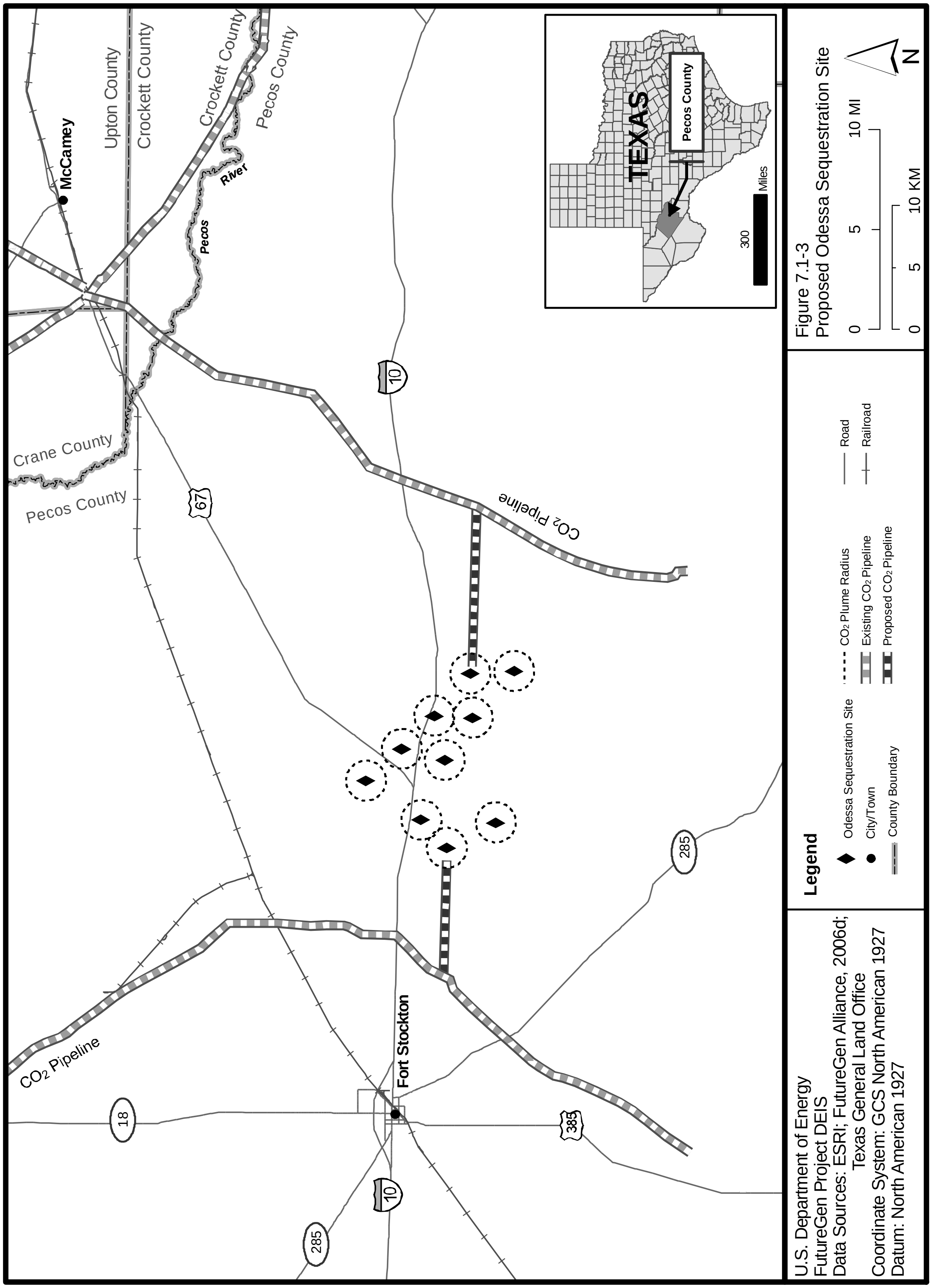
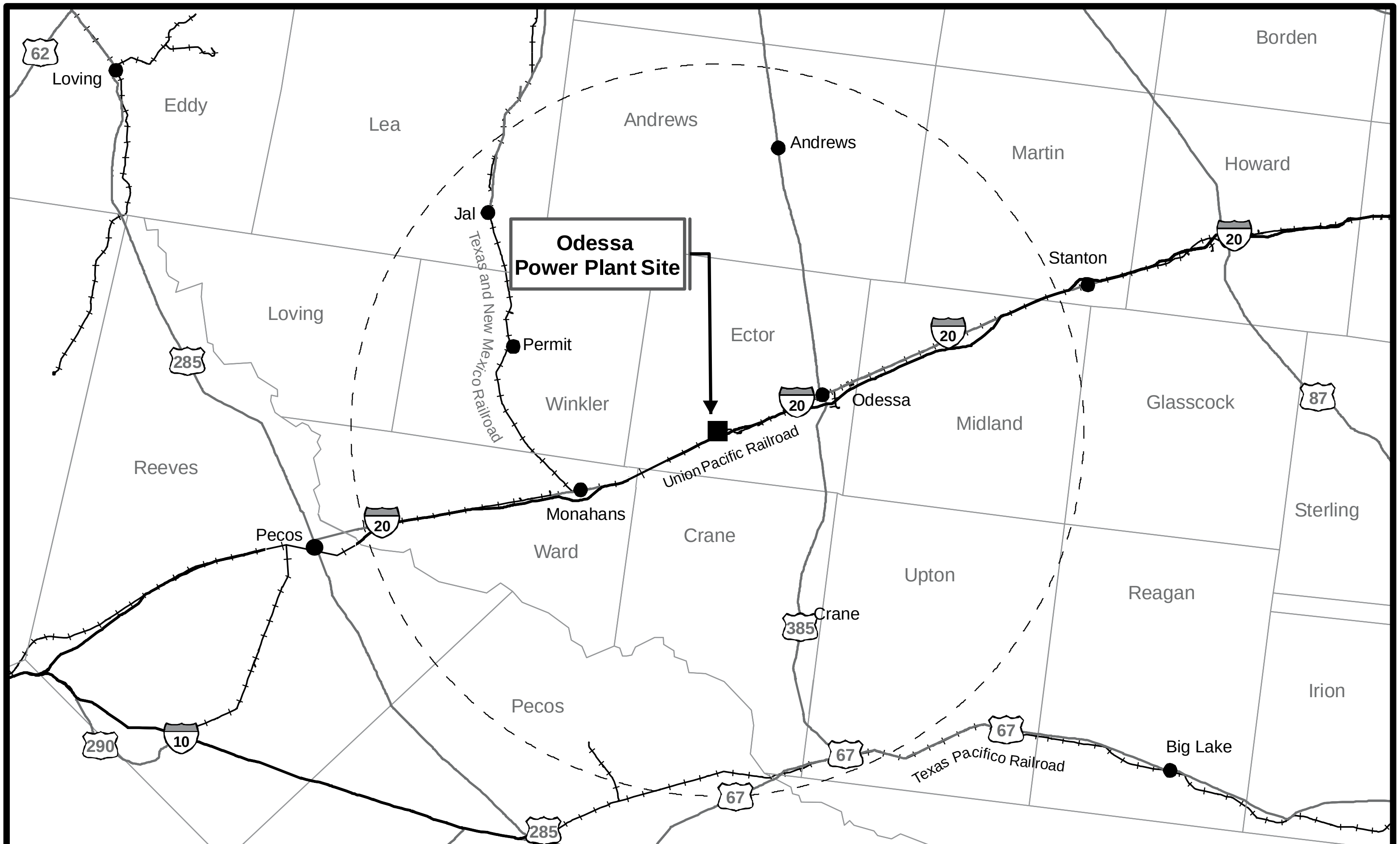


Figure 7.1-3
Proposed Odessa Sequestration Site



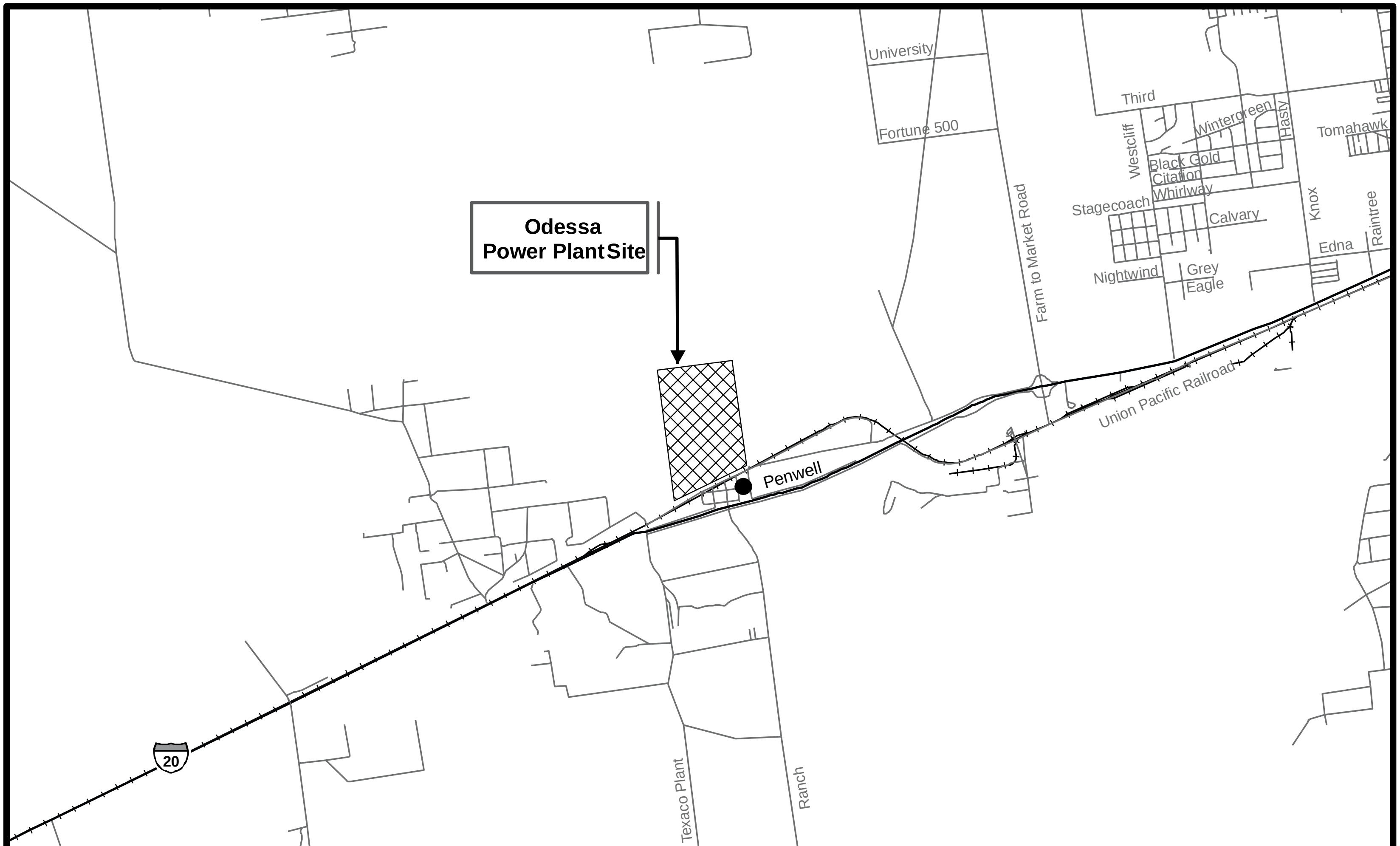
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006d
ESRI Data and Maps
Coordinate System: UTM Zone 13/14
Datum: North American 1983

Legend

- Odessa Power Plant Site
- Odessa Power Plant Site 50-Mile ROI
- City/Town
- Interstate Highway
- U.S. Highway
- Railroad

Figure 7.13-1
50-Mile Traffic and Transportation ROI

0 10 20 MI
0 10 20 KM
N



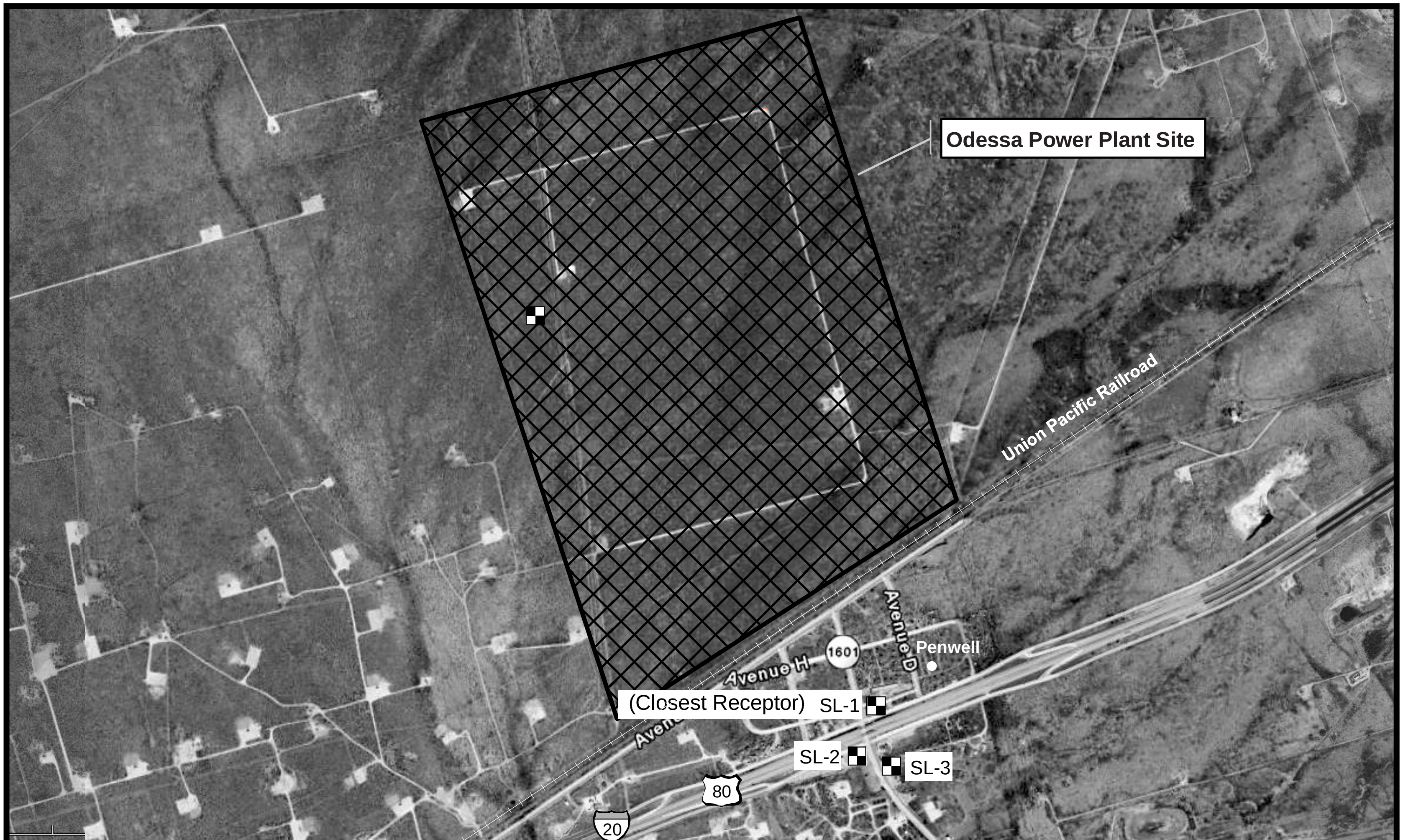
U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006d
ESRI Data and Maps
Coordinate System: UTM Zone 13/14
Datum: North American 1983

Legend

Odessa Power Plant Site
City / Town
57 Interstate Highway
Local Road
Railroad

Figure 7.13-2
Highway and Railroad Network

0 1 2 MI
0 1 2 KM
N



U.S. Department of Energy
FutureGen Project DEIS
Data Source: FutureGen Alliance, 2006d
Datum: WGS84

Legend

- Odessa Power Plant Site
- City/Town
- SL-X Sensitive Receptor Locations
- Railroad

Figure 7.14-2
Sensitive Receptor Locations near the Proposed Odessa Power Plant SIte

0 0.2 0.4 MI
0 0.2 0.4 KM
N

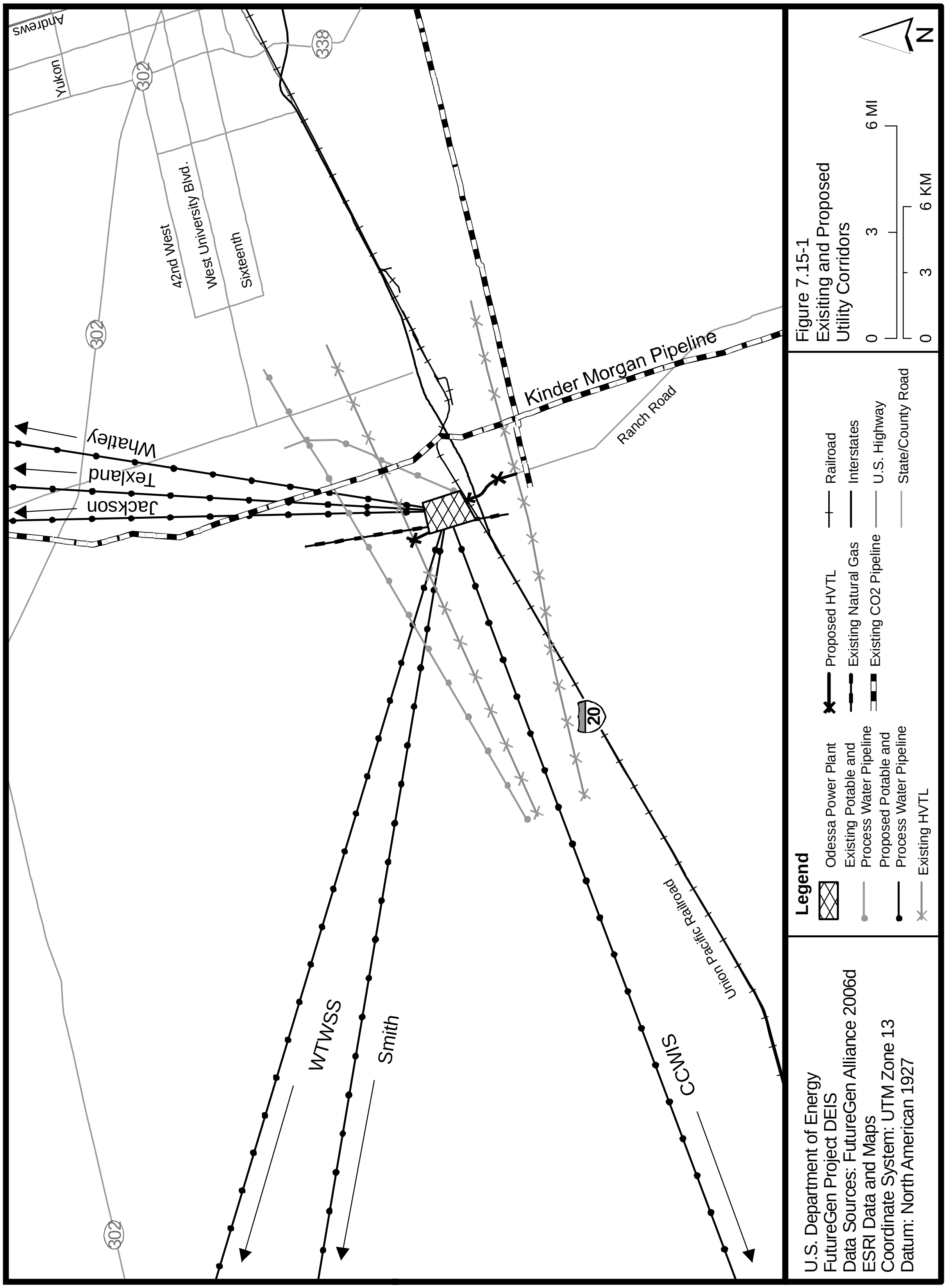
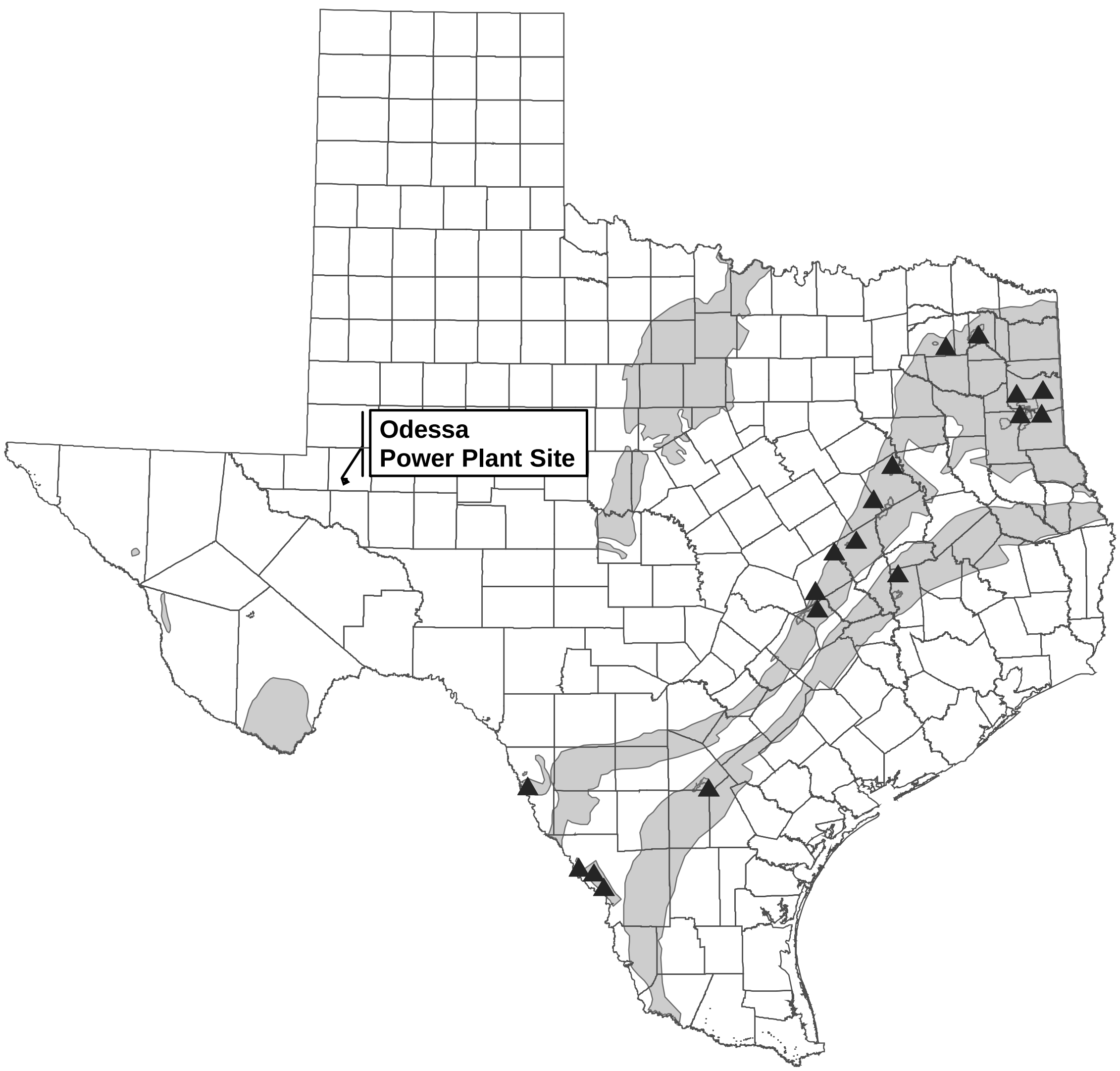


Figure 7.15-1
Exisiting and Proposed
Utility Corridors



U.S. Department of Energy
FutureGen Project DEIS
Source: FutureGen Alliance, 2006d

Legend

Odessa Power Plant Site
Coal Deposits
Coal Mines

Figure 7.16-1
Coal Resources

0 50 100 MI
0 50 100 KM
N

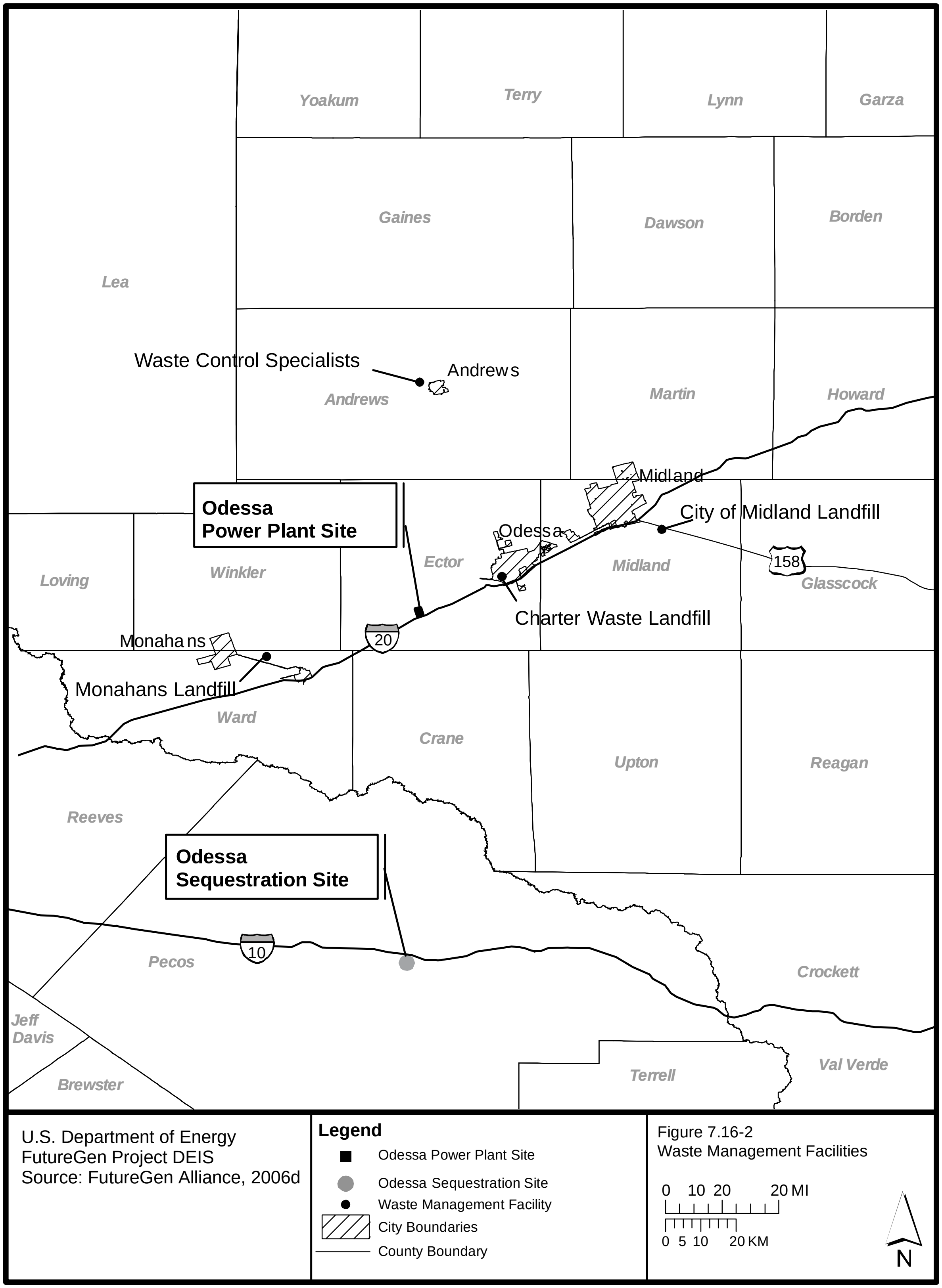
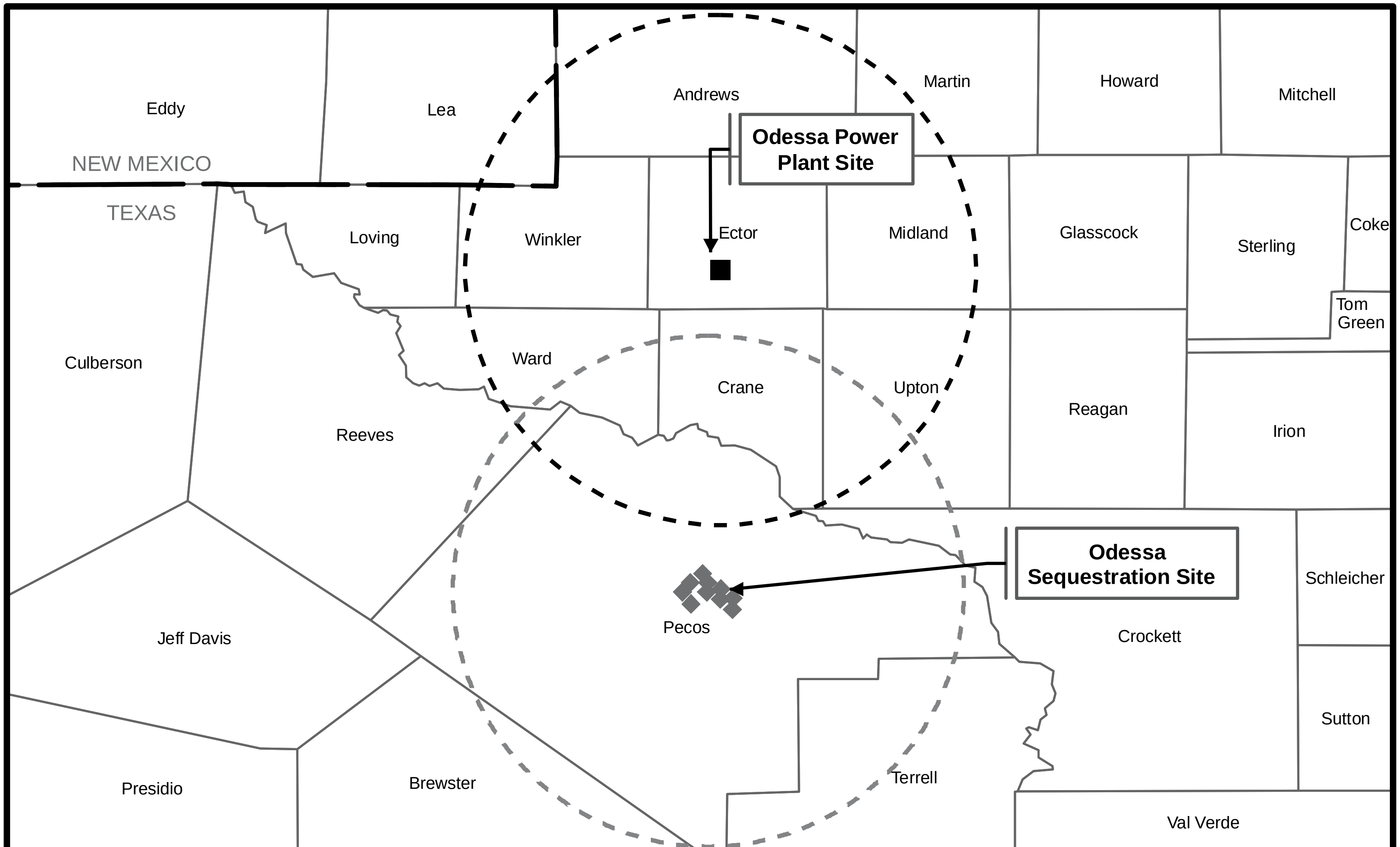


Figure 7.16-2
Waste Management Facilities



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006d
ESRI Data and Maps
Coordinate System: UTM Zone 13/14
Datum: North American 1983

Legend

- ■ Odessa Power Plant Site
- ◆ Odessa Sequestration Site
- Odessa Power Plant ROI
- Odessa Sequestration ROI
- State Boundary
- County Boundary

Figure 7.18-1
Proposed Odessa Power Plant and Sequestration Sites 50-Mile ROI

0 20 40 MI

0 20 40 KM

N

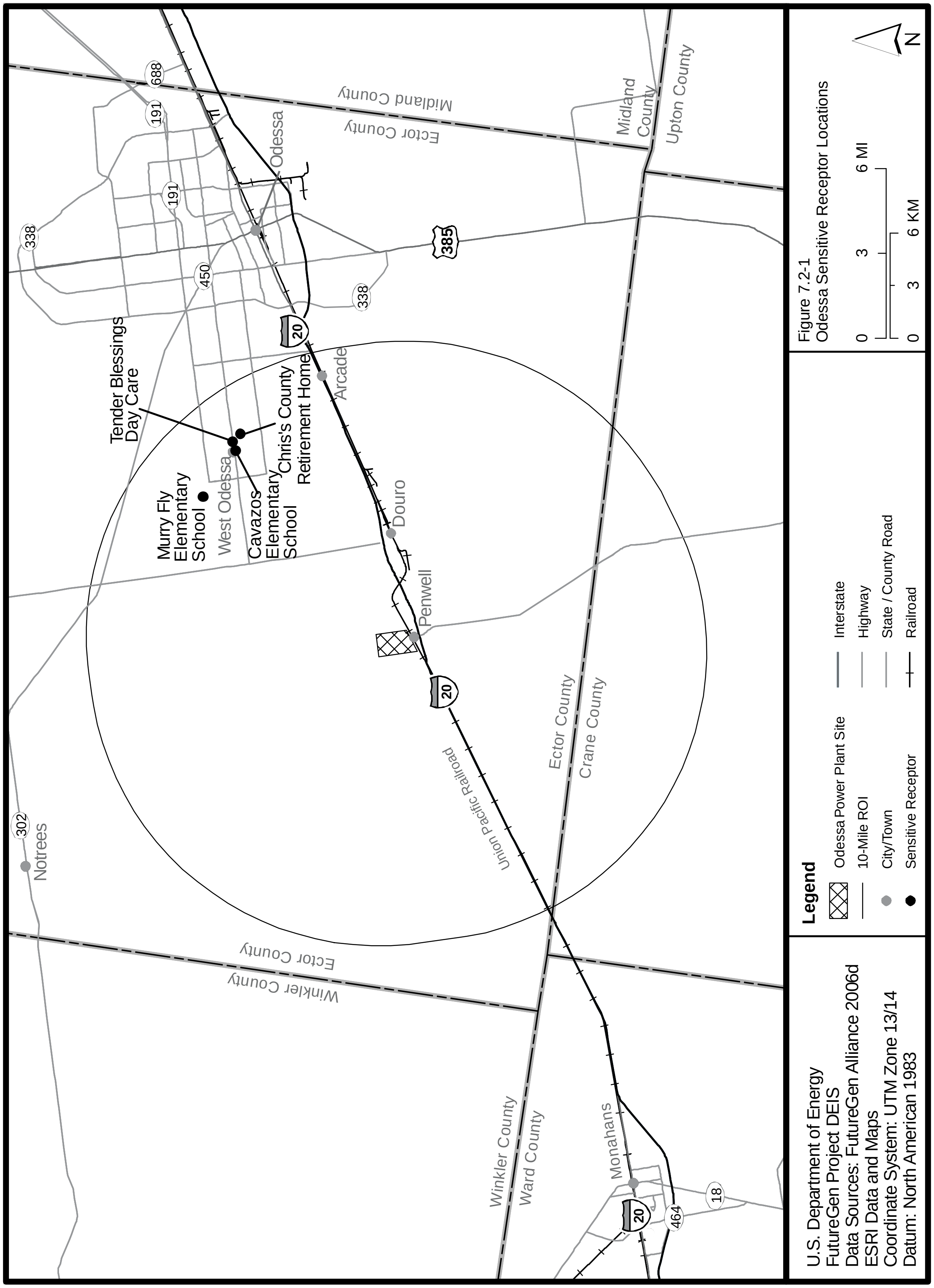
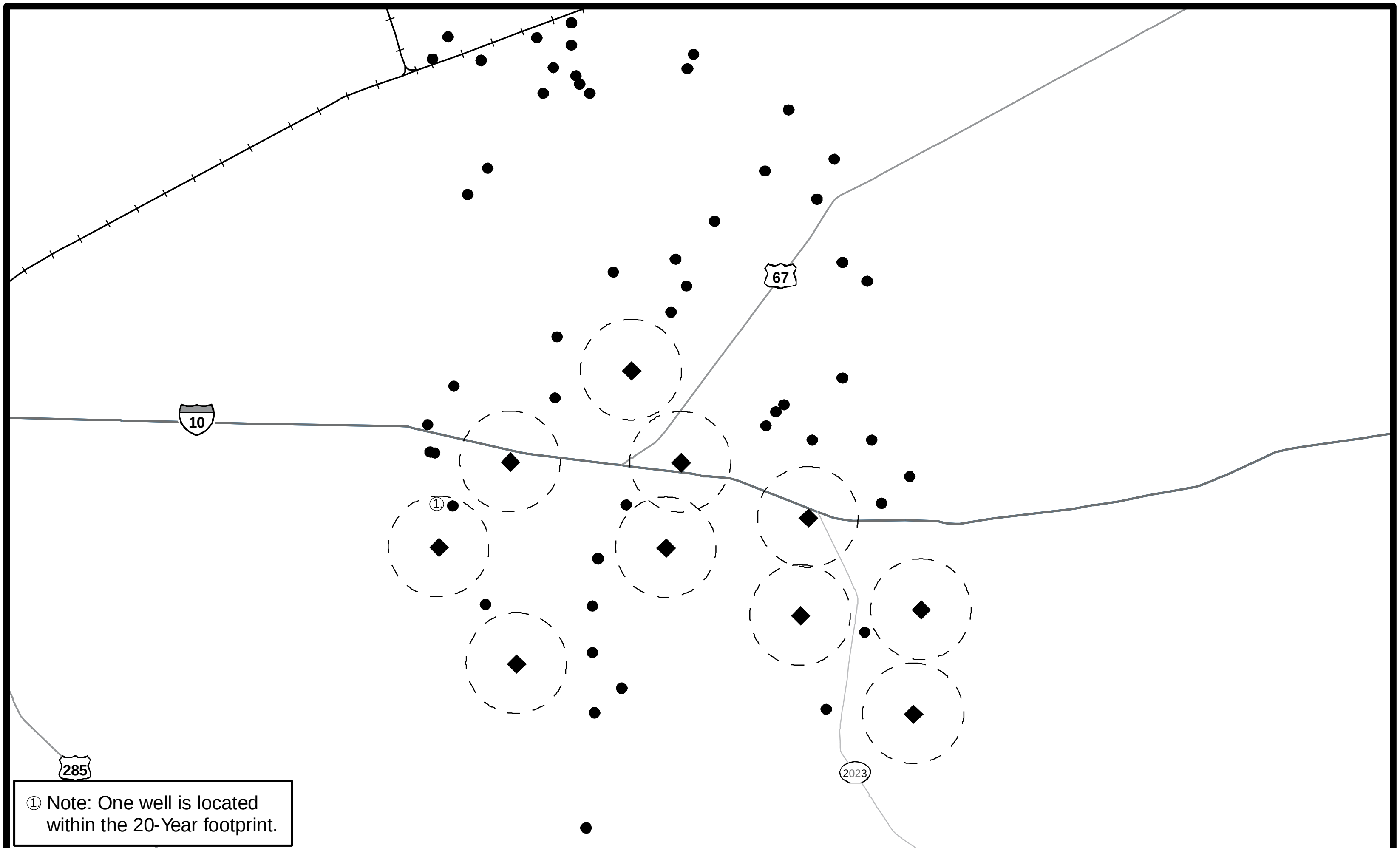


Figure 7.2-1
Odessa Sensitive Receptor Locations



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance 2006d
ESRI Data and Maps
Coordinate System: UTM Zone 13/14
Datum: North American 1983

Legend

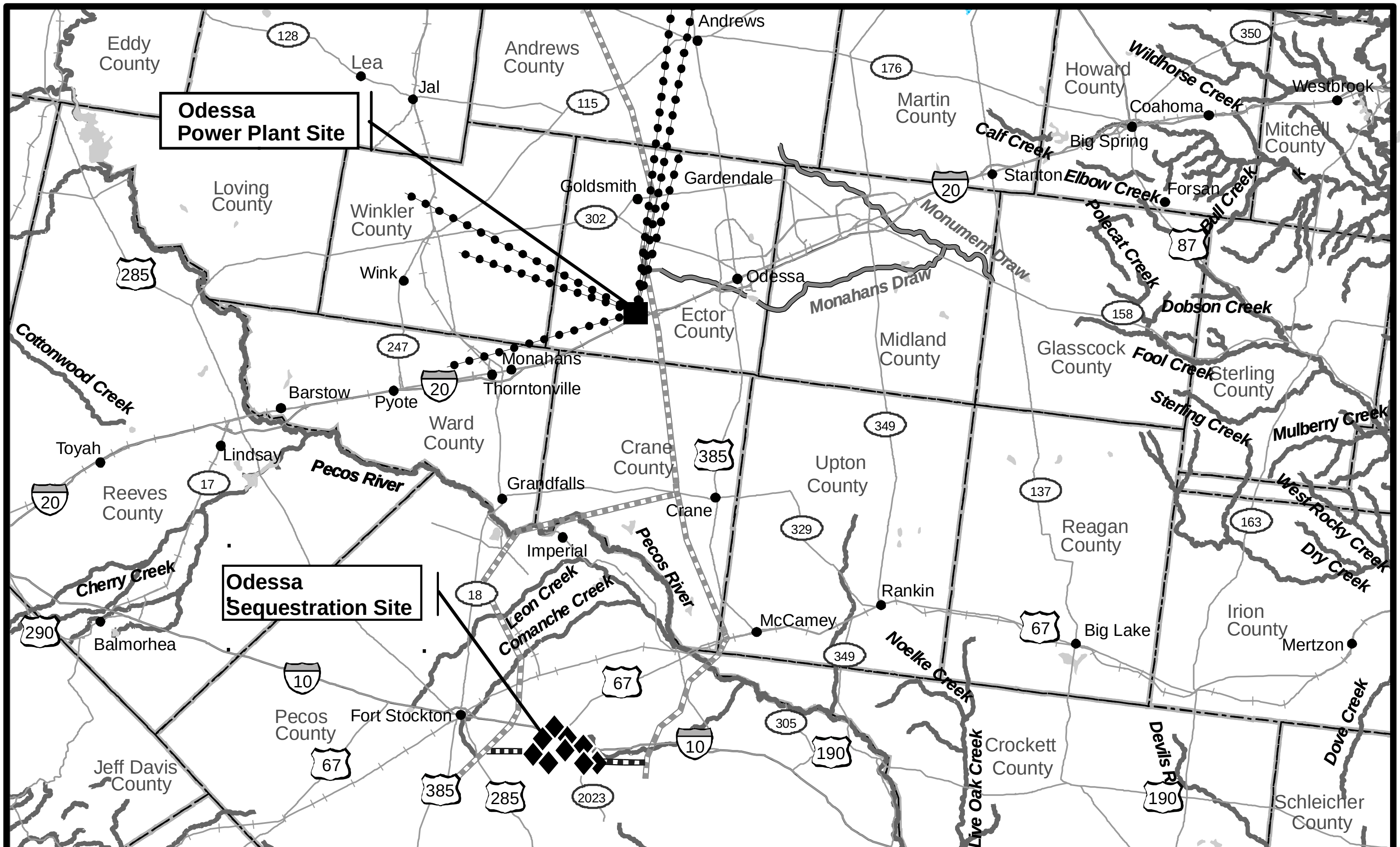
- ◆ Odessa Sequestration Site
- ● Existing Wells
- 20-Year plume at 2.5 MMT/year (1.0-Mile radius)
- Interstate
- Highway
- State/County Road
- Railroad

Figure 7.4-1
Plan View of the Lateral
Extent of the Subsurface ROI

0 2 4 MI

0 2 4 KM

N



U.S. Department of Energy
FutureGen Project DEIS
Data Sources: FutureGen Alliance, 2006d
Coordinate System: GCS North American 1927
Datum: North American 1927

Legend

- Odessa Power Plant Site
- Odessa Sequestration Site
- City/Town
- County Boundary
- Proposed Process Water
- Existing CO_2 Pipeline
- Proposed CO_2 Pipeline
- Road
- Railroad
- Stream

Figure 7.7-1
Odessa Surface Water Resources

0 5 10 MI
0 5 10 KM
N

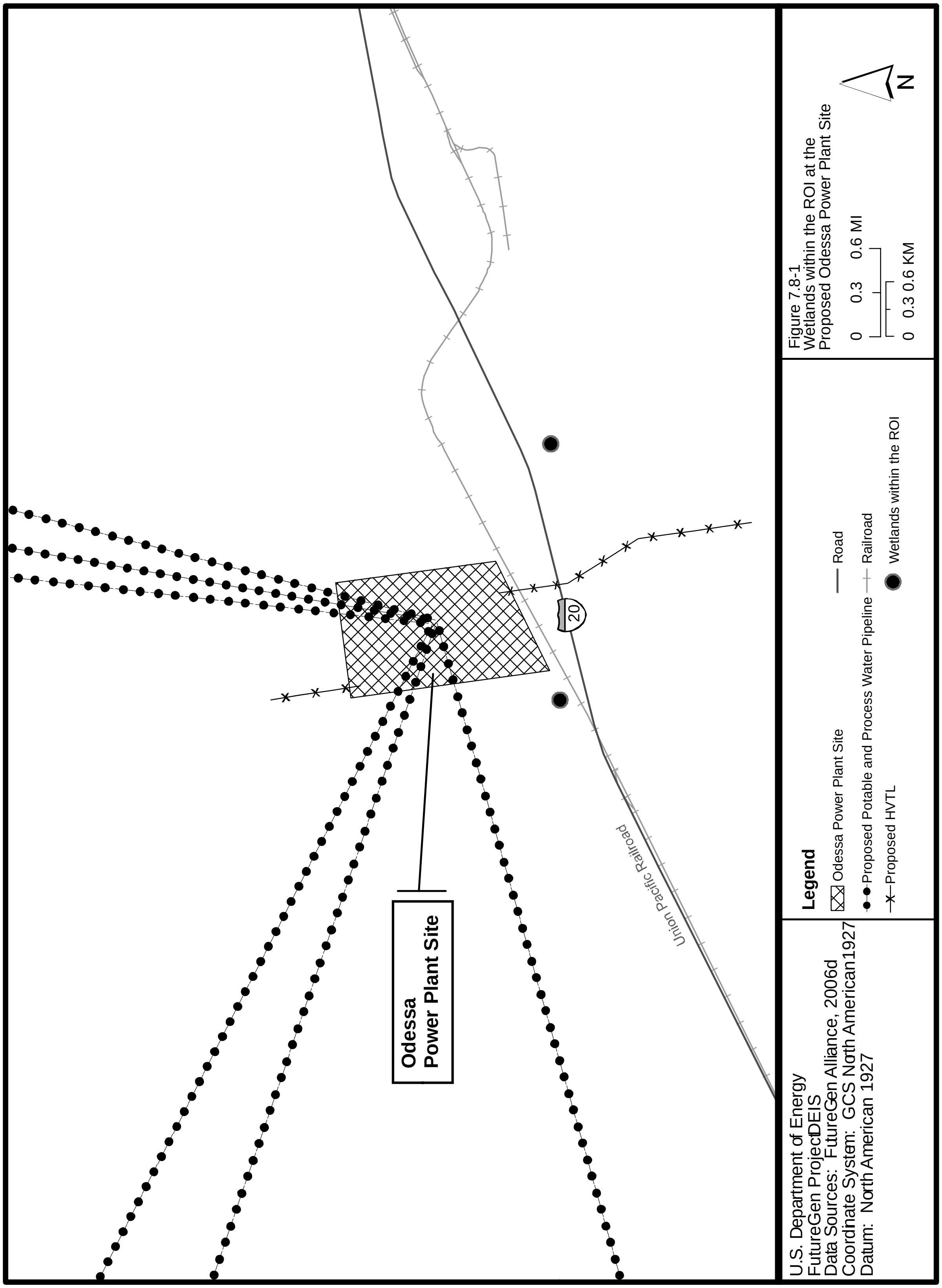
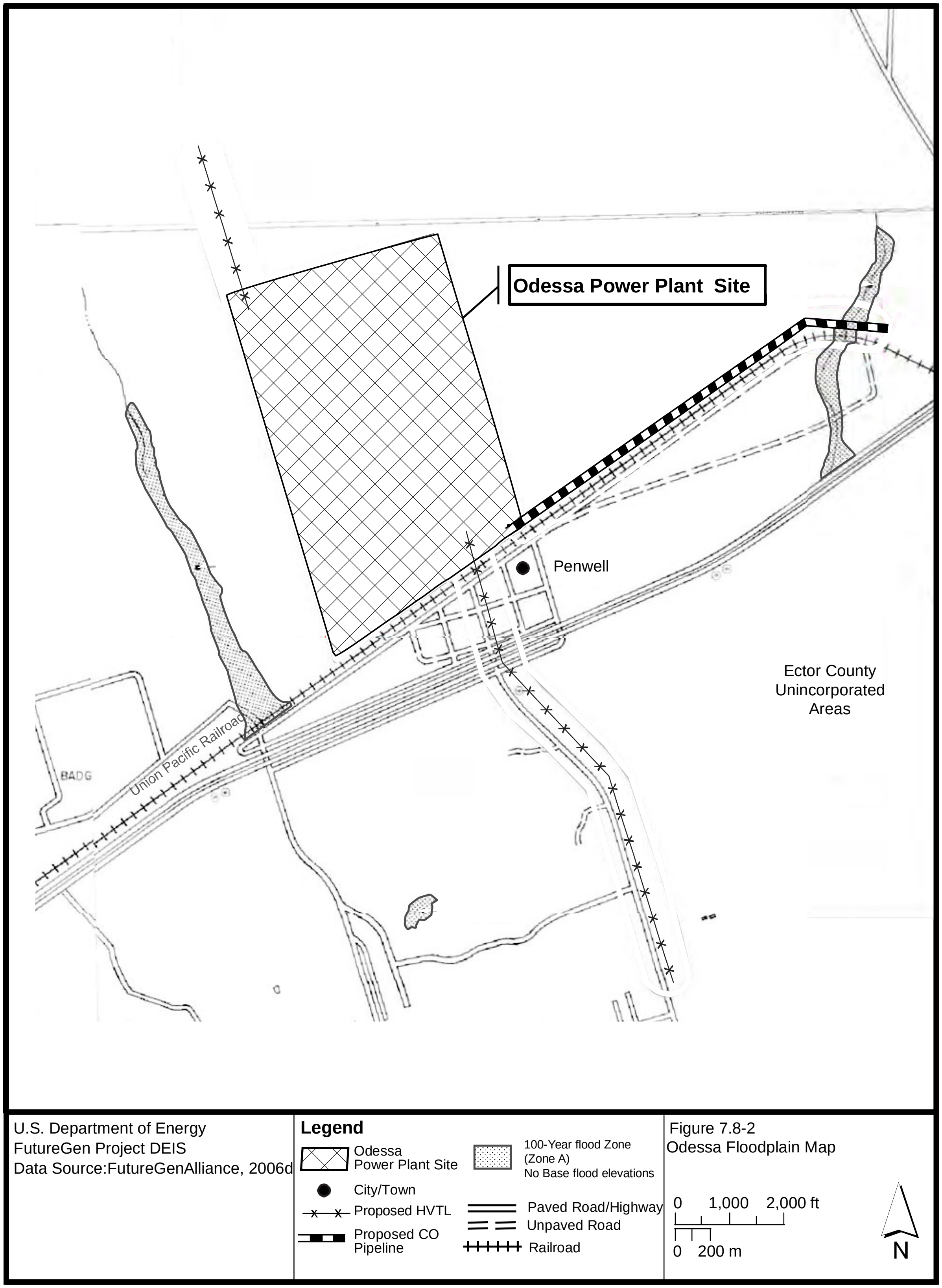


Figure 7.8-1
Wetlands within the ROI at the
Proposed Odessa Power Plant Site



U.S. Department of Energy
FutureGen Project DEIS
Data Source:FutureGenAlliance, 2006d

Figure 7.8-2
Odessa Floodplain Map

6. JEWETT SITE

6.1 CHAPTER OVERVIEW

This chapter provides information regarding the affected environment and the potential for impacts on each resource area in relation to construction and operation of the FutureGen Project at the proposed Jewett Site. To aid the reader and to properly address the complexity of the FutureGen Project, as well as the need to evaluate four sites (two in Illinois and two in Texas), this Environmental Impact Statement (EIS) was prepared as two separate volumes. Volume I of the EIS includes the purpose and need for the agency action, a description of the Proposed Action and Alternatives, and a summary of the potential environmental consequences. Volume II addresses the affected environment and potential impacts for each of the four proposed alternative sites. Presenting the affected environment immediately followed by the potential impacts on each resource area allows the reader to more easily understand the relationship between current site conditions and potential project impacts on a particular resource.

Volume II is organized by separate chapters for each proposed site: Chapter 4-Mattoon, Illinois; Chapter 5-Tuscola, Illinois; Chapter 6-Jewett, Texas; and Chapter 7-Odessa, Texas.

This chapter is organized by resource area as follows:

- 6.2 Air Quality
- 6.3 Climate and Meteorology
- 6.4 Geology
- 6.5 Physiography and Soils
- 6.6 Groundwater
- 6.7 Surface Water
- 6.8 Wetlands and Floodplains
- 6.9 Biological Resources
- 6.10 Cultural Resources
- 6.11 Land Use
- 6.12 Aesthetics
- 6.13 Transportation and Traffic
- 6.14 Noise and Vibration
- 6.15 Utility Systems
- 6.16 Materials and Waste Management
- 6.17 Human Health, Safety, and Accidents
- 6.18 Community Services
- 6.19 Socioeconomics
- 6.20 Environmental Justice

Each resource section provides an introduction, describes the region of influence (ROI) and the method of analysis, and discusses the affected environment and the environmental impacts from construction and operation of the FutureGen Project at the candidate site. The affected environment discussion describes the current conditions at the proposed power plant site, sequestration site, and utility and transportation corridors. This is followed by a discussion of potential construction and operational impacts. A summary and comparison of impacts for all four candidate sites are provided in the EIS Summary and in Chapter 3. Unavoidable adverse impacts, mitigation measures, and best management practices (BMPs) for all four candidate sites are also provided in Chapter 3.

6.1.1 POWER PLANT FOOTPRINT

The specific configuration of the power plant, rail loop, and access roads within the candidate sites would be determined after site selection, during the site-specific design phase. For purposes of analysis, the impact assessment for the proposed power plant site assumed a representative configuration or layout depicted in Chapter 2, Figure 2-18. The proposed power plant site would involve up to 200 acres (81 hectares) to house the power plant, coal and equipment storage, associated processing facilities, research facilities, railroad loop surrounding the power plant envelope, and a buffer zone; the site could ultimately be located anywhere within the larger power plant parcel. Therefore, impact discussions in this chapter identify environmentally sensitive areas to be avoided and address potential impacts to be evaluated, avoided, or mitigated within the entire power plant parcel.

6.1.2 NO-ACTION ALTERNATIVE

As discussed in Chapter 2, Proposed Action and Alternatives, the No-Action Alternative is treated in this EIS as the "No Build" Alternative. That is, under the No-Action Alternative, the Alliance would not undertake a FutureGen-like project in the absence of Department of Energy (DOE) funding assistance. In the unlikely event that the Alliance did undertake a FutureGen-like project in the absence of DOE funding assistance, impacts might be similar to those predicted in this EIS. However, the Alliance would not be subject to the oversight or the mitigation requirements of DOE.

One goal of the FutureGen Project would be to test and prove a technological path toward minimization of greenhouse gas (GHG) emissions from coal-fueled electric power plants. Should the FutureGen Project prove successful and the concept of carbon dioxide (CO_2) capture and geologic sequestration receive widespread application across the U.S. and around the world, the current trend of increasing CO_2 emissions to the atmosphere from coal-fueled power plants could be reduced. In the absence of concept proof, industry and governments may be unwilling to initiate all of the technological changes that would help to significantly reduce current trends and consequential increase of CO_2 concentrations in the Earth's atmosphere.

Impacts associated with the No-Action Alternative are provided in Chapter 3.

6.1.3 JEWETT SITE

Proposed Jewett Power Plant Site

(NRG Limestone Generating Station in the background)

The proposed Jewett Site is located in east-central Texas on approximately 400 acres (162 hectares) of formerly mined land northwest of the Town of Jewett. Key features of the Jewett Site are listed in Table 6-3. The proposed site is located at the intersection of Leon, Limestone, and Freestone counties, and bordered by U.S. Highway 79 (US 79) and Farm-to-Market Road (FM) 39. The Burlington Northern Santa Fe Railroad runs along the northeastern border of the proposed site. Potable water and process water would be obtained by drilling new wells on site or nearby. Sanitary wastewater would be treated through a new on-site wastewater treatment system. The proposed power plant would connect to the power grid via existing high voltage transmission lines. Natural gas would be delivered through an existing gas pipeline located at the northeastern corner of the proposed plant site. The proposed sequestration injection wells would be located on both private ranchland and state-owned prison land approximately 33 miles (53.1 kilometers) northeast of the proposed power plant site. A new CO_2 pipeline would be installed largely along existing ROWs, but would require some new ROWs. Following Table 6-3, Figures 6-9, 6-10, and 6-11 illustrate the Jewett Power Plant Site, utility corridors, and sequestration site, respectively.

6.10 CULTURAL RESOURCES

6.10.1 INTRODUCTION

Section 106 of the National Historic Preservation Act of 1996 (NHPA) and its implementing regulations at 36 CFR Part 800 (incorporating amendments effective August 5, 2004) require federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings.

Historic properties are a specific category of cultural resources. Cultural resources are any resources of a cultural nature (King, 1998). As defined at 36 CFR 800.16[l][1], a historic property is a cultural resource that is any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior. Historic properties include artifacts, records, and remains related to and located within such properties, as well as properties of traditional religious and cultural importance to Native American tribes or Native Hawaiian organizations, and properties that meet National Register criteria for evaluation (36 CFR 60.4).

36 CFR Part 800 outlines procedures to comply with NHPA Section 106. At 36 CFR Part 800(a), federal agencies are encouraged to coordinate Section 106 compliance with any steps taken to meet NEPA requirements. Federal agencies are to also coordinate their public participation, review, and analysis to meet the purposes and requirements of both NEPA and the NHPA in a timely and efficient manner. The Section 106 process has been initiated for this undertaking with the intent of coordinating that process with DOE's obligations under NEPA regarding cultural resources.

For purposes of this document, cultural resources are:

- Archaeological resources, including prehistoric and historic archaeological sites;
- Historic resources, including extant standing structures;
- Native American resources, including Traditional Cultural Properties (TCPs) important to Native American tribes; or
- Other cultural resources, including extant cemeteries and paleontological resources.

Participants in the Section 106 process include an agency official with jurisdiction over the FutureGen Project, the ACHP, consulting parties, and the public. Consulting parties include the State Historic Preservation Officer; Native American tribes and Native Hawaiian organizations; representatives of local

The **National Historic Preservation Act** of 1966 (16 USC 470), establishes a program for the preservation of historic properties throughout the Nation.

The **National Register** criteria for evaluation states that:

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

government; and applicants for federal assistance, permits, licenses, and other approvals. Additional consulting parties include individuals and organizations with a demonstrated interest in the FutureGen Project due to their legal or economic relation to the undertaking or affected properties, or their concern with effects of the undertakings on historic properties. In Texas, the State Historic Preservation Officer is the executive director of the Texas Historical Commission (THC).

If the proposed project would encompass any state-owned lands or use any public funding supplied by the State of Texas or its subdivisions, the project falls under the jurisdiction of the Antiquities Code of Texas (FG Alliance, 2006c). A building or site listed in the NRHP may also be designated as a State Archaeological Landmark (SAL) by the THC. A cultural resources planning document was published for the Central and Southern Planning Region of Texas (Mercado-Allinger et al., 1996), but there are currently no published planning documents for the portion of the state in which the proposed Jewett Power Plant Site is located.

6.10.1.1 Region of Influence

The ROI for cultural resources includes (1) the proposed power plant site and area within 1 mile (1.6 kilometers) of the proposed power plant site boundaries; (2) all related areas of new construction and those within 1 mile (1.6 kilometers) of said areas; and (3) the land area above the proposed sequestration reservoir(s). NHPA Section 106 states the correlate of the ROI is the Area of Potential Effects (APE).

> The **Area of Potential Effects** is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if such properties exist (36 CFR 800.16[d]).

Adverse effects to archaeological, paleontological, and cemetery resources are generally the result of direct impacts from ground disturbing activities. Therefore, the APE for such resources coincides with those areas where direct impacts from the construction and operation of the proposed facility would occur. Adverse effects to historic resources (i.e., standing structures) may occur through direct impacts that could change the character of a property's use or the physical features within a property's setting that contribute to its historic significance. Adverse effects may also occur through indirect impacts that could introduce visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features. For architectural resources, the APE encompasses the ROI as defined. TCPs may be subject to both direct and indirect impacts.

6.10.1.2 Method of Analysis

DOE reviewed the results of research and studies performed by the Alliance to determine the potential for impacts based on the following criteria:

- Archaeological Resources – Cause the potential for loss, isolation, or alteration of an archaeological resource eligible for NRHP listing.
- Historic Resources – Cause the potential for loss, isolation, or alteration of the character of a historic site or structure eligible for NRHP listing. Introduce visual, audible, or atmospheric elements that would adversely affect a historic resource eligible for NRHP listing.
- Native American Resources – Cause the potential for loss, isolation, or alteration of Native American resources, including graves, remains, and funerary objects. Introduce visual, audible, or atmospheric elements that would adversely affect the resource's use.
- Other Cultural Resources
  - Paleontological Resources – Cause the potential for loss, isolation, or alteration of a paleontological resource eligible for listing as a National Natural Landmark (NNL).
  - Cemeteries – Cause the potential for loss, isolation, or alteration of a cemetery.

The Alliance conducted archival research to determine whether cultural resources are known to exist or may exist within the APE/ROI. This research was conducted at the THC, Texas Archaeological Research Laboratory (TARL), Texas General Land Office (GLO); and in the THC's Texas Archaeological Sites Atlas Database (THC, 2006) and the National Park Service (NPS) National Register Information System (NPS, 2006a) database. The Alliance also reviewed of existing literature and publications pertaining to previous cultural resource studies in the region (FG Alliance, 2006c; Miller and Yost, 2006).

To identify the potential for TCPs, the Alliance used the NPS Native American Consultation Database (NPS, 2006b; Patterson, 2001). This study also incorporated background research and pedestrian reconnaissance survey results of the proposed power plant site conducted by Miller and Yost (2006). No survey in association with the proposed FutureGen Project was conducted within the ROI for related areas of new construction or land above the sequestration reservoir.

The Alliance conducted archival research at the University of Texas, Austin, Vertebrate Paleontology Laboratory and in the NPS NNL database to determine the potential for significant paleontological specimens within the ROI (NPS, 2004). The Alliance also interviewed Dr. Ernest Lundelius, retired director of the Vertebrate Paleontology Laboratory.

Paleontological resources are generally geological in nature rather than cultural, but several environmental regulations have been interpreted to include fossils as cultural resources. The Antiquities Act of 1906 refers to historic or prehistoric ruins or any objects of antiquity situated on lands owned or controlled by the U.S. Government, but the term "objects of antiquity" has been interpreted by the NPS, Bureau of Land Management (BLM), U.S. Forest Service (USFS), and other federal agencies to include fossils. An area rich in important fossil specimens can potentially be a NNL as defined in the NPS's National Registry of Natural Landmarks (NRNL) (36 CFR 62.2). Paleontological resources are not analyzed under NHPA Section 106 unless they are recovered within culturally related contexts (e.g., fossils included within human burial contexts, a mammoth kill site).

6.10.2 AFFECTED ENVIRONMENT

6.10.2.1 Archaeological Resources

Power Plant Site

Records maintained by the THC and TARL, and found in the Texas Archaeological Sites Atlas Database (THC, 2006), show that nearly the entire proposed power plant site and its ROI have been assessed as part of archaeological surveys associated with the Jewett Mine and the NRG Limestone Electric Generating Station. A pedestrian reconnaissance survey of the proposed power plant site was conducted by Miller and Yost (2006). The goal of that investigation was to assess current conditions on the proposed power plant site and the condition of previously recorded archaeological sites.

Fifty-seven archaeological or historical sites have been recorded in the proposed power plant site ROI, including 22 prehistoric sites, 28 historic sites, and 7 sites with both prehistoric and historic components (FG Alliance, 2006c). The prehistoric sites and components consist of open campsites and lithic scatters. Historic sites and components consist of homesteads, farmsteads, and mining sites. The NRHP and SAL status of these sites is undetermined.

Site 41LN95, the Evansville Mine, was recorded within the proposed power plant site as a historic lignite mine with evidence of collapsed pits and mine shafts, a railroad spur, cinder heaps, and brick and concrete structures. The site appears to have been destroyed by lignite mining (Miller and Yost, 2006).

Sites 41LN94 and 41FT88 were recorded within the ROI in close proximity to the proposed plant site. Site 41LN94 was a small log shack cleared by bulldozing. Site 41FT88 was the Walker Log Crib, a single pen log crib of hewn, split, and squared logs. Miller and Yost (2006) did not make observations regarding the condition of Site 41FT88, but there is a high likelihood that it has been destroyed by lignite mining (FG Alliance, 2006c).

Given that nearly the entire ROI for the proposed power plant site has been surveyed, and strip mining and land reclamation has extensively disturbed the entire property, including destruction of Sites 41LN94 and 41LN95, there appears to be an extremely low potential for the existence of intact, unrecorded prehistoric or historic sites within the proposed plant site.

Sequestration Site

Only a small percentage of the land above the sequestration reservoir has been previously surveyed. A total of 33 archaeological sites, mainly dating from the prehistoric period, have been recorded within the ROI for this area (see Table 6.10-1). Until injection well locations and other areas of ground disturbance in the proposed sequestration site are defined, it is not known if any of the archaeological sites would be directly impacted by the FutureGen Project.

Utility Corridors

Water Supply Pipeline

Records maintained by the THC and TARL, and found in the Texas Archaeological Sites Atlas Database (THC, 2006), show that the entire water supply pipeline corridor has been assessed as part of archaeological surveys associated with the Jewett Mine and the NRG Limestone Electric Generating Station.

Thirty-eight previously recorded archaeological sites are within the ROI for the water supply corridor, including 19 prehistoric sites, 15 historic sites, and four sites with both prehistoric and historic components. These numbers include sites within the proposed power plant ROI. The NRHP and SAL status of these sites is undetermined. The prehistoric sites and components consist of open campsites and lithic scatters. Historic sites and components consist of homesteads, farmsteads, and mining sites. Site 41LT130 is within the boundaries of the proposed construction corridor. The site is recorded as a prehistoric open campsite.

Given that nearly the entire ROI has been previously surveyed and the area is likely to be extensively disturbed from strip mining and land reclamation, there appears to be an extremely low potential for the existence of intact, unrecorded prehistoric or historic sites within the water supply ROI.

CO_2 Pipeline

A review for the six proposed CO_2 pipeline segments was conducted in records of the THC and TARL, and the Texas Archaeological Sites Atlas Database (THC, 2006). No field survey has been conducted in association with the proposed FutureGen Project undertaking. Table 6.10-1 summarizes the findings of the record review for the CO_2 pipeline segments and land above the proposed sequestration reservoir.

Approximately 75 percent of Segment A-C has been previously surveyed. A total of 141 archaeological sites have been recorded within this segment's ROI (see Table 6.10-1), three of which are within the proposed pipeline corridor. Site 41FT118 is a prehistoric site situated on a hilltop consisting of a crevice lined with hematite boulders, Site 41FT129 is the historic Taylor homestead, and Site 41FT390 is a multi-component prehistoric campsite and historic homestead. The NRHP/SAL status of these sites is undetermined and additional work was recommended at Site 41FT118.

Table 6.10-1. Summary of Previous Archaeological Investigations in CO_2 Pipeline Segments and Sequestration Sites

Segment	Previously Surveyed	Archaeological Sites	
A-C	Approximately 75 percent	Prehistoric	76
		Historic	45
		Multi-Component	18
		Unknown	2
		Total	141
B-C	Approximately 30 percent	Prehistoric	118
		Historic	45
		Multi-Component	20
		Unknown	1
		Total	184
C-D	Unspecified small percentage	Prehistoric	41
		Historic	12
		Multi-Component	5
		Unknown	3
		Total	61
D-F	Unspecified small percentage	Prehistoric	7
		Historic	1
		Multi-Component	-
		Unknown	1
		Total	9
F-G	Unspecified small percentage	Prehistoric	5
		Historic	1
		Multi-Component	-
		Unknown	-
		Total	6
F-H	Unspecified small percentage	Prehistoric	9
		Historic	1
		Multi-Component	3
		Unknown	12
		Total	25
Land above sequestration reservoir	Unspecified small percentage	Prehistoric	26
		Historic	1
		Multi-Component	2
		Unknown	4
		Total	33

Source: FG Alliance, 2006c.

Approximately 30 percent of Segment B-C has been previously surveyed. A total of 184 archaeological sites have been recorded within this segment's ROI (see Table 6.10-1), 15 of which are within the proposed pipeline corridor. Site 41LN3 is a prehistoric village that may contain burials. Sites 41LN39, 41LN40, 41FT75, 41FT383, and 41FT384 are prehistoric campsites. Sites 41FT81, 41FT335, and 41FT336 are prehistoric lithic scatters. Sites 41FT82 and 41FT334 are prehistoric campsites with associated lithic scatters. Sites 41LN53 and 41FT74 are historic homesteads. Site 41LN52 is the Evansville/Miller Cemetery. No site form was available for Site 41FT491. Site 41FT334 is potentially eligible for NRHP listing, and the NRHP/SAL status of the remaining sites is undetermined.

Only a small percentage of Segment C-D has been previously surveyed. A total of 61 archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1), 13 of which are within the proposed pipeline corridor. Sites 41FT62, 41FT73, 41FT75, 41FT82, 41FT374, 41FT383, and 41FT384 are prehistoric open campsites; Sites 41FT81 and 41FT380 are prehistoric lithic scatters; and Site 41FT33 is a prehistoric lithic procurement area. Site 41FT74 is a historic homestead. No site forms were available for Sites 41FT491 and 41FT493. Site 41FT33 is potentially eligible for NRHP listing in the NRHP, and the NRHP/SAL status of the remaining sites is undetermined.

Only a small percentage of Segment D-F has been previously surveyed. Nine archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1). Site 41FT494 is mapped within the proposed pipeline corridor. The site form for that archaeological site is unavailable.

Only a small percentage of Segment F-G has been previously surveyed. Six archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1), none of which are within the proposed pipeline corridor.

Only a small percentage of Segment F-H has been previously surveyed. A total of 25 archaeological sites have been recorded within the ROI for this segment (see Table 6.10-1), three of which are within the proposed pipeline corridor. Sites 41FT18 and 41FT495 are prehistoric open campsites and Site 41FT19 is a prehistoric shell midden. The NRHP/SAL status for these sites is undetermined.

6.10.2.2 Historic Resources

There are no documented historic properties listed in or potentially eligible for listing in the NRHP or SAL within the ROI for the proposed power plant site, related areas of new construction (including the water supply line corridor and the six proposed CO_2 corridors) or land above the proposed sequestration reservoir. However, there are four historical markers within the land above the proposed sequestration reservoir: the Harmony Baptist Church; the Jemison Quarters Cemetery; the Butler Soldiers' Home, C.S.A.; and the Mount Zion Methodist Church and Cemetery.

6.10.2.3 Native American Resources

No publicly documented TCPs are known to exist within the ROI for the proposed power plant site, related areas of new construction, or on the sequestration site. Consultation with federally recognized Native American tribes that may have an interest in the project area was initiated by letter on December 6, 2006 (see Appendix A). The following tribes received the consultation letter:

- The Caddo Nation of Oklahoma
- The Comanche Tribe of Oklahoma
- The Kiowa Tribe of Oklahoma
- The Tonkawa Tribe of Oklahoma
- The Wichita Tribe of Oklahoma
- The Alabama-Coushatta Tribe of Louisiana

Regional Directors for the Bureau of Indian Affairs in the Southern Plains Region also received a copy of the consultation letter. The Bureau of Indian Affairs Eastern Oklahoma Regional Office and the Southern Plains Regional Office both responded that they do not have jurisdiction over the alternative sites in Texas (see Appendix A). To date, one Native American tribe has responded to the consultation letter. The Alabama-Coushatta Tribe of Louisiana stated that they do not wish to continue receiving information on the project (see Appendix A).

6.10.2.4 Other Cultural Resources

Cemeteries

The presence of cemeteries within the project ROIs was determined through an examination of USGS topographic quadrangles, records maintained by the THC and TARL, and the Texas Archaeological Sites Atlas Database (THC, 2006).

Power Plant Site

Two formal cemeteries (the Wilson Chapel Cemetery [Site 41FT91] and the Evansville/Miller Cemetery [Site 41LN52]) and a third location (a historic homestead [Site 41LT143]) believed to contain two isolated graves are documented within the ROI of the proposed power plant. During Site 41LT143 documentation, local informants indicated that two ornamental bottles positioned on a fence-line near the homestead denoted the location of two graves associated with members of a family with the surname Connelly. None of these cemeteries are located within nor immediately adjacent to the boundaries of the proposed power plant site.

Sequestration Site

At least 11 formal cemeteries have been identified within the ROI for the proposed sequestration reservoir. The cemetaries include: Jimmison (or Jemison) Quarters, Tyus (Site 41FT285), Sand Hill, Maze, Pine Creek, Mount Zion, Antioch Church, Shiloh Church, Willis, Brooke, and Plum Creek. Until injection well locations and other areas of ground disturbance in the sequestration site are defined, it is not known if there would be potential for impact to these cemeteries.

Related Areas of New Construction – Water Supply Pipeline Corridor

Site 41LT143, a historic homestead that may contain two graves, is within the ROI of the water supply corridor. However, the site is neither within nor immediately adjacent to the proposed corridor boundaries.

Related Areas of New Construction – CO_2 Pipeline Corridor

There are four formal cemeteries within the ROI for Segment A-C: the Wilson Chapel Cemetery (Site 41FT91), the Old Spring Seat Church and Cemetery (Site 41FT85), the Post Oak Cemetery (Site 41FT120), and the Old Zion Cemetery (Site 41FT360). None of these cemeteries are located within or immediately adjacent to the proposed corridor boundaries for this segment.

There are four formal cemeteries within the ROI for Segment B-C: Jackson Cemetery, Sardis Church Cemetery, the Wilson Chapel Cemetery (Site 41FT91), and the Old Spring Seat Church and Cemetery (Site 41FT85). The Wilson Chapel Cemetery is within the proposed corridor boundary for this segment, and the remaining three cemeteries are outside of the corridor boundaries.

The Holly Grove Cemetery is located within the ROI of this segment, but is not located within the proposed corridor boundary.

The Shiloh Church Cemetery is located within the ROI of this segment, but is not located within the proposed corridor boundary.

The Tyus (Site 41FT285) and Sand Hill Cemeteries are formal cemeteries located within the ROI for this segment. Neither cemetery is located within the proposed corridor boundary.

Paleontological Resources

Paleontological resource investigations into the faunal prehistory of the region surrounding the proposed power plant site have been less productive of vertebrate remains than have many other parts of the state. The ROI for all aspects of the proposed FutureGen Project are situated at the very northwestern fringe of the Gulf Coastal Plains region (UTA, 1996). The Bureau of Economic Geology shows a transition from Mesozoic era deposits to Cenozoic era deposits some 25 miles (40.2 kilometers) west of the undertaking (UTA, 1970). Cretaceous period deposits from the transition between those the Mesozoic and Cenozoic have been lucrative to faunal specimen recovery. However, the ROIs are located in an Eocene epoch depositional band that is younger than Cretaceous deposits and traditionally unproductive of paleontological resources.

The likelihood of paleontological specimens existing within the ROI for the proposed FutureGen Project is low. A review of the NPS's NNL program indicated no recorded NNL properties within the ROI for this undertaking (NPS, 2004).

6.10.3 IMPACTS

6.10.3.1 Construction Impacts

Construction impacts to known or unknown cultural resources would primarily be direct and result in earth-moving activities that could destroy of some or all of a resource. As with any land-disturbing project, the potential for discovery or disturbance of unknown cultural resources exists, particularly in areas with no prior land disturbance. Although consultation with Native American tribes has not revealed the presence of TCPs in areas where disturbance could take place, this consultation is ongoing (see Appendix A) and the presence of these resources remains somewhat uncertain. However, before construction, previously unsurveyed areas with a potential for the presence of cultural resources would be surveyed. Potential impacts to cultural resources discovered during construction would be mitigated through avoidance or through other measures described in Table 3-14, including those identified through consultation with the THC or the respective Native American tribes.

Because ROIs for the proposed power plant site, sequestration site, and utility corridors are located in an area with relatively low potential for fossil specimens, there are no anticipated impacts to paleontological resources during construction.

Power Plant Site

The entire proposed power plant site and nearly the entire ROI for the plant site have been subject to cultural resource investigations. Miller and Yost (2006) found no historic archaeological sites, standing structures, or cemeteries within the ROI. In a letter dated August 28, 2006, from Horizon to the THC, a recommendation was made regarding the proposed power plant site that "a formal cultural resource survey of the proposed plant site is unwarranted" (FG Alliance, 2006c). The THC concurred with that recommendation with a concurrence line signature on that letter (FG Alliance, 2006c) (see Appendix A). Therefore, no direct or indirect impacts are anticipated from construction of the proposed power plant to cultural resources listed in or eligible for listing in the NRHP or SAL.

Sequestration Site

A small portion of the proposed sequestration site has been subject to cultural resource investigations and 33 archaeological sites, mainly prehistoric, have been recorded. Prehistoric archaeological sites in the region are typically located along major waterways and drainages. The presence of the Trinity River and numerous creeks, drainages, and lakes within the ROI suggests a high potential for additional unrecorded prehistoric archaeological sites in the ROI. The region has also been settled by Euro-Americans since at least the 1800s, and cemeteries and structures are shown on USGS topographic maps. Therefore, there is potential for direct impacts from construction at the proposed sequestration site to unrecorded archaeological and historical resources, including prehistoric or historic archaeological sites, standing structures, or cemeteries. In a letter dated October 5, 2006 (FG Alliance, 2006c), Horizon requested consultation and comments from the THC on cultural resource findings within the proposed sequestration site. In a letter dated October 31, 2006 (FG Alliance, 2006c), the THC concurred that archaeological survey of the sequestration site was needed (see Appendix A). Potential impacts would be mitigated through avoidance or through other measures, including those identified through further consultation with the THC.

Utility Corridors

In a letter dated October 5, 2006 (FG Alliance, 2006c), Horizon requested consultation and comments from the THC on the findings regarding cultural resources within areas of new construction that included the water supply pipeline and the CO_2 pipeline corridors. In a letter dated October 31, 2006 (FG Alliance 2006c), the THC concurred with recommendations, specifically that CO_2 pipeline segments C-D, D-F, F-G, and F-H would require surveys. CO_2 pipeline segments A-C and B-C, as well as the water pipeline corridor, would not require cultural resources surveys (see Appendix A).

Water Supply Pipeline

The proposed water supply corridor has been subject to cultural resources investigations that were associated with mining projects. Subsequent mining operations have likely destroyed any archaeological or historical sites in the area, including Site 41LT130, which was recorded within the proposed pipeline corridor. Therefore, there are no anticipated direct or indirect impacts from construction of the water supply pipeline to cultural resources listed in or eligible for listing in the NRHP or SAL.

CO_2 Pipeline

Portions of all proposed pipeline corridor segments were subjected to previous surveys that identified potential archaeological sites for which NRHP/SAL status has not been determined. Field assessments would be necessary to determine whether these sites have been affected by mining activity. Numerous creeks and drainage ways are present in the ROI for pipeline segments, and there is a long history of settlement by Euro Americans in the area. Hence, there is a moderate to high potential within the ROIs for additional unrecorded prehistoric and historic sites for which NRHP/SAL status has not been determined. Potential resources may be subject to impacts from construction that would be mitigated through avoidance or through other measures, including those identified through coordination with the THC. ROIs for seven corridor segments also include known cemeteries as listed below.

Approximately 75 percent of Segment A-C was previously surveyed. One hundred forty-one archaeological sites have been recorded within the ROI for this segment, three of which are within the proposed pipeline corridor. Four formal cemeteries are within the ROI for Segment A-C, but none are located within or immediately adjacent to the proposed corridor boundaries, and no construction impacts are anticipated.

Approximately 30 percent of Segment B-C was previously surveyed. One-hundred eighty-four archaeological sites have been recorded within the ROI for this segment, 15 of which are within the proposed pipeline corridor. Four formal cemeteries are within the ROI for Segment B-C, one of which is located within the proposed corridor boundaries and could be impacted by construction.

Approximately 30 percent of Segment C-D was previously surveyed. Sixty-one archaeological sites have been recorded within the ROI for this segment, 13 of which are within the proposed pipeline corridor. One formal cemetery is within the ROI for Segment C-D, but it is not located within or immediately adjacent to the proposed corridor boundaries, and no construction impacts are anticipated.

Only a small portion of the corridor for Segment D-F was previously surveyed. Nine archaeological sites have been recorded within the ROI for this segment, one of which is within the proposed pipeline corridor. One formal cemetery is within the ROI for Segment D-F, but it is outside the proposed corridor boundaries, and no construction impacts are anticipated.

Only a small portion of the corridor for Segment F-G was previously surveyed. Six archaeological sites have been recorded within the ROI for this segment, none of which are within the proposed pipeline corridor. Two formal cemeteries are within the ROI for Segment F-G; however, both are outside the proposed corridor boundaries, and no construction impacts are anticipated.

Only a small portion of the corridor for Segment F-H was previously surveyed. Twenty-five archaeological sites have been recorded within the ROI for this segment, three of which are within the proposed pipeline corridor. One formal cemetery is within the ROI for Segment F-H, but it is outside the proposed corridor boundaries, and no construction impacts are anticipated.

Transportation Corridors

The existing transportation infrastructure is adequate for the demands of the proposed FutureGen Project, and there are currently no plans to upgrade existing roads or railways or construct new ones. Therefore, there are no anticipated direct or indirect impacts associated with transportation infrastructure to cultural resources listed or eligible for listing in the NRHP or SAL.

6.10.3.2 Operational Impacts

The potential for impacts to cultural resources related to the proposed FutureGen Project operations would be limited to indirect impacts that could alter the historic character of a resource or its setting. There is minimal potential for direct impacts (e.g., a historic façade becoming coated with dust or ash) as a result of operations. Because there are no known cultural resources in areas where the proposed FutureGen Project operations would take place, no direct or indirect impacts are anticipated.

6.11 LAND USE

6.11.1 INTRODUCTION

This section identifies land uses that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site, sequestration site, and related corridors. It addresses the existing land use environment as well as potential effects on land uses and land ownership, relevant local and regional land use plans and zoning, airspace, public access and recreation sites, identified contaminated sites, and prime farmland. It also addresses potential effects related to subsurface rights for the proposed sequestration site.

6.11.1.1 Region of Influence

The ROI for land use includes the area within 1 mile (1.6 kilometers) of the boundaries of the proposed Jewett Power Plant Site, sequestration site, and all related areas of new construction, including proposed utility corridors.

6.11.1.2 Method of Analysis

DOE reviewed information provided in the Jewett EIV (FG Alliance, 2006c) and other relevant land use data, including the TPWD website, Federal Aviation Administration (FAA) regulations, and various databases related to contaminated sites. DOE also reviewed aerial photographs and made site visits to note site-specific land use characteristics. There are no comprehensive land use plans or zoning ordinances that apply to the proposed power plant site, sequestration site, or utility corridors.

DOE assessed the potential impacts based on whether the proposed FutureGen Project would:

- Introduce structures and uses that are incompatible with land uses on adjacent and nearby properties;
- Introduce structures or operations that require restrictions on current land uses on or adjacent to a proposed site;
- Conflict with a jurisdictional zoning ordinance; and
- Conflict with a local or regional land use plan or policy.

6.11.2 AFFECTED ENVIRONMENT

The proposed Jewett Power Plant Site consists of a contiguous 400-acre (162-hectare) parcel of land located in east-central Texas near the town of Jewett in the counties of Freestone, Limestone, and Leon. It is situated approximately 115 miles (185 kilometers) north of Houston, 105 miles (169 kilometers) south of Dallas, and 125 miles (201 kilometers) east of Austin. The cities of Corsicana, Waco, Huntsville and Bryan/College Station are located within a 75-mile (121-kilometer) radius of the site. Centerville, the county seat of Leon County, is 18 miles (29 kilometers) southeast of Jewett. The proposed power plant site is located in a generally rural area. No major surface water bodies are located on the proposed Jewett Power Plant Site or within its ROI. The closest significant water body is Lake Limestone, located approximately 3 miles (5 kilometers) west of the site.

The 400-acre (162-hectare) parcel that would house the power plant and associated facilities lies within a larger 3,000-acre (1,214-hectare) tract of land that is currently permitted and operating as a lignite coal mine. The existing Jewett Mine has been operated by Texas Westmoreland Coal Company (TWCC) for many years and provides lignite to the 1,700-megawatt (MW) NRG Limestone Electric

Generating Station mine-mouth power plant, which is located 0.5 mile (0.8 kilometer) northwest of the proposed Jewett Power Plant Site along FM 39. Adjoining properties are used for purposes related to energy production, including the Limestone power plant's ash management operations, which are located immediately north of the proposed Jewett Power Plant Site on the north side of CR 795. Other activities in the area consist of gas production and a mini-mill steel mill.

The proposed Jewett Sequestration Site is located in a rural area of Freestone and Anderson counties, approximately 33 miles (53 kilometers) northeast of the proposed Jewett Power Plant Site. The land area above the proposed sequestration reservoir is minimally developed both for surface or subsurface uses (ranch land, gas development, and agriculture). There are at least six small communities located on the land area above the proposed sequestration reservoir, including Plum Creek, Red Lake, Butler, Sand Hill, Massey Lake, and Harmony. The general area contains improved and unimproved roads, transmission lines, oil and gas pipelines, quarries, gravel pits, and borrow pits. The northeastern-most part of the proposed sequestration site is located within the TDCJ's prison farm system.

6.11.2.1 Local and Regional Land Use Plans

DOE identified no local or regional land use plans affecting the proposed Jewett Power Plant Site, sequestration site, or utility corridors. Limestone, Freestone, and Anderson counties have subdivision and roadway design and construction requirements that may need to be complied with, depending on final project design and specifics of land acquisition or division.

6.11.2.2 Zoning

There are no local zoning districts or development standards in effect in the area of the proposed Jewett Power Plant Site, sequestration site, or utility corridors.

6.11.2.3 Airspace

Two public airport facilities are located within a 25-mile (40-kilometer) radius of the proposed Jewett Power Plant Site. The closest public airport is the Teague Municipal Airport, located on FM 80 (also known as Airport Road) in Teague, Texas, approximately 16 miles (26 kilometers) from the proposed power plant site. The second closest airport is the Mexia-Limestone County Airport, located approximately 22 miles (35 kilometers) from the proposed power plant site in Mexia, Texas. The nearest airport to the sequestration site or any of the utility corridors is the Palestine Municipal Airport, located in the town of Palestine approximately 12 miles (19 kilometers) east of the northernmost sequestration area and CO_2 corridor segment F-H.

Because the proposed project would include a 250-foot (76-meter) heat recovery steam generator (HRSG) stack and 250-foot (76-meter) flare stack, DOE reviewed FAA regulations to determine their applicability to the project. In administering 14 CFR Part 77—Objects Affecting Navigable Airspace—the prime objectives of the FAA are to promote air safety and the efficient use of the navigable airspace. Pursuant to 14 CFR Part 77, the FAA must be notified if any of the following construction or alteration is being examined:

(1) Any construction or alteration of more than 200 feet (61 meters) in height above the ground level at its site.
(2) Any construction or alteration of greater height than an imaginary surface extending outward and upward at one of the following slopes:

(i) 100 to 1 for a horizontal distance of 20,000 feet (6,096 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with at least one runway more than 3,200 feet (975 meters) in actual length, excluding heliports.
(ii) 50 to 1 for a horizontal distance of 10,000 feet (3,048 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with its longest runway no more than 3,200 feet (975 meters) in actual length, excluding heliports (14 CFR 77).

6.11.2.4 Public Access Areas and Recreation

According to the TPWD website, there are no recreational areas within the proposed power plant site or its associated ROI (TPWD, 2006). The closest recreation area is Lake Limestone, located approximately 3 miles (5 kilometers) west of the site.

DOE personnel observed one recreational area within the proposed sequestration site. This is a roadside picnic area along westbound U.S. Highway 84, approximately 2 miles (3.2 kilometers) east of its intersection with FM 489. This highway pull-off rest stop has two canopied picnic tables and trash cans. There are no other facilities (e.g., restrooms) at this picnic area.

6.11.2.5 Contaminated Sites

Horizon Environmental Services, Inc., performed a Phase I Environmental Site Assessment (ESA) on the proposed Jewett Power Plant Site in April 2006 (Horizon Environmental Services, 2006). The site assessment indicates that metal storage sheds, diesel storage tanks, 55-gallon (208-liter) drums, waste/debris piles, tank trucks, chemical storage areas, storage areas for farm implements, and pipeline easements occur on the subject site in the area known as Site 2. During the site assessment, field personnel observed signs indicating surface spillage of petroleum-related substances, resulting in stained soils. According to the Phase I ESA, however, any resulting contamination was not determined to be significant with respect to siting another industrial facility on the site. The ESA recommended further soil testing before site construction to determine if any soil contamination might exceed the Texas Commission on Environmental Quality (TCEQ) Risk Reduction Standard for industrial sites (Horizon Environmental Services, 2006).

Based on a reporting of TCEQ information, there is no documented evidence of contaminated groundwater within 1 mile (1.6 kilometers) of the proposed Jewett Power Plant Site (FG Alliance, 2006c). If the Jewett site is selected for the FutureGen Project, groundwater samples would need to be taken and analyzed for hydrocarbons before construction to determine whether any contamination related to past operations at the site exists.

6.11.2.6 Land Ownership and Uses

Power Plant Site

The proposed Jewett Power Plant Site consists of mostly open land. The site and the general area around the site are located in a rural area where land use has been dominated historically by ranching, gas well activities, and lignite mining activities (Horizon Environmental Services, 2006). The proposed site is located southeast of the existing NRG Limestone Electric Generating Station and contains unimproved roads and structures related to gas well activities. The site also has electric utilities. General land use on the site and within its ROI is shown in the aerial photograph in Figure 6.11-1.

The property within the proposed Jewett Power Plant Site is currently held by NRG Texas and TWCC. All of the lands within the 1-mile (1.6-kilometer) ROI are also owned by NRG Texas or TWCC, and many of these parcels are leased by or otherwise have surface or subsurface rights with various other individuals.

Historical aerial photographs of the proposed power plant site, dated 1939, 1964, 1989, 1995, and 2004, indicate that the site consisted of grazing land and post oak woodland that changed very little from 1939 to 1964. Beginning in the 1980s, lignite surface mining activities began at the TWCC's Jewett Surface Lignite Mine (Jewett Mine) and continue to the present. The southern part of the proposed Jewett Power Plant Site consists of land that was previously surface-mined, and has since been reclaimed and stabilized in accordance with State of Texas (Railroad Commission of Texas, or RCT) post-mine reclamation regulations (Trouart, 2006). This part of the site is currently used as pasture land and for hay production. Much of the northern part of the site has not been mined and is currently wooded, primarily with deciduous trees (e.g., oak, willow) and scrub pine. The central part of the site includes an approximately 21-acre (8.5-hectare) white rock pad area, noted above as Site 2. This area currently is used as a contractor staging area, storage for mining and haybaling equipment, pipe-fusing area, and other general outdoor storage (Trouart, 2006). Two natural gas wells are located on the proposed power plant site, and one new gas well was being constructed near Site 2 at the time of DOE's November 2006 site visit.

In addition to the two gas wells on the proposed power plant site (and one under construction), RCT records indicate that a minimum of 35 gas wells are located within the ROI. Nine gas-gathering lines and one gas transmission line traverse the ROI at various locations. One of the lines at the northern end of the ROI is a sour gas (i.e., poison gas) line. At least 12 other gas pipelines traverse the ROI. Four of these pipelines traverse the proposed Jewett Power Plant Site (FG Alliance, 2006c). TWDB records reveal 23 documented water wells within the ROI (FG Alliance, 2006c). Two of these water wells are present within the boundaries of the proposed power plant site.

In addition to the NRG Limestone Electric Generating Station and the active TWCC Jewett Mine, which is located south of the proposed Jewett Power Plant Site, other notable land uses in the plant ROI include the NRG Limestone Electric Generating Station's ash management operations, which are located immediately north of the site on the north side of CR 795. These operations include ash handling facilities, a treatment plant, ash landfill, and other associated facilities. Much of the other adjacent land outside of the active plant area of the Jewett Mine has been reclaimed or is in the process of being reclaimed to prior uses in accordance with State of Texas regulations (Trouart, 2006).

No residences, churches, libraries, schools, prisons, nursing homes, hospitals, recreational areas, or historic areas are located within the ROI of the proposed Jewett Power Plant Site. One cemetery, the Wilson Chapel and Cemetery, is located along CR 795, just north of the proposed power plant site. This cemetery also has a building used for burial services, but no church services are held at this facility (Trouart, 2006).

Sequestration Site

The proposed sequestration site is located in rural areas of Freestone and Anderson counties, where land use has been dominated historically by ranching, farming, and oil and gas activities. The area is located on both sides of U.S. Highway 84, with the majority of the area situated north of the highway. Two of the three proposed injection sites are located on the Hill Ranch in Freestone County near the Trinity River, which divides Freestone and Anderson counties. The other proposed injection site is located on the north (or east) side of the Trinity River in Anderson County on land owned by the Texas

Department of Criminal Justice. The 22,000-acre (8,903-hectare) Department of Criminal Justice property includes five prison units, but a majority of the property is undeveloped. The general land area above the proposed sequestration reservoir appears to have experienced little commercial growth with the exception of cattle ranching and the cultivation of crops, as well as natural gas activities. The majority of the area consists of range and crop land with a low population density.

The Jewett EIV reports a minimum of 322 permitted or developed natural gas and oil wells existing within the land area above the proposed sequestration reservoir (FG Alliance, 2006c). A minimum of 21 natural gas pipeline systems, two crude oil pipeline systems, and one liquefied petroleum gas pipeline system exists within or cross the area. TWDB records indicate a minimum of 146 documented water wells occurring within the area (FG Alliance, 2006c). The actual number of wells may be somewhat lower than stated because the southernmost sequestration reservoir area (located generally south of the communities of Red Lake and Butler), which was included initially in project planning efforts, has since been withdrawn from the proposal by the site proponents (FG Alliance, 2006c).

The towns or communities of Harmony, Sand Hill, Red Lake, and Butler are located within the land area above the proposed sequestration reservoir. Butler has the area of highest population (67 residents), while Harmony has 12 residents (FG Alliance, 2006c). No populations were noted for the communities of Sand Hill or Red Lake in the 2000 federal Census data; however, DOE personnel observed a number of residences and farms along FM 489 and FM 360 in the community of Red Lake during the November 2006 site visit.

The Jewett EIV (FG Alliance, 2006c) reports that topographic maps show approximately 704 undifferentiated residential and commercial structures existing within the land area above the proposed Jewett Sequestration Reservoir (FG Alliance, 2006c). Thirteen churches, seven cemeteries, three schools, and one correctional facility (the previously mentioned prison farm) are shown within the area. No libraries, nursing homes, hospitals, or historic areas were shown to exist in the area. DOE personnel observed one recreational area (a roadside picnic area) during the November 2006 site visit along U.S. Highway 84 (see Section 6.11.2.5). In addition, DOE personnel observed two recreational areas (Red Lake Fishing & Hunting Club and Lake Burleson Fishing Club) along FM 360 near the community of Red Lake during the November 2006 site visit.

An offer has been made for a 50-year lease on the Jewett Sequestration Site, with 100 percent surface access and a waiver of mineral and water rights for at least three injection sites totaling approximately 1,550 acres (627 hectares) in two locations: approximately 1,125 acres (455 hectares) at one location and approximately 425 acres (172 hectares) at a second location (FG Alliance, 2006c). However, the status of this offer is uncertain, and complete title searches for subsurface rights at the injection sites, proposed Jewett Sequestration Reservoir, and a 0.25-mile (0.4-kilometer) buffer, including questions of who owns the rights to the reservoir and what those specific rights are, have not been researched for inclusion in this EIS. Entities with potential property rights include the land surface owners (e.g., the Hill Ranch and the State of Texas), mineral and resource interest owners, royalty owners, and reversionary interest owners (that is, owners of an interest in a reservoir that becomes effective at a specified time in the future [de Figueiredo et al., 2005]). Mineral and resource rights are discussed in further detail in Section 6.4.

Utility Corridors

Process Water Pipeline Corridor

The Alliance would obtain process water by installing wells on site or within less than 1 mile (1.6 kilometers) of the site. If needed, the process water supply pipeline from off-site wells would be located south of the existing NRG Limestone Electric Generating Station and a pipeline less than 1 mile

(1.6 kilometers) long would be constructed. The corridor contains unimproved roads and structures related to gas well activities. The corridor crosses FM 39, a north-to-south running county road that is the primary access for the Jewett Mine, NRG Limestone Electric Generating Station, and proposed Jewett Power Plant Site. The ROI appears to have experienced little commercial growth with the exception of surface lignite mining activities beginning in the 1980s. The process water line itself, as currently conceived, would cross from west to east, immediately north of the current entrance to the Jewett Mine and office. The majority of the ROI consists of range and crop land with a low population density. The ROI is located in an area of moderate gas well development.

The Jewett EIV (FG Alliance, 2006c) includes a summary comparison of the existing land uses within the proposed water supply corridor and ROI, including undifferentiated structures, pipelines, permitted or developed gas and oil wells, water wells, sensitive receptors, and major road crossings, as presented in Table 6.11-1. The summary is based on a review of topographic maps (FG Alliance, 2006c) and DOE site observations.

Table 6.11-1. Comparison of Land Uses Within the Potential Utility Corridors and their ROIs.

Corridor	Total Length (miles [kilometers])	Structures	Gas/Oil Pipelines	Gas/Oil Wells	Water Wells	Sensitive Receptors[1]	Major Roads[2]
Process Water Pipeline							
	<1 (<1.6)	40	9	28	13	0	1
CO_2 Pipeline							
Segment A-C	8 (12.9)	56	12	103	35	6	1
Segment B-C	14.5 (23.3)	63	11	85	16	6	1
Segment C-D	15 (24.1)	130	11	48	17	2	4
Segment D-F	9 (14.5)	45	11	25	13	1	1
Segment F-G	6 (9.7)	30	6	24	7	2	0
Segment F-H	14 (22.5)	30	8	28	4	1	0

[1] Sensitive Receptors = cemeteries, churches, libraries, schools, prisons, nursing homes, hospitals, recreation areas, or historic areas.
[2] Major Roads = State or County Roads.
Source: Compiled from FG Alliance, 2006c.

CO_2 Pipeline Corridor

All six segments of the proposed CO_2 pipeline corridor traverse very similar land uses and terrain. All are located in rural areas where land use has been and continues to be dominated by ranching, gas well activities, cropland, and in the southern parts of the ROI near the Jewett Mine, surface lignite mining. Almost all include crossings of unimproved roads and structures related to gas well activities or ranching. Most corridors and ROIs appear to have experienced little commercial growth. Other than the small communities identified previously, the area within the ROI has a low population density. Table 6.11-1 describes a summary comparison of the additional land uses within the proposed CO_2 pipeline corridor and ROI, including undifferentiated structures, pipelines, permitted or developed gas and oil wells, water wells, sensitive receptors, and major road crossings.

As shown in Table 6.11-1, most of the CO_2 pipeline segment ROIs contain a number of undifferentiated structures, gas or oil pipelines, permitted or developed gas or oil wells (primarily gas), water wells, and sensitive receptors. Of the two possible southern segments (A-C and B-C) (refer to Figures 2-10 and 2-11), B-C is approximately 6.5 miles (10.5 kilometers) longer, but contains fewer potential land use conflicts within the corridor, particularly gas and water wells. Segments A-C and B-C have the highest number of gas or oil wells within their ROIs of any of the segments, and the segment A-C has the highest number of water wells. Topographic maps indicate that there are generally more undifferentiated residential and commercial structures located within segment C-D than the other segments, while segments A-C and B-C have more sensitive non-residential/commercial receptors than the other segments. Four cemeteries and two churches also exist within the segment A-C and B-C corridor ROIs. Each of the other segments has at least one cemetery within its ROI, and segment C-D contains a recreational area.

The only nearby area of relatively high population density in the southern segment corridors is the town of Jewett, located 2.5 miles (4.0 kilometers) and 7 miles (11 kilometers) southeast of the B-C and A-C segment corridor ROIs, respectively. Jewett has a population of approximately 861 individuals (FG Alliance, 2006c). The nearby areas of comparatively high population density near the segment C-D corridor ROI are the towns of Buffalo and Dew, located 2 miles (3 kilometers) east and 4 miles (6 kilometers) northwest of the ROI, respectively. Buffalo has a population of approximately 1,804 and Dew has a population of approximately 71 (FG Alliance, 2006c). The northernmost part of the proposed CO_2 pipeline corridor (segment F-H, located north of the Trinity River in Anderson County) traverses the previously mentioned prison farm. Much of this land north of the Trinity River consists of ranch and cattle grazing lands with some wooded areas. A few small gas and oil operations are also located in this area. The most notable land use within the segment F-H corridor ROI is the prison farm itself. The entire property upon which the prison and the northeastern-most proposed injection site is located incorporates 22,000 acres (8,903 hectares), and features five individual prison units and associated facilities for approximately 15,000 inmates (Karriker, 2006).

6.11.2.7 Prime Farmland

The Gasil fine sandy loam is considered prime or unique farmland soil within the proposed Jewett Power Plant Site in Leon and Freestone Counties (NRCS, 2006). This soil type makes up only a small portion of the site. None of the soil types in Limestone County are considered prime or unique soil types (NRCS, 2006). Gasil, Padina, and Silstid fine sandy loams are considered prime farmland soils found within the proposed water supply pipeline corridor. Gasil, Rader, Silawa, and Oakwood fine sandy loams are considered prime farmland soils found within four of the six proposed CO_2 pipeline corridor segments (i.e., A-C, B-C, C-D, and F-G).

> The U.S. Department of Agriculture (**USDA**) Natural Resource Conservation Service's (**NRCS**) website defines prime farmland as land that has the best combination of physical characteristics for producing food, feed, forage, and oilseed crops and is available for these uses (NRCS, 2000).

6.11.3 IMPACTS

6.11.3.1 Construction Impacts

Power Plant Site

Construction of the FutureGen Project at the proposed Jewett Power Plant Site would have little notable impact on existing land use on the site or within the 1-mile (1.6-kilometer) ROI of the site. The project would require a laydown area for construction equipment and materials and would require construction of a power plant, rail loop, parking area, coal storage site, visitor center, and research and development center. Project construction would have a long-term impact on the current uses of pasture land, gas activities, and a storage/maintenance area associated with the adjacent TWCC Jewett Mine, which would need to be relocated on another part of the mine property. The use of at least two active gas wells and a new well on the project site could be lost or the wells relocated, depending on final design and layout of the facility. Project construction would have no impacts on any residents or sensitive receptors in the area. Only minor impacts to the TWCC mine and associated ash management operations located along FM 39 and CR 795 (possible temporary access delays during construction) could potentially occur. However, depending on final design and location of construction laydown areas, land use itself on these properties should not be affected.

As noted previously, the Phase I ESA (Horizon Environmental Services, 2006) recommended further soil testing before site construction to determine if any soil contamination might exceed the TCEQ Risk Reduction Standard for industrial sites. If evidence of a leak or spill is identified in soils during construction, project construction would cease while the area is assessed to determine the extent of contamination and to minimize potential health impacts to construction workers. Any such investigations and subsequent remediation, if necessary, would be performed in accordance with appropriate federal and state of Texas regulations.

Land use at the one cemetery located within the ROI (Wilson Chapel and Cemetery) would not be affected by construction of the plant at the proposed Jewett Power Plant Site. In addition, because the proposed site is well outside the 20,000-foot (6,096-meter) radius within which FAA Part 77 Airspace Obstruction Analysis is required, and because there is no military restricted use airspace in the vicinity of the proposed site, construction of the power plant would have no effect on airspace.

Sequestration Site

Construction at the Jewett Sequestration Site would have little direct or indirect impact in terms of the overall land use in the vicinity. Construction at the sequestration site would remove up to 10 acres (4 hectares) of land from a ranch or from the Texas Department of Criminal Justice depending upon the alternative chosen. Areas surrounding the injection wells and equipment would be available for future ranching or other uses. In addition, some areas of land would be lost temporarily to the construction of access roads needed to reach the injection sites. Together, fewer than 10 acres (4 hectares) would be required for wells and access. Construction schedules and requirements would be coordinated closely with the Texas Department of Criminal Justice and the Hill Ranch to minimize any potential temporary impacts on their operations. No other direct or indirect impacts to land uses, including land use plans, airspace, sensitive receptors, public access/recreation, or other uses are expected.

Utility Corridors

Construction at the proposed pipeline corridors would have temporary, minor effects on land use during the actual construction period due to trenching, equipment movement, and material laydown. The ability to use current lands for their existing uses (primarily cattle ranching and gas production) along each of the utility corridors would be temporarily lost during construction. This is particularly true for utilities requiring subsurface construction (i.e., water and CO_2 pipelines). CO_2 pipeline Segments A-C and F-G would likely have the largest area of temporary impact on existing land uses of any of the segments based solely on the amount of new ROW that would need to be constructed through otherwise undisturbed land; the remaining segments would generally follow existing ROW and would be expected to result in less temporary land use disturbance than the segments needing new ROW. For the two CO_2 pipeline segment options leading from the proposed power plant, Segment A-C, although shorter, would likely result in more disturbance than B-C because of the amount of new ROW needed.

The proposed Jewett Power Plant Site could connect to either a 345-kilovolt (kV) transmission line bordering the northwest boundary of the site with a new substation or a 138-kV line within about 2 miles

(3.2 kilometers) from the site (FG Alliance, 2006c). Construction to connect to the 138-kV line would result in temporary, minor effects on range land. After construction is complete, the range land would likely return to their current use.

Because of the open land, sparse population, and low number of structures located throughout all the corridors, DOE expects that the underground utilities could be routed in most places to avoid conflicts with any structures other than pipeline or road crossings. After construction is complete, the areas would be regraded and revegetated in accordance with conditions of any applicable permits, and most original land uses should be able to continue.

Transportation Corridors

Direct and indirect impacts from construction of the proposed transportation infrastructure would be similar to those for the power plant: a loss of some existing pasture land and range land, depending upon their locations. Leon County, in association with the TWCC, is scheduled to relocate a portion of FM 39, east of the proposed power plant site, farther to the north to allow TWCC to mine farther to the north (Trouart, 2006). This project is expected to start in 2008 and last for 1 year. Construction of any proposed project-related transportation infrastructure in this area south and east of the proposed Jewett Power Plant Site would be carefully coordinated with Leon County and TWCC to minimize any potential conflicts during construction.

As mentioned previously, Limestone, Freestone, and Anderson Counties have subdivision and roadway design and construction requirements that may need to be complied with, depending on final project design and specifics of land acquisition or division. Construction of project-related transportation infrastructure requiring compliance with any regulations would be coordinated with the county governments as deemed necessary.

6.11.3.2 Operational Impacts

Power Plant Site

Construction and operation of the FutureGen Project at the proposed Jewett Power Plant Site would permanently convert up to 200 acres (81 hectares) of existing pasture land located on the site to an industrial use that would be generally unusable for other purposes. Up to 3 oil and gas production wells would be displaced or relocated. The remaining 200 acres (81 hectares) on the site could continue to be used for existing purposes. However, there would be little notable impact on existing land use in the immediate site vicinity or within the 1-mile (1.6-kilometer) ROI of the site. The proposed Jewett Power Plant would be compatible with the land uses near the plant site because the majority of the land within the ROI is used for industrial purposes (i.e., coal production, ash management, power production, and gas well activities). Other than these compatible operations, little other development is present within the ROI.

The use of the Wilson Cemetery located north of the site, rarely used in recent years (Trouart, 2006), would not be affected by the proposed power plant and could continue its minimal operations without impact. The proposed Jewett Power Plant Site is well outside the 20,000-foot (6,096-meter) radius within which FAA Part 77 Airspace Obstruction Analysis applies (FG Alliance, 2006c). There is no military restricted use airspace near the proposed power plant, sequestration reservoir, utility corridors, or areas of related construction. Project operation would, therefore, have no appreciable impact on the use of airspace. However, signal lights would be required atop the HRSG and flare stacks because FAA regulations require such lighting for any structure more than 200 feet (61 meters) tall (14 CFR Part 77).

Only a very small amount (less than 5 acres (2 hectares), if any) of prime or unique farmland soils (Gasil fine sandy loam) located on the site could potentially be affected.

Sequestration Site

Operation of the injection sites would be compatible with the overall land use in the vicinity. Small areas at the injection sites and access roads to the injection sites (less than 10 acres [4 hectares] overall) would be unavailable for future ranching or other uses. The Texas Administrative Code (Title 30, Chapter 331) and the State Water Code (Chapter 27) contain requirements relating to underground injection wells and controls. These regulations would need to be adhered to during project construction and operation. No other impacts to land uses, including land use plans, airspace, sensitive receptors, or public access/recreation would be expected. While some soils considered to be prime farmland are located within the lands above the sequestration reservoir, most of this land is currently used as ranchland, so little or no prime farmland and no agricultural use would be affected.

An offer has been made for a 50-year lease on the Jewett Sequestration Site lands with 100 percent surface access and a waiver of mineral and water rights for at least three injection sites totaling approximately 1,550 acres (626 hectares) in two locations (FG Alliance, 2006c). However, the status of this offer and any other conditions are uncertain at this time. Any applicable subsurface rights for minerals or oil and gas resources would still need to be acquired or otherwise negotiated.

Utility Corridors

Depending on the depth below grade of the underground utilities and the need to retain a cleared ROW, it is likely that most lands above the proposed utility corridors and related areas of construction could continue to be used for ranching, farming, or any passive uses. Any existing or future subsurface activities (e.g., gas drilling or mining) would not be possible in the immediate utility corridor once the utilities were installed. The use of potential prime farmland soils (i.e., Gasil, Rader, Silawa, Silstid, Padina, and Oakwood fine sandy loams found within the proposed water supply corridor ROI and four of the six proposed CO_2 pipeline corridors), if any, could potentially be lost to active farming. As discussed previously, however, the majority of lands within the CO_2 pipeline corridors are range land; therefore, minimal impacts to prime farmland soils would be expected.

If the new 2-mile (3.2-kilometer) transmission line is built, permanent loss of land would only occur at the pole locations.

Transportation Corridors

The proposed transportation infrastructure could result in the loss of a very small amount of ranch land and pasture land on the proposed Jewett Power Plant Site and in areas where access roads would be needed to reach the sequestration injection sites and utility ROW. The new transportation infrastructure to the power plant site (e.g., railroad spurs and access roads) would occur on the site itself, so additional offsite impacts would be minimal.

6.12 AESTHETICS

6.12.1 INTRODUCTION

This section identifies viewsheds and scenic resources that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site, sequestration site, and related corridors. It addresses the appearance of project features from points where those features would be visible to the general public, and takes into account project characteristics such as light and glare. The distance from which the proposed power plant and associated facilities would be visible depends upon the height of the structures associated with the facilities, including buildings, towers, and electrical transmission lines, as well as upon the presence of existing intervening structures and local topography. Effects on visual resources can result from alterations to the landscape, especially near sensitive viewpoints, or an increase in light pollution.

6.12.1.1 Region of Influence

The ROIs for aesthetic resources include areas from which the proposed Jewett Power Plant Site and all related areas of new construction would be visible. The ROIs are defined as 10 miles (16.1 kilometers) surrounding the proposed power plant site, 1 mile (1.6 kilometers) around the proposed sequestration site and on either side of the proposed electrical transmission line corridor, and immediately adjacent to the proposed underground utility corridors.

6.12.1.2 Method of Analysis

DOE identified land uses and potential sensitive receptors in the ROIs of the proposed power plant site, sequestration site, and utility corridors based on site visits and a review of information included in the Jewett EIV (FG Alliance, 2006c). The EIV includes analyses of 1964 and 1982 topographic maps as well as recent aerial photography (USDA-FSA-APFO, 2004). DOE used two approaches to assess the potential impacts of the proposed FutureGen Project on aesthetic resources. First, DOE applied Geographic Information Systems (GIS)-based terrain modeling, combined with height information associated with the proposed project facilities (i.e., the 250-foot [76-meter] HRSG stack and 250-foot [76-meter] flare stack), to determine the distance from which the facilities could be seen if there were no intervening structures or vegetation to screen the view. Secondly, DOE considered two artistic concepts of the proposed FutureGen Power Plant to depict a range of aesthetic approaches to the project. One concept is of a typical power plant with minimal screening and architectural design, while the second concept includes extensive screening and architectural design. DOE compared and contrasted the two concepts to assess the relative level of visual intrusiveness for each concept.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect a national, state, or local park or recreation area;
- Degrade or diminish a federal, state, or local scenic resource;
- Create visual intrusions or visual contrasts affecting the quality of a landscape; and
- Cause a change in a BLM Visual Resource Management classification.

6.12.2 AFFECTED ENVIRONMENT

6.12.2.1 Landscape Character

Natural and human-created features that give the landscape its character include topographic features, vegetation, and existing structures. The topography of the ROI consists of undulating hills with elevations ranging from 420 to 500 feet (128.0 to 152.4 meters) above mean sea level. The highest elevation of the proposed Jewett Power Plant Site is located on the northeastern side, while the lower elevations are located along Red Hollow Creek on the southeastern side.

Prior to mining activities, the vegetation around the proposed Jewett Power Plant Site consisted of oak woodlands and pasture land. Today, the vegetation at the site is primarily post-mine reclamation grasses. A more detailed description of the vegetation of the proposed Jewett Power Plant Site is provided in Section 6.9.

The proposed Jewett Power Plant Site and surrounding environs are situated in a rural area characterized by ranching, gas well activity, and surface lignite mining. Unimproved roads and structures related to gas well activities are located on the site. Existing industrial structures, including the NRG Limestone Electric Generating Station less than 0.5 mile (0.8 kilometer) west of the site (Figure 6.12-1) and overhead electric utilities lines, have already affected the character of the surrounding landscape.

Additionally, mining activities continue approximately 2 miles (3.2 kilometers) to the northeast and less than 1 mile (1.6 kilometers) to the southwest of the proposed Jewett Power Plant Site. Consequently, previous disturbances have altered the natural characteristics of the landscape.

Figure 6.12-1. Proposed Jewett Power Plant Site with NRG Limestone Electric Generating Station in the Background

Structures within the ROI for the Jewett Power Plant Site include the NRG Limestone Electric Generating Station facilities, roadways, a railroad, cemeteries, and a church. As previously mentioned, the presence of the stacks and other tall buildings associated with the NRG Limestone Electric Generating Station within the ROI has already altered character of the natural landscape. Several local roadways are situated within the ROI, including FM 39, CR 795, and numerous other improved roads associated with the NRG Limestone Electric Generating Station, mining activities, and well pads. The Burlington Northern Santa Fe Railroad line runs along the east side of the ROI, and a spur of the railroad runs along the northern side of the proposed Jewett Power Plant Site. Based on aerial photography, no modern residential structures appear to be located within the ROI for visual effects.

No BLM or USFS Visual Resources Management classifications or designated scenic vistas are located within the visual resources ROI (Herrera, 2006). According to the TPWD website, there are no recreational areas within the proposed Jewett Power Plant Site or its associated ROI (TPWD, 2006).

The proposed Jewett Sequestration Site is located in a rural area where land use has been dominated historically by ranching, farming, and oil and gas activities. The area is located on both sides of US 84, with most of the area situated south of US 84. Pending final design and land agreements, this land may extend further north into Anderson County to encompass considerable land currently owned by the TDCJ (see Figure 6.12-2). The area appears to have experienced little commercial growth with the exception of cattle ranching and the cultivation of crops, as well as natural gas activities. The majority of the area consists of range and crop land with a low population density, although eight small communities or towns are located on the land area above the proposed sequestration reservoir (FG Alliance, 2006c).

Figure 6.12-2. Proposed Jewett Sequestration Site

The related areas of new construction associated with the proposed Jewett Power Plant Site include a proposed water supply pipeline corridor and seven segments of the proposed CO_2 pipeline corridor. The proposed 52- to 59-mile (83.7- to 95.0-kilometer) long CO_2 pipeline corridor passes through undulating hills in primarily undeveloped areas dominated by rolling hills and post oak woodland vegetation. Developments include improved and unimproved roads, transmission lines, pipelines, gravel pits, drill holes, and oil and gas development. The ROI of segment F-H also includes a landing strip, an athletic field, a sewage disposal facility, and a pumping station (FG Alliance, 2006c).

6.12.2.2 Light Pollution Regulations

Light pollution is defined as the night sky glow cast by the scattering of artificial light in the atmosphere. According to the online database of Texas laws and regulations maintained by Texas Legislation Online (TLO), Texas has three state codes referencing light pollution (TLO, 2006):

- In 2001, Local Government Code Chapter 240, Subchapter B, authorized counties to regulate outdoor lighting in the vicinity of the George Observatory near Houston, Stephen F. Austin University at Nacogdoches, and within a 57-mile (91.7-kilometer) radius of the McDonald Observatory in southwest Texas.
- In 1999, Health and Safety Code Subtitle F, Light Pollution, Chapter 425, stated that all new or replacement state-funded outdoor lighting must be from cutoff luminaries if the rated output of the fixtures is greater than 1,800 lumens.
- In 1995, Transportation Code Chapter 315, Subchapter A, authorized municipalities to regulate artificial lighting and outlined their responsibilities. This did not include unincorporated areas in counties.

These state codes do not apply to the area within the proposed Jewett Power Plant Site or associated ROI. Additionally, within the tri-county (Freestone, Limestone, and Leon) area, there are no local ordinances, plans, or goals for light pollution abatement (Wilkinson, 2006).

6.12.3 IMPACTS

6.12.3.1 Construction Impacts

Power Plant Site

During construction at the proposed Jewett Power Plant Site, only workers at the nearby mine and power plant would have an unobstructed view of the construction site and equipment moving on and off the site during the 44-month construction period. Construction would not be visible to the general public.

Given the scale of past mining and oil extraction activities in the area, it is unlikely that any historic structures in the Jewett Power Plant Site ROI are preserved enough to be protected. Furthermore, the presence of the NRG Limestone Electric Generating Station and its associated facilities has already altered the viewshed of these structures.

Sequestration Site

Construction at the proposed Jewett Sequestration Site would not be visible to the general public.

Utility Corridors

During construction along the proposed water supply and CO_2 pipeline corridors, equipment used for trenching, pipe laying, and other construction activities would be visible only to viewers immediately adjacent to the pipeline corridors and construction laydown areas. This would constitute a direct short-term impact on those nearest the corridors during the construction period, which would vary depending upon the number of construction crews and the selected corridor. A single crew laying 1 mile (1.6 kilometers) of pipeline per week (FG Alliance, 2006c) would complete CO_2 pipeline construction in 25 to 45 weeks and water supply pipeline construction in about one week.

Transportation Corridors

Once construction is complete, the transportation corridors would appear similar to other transportation infrastructure already in place and would not cause an additional visual impact.

6.12.3.2 Operational Impacts

Power Plant Site

Major equipment for the power plant would include the gasifier and turbines, a 250-foot (76-meter) tall HRSG stack, a 250-foot (76-meter) tall flare stack, synthesis gas cleanup facilities, coal conveyance and storage systems, and particulate filtration systems. Additionally, the project would include on-site infrastructure, such as a rail loop for coal delivery, plant roads and parking areas, administration buildings, ash handling and storage facilities, water and wastewater treatment systems, and electrical transmission lines, towers, and a substation.

Once construction is complete, the tallest structures associated with the proposed Jewett Power Plant Site would include the main building, stacks, and communications towers. The maximum proposed height of the facility is 250 feet (76 meters). DOE's terrain analysis indicates that the facility would be visible from a distance of 7 to 8 miles (11.3 to 12.9 kilometers). The proposed FutureGen Power Plant would have aesthetic characteristics similar to other industrial facilities in the immediate area, such as the NRG Limestone Electric Generating Station.

For those viewing the power plant from the adjacent roads or nearby industrial facilities or from a greater distance, the appearance of the facilities would depend upon the degree of architectural development and visual mitigation included in the design. Figures 6.12-3 and 6.12-4 show two points on a range of conceptual IGCC plant designs. Figure 6.12-3 is an artist's rendering of an IGCC facility proposed for Orlando, Florida (DOE, 2006a). This rendering shows a plant with minimal screening or enclosure of the facility components. Figure 6.12-4 is the artist's conceptual design of the proposed FutureGen Power Plant that was used during the scoping process for this EIS (DOE, 2006b). This rendering shows a plant with a high degree of architectural design, including enclosure of most of the plant features.

The proposed facility is still in the design stage, and decisions have not yet been made about the final configuration or appearance of the power plant. A plant design similar to Figure 6.12-3 would create a more industrial appearance, similar to the existing NRG Limestone Electric Generating Station. Although still very large in scale, a plant design similar to Figure 6.12-4 would have a less industrial appearance, and would be visually less intrusive than the plant design shown in Figure 6.12-3.

Regardless of the final appearance of the proposed power plant, plant lighting and the flare would be highly visible at night. The facility, including the vapor plumes, would likely be visible for a comparable distance. Intervening buildings, vegetation, and topography would reduce the visibility of the plant from some vantage points. The lights would likely be visible for approximately 7 to 8 miles (11.3 to 12.9 kilometers) or more at night.

Because there are no BLM visual resource management classifications or designated scenic vistas in the power plant site, sequestration site, or transmission line ROIs, the project would not have any effect on those classifications. Additionally, because there are no light pollution standards applicable in the area, the plant would create no conflict with such standards. Nonetheless, the choice of appropriate outdoor lighting and the use of various design mitigation measures (e.g., luminaries with controlled candela distributions, well-shielded or hooded lighting, directional lighting) could reduce the effects of nighttime glare associated with plant lighting.

Sequestration Site

Once construction is complete, the tallest structures associated with the proposed Jewett Sequestration Site would be about 10 feet (3.0 meters) tall. Some wellheads would be visible to those passing by on the adjacent roads, but would not be visible from a distance. Thus, the project would create a direct, minor visual intrusion for those nearest the site.

Utility Corridors

Once construction is complete, the pipeline corridors would be revegetated and would have essentially the same appearance as before construction, except in areas where trees were removed. The pipeline corridor would be kept clear of trees for the life of the project. Pump stations or compressor stations that could be associated with proposed pipelines would be noticeable to those traveling on adjacent roads.

Transportation Corridors

Once construction is completed and the power plant is in operation, the visual impacts would be similar to those for the power plant site, sequestration site, and utility corridors.

INTENTIONALLY LEFT BLANK

6.13 TRANSPORTATION AND TRAFFIC

6.13.1 INTRODUCTION

This section discusses the roadway and railroad networks that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site.

6.13.1.1 Region of Influence

The ROI for the proposed Jewett Power Plant Site includes roadways within a 50-mile (80.5-kilometer) radius of the boundaries of the site (see Figure 6.13-1). The site is located just northwest of the town of Jewett. The proposed Jewett Site is bordered by FM 39 and can be accessed via US 79, and is 12 miles (19.3 kilometers) from I-45. Because most vehicle trips to the site would primarily be via FM 39, the analysis focuses on FM 39 and its connecting roads: I-45; US 79 and 84; and SH 164. The Burlington Northern Santa Fe railway line runs along the northeastern border of the proposed power plant site.

6.13.1.2 Method of Analysis

DOE reviewed information provided in the Jewett EIV (FG Alliance, 2006c), which characterizes elements in the roadway hierarchy within the ROI based on function (e.g., city street and rural arterial), traffic levels, and observed physical condition. The EIV also includes traffic data obtained from the Texas Department of Transportation (TxDOT). The number of vehicle trips generated during construction and operations was based on data provided in the Jewett EIV (FG Alliance, 2006c).

LOS is a qualitative measure that describes operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000).

Traffic impacts were assessed using the planning methods outlined in the Transportation Research Board's "2000 Highway Capacity Manual" (2000 HCM) (TRB, 2000), which assigns a level of service (LOS) to a particular traffic facility based on operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000); and The American Association of State Highway and Transportation Officials' (AASHTO) "A Policy on the Design of Highways and Streets" (the Green Book) (AASHTO, 2004), which describes LOS in more qualitative terms. The Green Book defers to the 2000 HCM to define LOS by facility type. The measures of effectiveness to assign LOS vary depending on the traffic facility. Highway Capacity Software Plus (HCS+) was used to perform capacity analysis.

For two-lane highways, the measure of effectiveness in assessing operations is the percent of time spent following another vehicle. LOS A through LOS F are assigned to a facility based on this measure of effectiveness. The LOS depends on the Highway Class (I or II), lane and shoulder widths, access-point density, grade and terrain, percent of heavy vehicles, and percent of no-passing zones within the analysis segment. Class I highways, according to the 2000 HCM, are highways where a motorist expects to travel at relatively high speeds. They are typically primary links in a state or national highway network and serve long-distance trips. A Class II highway typically operates at lower speeds and most often serves shorter trips. Class II also includes scenic or recreational routes. Table 6.13-1 defines each LOS category for Class I and II two-lane highways.

Table 6.13-1. Level of Service Criteria, Two-Lane Highways

LOS	Class I Two-Lane Highway		Class II Two-Lane Highway
	Percent Time Spent Following Another Vehicle	Average Travel Speed (mph [kmph])	Percent Time Spent Following Another Vehicle
A	< 35	>55 (88.5)	< 40
B	> 35 - 50	> 50 - 55 (80.5 – 88.5)	> 40 - 55
C	> 50 - 65	> 45 - 50 (72.4 – 80.5)	> 55 - 70
D	> 65 - 80	> 40 - 45 (64.4 – 72.4)	> 70 - 85
E	> 80	≤ 40 (64.4)	> 85

LOS F applies whenever the flow rate exceeds the capacity of the highway segment.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For multi-lane highways, the primary measure of effectiveness is density, measured in passenger cars per mile per lane. The traffic density is defined on the free-flow speed, ranging from 45 to 60 mph (72.4 to 96.6 kmph). The LOS depends on the lane width, lateral clearance, median type, number of access points, free-flow speed, and percent of heavy vehicles. Table 6.13-2 defines the LOS criteria for each free-flow speed on a multi-lane highway.

Table 6.13-2. Level of Service Criteria, Multi-Lane Highways

Free-Flow Speed (mph [kmph])	Criterion	LOS				
		A	B	C	D	E
60 (96.6)	Maximum density (pc/mi/ln)	11	18	26	35	40
55 (88.5)		11	18	26	35	41
50 (80.5)		11	18	26	35	43
45 (72.4)		11	18	26	35	45

LOS F is not included in the table; vehicle density is difficult to predict due to highly unstable and variable traffic flow.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For basic freeway segments, the measure of effectiveness is density, measured in passenger cars per mile per lane. The LOS depends on the lane width, lateral clearance, number of lanes, interchange density, free-flow speed, and percent of heavy vehicles. Table 6.13-3 defines the LOS criteria for each free-flow speed.

The Green Book describes LOS in qualitative terms as follows: LOS A represents free flow, LOS B represents reasonably free flow, LOS C represents stable flow, LOS D represents conditions approaching unstable flow, and LOS E represents unstable flow; and LOS F represents forced or breakdown flow (AASHTO, 2004).

Table 6.13-3. Level of Service Criteria, Basic Freeway Segments

LOS	Passenger Cars Per Mile Per Lane
A	0 – 11
B	>11 – 18
C	>18 – 26
D	>26 – 35
E	>35 – 45
F	>45

LOS = Level of Service.
Source: TRB, 2000.

No information is available for turning movements at specific intersections within the ROI. Therefore, intersection LOS has not been estimated for this analysis. However, DOE identified key intersection and evaluated the LOS qualitatively based on relative traffic volumes on intersecting roadways.

Though there are accident reduction factors that can be used to estimate a reduction in crashes based on a specific type of highway improvement, no methods are available for estimating the increase in crashes due to increased roadway volume. In addition, specific recent accident data for the roadways around the proposed Jewett Power Plant Site are not available. DOE qualitatively assessed potential safety impacts in this analysis.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Increase traffic volumes as to degrade LOS conditions on roadways;
- Alter traffic patterns or circulation movements;
- Alter road and intersection infrastructure;
- Conflict with local or regional transportation plans;
- Increase rail traffic compared to existing conditions on railways in the ROI; and
- Conflict with regional railway plans.

6.13.2 AFFECTED ENVIRONMENT

6.13.2.1 Roads and Highways

Access to the proposed Jewett Power Plant Site is primarily via FM 39, which intersects US 79 and SH 164 within 10 miles (16.1 kilometers) of the site boundary. The site is less than 15 miles (24.1 kilometers) from I-45. Figure 6.13-2 shows the regional highway network. The proposed Jewett Sequestration Sites are located about 33 miles (53.1 kilometers) northeast of the proposed Jewett Power Plant Site. Access to the proposed sequestration sites would be primarily via US 84.

TxDOT Highways/Roadways

FM 39 runs north and south, paralleling I-45 for approximately 90 miles (144.8 kilometers) between Dawson and Singleton. FM 39 has a weight capacity of 58,420 pounds (26,499 kilograms) (FG Alliance, 2006c) and provides one lane in each direction in the vicinity of the proposed Jewett Power Plant Site.

US 79 runs northeast to southwest, facilitating transportation between Austin, Texas, and Louisiana. Vehicle loadings of up to 80,000 pounds (36,287 kilograms) may travel on US 79 without a permit. A vehicle that weighs 80,000 to 100,000 pounds (36,287 to 45,359 kilograms) may travel on US 79 with a permit (FG Alliance, 2006c). US 79 is a four-lane limited access highway in the vicinity of the proposed Jewett Power Plant Site.

The I-45 corridor directly connects Dallas to Houston and the Gulf Coast. In the vicinity of the proposed FutureGen Project, I-45 provides two lanes in each direction with a median. I-45 is rated to carry 80,000 pounds (36,287 kilograms) per vehicle, which is the state standard (FG Alliance, 2006c).

Traveling east and west is also possible via SH 164 or US 84. SH 164 is a two-lane highway in the vicinity of the proposed Jewett Power Plant Site. US 84 is a two-lane highway in the vicinity of the proposed Jewett Sequestration Site.

Key intersections in the vicinity of the proposed plant site include:

- FM 39 and US 79 (ramp termini)
- FM 39 and SH 80
- US 79 and I-45 Northbound ramps
- US 79 and I-45 Southbound ramps
- SH 164 and I-45 Northbound ramps
- SH 164 and I-45 Southbound ramps

The State of Texas does not have truck route designations for their highway or roadway network.

Programmed Transportation Improvements

Certain parts of the ROI would be affected or touched by the development of the proposed Trans-Texas Corridor (TTC). The TTC is a proposed multi-use, statewide network of transportation routes in Texas that would incorporate existing and new highways, railways, and utility ROWs. The TTC would also include separate lanes for passenger vehicles and large trucks, freight railways, and high-speed commuter railways, as well as infrastructure for utilities including water lines, oil and gas pipelines, and transmission lines for electricity, broadband, and other telecommunications services. TTC is projected to be completed in phases over the next 50 years. TxDOT will oversee planning, construction, and ongoing maintenance of the TTC (FG Alliance, 2006c).

TxDOT also anticipates widening or new location projects to begin in the next 10 years on roadways within the ROI (FG Alliance, 2006c). The following identifies the proposed projects and approximate distance from the proposed Jewett Power Plant Site:

- FM 2154 (Wellborn Road), widening from two to six lanes from FM 2818 to SH 40 (50 miles [80.5 kilometers]);
- SH 21, widening from two to four lanes from Kurten to the Navasota River (40 miles [64.4 kilometers]);
- SH 6 widening from two to four lanes from US 79 in Hearne to FM 1644 in Calvert (40 miles [64.4 kilometers]); and
- FM 60 (University Drive), widening from two to four lanes from SH 6 to FM 158 (48 miles [77.2 kilometers]).

The TWCC will relocate a section of FM 39 and the current train overpass to reclaimed land, to facilitate the continuation of mining operations at its Jewett Surface Lignite Mine (Jewett Mine). This relocation is scheduled to begin in 2007 and be completed in approximately one year (FG Alliance, 2006c).

6.13.2.2 Railroads

Class I – Gross annual operating revenues of $277.7 million or more

Class II – Non-Class I railroad operating 350 or more miles and with gross annual operating revenues between $40 million and $277.7 million

Class III – Gross annual operating revenues of less than $40 million

Texas ranks second nationally in the number of freight railroads (40) (TxDOT, 2005). The Surface Transportation Board categorizes rail carriers into three classes based upon annual earnings. The earnings limits for each class were set in 1991 and are adjusted annually for inflation.

The proposed Jewett Power Plant Site is located approximately halfway between two major Texas transportation centers – Dallas/Fort Worth and Houston/Galveston metropolitan areas. There are two Class I railroads in the ROI, the Union Pacific and the Burlington Northern Santa Fe (see Figure 6.13-1). The site lies 6.5 miles (10.5 kilometers) from the junction of these two major railroads. The Burlington Northern Santa Fe crosses through the area approximately 2 miles (3.2 kilometers) from the proposed Jewett Power Plant Site, with a railroad spur along the northern side of the proposed power plant site (FG Alliance, 2006c). The Burlington Northern Santa Fe rail line connects with coal fields in Wyoming, the Illinois Basin, Appalachia, and the west. The existing rail spur at the proposed Jewett Power Plant Site can be used for construction materials lay-down. This line has access to lines in Mexico, the West Coast, Midwest, Gulf Coast, and East Coast, that provide service to potential sources of fuel and materials for construction and operation.

Representatives from both the Union Pacific and the Burlington Northern Santa Fe provided the following information about the railroads they represent, unless otherwise specified. The rail lines within the ROI are used for freight, and passenger trains rarely, if ever, use this section of the railroad. The railways that pass through the ROI are designed with a maximum grade of 1 percent (FG Alliance, 2006c).

The weight capacity of the Burlington Northern Santa Fe track within the ROI is a maximum of 286,000 pounds (129,727 kilograms) gross weight (railcar plus lading) per carload. Including locomotives, the length of a Burlington Northern Santa Fe train is typically 7,400 feet (2,256 meters), with a gross loaded weight of approximately 19,100 tons (17,330 metric tons). Coal unit trains typically consist of three to four locomotive units trailed by 128 railcars. This north-south line passes near Jewett and is one of two primary Burlington Northern Santa Fe lines between the Dallas/Fort Worth and Houston/Galveston areas. The Burlington Northern Santa Fe currently serves two coal-burning power plants within the ROI. Wyoming Powder River Basin coal is shipped to these two existing power plants, with a combined weight of 4.5 million tons (4.1 million metric tons) of coal per year (FG Alliance, 2006c).

Union Pacific's track allows for a train speed of 40 mph (64.4 kmph). With access to the Powder River Basin in Wyoming and coal fields in Illinois, Colorado, and Utah, the Union Pacific moves more than 250 million tons (226.8 million metric tons) of coal per year. There are three main lines that run near the proposed Jewett Power Plant Site. The two north-south lines each have a gross weight capacity of car on rail set at 315,000 pounds (142,881 kilograms). The east-west line has a gross weight capacity of car on rail set at 286,000 pounds (129,727 kilograms) (FG Alliance, 2006c).

6.13.2.3 Local and Regional Traffic Levels and Patterns

Regional Traffic

In 2005, FM 39 had an average daily traffic (ADT) volume of 2,650 vehicles per day (vpd) (FG Alliance, 2006c). The 2005 ADT on US 79 was 7,500 vpd. I-45 had an ADT volume of 29,000 vehicles per day (vpd) in 2005 in the vicinity of the proposed Jewett Power Plant Site. These volumes as well as those on other routes are shown in Table 6.13-4.

Typically, morning and afternoon peak hour volumes range from 8 to 12 percent of the ADT (Table 6.13-4). Peak hour truck percentages are typically slightly lower than the daily truck percentage because truckers prefer to travel in off-peak hours. However, to be conservative, the existing daily truck percentages were maintained for this analysis.

Based on the existing roadway LOS reported in Table 6.13-4, DOE concluded that the key intersections near the proposed Jewett Power Plant Site are likely to be operating at LOS C or better as well.

Table 6.13-4. 2005 Average Daily and Peak Hour Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[2] (vpd)	Weekday Peak Hour Volume[3] (vph)	Weekday Peak Hour Truck Volume[2,3] (vph)	LOS[4]
FM 39	2,650	265	265	27	B
US 79	7,500	750	750	75	A
I-45	29,000	2,900	2,900	290	B
SH 164	2,740	274	274	27	B
US 84	6,500	650	650	65	C

[1] Source: FG Alliance, 2006c.
[2] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
[3] DOE estimate of peak hour volume and LOS assumed peak hour equals 10 percent of ADT.
[4] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Truck Traffic

The area surrounding the proposed Jewett Power Plant Site is an active lignite mine, so mining trucks could deliver lignite to the plant on dedicated coal haul roads if that coal source were used. I-45 lies 12 miles (19.3 kilometers) from the proposed site and intersects with US 79 and SH 164, which are both near the site, allowing for truck delivery of fuels or equipment.

No truck traffic volumes were available for the roadways surrounding the proposed Jewett Power Plant Site. DOE assumed that the existing volumes include 10 percent trucks. Based on this assumption, the 2005 truck ADT on FM 39 was 265 trucks per day. Based on the same assumption, approximately 750 trucks per day used US 79, and approximately 2,900 trucks per day used I-45.

Rail Traffic

The proposed Jewett Power Plant Site would be served by the Union Pacific and the Burlington Northern Santa Fe railroads. The Burlington Northern Santa Fe Railroad borders the site to the northeast (see Figure 5.13-2). No data were available regarding the exact number of trains that run by the Burlington Northern Santa Fe. Union Pacific currently runs 10 to 12 freight trains per day through the ROI (FG Alliance, 2006c). Walden (2006) assumed that Burlington Northern Santa Fe runs a similar number of trains (10 to 12 trains per day) near the proposed Jewett Power Plant Site.

In order to establish a new railroad grade crossing, a petition must be filed with the Interstate Commerce Commission (ICC) by either the railroad (or the track owner), the Local Roadway Authority, or TxDOT. It is ICC policy to require signals and gates (at a minimum) if permission is granted to install a new crossing. The petitioner is generally assessed all installation costs. If the new crossing is within 100 feet (30.5 meters) of a signalized crossing, the rail and roadway signals would need to be interconnected so that train movement will pre-empt roadway signals in order to clear a crossing for the train's entry. Access to the proposed power plant site should be designed such that no new at-grade rail crossing is required.

6.13.3 IMPACTS

6.13.3.1 Construction Impacts

Power Plant Site

Based on the necessary permitting and design requirements, DOE expects that the earliest year that construction would begin on the proposed power plant site would be 2009 (FG Alliance, 2006e). Table 6.13-5 shows 2009 No-Build traffic volumes, which DOE projected to the construction year by applying a background growth rate of 0.5 percent per year to 2005 volumes. DOE determined this growth rate by reviewing other TxDOT project EISs and study documentation (TxDOT, 2006a, 2006b).

Table 6.13-5. 2009 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[2] (vpd)	Weekday Peak Hour Volume[1] (vph)	Weekday Peak Hour Truck Volume[3] (vph)	LOS[3]
FM 39	2,703	270	270	27	B
US 79	7,651	765	765	77	A
I-45	29,584	2,958	2,958	296	B
SH 164	2,795	280	280	28	B
US 84	6,631	663	663	66	C

[1] DOE estimate based on 0.5 percent growth per year from 2005.
[2] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Based on the 2009 No-Build volumes, DOE estimated roadway capacity (Table 6-13.5). Because there is no predicted change in the roadway LOS between the 2005 existing conditions and 2009 No-Build conditions, DOE concluded that there would be no change in LOS at key intersections near the proposed Jewett Power Plant Site. All intersections are expected to continue to operate at LOS C or better.

Over a 44-month construction period (2009 to 2012), the construction workforce site is estimated to average 350 workers on a single shift (FG Alliance, 2006e), with a peak of 700 workers would be anticipated to be on the site working a single shift. DOE assumed that 100 percent of the construction workforce would arrive at the construction site in single-occupant vehicles. For the analysis of construction conditions, DOE used the peak period of construction to estimate the highest level of potential impact during construction.

The majority of trips would use I-45, which provides access to the Dallas-Fort Worth and Houston/Galveston metro areas. The balance of trips would come to the proposed site via US 79 from the west. DOE assumes that access to the proposed site would be provided via FM 39 (FG Alliance, 2006c).

DOE assumed that the construction workforce would work a 10-hour workday, 5 days per week. Construction work force trips would generally occur before the morning peak hours (7:00 am to 9:00 am) and coincide with the afternoon peak hours (4:00 pm to 6:00 pm). It is unlikely that many, if any, trips would occur during mid-day because construction workers typically do not leave a job site during the 30-minute lunch period.

Based on these construction workforce estimates, DOE estimated the percent change in ADT and peak-hour traffic volumes from 2009 No-Build conditions to 2009 construction conditions for likely routes to the proposed site during the expected 44-month construction period (Table 6.13-6). The largest construction traffic impact would occur on FM 39. FM 39 would experience a 53 percent increase in daily traffic during construction of the proposed power plant.

As shown in Table 6.13-6, the number of passenger vehicle trips by construction workers would be relatively small in terms of available roadway capacity, and direct traffic impacts due to construction would be temporary. The roadway that would experience the most direct impact during construction at the proposed Jewett Power Plant Site would be FM 39 because all construction-related trips would use this roadway en route to and from the proposed Jewett Power Plant Site. FM 39 would operate at LOS D (approaching unstable flow) during construction compared to LOS B (reasonably free flow) under 2009 No-Build conditions, which would be inconvenient for travelers on the highway, particularly during peak traffic hours, but is acceptable for a temporary condition during construction (TxDOT, 2006c). Given that the roadways would be operating at LOS D or better, there is no reason to conclude that there would be any notable increase in traffic accidents. The capacity analysis summary for the 2009 Construction Conditions of the project area roadways is shown in Table 6.13-6.

Based on the volumes and LOS on these roadways during construction, the key intersections around the proposed site, identified in Section 6.13.2.1, should be able to accommodate these daily and peak hour traffic volumes at LOS D or better. The ramp termini intersections at I-45 and US 79, as well as the ramps from FM 39 to US 79 could see some temporary change in LOS due to the volumes generated during construction. Changes to traffic signal timings may be required at the US 79/I-45 ramp intersections to accommodate changes in the turning volumes at those intersections.

In addition to worker traffic, materials and heavy equipment would be transported to the proposed site on trucks and via the adjacent rail line. Heavy equipment would remain at the proposed site for the duration of its use. Material deliveries and return trips by empty trucks would likely occur throughout the workday. The area around the proposed Jewett Power Plant Site is served by several large construction material supply firms offering concrete, asphalt, gravel, and fill. DOE did not estimate a specific number of trips by truck from any specific supply location; however, DOE included 40 truck trips per day

(20 entering and 20 exiting the site) in the analysis. Based on the available roadway capacities and the fact that estimated 2009 No-Build LOS are C or better, DOE concluded that 40 truck trips per day would not have a significant direct impact on traffic operations on roadways surrounding the proposed site. Moreover, DOE also concluded that even if the number of trips did occasionally exceed 40 per day, it is highly unlikely that it would result in a significant direct impact on roadways surrounding the proposed site.

Table 6.13-6. 2009 Average Daily and Peak Hour Construction Traffic Volumes

Roadway	ADT[1] (vpd)	Change in ADT[1] (percent)	Peak Hour Volume[2] (vph)	Change in Peak Hour Volume[2] (percent)	LOS[3]
FM 39	4,143	53	974	260	D
US 79	8,399	10	1,131	48	A
I-45	31,024	5	3,662	25	B
SH 164	3,487	25	618	121	C
US 84	6, 631	0	763	0	C

[1] DOE estimate based on peak workforce of 700 workers arriving at site in single-occupancy vehicles, plus 40 truck trips per day (20 entering and 20 exiting the site).
[2] DOE derived peak hour volumes assuming half of all passenger car trips occur in peak hour and truck trips are evenly distributed over a 10-hour construction work day.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Sequestration Site

The surface extent of the land area above the proposed Jewett Sequestration Site would be located within Freestone and Anderson counties. There would be comparatively less construction activity at the proposed Jewett Sequestration Site and along the CO_2 pipeline connecting the proposed sequestration site with the proposed power plant site, than at the power plant site. Construction traffic to the reservoir would have a negligible effect on roadways and traffic.

Utility Corridors

All underground utilities (potable water, process water, wastewater, natural gas, and CO_2) are proposed to be constructed using open trenching (FG Alliance, 2006c). Though there would be a need for staging areas for this construction, DOE assumes that typical construction techniques would be employed and all roadways would maintain one lane of traffic in each direction during construction. Construction of several of the proposed utility lines (process water, CO_2) could last for approximately four to 12 months (FG Alliance, 2006c), depending on the length of the corridor chosen. During this time there would be minor disruptions to traffic, but they would not create a substantial direct impact to traffic operations.

Construction of the utility lines would require approximately 60 persons for all construction to occur concurrently (FG Alliance, 2006c). In the most conservative case, all construction workers would travel in single-occupant vehicles. Therefore, there would be approximately 120 additional daily trips on the roadway network during construction of the utilities. Assuming that construction operations typically start earlier than the morning peak period of traffic, 60 trips would take place before the morning peak hour. The 60 afternoon trips made by construction workers leaving job sites would likely coincide with the afternoon peak period. Given the proposed locations of the utility corridors, these trips would be spread out on various roadways in the ROI and would not be expected to have any appreciable direct impact on traffic operations.

Transportation Corridors

A new private sidetrack from the Burlington Northern Santa Fe Railroad would be constructed on the proposed Jewett Power Plant Site and would require approximately nine to 11 months to complete that could be spread over more than one construction season. It is estimated that up to 18 construction workers would be traveling to and from the site, resulting in an additional 36 trips per day on the roadway network. The other 18 trips would take place before the morning peak period, assuming that construction activities typically begin earlier than the regular work day. Eighteen of those trips would occur during the afternoon peak period, assuming a 10-hour work day. Given that all roadways would be operating at LOS D or better during construction (see Table 6.13-6), these trips would not be expected to appreciably change traffic operations on the roadway network.

During connection of the new rail loop to the existing Burlington Northern Santa Fe Railroad, railroad safety flaggers would be required. The construction could have some temporary impacts on Burlington Northern Santa Fe Railroad operations while the connection between the private sidetrack and the mainline is completed. This temporary impact could be avoided by completing the connection during hours when the Burlington Northern Santa Fe track has the lightest expected traffic.

6.13.3.2 Operational Impacts

The proposed FutureGen Project is expected to begin operating in 2012 (FG Alliance, 2006e). Table 6.13-7 shows 2012 No-Build traffic volumes, which DOE projected to the opening year by applying a background growth rate of 0.5 percent per year to 2005 volumes. This growth rate was determined through review of other TxDOT project documentation (TxDOT, 2006a, 2006b). Based on the 2012 No-Build volumes, the capacity of each roadway was estimated (Table 6.13-7).

Table 6.13-7. 2012 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	2012 No-Build ADT[1] (vpd)	2012 No-Build Truck ADT[1] (vpd)	2012 No-Build Peak Hour Volume[1] (vph)	2012 No-Build Peak Hour Truck Volume[1] (vph)	LOS[2]
FM 39	2,744	274	274	27	B
US 79	7,766	777	777	78	A
I-45	30,030	3,003	3,003	300	B
SH 164	2,837	284	284	28	B
US 84	6,731	673	673	67	C

[1] DOE estimate based on 0.5 percent growth per year from 2005.
[2] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Power Plant Site

The operating workforce for the proposed power plant would be approximately 200 employees, of which 80 administrative personnel would work a regular office day (9:00 am to 5:30 pm), and 40 shift workers would work a daytime shift (7:00 am to 3:30 pm) and each of the two nighttime shifts (FG Alliance, 2006c). The workforce would result in 160 new peak hour trips in both the morning and afternoon. For this analysis, DOE assumed these employees would arrive at the plant in single-occupant vehicles and that the trip distribution would be the same as for the construction worker trips. A majority of these trips would use I-45, which provides access to the Dallas-Fort Worth and Houston/Galveston metro areas. The balance of trips would come to the proposed site via US 79 from the west. Depending on how the proposed power plant is oriented, a single access gate would be located on FM 39 (FG Alliance, 2006c).

A small number of delivery trucks would travel to the proposed power plant to support personnel, and administrative functions and deliver spare parts. Coal would be delivered primarily by rail. Other bulk materials used by the plant and byproducts are expected to be delivered or removed from the proposed Jewett Power Plant Site by truck. DOE estimates that 13 trucks per week would be required for delivery of materials, while 98 trucks per week would be required for removal of byproducts, including slag, sulfur, and ash. DOE estimated the number of trucks required based on the estimated annual quantities of materials/byproducts (FG Alliance, 2006e). Based on these estimates and assuming an even distribution of trucks over each day of the week, materials delivery would require 4 truck trips per day, 2 entering and 2 exiting, and byproduct removal would result in an additional 28 trips per day, 14 entering and 14 exiting. These trips are included in the 2012 Build ADT and peak hour traffic volumes shown in Table 6.13-8. The change in ADT and peak hour volumes between 2012 No-Build and 2012 Build conditions is also shown in Table 6.13-8.

Table 6.13-8. 2012 Average Daily and Peak Hour Build Traffic Volumes

Roadway	2012 Build ADT[1] (vpd)	Change in ADT[1] (percent)	2012 Build Peak Hour Volume[2] (vph)	Change in Peak Hour Volume[2] (percent)	LOS[3]
FM 39	3,176	16	438	60	C
US 79	7,991	3	862	11	A
I-45	30,462	1	3,167	6	B
SH 164	3,045	7	363	28	C
US 84	6,895	2	837	24	C

[1] DOE derived ADT using the maximum operating workforce (200 people; 400 vpd) passenger car trips (FG Alliance, 2006c) and assuming 32 operations-related truck trips daily (16 arriving and 16 exiting the site).
[2] DOE derived peak hour volumes assuming that administration and 1/3 of shift workers arrive in peak hour, and that four truck trips occur in each peak hour.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

These volumes would result in a small direct impact on the roadways surrounding the proposed Jewett Power Plant Site, based on the predicted 2012 Build Conditions capacity analysis summary given in Table 6.13-8. FM 39, which would be the most affected roadway due to the trips made by employees, would operate at LOS C (stable flow) under the 2012 Build conditions compared to LOS B (reasonably free flow) under 2012 No-Build conditions. Given that the roadways would be operating at LOS C or better, there is no reason to conclude that there would be any notable increase in traffic accidents.

Based on the volumes and LOS on these roadways under the proposed operating conditions, DOE concluded that the key intersections around the proposed site should be able to accommodate these daily and peak hour traffic volumes. Changes to traffic signal timings may be required at the US 79/I-45 ramp intersections to accommodate changes in turning volumes at those intersections.

The primary component of materials transport would be the delivery of coal to the plant by rail, using a spur track constructed for the purpose. It is anticipated that coal deliveries would require five 100-unit trains per week, or 10 entering or exiting train trips per week (FG Alliance, 2006e). This would equal a 12 to 14 percent increase in the number of trains on the main line, which currently accommodates 70 to 84 trains per week (10 to 12 freight trains seven days per week) (Walden, 2006).

Sequestration Site

There would be very little operational traffic to and from the proposed Jewett Sequestration Site, and essentially no direct or indirect traffic or roadway impact.

Utility Corridors

The proposed utility corridors would have little or no impacts on traffic operations and roadway LOS once the proposed Jewett Power Plant is operating. There would be no direct impact on traffic unless there is a problem with a utility line that requires open trenching to repair. It is expected that this would be an infrequent occurrence, thus having little to no long-term potential to affect traffic.

Transportation Corridors

The proposed rail connection on the proposed Jewett Power Plant Site would have very little direct impact on the rail operations on the Burlington Northern Santa Fe or Union Pacific main lines. The rail lines have the capacity to absorb the 10 to 11 percent increase in rail traffic.

6.14 NOISE AND VIBRATION

6.14.1 INTRODUCTION

Noise is defined as any sound that is undesired or interferes with a person's ability to hear something. The basic measure of sound is the sound pressure level (SPL), commonly expressed as a logarithm in units called decibels (dB). Vibration, on the other hand, consists of rapidly fluctuating motions having a net average motion of zero that can be described in terms of displacement, velocity, or acceleration. This chapter provides the results of the analyses completed for both noise and vibration. Specific details of the noise and vibration analysis are provided in sequence under each subsection, with the results of the noise analysis presented first followed by those of the ground-borne vibration analysis.

6.14.1.1 Region of Influence

The ROI for noise and vibration includes the area within 1 mile (1.6 kilometers) of the proposed Jewett Power Plant Site boundary and within 1 mile (1.6 kilometers) of the boundaries of all related areas of new construction, including the proposed sequestration site and the utility and transportation corridors.

6.14.1.2 Method of Analysis

This section provides the methods DOE used to assess the potential noise and vibration impacts of construction and operational activities related to the proposed Jewett Power Plant Site, sequestration site, and related corridors. In preparing the noise and vibration analysis, DOE evaluated information presented in the Jewett EIV (FG Alliance, 2006c), estimated increases in ambient noise and ground-borne vibration levels, and evaluated potential impacts on sensitive receptors.

DOE assessed the potential for impacts based on the following criteria:

- Conflicts with a jurisdictional noise ordinance;
- Permanent increases in ambient noise levels at sensitive receptors during operations;
- Temporary increases in ambient noise levels at sensitive receptors during construction;
- Airblast noise levels in excess of 133 dB;
- Blasting peak particle velocity (PPV) greater than 0.5 inches per second (in/sec) (12.7 millimeters per second [mm/sec]) at off-site structures; or
- Exceeding the Federal Transit Administration's (FTA) distance screening and human annoyance thresholds for ground-borne vibrations of 200 feet (61 meters) and 80 velocity decibels (VdB).[1]

Noise Methods

Generally, ambient conditions encountered in the environment consist of an assortment of sounds at varying frequencies (FTA, 2006). To account for human hearing sensitivities that are most perceptible at frequencies ranging from 200 to 10,000 Hertz (Hz) or cycles per second, sound level measurements are often adjusted or weighted and the resulting value is called an "A-weighted" sound level.

> The **A-weighted** scale is the most common weighting method used to conduct environmental noise assessments and is expressed as a dBA.

A-weighted sound measurements (dBA) are standardized at a reference value of zero decibels (0 dBA), which corresponds to the threshold of hearing, or SPL, at which people with healthy hearing mechanisms can just begin to hear a sound. Because the scale is logarithmic, a relative increase of

[1] FTA threshold standards are not applicable to this project, but were used as a basis for comparing effects.

10 decibels represents an SPL that is nearly 10 times greater. However, humans do not perceive a 10-dBA increase as 10 times louder; rather, they perceive it as twice as loud (FTA, 2006). Figure 6.14-1 lists measured SPL values of common noise sources to provide some context.

The following generally accepted relationships (Bolt et al., 1973) are useful in evaluating human response to relative changes in noise level:

- A 2- to 3-dBA change is the threshold of change detectable by the human ear in the ambient conditions;
- A 5-dBA change is readily noticeable; and
- A 10-dBA change is perceived as a doubling or halving of the noise level.

The SPL that humans experience typically varies from moment to moment. Therefore, a variety of descriptors are used to evaluate noise levels over time. Some typical noise descriptors are defined below:

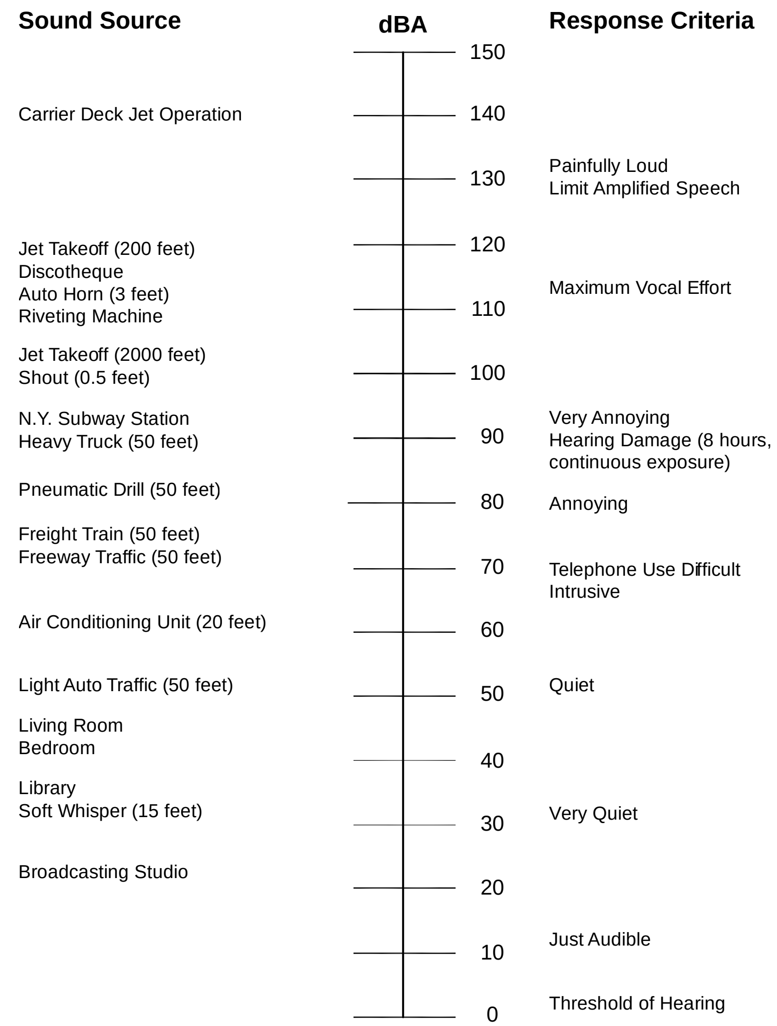
- L_{eq} is the continuous equivalent sound level. The sound energy from fluctuating SPLs is averaged over time to create a single number to describe the mean energy or intensity level. Because L_{eq} values are logarithmic expressions, they cannot be added, subtracted, or compared as a ratio unless that value is converted to its root arithmetic form.
- L_{max} is the highest, while L_{min} is the lowest SPL measured during a given period of time. These values are useful in evaluating L_{eq} for time periods that have an especially wide range of noise levels.

For this analysis, DOE evaluated noise levels generated by stationary (i.e., fixed location) sources such as construction-related and power plant operating equipment, and mobile (i.e., moving) sources such as construction-related vehicle trips and operational deliveries by rail, car, and truck. DOE predicted stationary source noise levels during construction and normal plant operations at sensitive receptor locations in direct line-of-sight of proposed project facilities by summing anticipated equipment noise contributions and applying fundamental noise attenuation principles. DOE used the following logarithmic equation (Cowan, 1994) to predict noise levels at the sensitive receptor locations selected for the stationary source analysis:

$SPL_1 = SPL_2 – 20 \text{ Log } (D_1/D_2) – A_e$, where:

- SPL_1 is the noise level at a sensitive receptor due to a single piece of equipment operating throughout the day;
- SPL_2 is the equipment noise level at a reference distance D_2;
- D_1 is the relative distance between the equipment noise source and a sensitive receptor;
- D_2 is the reference distance at which the equipment level is known; and
- A_e is a noise level reduction factor applied due to other attenuation effects.

DOE compared the calculated results to the existing ambient noise levels. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment is not available. In lieu of project-specific data, DOE used comparable noise data predicted for the proposed Orlando IGCC power plant facility (DOE, 2006) to estimate the increase in the noise level at sensitive receptors in the vicinity of the proposed Jewett Power Plant Site. Any residences, schools, hospitals, nursing homes, houses of worship, and parks within the 1-mile (1.6-kilometer) ROI were considered sensitive receptors in this analysis.



Source: Barksdale, 1991

Figure 6.14-1. SPL Values of Common Noise Sources

For mobile sources, DOE estimated noise levels using traffic noise screening techniques to compare the vehicle traffic mix data for the future Build and No-Build traffic conditions on each roadway studied. DOE calculated the ratio of the future Build and future No-Build traffic volumes using the following equation (FHWA, 1992):

Predicted Change in Noise Level (dBA) = 10 Log (Future Build PCE/Future No-Build PCE), where
one heavy truck = 28 passenger car equivalents (PCEs)

In applying this equation, a doubling of traffic means future Build conditions are predicted to be twice the future No-Build condition. A doubling in the vehicle traffic volume would result in a 3-dBA increase in the noise level (10 Log [2/1] = 3 dBA). A ten-fold increase in traffic would result in a +10 dBA change (10 Log [10/1] = 10 dBA).

For this analysis, DOE considered a 3-dBA increase in the ambient noise level at sensitive receptors located adjacent to the project-related transportation routes as a threshold indicating that further detailed noise analysis (e.g., modeling) would be needed during evaluation of the final design to determine if the impacts would be potentially significant. Otherwise, DOE concluded that the anticipated increase in noise levels resulting from project-related activities would not be noticeable and would require no further analysis.

Vibration Methods

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration.

The concept of vibration is easily understood in terms of displacement as it relates to the distance a fixed object (e.g., floor) moves from its static position. Common measurements of velocity are not well understood by the average person. For example, the preferred vibration descriptors used to assess human annoyance/interference and building damage impacts are the root-mean-square (RMS) vibration velocity level and the PPV, respectively. The RMS vibration level is expressed in units of VdB. The PPV, expressed in in/sec or mm/sec, represents the maximum instantaneous speed at which a point on the floor moved from its static position (FTA, 2006).

Generally, the background vibration velocity level encountered in residential areas is 50 VdB or lower (FTA, 2006). The threshold of perception for humans to experience vibrations is 65 VdB. Typical sources of vibration include the operation of mechanical equipment indoors, slamming of doors, movement of trains on rails, and ground-breaking construction activities such as blasting and pile driving. The effects on vibration-sensitive receptors from these activities can range from feeling the window and the building floor shake, to rumbling sounds, to causing minor building damage (e.g., cracks in plaster walls) in rare cases. The criterion for minor structural damage is 100 VdB, or 0.12 in/sec (3.05 mm/sec) in terms of PPV, for fragile buildings (FTA, 2006).

DOE performed the vibration analysis using progressive levels of review. Initially, DOE prepared a vibration screening analysis to evaluate the potential effects that ground-borne vibrations generated by project-related construction and operational activity would have on adjacent sensitive receptors, including humans, buildings, and vibration-sensitive equipment. If the results of this preliminary analysis showed that screening thresholds would be exceeded, DOE applied further vibration study methods to determine if the impacts would be potentially significant.

6.14.2 AFFECTED ENVIRONMENT

6.14.2.1 Power Plant Site

The proposed Jewett Power Plant Site and the land area within 1 mile (1.6 kilometers) of the site boundary are located in a rural environment. The predominant land uses in the ROI include power production, lignite mining, and gas well exploration drilling. The site consists of undeveloped and gently rolling land, utility pipelines, unimproved roads, and structures relating to gas well activities. No residential receptors are located within the footprint or the ROI of the proposed Jewett Power Plant Site. The Wilson Chapel and associated cemetery are located approximately 0.25 miles (0.4 kilometers) north of the proposed Jewett Power Plant Site. In addition, the Evansville/Miller Cemetery is located 0.7 miles (1.1 kilometers) southeast of the proposed Jewett Power Plant Site. DOE evaluated both sites as sensitive receptors near the proposed Jewett Power Plant (FG Alliance, 2006c), as shown in Figure 6.14-2. There are no schools or other sensitive receptors in the ROI.

Ambient noise sources within the site and ROI include existing electric generating and mining facilities, traffic on Farm-to-Market Road (FM) 39, and the Burlington Northern Santa Fe rail spur leading to the electric generating facility. No noise measurements were taken in this rural area; however, noise levels within the site are expected to be generally typical of a rural environment ranging from a L_{eq} of 47 to 57 dBA (NYSDEC, 2000). Vehicular traffic (e.g., commercial trucks and passenger cars) along FM 39 could generate slightly elevated noise levels in this area during the daytime peak hours (6:00 AM to 8:00 AM and 5:00 PM to 7:00 PM). In addition, periodic noise level spikes exceeding 75 dBA may be generated when trains from the Burlington Northern Santa Fe pass by this area (FG Alliance, 2006c).

6.14.2.2 Sequestration Site

The proposed CO_2 sequestration site is located in Cherokee and Anderson counties in a semi-rural area about 33 miles (53.1 kilometers) northeast of the proposed power plant, 20 miles (32.2 kilometers) east of Interstate 45 (I-45), and about 60 miles (96 kilometers) east of Waco. Land uses in this area are primarily agricultural farming with only a few residences and the Coffield State Prison Farm (FG Alliance 2006c). As such, ambient noise levels in this area are generally expected to be typical of a rural environment ranging from a L_{eq} of 47 to 57 dBA.

6.14.2.3 Utility Corridors

The related areas of new construction associated with the proposed power plant include a possible water supply pipeline and a CO_2 pipeline corridor. If process water is not obtained by installing wells on site, the water supply corridor would extend less than 1 mile (1.6 kilometers) to the southeast of the proposed Jewett Power Plant Site. The proposed CO_2 pipeline corridor involves a 52- to 59-mile (83.7- to 95-kilometer) network of segment connections traversing rural areas dominated by rolling topography and shaped by numerous streams, creeks, and post oak woodland vegetation. The transmission line would connect to a 345-kV transmission line on the northwestern boundary of the site or a 138-kV line within a few miles of the site. The ambient noise environment along these corridors is likely the same as the proposed sequestration site.

6.14.2.4 Transportation Corridors

There are no residential receptors along the local access route (FM 39) leading to the proposed Jewett Power Plant Site. The major thoroughfares that intersect FM 39 are United States Highway (US) 79 and State of Texas Highway (SH) 164.

6.14.2.5 Regulatory Setting

The State of Texas and the counties of Leon, Limestone, and Freestone do not have noise or vibration standards applicable to activities proposed for the FutureGen Project. However, the FTA establishes guidelines and threshold standards for noise and vibration related to projects affecting transit facilities (FTA, 2006).

FTA established guidelines and methods to perform noise and vibration impact assessments for proposed projects involving transit facilities (FTA, 2006). To assess noise impacts, FTA recommends applying the same methods described in Section 6.14.1.2 to identify receptors that the project could potentially affect and to estimate noise contributions from project related mobile and stationary sources. To determine if the proposed transit project would significantly increase ambient conditions at a particular sensitive receptor, FTA established incremental change and absolute daytime/nighttime limits. For vibration, FTA recommends progressive levels of analysis depending on the type and scale of the project, the stage of project development, and the environmental setting. Such analysis typically begins with a screening process, which considers relative distance information between the source of ground-borne vibrations and the vibration-sensitive receptors that have been identified. If the relative distance from the source of ground-borne vibrations to a residential receptor is greater than 200 feet (61 meters), FTA guidelines indicate that it is reasonable to conclude that no further consideration of potential vibration impacts is needed (FTA, 2006). Otherwise, FTA provides criteria to assess the impacts of human annoyance, as well as building and vibration-sensitive equipment damage using detailed quantitative analyses to predict VdB and PPV values generated by the proposed project.

6.14.3 IMPACTS

6.14.3.1 Construction Impacts

Construction of the proposed Jewett Power Plant is expected to be typical of other power plants in terms of schedule, equipment used, and other related activities. Noise and vibration would be generated by a mix of mobile and stationary equipment noise sources, including bulldozers, dump trucks, backhoe excavators, graders, jackhammers, pile drivers, cranes, pumps, air compressors, and pneumatic tools during construction of the proposed power plant and the related utilities. For the purposes of this analysis, DOE considered the proposed project site an area-wide stationary source with construction equipment operating within its boundary. The results of DOE's noise and vibration analyses show that, in the absence of mitigation, the proposed project would result in significant ambient noise level increases at the non-residential sensitive receptors located within the 1-mile (1.6-kilometers) ROI. There are no residential receptors within the ROI. Mobile source impacts would not be anticipated because there are no sensitive receptors associated with the transportation corridors.

Power Plant Site

Noise levels generated during construction at the proposed Jewett Power Plant Site would vary depending upon the phase of construction. Typical power plant construction activity entails the following phases:

- Site preparation and excavation;
- Foundation and concrete pouring;
- Erection of building components; and
- Finishing and cleanup.

DOE anticipates that construction noise contributions would be greatest at the site during the initial site preparation and excavation phase due to the almost constant loud engine and earth breaking noises generated by the use of heavy equipment such as a backhoe excavator, earth grader, compressor, and dump truck. In addition, noise level increases are anticipated along the off-site routes leading to the site because of entry/exit truck movements, especially during the foundation and concrete pouring construction phase. The other phases would generate less audible noise because the equipment used for these activities (e.g., crane) generally would be transient in nature or would not generate much noise. Table 6.14-1 provides standard noise levels for construction equipment measured at a reference distance of 50 feet (15.2 meters).

To evaluate the potential maximum effects of the anticipated noise level increases on the sensitive receptors located to the north and southeast of the site boundary, DOE predicted equipment source noise levels using the logarithmic equation described in Section 6.14.1.2. First, the combined noise level expected from the three noisiest pieces of equipment (excavator, grader, and dump truck) used during the initial phase of construction was attenuated over relative distances from the site boundary to the following two directional noise-sensitive receptors:

- SL-1: Wilson Chapel, 0.25 miles (0.4 kilometers) from northern site boundary
- SL-2: Evansville/Miller Cemetery, 0.7 miles (1.1 kilometers) southeast of site boundary

Table 6.14-1. Common Equipment Sources and Measured Noise Levels at a 50-foot (15-meter) Reference Distance

Equipment	Noise Level in dBA
Backhoe Excavator	85
Bulldozer	80
Grader	85
Dump Truck	91
Concrete Mixer	85
Crane	83
Pump	76
Compressor	81
Jackhammer	88
Pile Driver	101

dBA = A-weighted decibels.
Source: Bolt et al., 1971.

The averaged existing ambient and distance-attenuated noise levels were then logarithmically summed to predict estimated noise levels at the receptor location identified above, as shown in Table 6.14-2. This represents a very conservative (that is, a maximum) noise prediction estimate because sound waves generated by the noisiest pieces of equipment are assumed to start at from the site boundary and continuously propagate in open air. In addition, the result does not account for any decibel-reducing factors due to atmospheric and ground attenuation effects.

A comparison of the predicted noise levels with the averaged ambient noise levels at SL-1 and SL-2 shows that construction of the proposed Jewett Power Plant would be noticeable at these receptors because the incremental change from the existing condition would be 12.8 and 5.2 dBAs, respectively. As noted earlier, a noise level increase of 10 dBA is perceived as a doubling of the noise level, while a 5 dBA increase is readily noticeable to the human ear. DOE does not consider the noise level increases at the chapel and cemetery to be major impacts because the receptors are not residential, and the chapel is seldom used. Most impacts could be avoided at either sensitive receptor if loud construction activity at the proposed power plant site is scheduled around any funeral proceedings. There are no residences or schools within the radius corresponding to a greater than 3 dBA increase in noise level.

Table 6.14-2. Estimated Noise Level at Selected Receptor Locations

Sensitive Receptor	Relative Distance in miles (kilometers)	Existing Ambient Noise Level (dBA)	Combined Equipment Noise Level (dBA)	Equipment Noise Level Attenuated by Distance (dBA)	Estimated Noise Level (dBA)	Change in dBA
SL-1	0.25 (0.4)	52	93	64.6	64.8	+12.8
SL-2	0.7 (1.1)	52	93	55.6	57.2	+5.2

Combined equipment noise level is 93 dBA at 50 feet (15 meters) from source.
The anticipated ambient noise level used for this calculation is 52 dBA – which is the mean between 47 and 57 dBA as predicted in Section 6.14.2.1.
dBA = A-weighted decibels.

During power plant startup, steam blowdown would be required toward the end of the construction phase. The blowdown activity would consist of several blows to test the IGCC system, including the gasifier steam lines, HRSG, and steam turbine. DOE anticipates that very loud noises as high as 102 dBA would be generated during all steam blows. The blowdown noise is assumed to originate at the center of the property and would attenuate to approximately 70 dBA at the property boundary. The noise would attenuate to approximately 65 dBA at the closest sensitive receptor (SL-1) resulting in an increase of 13 dBA compared to the existing ambient noise level. At SL-2, the blowdown noise would attenuate to 61 dBA, which would result in an increase of up to 9 dBA. No residences or schools exist within the ROI and any increase in noise level at the nearest residence or school would be less than 3 dBA. Precautionary measures that could be taken to mitigate impacts include limiting steam blows to the daytime hours and providing advance notice to those who manage the chapel and cemeteries before beginning plant blowdown activity. Blowdown activities generally would last no more than 2 weeks.

DOE anticipates no vibration impacts at sensitive receptors during construction because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment are not located within the 200-foot (61-meter) distance screening and human annoyance threshold for ground-borne vibrations defined by FTA guidance (2006).

Sequestration Site

Construction at the sequestration site would be limited to the installation of CO_2 injection wells. No sensitive receptors are close enough to the proposed injection well locations for noise or vibration impacts to occur. Noise level increases during construction would be less than 3 dBA at the nearest residences.

Utility Corridors

Transmission Corridors

Construction of the proposed transmission line in any of the corridor options would occur on the northwestern boundary or within a few miles of the site. No major noise and vibration impacts are anticipated, although a temporary increase in noise due to construction would occur. No major noise and vibration impacts are anticipated at the chapel and cemetery because of their distance from the corridors and the temporary duration of construction. Temporary construction activities would include activities such as installing a substation or constructing a few miles of new transmission to intersect with an existing transmission line (FG Alliance, 2006c).

Pipeline Corridors

Trench excavations to install the process/potable water and CO_2 pipelines would occur at a rate of 1 mile/week (1.6 kilometer/week). Construction of CO_2 pipelines along the 52- to 59-mile (83.7- to 95-kilometer) network has been divided into workable segments. During this period, elevated noise levels would be experienced by sensitive receptors located in the vicinity of the proposed pipeline corridor sites. However, due to the temporary and linear nature of the pipeline construction, minimal noise and vibration impacts would be anticipated. Equipment used for these types of short-term linear and limited ground disturbance construction activities includes an excavator and a dump truck.

Transportation Corridors

No residential receptors are located along the local access route (FM 39) leading to the proposed Jewett Power Plant Site and no receptors would be affected. The major thoroughfares that intersect

FM 39 are US 79 and SH 164. Project-related vehicular traffic would likely increase the existing ambient noise levels along these roadways.

During construction of the rail spur loop, the noise and vibration impacts would be the same as described for the proposed power plant site.

6.14.3.2 Operational Impacts

The projected noise levels calculated using the noise screening and analysis methods described in Section 6.14.1.2 show that none of the criteria listed in Section 6.14.1.2 would be exceeded due to the operation of the proposed power plant facility. DOE expects impacts would be minimal at the closest non-residential sensitive receptor, and DOE expects no operational impacts at the constructed CO_2, natural gas, cooling and potable water pipeline corridors because they would be buried underground. The electrical transmission line may generate some additional noise to the existing ambient environment; however, the results of the impacts analysis show that any impacts would be minimal.

Power Plant Site

The principal equipment noise sources during plant operation include the gas combustion turbine/generator, steam turbine/generator, heat recovery systems, turbine air inlets, exhaust stack, six-cell mechanical-draft cooling tower, coal crusher, coal mill, pumps (e.g., feed, circulating), fans, and compressors, as well as noise from piping flow and flared gas. For the most part, these noise sources would be enclosed inside of a building. In addition, noise sources within the building would be fitted with acoustical enclosures or other noise dampening devices to attenuate sound. Conversely, noise generated by equipment installed without full enclosures and exposed to the outside environment (e.g., flare) could potentially increase the ambient noise levels in the surrounding community.

To determine the impacts of normal plant operations, DOE used a noise prediction algorithm to estimate projected equipment noise contributions at the closest sensitive receptor location. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment was not available. DOE used comparable noise data estimated for the proposed Orlando IGCC power plant facility (DOE, 2006) to determine the potential effects of operational noise on sensitive receptors in the vicinity of the proposed Jewett Power Plant Site. Using the predicted noise level of 53 dBA at 0.6 miles (1.0 kilometer) that was obtained in the model run completed for the Orlando gasification project (DOE, 2006), DOE used the logarithmic distance attenuation formula to derive an estimated source noise level of 89 dBA for the proposed Jewett Power Plant.

DOE applied the source noise level to the proposed 400-acre (162-hectare) site to compute the attenuated noise level at the property boundary, assuming the noise sources would be at the center of the property. Based on a relative distance of 0.4 miles (0.6 kilometers) from the center of the property to the site's perimeter, DOE predicted noise levels of 57 dBA and 52 dBA at the property boundary and at the closest noise-sensitive receptor (SL-1), respectively. The predicted noise level at SL-1 is the same as the anticipated ambient noise level of 52 dBA at the chapel. As a result, operational activity at the proposed Jewett Power Plant would result in an increase of less than 3 dBA. At SL-2, the predicted noise contribution of the operating power plant is 48 dBA, which results in a combined noise level of 53 dBA, and a change of 1 dBA from the existing ambient noise level. Therefore, DOE concluded that there would be no potential impacts at any sensitive receptors because any increase in noise would be less than 3 dBA.

During coal deliveries, noise would be generated by unloading/loading activities such as the movement of containers, placement of coal feedstock on conveyor systems, and surficial contact of rail containers with other metallic equipment. Based on the estimated number of coal deliveries anticipated for the proposed power plant site, DOE estimated an hourly Leq of 69 dBA from unloading/loading activities at the rail yard using the noise prediction equations listed in Table 5-6 of FTA's guidance document (FTA, 2006). To determine the maximum effects on nearby receptors, DOE assumed that the rail yard noise would occur along the site boundary closest to the nearest sensitive receptor. Adding the predicted values for plant operational noise at the site boundary (59 dBA) to that of rail yard noise, a combined noise level of 69 dBA was estimated to be generated at the site boundary during unloading/loading activity. At the closest receptor (SL-1), noise from unloading/loading operations at the rail yard noise would attenuate to 41 dBA, which is lower than the existing predicted ambient L_{eq} of 52 dBA. As such, the anticipated rail yard noise from the proposed power plant site would not be noticeable at the chapel or cemetery (SL-2).

During unplanned or unscheduled restarts of the power plant, combustible gases would be diverted to the flare for open burning. Potential noise sources from flare operation that could affect nearby receptors include steam-turbulent induced noise in piping flow and noise generated by pulsating or fluttering flames from the incomplete combustion of the gases. These noise sources could temporarily increase the ambient noise levels in the vicinity of the flare to a range of 96 to 105 dBAs. Positioning the flare unit at a location farthest from a receptor and implementing measures to control the flow of flare gas or steam through piping connected to the flare unit and the incomplete combustion of gases would reduce any potential impacts. Measures to minimize these short-term impacts would be addressed during the final conceptual design of the IGCC power plant.

The foregoing analysis does not include additional intermittent noise and vibrations that may be generated by rail car shakers if they are used to loosen coal material from the walls of the rail cars during unloading. Typically, the shakers are mounted on a hoist assembly and are used intermittently for a 10-second period to induce material movement in the rail car (Bolt et al., 1984). Pneumatic or electric rail car shakers could generate noise levels up to 118 dBA (VIBCO, Undated-a; VIBCO, Undated-b; Western Safety Product, 2007). If the shaker is used on every rail car, it is estimated that the shaker would be used 253 to 428 times per week. Final design of the coal handling equipment should consider the noise and vibration contributions from the rail car shakers.

Sequestration Site

Operations at the sequestration site would entail pumping CO_2 underground. Only minimal noise impacts would be anticipated during operation and maintenance at the injection well point. No noise impacts would be anticipated in the remainder of the proposed sequestration site because there would be little or no activity there. Noise level increases during construction would be less than 3 dBA at the nearest residences.

Ground-borne vibrations could be experienced by nearby receptors during borehole micro-seismic testing and surface seismic surveys performed at the sequestration injection site.

Utility Corridors

Transmission Corridors

No notable impacts would be anticipated from operation of the electrical transmission lines. However, under wet weather conditions, the transmission lines may generate audible or low frequency noises, commonly referred to as a “humming noise.” The audible noise emitted from transmission lines is caused by the discharge of energy (corona discharge) that occurs when the electrical field strength on the conductor surface is greater than the “breakdown strength” (the field intensity necessary to start a flow of electric current) of the air surrounding the conductor. The intensity of the corona discharge and the resulting audible noise are influenced by atmospheric conditions. Aging or weathering of the conductor surface generally reduces the significance of these factors.

Corona noise would not be noticeable because humans are generally insensitive to low frequency noise. However, in some cases, corona noise could be annoying to receptors that are located very near the transmission lines. To mitigate this occurrence, transmission lines are now designed, constructed, and maintained to operate below the corona-inception voltage.

Corona noise is caused by partial discharge on insulators and in air surrounding electrical conductors of overhead power lines.

Pipeline Corridors

The CO_2 pipeline would be buried except where it is necessary to come to the surface for valves and metering. Although valve spacing has not been determined at this time, a typical distance between metering stations is 5 miles (8 kilometers). Typically, these features are installed on concrete pads and surrounded by fencing. Alternatively, these features could be enclosed in metal buildings. These features do not have to be above ground; it is not uncommon for valves and meters to be located below grade in concrete vaults. Limited noise impacts from equipment above ground would be anticipated along the proposed CO_2 pipeline corridor during plant operation.

No noise or vibration impacts would be anticipated at the other proposed pipeline corridors during plant operation.

Transportation Corridors

Similarly to what has been described for the construction period, no noise impacts from operations would be anticipated at project-related transportation roads or rail corridors.

During the early phase of plant operation, short-term traffic noise impacts are anticipated along the transportation routes related to an increased level of trucks entering/leaving the proposed power plant. Adhering to the recommended truck routes and limiting trips to the daytime hours would help reduce noise impacts at residences along transportation routes.

Five 100-unit trains per week for coal deliveries would use the Burlington Northern Santa Fe. Based on estimated noise levels listed in FTA's guidance document (FTA, 2006), L_{max} values ranging from 76 to 88 dBAs are anticipated from the locomotive, rail cars, whistles/horns, and track switches/crossovers as the freight train passes by any nearby receptor. The L_{max} values are based on an operating speed of 30 mph (48.3 kmph), as measured approximately 50 feet (15.2 meters) from the track's centerline. Comparing the number of additional rail trips projected for coal deliveries during plant operations with the existing rail trips (70 to 84 trains per week), DOE estimated that the number of trains on the line would increase by 12 to 14 percent (less than 2 additional trains per day).

No vibration impacts are anticipated because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment, are not located within the 200-foot (61-meter) perimeter defined by FTA's distance screening threshold guidance (FTA, 2006). The closest vibration-sensitive receptor that could possibly be affected by ground-borne vibrations generated by project-related rail deliveries is approximately 0.25 miles (0.4 kilometers) from the Burlington Northern Santa Fe.

6.15 UTILITY SYSTEMS

6.15.1 INTRODUCTION

This section identifies utility systems that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Jewett Power Plant Site, sequestration site, and related utility corridors. It addresses the ability of the existing utility infrastructure to meet the needs of the proposed FutureGen Project while continuing to meet the needs of other users, and also addresses the question of whether construction of the proposed FutureGen Project could physically disrupt existing utility system features (i.e., pipelines, cables, etc.) encountered during construction.

6.15.1.1 Region of Influence

The ROI for utility systems includes two components: (1) the existing infrastructure that provides process and potable water, sanitary wastewater treatment, electricity, and natural gas to nearby existing users and that would also provide service to the proposed project; and (2) pipelines, transmission lines, and other utility lines that lie within or cross the proposed power plant site, sequestration site, or utility corridors.

6.15.1.2 Method of Analysis

Based on data provided in the Jewett EIV (FG Alliance, 2006c), DOE performed a comparative assessment of the FutureGen Project utility needs versus the existing infrastructure to determine if the proposed project would strain any of the existing systems. Additionally, DOE used data provided in the EIV (FG Alliance, 2006c) to identify the presence of utility infrastructure that could be affected by project construction.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect the capacity of public water utilities directly or indirectly;
- Require extension of water mains involving off-site construction for connection with a public water source;
- Require water supply for fire suppression that would exceed water supply capacity;
- Affect the capacity of public wastewater utilities;
- Require extension of sewer mains involving offsite construction for connection with a public wastewater system; and
- Affect the capacity and distribution of local and regional energy and fuel suppliers.

6.15.2 AFFECTED ENVIRONMENT

Two or three natural gas wells are located on the power plant site, and one new gas well is currently under construction. In addition to these wells, Railroad Commission of Texas (RCT) records indicate that a minimum of 35 gas wells are located within 1 mile (1.6 kilometers) of the site. Nine gas-gathering lines and one gas transmission line traverse the area within 1 mile (1.6 kilometers) of the site at various locations; one of these lines, approximately 1 mile (1.6 kilometers) north of the proposed power plant site, is a sour gas (i.e., poison gas) line. At least 12 other gas pipelines traverse the area within 1 mile (1.6 kilometers) of the proposed power plant site; four of these pipelines traverse the proposed site itself (FG Alliance, 2006c). The TWDB records reveal 23 documented water wells within 1 mile (1.6 kilometers) of the proposed power plant site; two of these water wells are present within the site boundaries (FG Alliance, 2006c). A dual-circuit, 345-kV transmission line forms the northwestern boundary of the Jewett Power Plant Site. Other transmission lines of 69 kV and above exist within roughly a 30-mile (48.3-kilometer) radius of the site.

The proposed sequestration site is minimally developed both for surface and subsurface uses (ranch land, gas development, agriculture). There are eight small communities located on the sequestration site. The proposed sequestration site would be located adjacent to or, depending on final selected injection sites, within the TDCJ's Coffield property. A minimum of 322 permitted or developed natural gas and oil wells exist within the sequestration site. A minimum of 21 natural gas pipeline systems, two crude oil pipeline systems, and one liquefied petroleum gas pipeline system exist within or cross the area. TWDB records indicate a minimum of 146 documented water wells occurring within the area (FG Alliance, 2006c).

6.15.2.1 Potable Water Supply

No potable water supply currently exists within, or adjacent to, the proposed Jewett Power Plant Site that could be used to provide potable water to the site. A water line currently provides potable water to the nearby NRG Limestone Electric Generating Station, but no additional capacity exists in that line for use by the FutureGen facility. The proposed Jewett Power Plant Site would receive its required 4.2 gallons (15.9 liters) per minute potable water supply from Carrizo-Wilcox aquifer. A sufficient groundwater supply is available from the aquifer. Because these proposed wells would exist on site or on immediately adjacent land, only a small amount of pipeline infrastructure would be required to deliver this water to the site. The adjacent property owner, NRG Texas, has made a commitment to allow drilling and easement rights on company land to the benefit of the FutureGen Project (FG Alliance, 2006c).

6.15.2.2 Process Water Supply

No water supply pipelines currently exist within, or adjacent to, the proposed Jewett Power Plant Site. A groundwater resource assessment indicates that a sustained pumping rate of 3,000 gallons (11,370 liters) per minute is attainable from the aquifer, which would meet project demand. The proposed source of process water for the site would involve development of a well field within the site, or on adjacent land with a process water pipeline no longer than about 1 mile (1.6 kilometers) to the north of the plant site boundary, that would draw from the Carrizo-Wilcox aquifer. The proximity of these wells would mean that only a small amount of pipeline infrastructure would be required to deliver water to the site (FG Alliance, 2006c). The process water source would also be used for fire suppression.

6.15.2.3 Sanitary Wastewater System

No sanitary wastewater lines currently exist near the proposed Jewett Power Plant Site. Sanitary wastewater would be treated and disposed of by constructing and operating an on-site wastewater treatment system to accommodate the 6,000 gallons (22,712 liters) per day capacity.

6.15.2.4 Electricity Grid, Voltage, and Demand

The proposed Jewett Power Plant Site is located in the Electric Reliability Council of Texas (ERCOT) region, which serves a 200,000-square-mile (518,000-square-kilometer) area. ERCOT is the regional reliability organization for this part of the country, charged with operating and ensuring reliability for the transmission system. Within the ERCOT Region, the proposed Jewett Power Plant Site is located in the North Regional Transmission Planning Group.

Peak demand in the ERCOT region occurs during the summer months. As of 2006, the total peak demand in the region was 61,656 megawatts (MW), and this is forecast to increase to 69,034 MW by

2011, representing a growth rate of 2.3 percent per year. If this growth is extrapolated to 2015, peak demand would reach 75,686 MW by 2015. Annual electric energy usage in the region was 299,219 gigawatt-hour (GWh) in 2005 (ERCOT, 2006a). Energy usage is forecast to grow at 2.1 percent per year, which would result in potential energy requirements of 368,338 GWh by 2015 (NERC, 2006).

> Annual average sales of electrical energy in the U.S. are expected to grow from 3,567,000 GWh in 2004 to 5,341,000 GWh by 2030—an increase of about 50 percent (EIA, 2006). The FutureGen Project is scheduled to go on line in 2012 and may contribute toward meeting this need; however, its primary purpose is to serve as a research and development project.

In 2006, ERCOT had 70,498 MW of net resources. This is expected to grow to 70,987 MW by 2011, which would result in very low reserve margins of 4.5 percent in 2011. There are, however, several thermal plants that have been proposed for construction in the region, which together could increase the margin to as much as 23.5 percent (NERC, 2006). Thus, the reserve margin in 2012 is expected to be anywhere between 4.5 percent and 23.5 percent. The proposed Jewett Power Plant Site could connect to either a 345-kilovolt (kV) transmission line bordering the northwest boundary of the site with a new substation or a 138-kV line within about 2 miles (3.2 kilometers) from the site (FG Alliance, 2006c).

6.15.2.5 Natural Gas

An existing, on-site natural gas pipeline (owned and operated by Energy Transfer Corporation) enters the Jewett Power Plant Site at its northwestern corner. The proposed Jewett Power Plant Site would receive its required 1.8 million cubic feet (50,970 cubic meters) per hour natural gas supply from this pipeline. The pipeline has the capacity to deliver 12 million cubic feet (339,802 cubic meters) per hour of natural gas at a pressure of 450 pounds per square inch (3.1 megapascals).

6.15.2.6 CO_2 Pipeline

No CO_2 pipelines exist in the immediate vicinity of the proposed power plant and sequestration sites.

6.15.3 IMPACTS

6.15.3.1 Construction Impacts

During construction, construction equipment, particularly trenching equipment, could accidentally sever or damage existing underground lines. Additionally, construction equipment could damage power or telephone poles and lines if the equipment were to come into contact with them. However, all of the proposed ROWs would have sufficient width to allow for the safe addition of project-related lines without interfering with the existing utilities if standard construction practices are followed. Estimated construction requirements for new utility infrastructure are presented in Table 6.15-1.

Power Plant Site

The 200-acre (81-hectare) envelope, which includes the power plant footprint and railroad loop, could ultimately be located anywhere within the proposed 400-acre (162-hectare) Jewett Power Plant Site. The 200-acre (81-hectare) envelope could accommodate surface facilities required for an on-site sanitary wastewater treatment facility. As shown in Figure 6.15-1, several gas lines currently cross the site. These existing utility systems would need to be taken into account during the final siting of the power plant and related facilities to avoid being damaged. It is possible that some existing lines might need to be rerouted, which would result in a short-term effect on existing gas users.

Table 6.15-1. Utility System Construction Requirements

Infrastructure Element	Equipment	Duration	Manpower
Potable water pipeline Using same source as process water source	Same as process water	Same as process water	Same as process water
Process water pipeline Proposed groundwater source on site; assume pipeline corridor no longer than 1 mile (1.6 kilometers) north of site boundary. Other options are available (see Section 3.6)	Heavy and light construction equipment, incl. 2 D-6 dozers, trencher, 3 track hoes, 2 rubber-tired back hoes, 3 561 sidebooms, motor grader, and small vehicles and implements	1 week per mile	30 workers
Sanitary Wastewater pipeline Plan to create an on-site wastewater system	n/a	n/a	n/a
Transmission line North Option: 345-kV line along northwestern power plant site boundary with new substation 0.7 mile (1.1 kilometers) South Option: 138-kV line connection 2 miles (3.2 kilometers) in length	Crane for setting poles, bulldozer for earth moving and path leveling, and several bucket trucks	Not estimated	Not estimated
Natural gas pipeline Using existing line that enters site at northwest corner	n/a	n/a	n/a
CO_2 pipeline 52- to 59-mile (83.7- to 95-kilometer) pipe to sequestration site, with spurs to multiple injection wells	Heavy and light construction equipment, incl. 2 D-6 dozers, trencher, 3 track hoes, 2 rubber-tired back hoes, 3 561 sidebooms, motor grader, and small vehicles and implements	1 week per mile	30 workers

n/a = not applicable.
Source: FG Alliance, 2006c.

Sequestration Site

Utility needs at the Jewett Sequestration Site would be limited to the provision of an electric service line to operate pumps and other equipment. Construction at the proposed Jewett Sequestration Site could therefore affect existing utilities or utility systems if appropriate care were not taken during the selection of well sites and during construction.

Utility Corridors

Potable Water Supply

The potable water pipeline corridor has not been selected at this point, and could potentially cross existing oil and gas pipelines in the area. The proposed potable water source would either be an on-site well or a pipeline corridor less than 1 mile (1.6 kilometers) in length.

Process Water Supply

The process water pipeline corridor has not been selected at this point, and could potentially cross existing oil and gas pipelines in the area. The proposed process water source would either be an on-site well or a pipeline corridor less than 1 mile (1.6 kilometers) in length.

Sanitary Wastewater System

Sanitary wastewater would be treated by constructing and operating on-site wastewater system, so no off-site sanitary sewer wastewater pipelines would be required (FG Alliance, 2006c).

Transmission Line System

The corridor that would be used to reach the 138-kV line has not been selected at this point. The electrical transmission line would either connect to a new substation at the site boundary or a new 2-mile (3.2-kilometer) transmission line would be built. Given the number of oil and gas pipelines in the area, it is likely that any new transmission corridor would cross some existing underground pipelines.

Natural Gas Pipeline

An existing natural gas pipeline (owned and operated by Energy Transfer Corporation) enters the site at its northwestern corner, so no off-site natural gas pipeline corridor would be required (FG Alliance, 2006c).

CO_2 Pipeline

The Jewett Power Plant Site would be interconnected to the proposed sequestration reservoir by a CO_2 pipeline between 52 and 59 miles (83.7 and 95 kilometers) long. Several potential corridor segments have been proposed, most of which use existing natural gas pipeline ROWs. Segments A-C and B-C are options that would connect the plant site to the beginning of the common pipeline segments at point "C". Only one of these options would be selected. Figure 6.15-1 shows the proposed pipeline corridor configuration and corridor segments as follows:

- Segment A-C: This segment would begin on the western side of the power plant site and follows about 2 miles (3.2 kilometers) of existing railroad ROW owned by the Burlington Northern Santa Fe Railroad. It continues another 3 miles (4.8 kilometers) along new ROW until it intersects a section of the 12-inch (30.5-centimeter) Pinnacle pipeline. It would then follow this pipeline eastward for another 3 miles (4.8 kilometers) until it joins the primary 24-inch (61-centimeter) trunk of the Pinnacle pipeline.
- Segment B-C: This corridor segment would begin along the southern boundary of the power plant site and extends eastward about 2.5 miles (4 kilometers) along FM 39. It would then follow the ROW of a small-diameter natural gas pipeline owned by Enbridge Pipelines for another 4 miles (6.4 kilometers) until it joins the main Pinnacle pipeline ROW, which continues northward for about 8 miles (12.9 kilometers).
- Segment C-D: This corridor segment would continue to follow the 24-inch (61-centimeter) Pinnacle pipeline northward for about another 15 miles (24.1 kilometers)
- Segment D-E: This segment is no longer being evaluated for the project and is not addressed in this EIS.
- Segment D-F: This segment would continue north along the 24-inch (61-centimeter) Pinnacle pipeline ROW for almost 9 miles (14.5 kilometers).

- Segment F-G: This segment would extend east along new ROW approximately 6 miles (9.7 kilometers) into the proposed sequestration reservoir area.
- Segment F-H: This corridor segment would continue northward along the existing 24-inch (61-centimeter) Pinnacle pipeline ROW for about 2 miles (3.2 kilometers) where it crosses north of the Trinity River. It would then intersect with the corridor of a 12-inch (30.5-centimeter) Pinnacle pipeline, which it would follow east for about 6 miles (10 kilometers). The line would then continue in a generally eastward direction along county highway ROW and TDCJ land for approximately another 6 miles (9.7 kilometers) to the proposed injection well site on TDCJ land.

6.15.3.2 Operational Impacts

All of the proposed operational requirements for potable and process water, sanitary wastewater, and natural gas are well within the capacities of the systems that already exist or would be developed, as described below. A feasibility report from ERCOT (2006b) indicates that operational impacts on the existing transmission system can be handled pending construction of other power plants in the vicinity of the proposed site for the FutureGen Project.

Power Plant Site

Potable Water Supply

No water supply pipelines currently exist near the proposed Jewett Power Plant Site that could be used to provide potable water. A water line currently provides potable water to the nearby NRG Limestone Electric Generating Station, but this line has no additional capacity for use by the proposed FutureGen facility. The proposed primary source of water for the site would involve development of a well field within the site and on adjacent land into the Carrizo-Wilcox aquifer. A groundwater resource assessment conducted by a hydrogeology expert for this area indicates that sustained groundwater pumping of at least 3,000 gallons (11,356 liters) per minute is easily attainable (FG Alliance, 2006c). For 200 employees using 30 gallons (113.6 liters) of potable water a day, the potable water consumption rate would average 4.2 gallons (15.9 liters) per minute, which would be negligible compared to the water supply capacity.

Process Water Supply

The proposed primary source of process water for the site would involve development of a well field within the site and on adjacent land into the Carrizo-Wilcox aquifer. Because these proposed wells would exist on site or on immediately adjacent land, only a small amount of pipeline infrastructure would be required to deliver water to the site. A groundwater resource assessment conducted by a hydrogeology expert for this area (FG Alliance, 2006c) indicates that sustained groundwater pumping of at least 3,000 gallons (11,356 liters) per minute is easily attainable, which would provide adequate process water for the FutureGen Project.

Sanitary Wastewater System

Because the proposed Jewett Power Plant would use a ZLD system, there would be no process-related wastewater associated with the project. The daily sanitary wastewater effluent from the facility would be limited to the sanitary needs of a workforce of 200 employees. Assuming 30 gallons (113.6 liters) of sanitary wastewater per employee per day (FG Alliance, 2006e), the wastewater needs would equal 6,000 gallons (22,712 liters) per day. No wastewater pipelines currently exist near the proposed Jewett Power Plant Site. Sanitary wastewater would be treated and disposed of by construction and operation of a new on-site wastewater treatment system. Therefore, the operational requirements of the project would have no adverse effect on any existing wastewater treatment plant's ability to meet current and future treatment needs.

Transmission Line System

The proposed power plant would provide a nominal 275 MW of capacity. The project would operate at an 85 percent plant factor over the long term, which would result in an average output of 2.0 gigawatt-hour (GWh) of energy per year.

The ERCOT Security Screening Study (ERCOT, 2006b) indicates that the transfer limit of the existing 345-kV line would be greater than 400 MW for the FutureGen Project if no other additional generation resources were connected to the line. Even if 2,500 MW of new generation were added near the site, the transfer limit would still be greater than 400 MW for the FutureGen Project facility if several, mostly minor, upgrades were made. The minor upgrades would not require any new ROW and would not cause an extensive transmission outage during the system upgrades. However, one new 345-kV double circuit line from the Texas New Mexico Power Cooperative (TNP) to Sandow, Texas would be required, which is to be expected if 2,500 MW of new generation were added to the system.

The 138-kV connection through the Farrar substation would allow a transfer limit of 350 MW with three relatively minor megavolt-ampere (MVA) upgrades, which would be sufficient to handle the expected FutureGen Project generation. If these 138-kV lines were not completed by 2012, the application of a Special Protection Scheme or Remedial Action Plan could allow the proposed FutureGen Power Plant to operate in curtailed mode until the needed transmission lines were constructed. Curtailment occurs when the system controller from the Independent System Operator (in this case, ERCOT) observes a thermal or voltage limit overload for an operating situation or, upon performing a contingency analysis, predicts a thermal or voltage limit overload for a planned project. If this occurs ERCOT would notify the participant or power source that new transmission facilities must be completed to avoid this problem. If the facility is predicted to cause an overload, it would have to operate in a curtailed mode. If the power source is already operating and an overload is apparent, ERCOT would issue a directive to curtail the production of energy from a particular facility or more than one facility on a pro-rata basis if several facilities are involved in causing the overload.

The FutureGen Project would aid in meeting regional load, reserve, and energy requirements, and could potentially defer the need for alternative generation sources. However, the FutureGen Project would be capable of meeting only a small percentage of projected load growth over the next 10 years in the ERCOT region. There are several thermal plants that have been proposed for construction in the region, which could increase the margin to as much as 23.5 percent (NERC, 2006). Some of these projects may have received the air quality permits that are required before construction can begin. However, they still lack interconnection agreements, which must also be in place in order for a new project to transmit its power from the plant to consumers.

Natural Gas Pipeline

As previously mentioned, the existing natural gas pipeline that would be used to service the proposed FutureGen facility has the capacity to deliver 200,000 standard cubic feet (5,663 standard cubic meters) per minute of natural gas at a pressure of 450 pounds per square inch (3.1 megapascals). This is more than sufficient to supply the demands of the proposed FutureGen Project (startup: 500 standard cubic feet per minute at 450 psi [3.1 megapascals] [min] to 30,000 standard cubic feet [849.5 standard cubic meters] per minute). Thus, the operational needs of the project would not have an adverse effect on the ability of the system to supply existing and other future demands for natural gas.

CO_2 Pipeline

The pipelines would have sufficient capacity to accommodate the CO_2 expected from the proposed Jewett Power Plant. However, new segments of pipeline and ROW would be required between the plant site and sequestration site.

Sequestration Site

Once construction was completed, the operation of the injection wells at the sequestration site would have no effect on the operation of other utilities present in the area.

Utility Corridors

Once construction was completed, the operation of project-related utilities would have no effect on the operation of other utilities sharing the corridors.

6.16 MATERIALS AND WASTE MANAGEMENT

6.16.1 INTRODUCTION

Construction and operation of the FutureGen Project would require a source of coal, access to markets for sulfur products, a means to reuse byproducts such as slag, and the ability to capture and sequester CO_2 and dispose of any waste that is generated. This section discusses the capabilities of the proposed Jewett Site to meet each of these requirements. It describes the potential impact of the demands posed by the FutureGen Project on the supply of construction and operational materials in the region. It also discusses the impacts to regional waste management resources.

6.16.1.1 Region of Influence

The ROI includes waste management facilities; industries that could use the FutureGen by-products; and the suppliers of construction materials, coal, and process chemicals used in the construction and operation of the proposed FutureGen Project (power plant, sequestration site, CO_2 distribution system, and associated utilities and transportation infrastructure). The extent of the ROI varies by material and waste type. For example, the ROI for construction material suppliers and solid waste disposal facilities is small (within about 50 miles [80 kilometers] of the proposed Jewett Site) because these types of resources are widely available and the large volumes of materials or waste that would be needed or waste that would be generated are costly to transport over large distances. Treatment and disposal facilities for hazardous waste are less common and the associated ROI includes a multi-state (Texas and Louisiana) area extending 300 miles (483 kilometers) from the site. The ROI for coal and process chemicals, as well as the sulfur product, includes the State of Texas and could extend farther if the cost or value of the commodity makes it economical to transport over a greater distance.

6.16.1.2 Method of Analysis

DOE evaluated impacts by comparing the demands posed by construction and operation of the FutureGen power plant, sequestration site, utility corridors, and transportation infrastructure to the capacities of materials suppliers and waste management facilities within the ROI. The analysis also evaluated regional demand and access to markets for sulfur products. DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause new sources of construction materials and operational supplies to be built, such as new mining areas, processing plants, or fabrication plants;
- Affect the capacity of existing material suppliers and industries in the region;
- Create waste for which there are no commercially available disposal or treatment technologies;
- Create hazardous waste in quantities that would require a treatment, storage or disposal (TSD) permit;
- Affect the capacity of hazardous waste collection services and landfills;
- Create reasonably foreseeable conditions that would increase the risk of a hazardous waste release; and
- Create reasonably foreseeable conditions that would increase the risk of a hazardous material release.

DOE reviewed information provided in the Jewett Site EIV (FG Alliance, 2006c) and proposal (FG Site Proposal [Jewett, Texas], 2006). Letters of interest, bid prices, and other prospective material supplier information were identified for use in the EIS. DOE then consulted waste management and

material supplier information compiled by state agencies and trade organizations to confirm availability of these resources in the ROI. Uncertainty regarding the specific technologies that would be employed in the FutureGen facility and variability in the potential coal feeds made it difficult to quantify operational materials requirements and waste generation. The maximum value for each item was used in the analysis to bound the potential impacts of the technologies that could be selected. Limited information is available regarding materials requirements or waste generation for construction. DOE used NEPA documentation and design information for facilities of similar scope and size to augment the FutureGen-specific information.

6.16.2 AFFECTED ENVIRONMENT

The Jewett Power Plant Site consists of approximately 400 acres (162 hectares) of mostly open land. The site and its surroundings are located in a rural area where land use has been dominated historically by ranching, gas well activities, and lignite mining activities. The site contains unimproved roads and structures related to gas well activities. It is located northeast of the existing NRG Limestone Electric Generating Station. The Burlington Northern Santa Fe Railway line runs along the northern border of the site. A Phase I ESA found evidence of recognized environmental conditions: underground and aboveground tanks, surface-spillage of petroleum related substances, waste/debris piles, chemical storage areas, and several hundred drums (some were empty, some were full). However, any resulting contamination is not significant with respect to siting another industrial facility on the site (Horizon Environmental Services, 2006).

The TCEQ verified that the proposed site is not on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and that no unremediated hazardous waste identified or listed pursuant to Section 3001 of the Resource Conservation and Recovery Act (RCRA) have been disposed of at the proposed Jewett Power Plant Site (TCEQ, 2006a).

6.16.2.1 Construction Materials

A number of suppliers and producers of construction materials are available in the area offering concrete, asphalt and aggregate materials. A sample of the surrounding industry is described in the following subsections, including information on the suppliers' capacities and sources.

Concrete

Large companies supplying concrete services in the area include Transit Mix and A. L. Helmcamp with a combined capacity of 550 cubic yards (420 cubic meters) per hour. Other local suppliers include Young Ready Mix, Boyd Concrete, Texcon, Aggieland Concrete, Texas EMC Products, Houston Concrete Company, and several smaller suppliers (FG Alliance, 2006c).

- Transit Mix Concrete and Materials Company is located in Bryan, Waco, College Station, Hearne, Huntsville, and other central Texas cities. With an on-site mix station, Transit Mix has the capacity to supply 250 cubic yards (191 cubic meters) per hour and average 3,500 cubic yards (2,676 cubic meters) per day. The company has a fleet of more than 450 mixer trucks.
- A.L. Helmcamp can supply concrete at an average of approximately 300 cubic yards (229 cubic meters) per hour. Portable plants are its main source of production.

Asphalt

There are three large asphalt producers in the area of the Jewett Site with a total daily capacity of 8,000 tons (7,257 metric tons) (FG Alliance, 2006c).

- A.L. Helmcamp has the capacity to supply 400 tons (363 metric tons) of asphalt per hour and is able to lay an average of 3,000 to 4,000 tons (2,721 to 3,629 metric tons) per day. The company's asphalt, known as prime, is shipped to its local facilities from Houston and Louisiana. A.L. Helmcamp has two portable asphalt plants, one of which is currently located in Leon County.
- Armor Materials serves Leon and other central Texas counties. There are two locations established within close proximity to the Jewett Site, in Palestine and Corsicana, Texas. Armor Materials has the capacity to supply 2,000 to 2,500 tons (1,814 to 2,268 metric tons) per day. Its asphalt supplies are shipped from Henderson, Texas, and its aggregate supplies come from Oklahoma.
- Young Contractors, Inc. Asphalt produces specific hot mix asphalt for any mix design requirement. Young Asphalt can supply approximately 1,500 tons (1,360 metric tons) of asphalt per day. There are numerous Young Asphalt locations throughout central Texas, including Waco, Hillsboro, and Bryan.

Aggregate and Fill Material

Several sources in central Texas provide gravel, sand, dirt, and rock to suppliers that could serve the proposed project. In particular, Mexia, Texas, is a large source of limestone for this area. Waco and areas north of Bryan, Texas, are also known as good sources for gravel and sand (FG Alliance, 2006c).

- Frost Crushed Stone is a major supplier of limestone for the area, having over 6.5 million tons (5.9 MMT) of fill materials on reserve with an abundance of supplies readily available in Mexia, Texas. Frost Crushed Stone currently provides limestone for highway construction and power plants.
- Young Contractors, Inc. Aggregates (Young Aggregates) supplies all types of base material, crushed limestone aggregates, and sand and gravel products. Young Aggregates has the capacity to produce and supply 10,000 to 15,000 pounds (4,536 to 6,804 kilograms) of fill material per day. Its large trucking fleet can deliver material from its numerous locations throughout central Texas. Currently there are two plants in Mexia, two plants in Waco, and one plant in Bryan that could serve the Jewett Site.
- Trinity Materials, Inc. operates 14 mining facilities located in Texas and Louisiana. Its production consists of gravel, pea gravel, crushed gravel, capillary rock, remix, road base, concrete sand, mason sand, plaster sand, flume sand, and golf course sand.
- A.L. Helmcamp can produce 3,000 to 5,000 yards (2,743 to 4,572 meters) of fill per day. All of their material is gathered within the general area of the job site.

6.16.2.2 Process-Related Materials

Coal Supply Environment

Figure 6.16-1 shows the location of coal mines and probable locations of coal deposits in relation to the proposed Jewett Power Plant Site. The Jewett Site sits in the middle of a vast belt of lignite coal – the largest in North America – that stretches from Louisiana, across Texas, and into northern Mexico. The site is located at the Jewett lignite mine and can take advantage of existing mining infrastructure and truck transport systems.

The site has ready access to several types of coal at economical rates. The abundance of low cost, hydrogen-rich Texas lignite, PRB coal, and Gulf Coast petroleum coke provides many fuel options at attractive rates. There is an alternate fuel option due to the proximity to two ranks of high BTU Mexican bituminous coal from the Sabinas and Fuentas basins in Northern Mexico. In all, the infrastructure would allow at least six different sources of coal to be delivered to the Jewett Site.

The proposed site is a mine-mouth property capable of delivering 100 percent of the lignite required to fuel the proposed power plant for more than 30 years (FG Site Proposal (Jewett, Texas), 2006). Lignite could be mined on site. Lignite, other coal ranks, and petroleum coke would be delivered by rail to the Jewett Site. The Burlington Northern Santa Fe railway runs along the property boundary ensuring that fuel can be delivered economically. This line is easily accessible to lines in Mexico, the West Coast, Midwest, Gulf Coast, and East Coast that provide service to entities that are potential sources of fuel and materials to the site. Table 6.16-1 indicates coal and transportation bids for the Jewett Site.

Table 6.16-1. Coal Price Projections

	Coal Cost	Rail Transport Cost	Delivered Cost
	Dollars per ton (Dollars per metric ton) of coal		
Powder River Basin	8-9 (8.80-9.90)	13 (14.30)	21-22 (23.10-24.20)
Texas Lignite	10-12 (11-13.20)	3 (3.3)	13-15 (14.30-16.50)
Pennsylvanian	26-28 (28.60-30.8)	7 (7.70)	33-35 (36.30-38.50)
Illinois Basin	27-29 (29.70-31.90)	7 (7.70)	34-36 (37.40-39.60)

All costs in 2005 dollars. Prices projected for the year 2011.
Rail transportation costs were based on mileage estimates to the proposed Odessa Site at an approximately transport costs of 12 cents per ton-mile. Given the reduced distance from the Texas lignite resources to the proposed Jewett Site, the transportation costs for Texas lignite are expected to be somewhat less than indicated.
Source: FG Site Proposal (Jewett, Texas), 2006.

Process Chemical Supply Markets

The process chemicals required by the proposed project are common water treatment and conditioning chemicals that are widely used in industry with broad regional and national availability. Large suppliers of water and waste treatment chemicals in the area include Ciba, Kemira, Nalco, Stockhausen, and the SNF Group.

6.16.2.3 Sulfur Markets

The technologies that would be available for sulfur removal at the proposed power plant are similar to the technologies employed in the petroleum refining industry. These treatment technologies result in the production of elemental sulfur, which is marketable. Texas has a large and mature sulfur production, transportation, and marketing system that can assist in the off-take of sulfur that is produced and treated at the FutureGen site. U.S. production of sulfur was 13.6 million tons (12.3 MMT) in 2002 (TIG, 2002). The sulfur is used in the manufacture of numerous chemical, pharmaceutical, and fertilizer products. Prices in 2005 averaged $51 to $53 per ton in Houston and the current prices are at $60 to $63 per ton in Houston (FG Site Proposal [Jewett, Texas] 2006).

The worldwide supply of sulfur is expected to exceed demand by 5.4 and 5.9 million tons (4.9 and 5.4 MMT) in 2006 and 2011, respectively. The surplus could increase up to 12.1 million tons (11 MMT) in 2011 if clean fuel regulations continue to be implemented worldwide. However, the

Sulphur Institute, an international non-profit organization founded by the world's sulfur producers to promote and develop uses for sulfur, sees market potential in developing plant nutrient sulfur products and sulfur construction materials, especially sulfur asphalt. The estimate for the plant nutrient sulfur market is 10.5 million tons (9.5 MMT) annually by 2011. The Sulphur Institute estimates the potential consumption of sulfur in the asphalt industry in North America could reach 0.45 million tons (0.41 MMT) by 2011 (assuming sulfur captures 5 percent of the 30-million-ton [27-million-metric-ton] asphalt market and an average of 30 percent by weight of asphalt replaced by sulfur). Tests on asphalt made with sulfur show it to have a greater resistance to wheel rutting and cracking than conventional asphalt (Morris, 2003).

6.16.2.4 Recycling Facilities

The bottom slag and ash produced by the gasifier would have local and regional markets for reuse. The American Coal Ash Association (ACAA), a non-profit organization that promotes the beneficial use of coal combustion products, reported that 96.6 percent of the bottom slag and up to 42.9 percent of the ash generated by power plants in 2005 was beneficially used rather than disposed of. Primary uses of slag are as blasting grit and as roofing granules, with lesser amounts in structural and asphalt mineral fills. Ash is primarily used in concrete products, structural fills, and road base construction. The ACAA expects the demand for coal combustion products to increase in the next few years. Some of the increase would be due to federal and state transportation departments promoting the use of coal combustion products for road construction (ACAA, 2006).

6.16.2.5 Sanitary Waste Landfills

TCEQ permits landfills receiving nonhazardous waste by type. Type I landfills are sanitary waste landfills and Type IV landfills are construction and demolition debris landfills (30 Texas Administrative Code [TAC] 330.5). TCEQ (30 TAC 330.3 and 30 TAC 330.173) defines nonhazardous industrial waste in three classes, Class 1, 2, and 3, and establishes what landfills are acceptable for disposal of the waste classes as presented below.

- Class 1 waste—Any industrial solid waste or mixture of industrial solid waste that because of its concentration, or physical or chemical characteristics is toxic, corrosive, flammable, a strong sensitizer or irritant, a generator of sudden pressure by decomposition, heat, or other means, or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed. Waste that is Class 1 only because of asbestos content may be accepted at any Type I landfill that is authorized to accept regulated asbestos-containing material. With approval of the TCEQ Executive Director, Type I and IV landfills can receive Class 1 industrial solid waste and hazardous waste from conditionally exempt small quantity generators, if properly handled and safeguarded in the facility (30 TAC 330.5).
- Class 2 waste—Any individual solid waste or combination of industrial solid waste that are not described as Hazardous, Class 1, or Class 3. Class 2 industrial solid waste, except special waste as defined in §330.3 of this title, may be accepted at any Type I landfill provided the acceptance of this waste does not interfere with facility operation. Type I and Type IV landfills may accept Class 2 industrial solid waste consistent with the established limitations.
- Class 3 waste—Inert and essentially insoluble industrial solid waste, usually including, but not limited to, materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable. Class 3 industrial solid waste may be disposed of at a Type I or Type IV landfill provided the acceptance of this waste does not interfere with facility operation.

Sanitary waste planning in Texas is the responsibility of 24 Councils of Governments. The Jewett Power Plant Site is located in the Brazos Valley Council of Governments. This area has only one landfill, Rock Prairie Road Landfill, with less than five years remaining capacity in place (Best, 2006). Another landfill has been permitted in Grimes County and should be operational in 2009 (Best, 2006). Landfills located in the Heart of Texas Council of Governments are closer to the proposed site and the remaining disposal capacity in that region is 89 years (TCEQ, 2006b).

Table 6.16-2 lists the sanitary waste landfills in the region and their remaining disposal capacity. Regional landfill capacity in the Jewett area would be available for up to 132 years (based on the disposal capacity for all classes of waste) at current disposal rates. Space on the 400-acre (162-hectare) proposed plant site would be available for a landfill if needed. Figure 6.16-2 shows the location of these facilities in relation to the proposed site in Jewett, Texas.

Table 6.16-2. Nearby Sanitary Waste Landfills

Landfill	Council of Governments	City	Remaining Disposal Capacity in Place (yd^3 [m^3])[1]	Remaining Years of Disposal Capacity[1]	Approximate Distance from Site (miles [km])
Landfills Accepting Classes 2 and 3 Nonhazardous Industrial Waste					
City of Waco Landfill 948A	Heart of Texas	Waco	10,049,250 (7,683,203)	20	63 (101)
Lacy-Lakeview Landfill	Heart of Texas	Waco	2,660,321 (2,033,961)	22	53 (85)
Mexia Landfill	Heart of Texas	Mexia	7,761,832 (5,934,346)	132	18 (29)
Rock Prairie Road Landfill	Brazos Valley	College Station	2,319,310 (1,773,239)	6	85 (137)
Grimes County Landfill	Brazos Valley	Carlos	Permitted, not yet open	30	92 (148)
Landfills Accepting Class 1 Nonhazardous Industrial Waste					
CSC Disposal and Landfill	North Central Texas	Avalon	32,131,976 (24,566,658)	92	67 (108)
Itasca Municipal Solid Waste Landfill	Heart of Texas	Itasca	35,819,409 (27,385,903)	266	77 (124)

[1] Capacity as of September 2005.
yd^3 = cubic yards; m^3 = cubic meters; km = kilometers.
Source: TCEQ, 2006b.

The proposed facility would have the option of disposing of its nonhazardous waste by constructing and operating an on-site landfill, as allowed under the Texas Health and Safety Code. The Texas Health and Safety Code, §361.090, Regulation and Permitting of Certain Industrial Solid Waste Disposal, allows the collection, handling, storage, processing, and disposal of industrial nonhazardous solid waste on site without obtaining a permit or authorization from the TCEQ. A notification to the TCEQ of the on-site waste management activity in accordance with 30 TAC 335.6 and deed recordation in accordance with 30 TAC 335.5 would be required for land disposal of waste.

6.16.2.6 Hazardous Waste Treatment, Storage, or Disposal Facilities

Two hazardous waste disposal facilities are less than 300 miles (483 kilometers) from the Jewett Site.

- U.S. Ecology Texas, located in Robstown near Corpus Christi, Texas, is approximately 270 miles (435 kilometers) from the proposed power plant site. The facility currently has approximately 140,000 cubic yards (107,038 cubic meters) of remaining capacity with an additional 412,000 cubic yards (314,997 cubic meters) of permitted capacity not yet constructed. A permit modification has been submitted to the TCEQ requesting an additional 2,740,000 cubic yards (2,094,880 cubic meters) of capacity that would replace the current permitted capacity yet to be constructed (FG Alliance, 2006c).
- Chemical Waste Management's Lake Charles Facility, located in Sulphur, Louisiana, is approximately 275 miles (443 kilometers) from the Jewett Site. This facility received 103,621 tons (93,003 metric tons) of hazardous waste in 2003 (EPA, 2003).

6.16.3 IMPACTS

6.16.3.1 Construction Impacts

Power Plant Site

Power plant construction materials would consist primarily of structural steel beams and steel piping, tanks, and valves. Locally obtained materials would include crushed stone, sand, and lumber for the proposed facilities and temporary structures (e.g., enclosures, forms, and scaffolding). Components of the facilities would also include concrete, ductwork, insulation, electrical cable, lighting fixtures, and transformers.

Waste from construction of the proposed facilities would include excess materials, metal scraps, and pallets, crates, and other packing materials. Excess supplies of new materials would be returned to vendors or be retained for future use. Surplus paint and other consumables, partial spools of electrical cable, and similar leftover materials would also be retained for possible future use in maintenance, repairs, and modifications. Scrap metal that could not be reused on site would be sold to scrap dealers. Other scrap materials could also be recycled through commercial vendors. Packaging material (e.g., wooden pallets and crates), support cradles used for shipping large vessels and heavy components, and cardboard and plastic packaging would be collected in dumpsters and periodically transported off site for disposal.

Construction equipment would include cranes, forklifts, air compressors, welding machines, trucks, and trailers. Operation of heavy equipment would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor.

Petroleum products are sometimes spilled at construction sites as a result of equipment failure (split hydraulic lines, broken fittings) or human error (overfilled tanks). To mitigate the impacts of spills, use of petroleum products, solvents, and other hazardous materials would be restricted to designated areas equipped with spill containment measures appropriate to the hazard and volume of material being stored on the construction site. Refueling, lubrication, and degreasing of vehicles and heavy equipment would take place in restricted areas. An SPCC Plan would be prepared in accordance with 40 CFR 112.7. Personnel would be trained to respond to petroleum and chemical spills and the necessary spill control equipment would be available on site and immediately accessible.

The proposed Jewett Power Plant Site includes up to 200 acres (81 hectares) to allow for the power plant, coal and equipment storage, associated processing facilities, research facilities, the railroad loop surrounding the power plant envelope, and a buffer zone. Debris would be generated as a result of clearing and grading. Only about 60 acres (24 hectares) of the site would be required for the facilities comprising the power plant footprint (see Figure 2-18). Any excavated material could be used as fill on the site. This debris would be disposed on site or transported to an off-site landfill for disposal.

The waste requiring disposal could be disposed of on site, if an on-site landfill was developed, or at permitted off-site landfills. Ample room would be available for an on-site solid waste landfill.

Area sanitary landfills would have ample capacity to receive project construction waste. Because the quantity of waste from project construction would be small in comparison with the landfill capacity and waste quantities routinely handled, disposal of this waste would not be expected to have an impact.

Sequestration Site

The proposed sequestration site is located 33 miles (53 kilometers) away from the Jewett Power Plant Site. The components to be constructed at the sequestration site would include injection wells, four production wells, associated piping, and an access road (road construction is discussed below.). CO_2 would be injected into two target reservoirs (Woodbine [two wells] and Travis Peak [one well]) at slightly different pressures. A recompression pump would be needed to increase the pressure of the CO_2 that would be injected into the deeper formation. The materials needed are piping and concrete for seaming. Sources for these construction materials are well established nationally; none of the quantities of materials required would create demand or supply impacts.

The materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris. Heavy equipment would be used that require fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

Utility Corridors

The following utility infrastructure would be constructed to support the proposed FutureGen facility:

- New electric transmission substation (an option involving up to 2 miles (3.2 kilometers) of transmission line in new ROW is also being evaluated).
- 2,000-foot (610-meter) long water pipeline on site serving both process water and potable water needs.
- On-site wastewater treatment facility.
- Options involving 43 to 53 miles (69.2 to 85.3 kilometers) of CO_2 pipeline using existing ROW and 6 to 9 miles (10 to 14 kilometers) of new ROW are being evaluated.

Where utilities would be placed along existing utility corridors minimal clearing of vegetation and grading, creating land clearing debris may require removal and disposal. New ROW may require more extensive land clearing and grading. However, construction debris disposal capacity would be available at area landfills or at an on-site landfill, if developed.

The construction of the pipelines, transmission lines, transmission substation, and wastewater treatment system would require pipe, joining and welding materials including compressed gases, steel cable and structures, and insulated wiring for transmission lines, and building construction materials such as lumber and masonry materials. Sources for these construction materials are well established nationally; and the quantities of materials required to construct the infrastructure would not create demand or supply impacts.

Construction materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris. Heavy equipment would be used that require fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

Transportation Corridors

Roads

The proposed Jewett Power Plant Site is served by a road system that is adequate for the site and no upgrades as planned (FG Alliance, 2006c). The FutureGen contractor would be responsible for constructing on-site roads.

The materials needed for on-site road construction are concrete, aggregate, and asphalt. Road construction results in minimal waste due to the ability to recycle and reuse these materials. Excavated soil would be used for fill elsewhere along the route and asphalt would be recycled. Road construction would require heavy equipment that would need fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

Rail

The proposed power plant site has rail access that would require the construction of an on-site rail loop. The materials needed for construction of an industrial rail siding and loop track would be steel for rails and pre-cast concrete railbed ties, and rock for ballast. The sources for rails and railbed ties are well established nationally; none of the quantities of materials required for constructing a rail spur would create demand or supply impacts. Furthermore, these materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris.

In addition, to the materials to be installed, construction of the rail loop would require fuel, oils, lubricants, and coolants for heavy machinery, and compressed gasses for welding. Should any of these require disposal, they would be special waste or hazardous waste and shipped to permitted hazardous waste treatment and disposal facility. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur.

Solid and hazardous waste disposal capacity in the region is detailed in Table 6.16-2 and Section 6.16.2.6. There would be no impact to waste collection services or disposal capacity.

6.16.3.2 Operational Impacts

Power Plant Site

The FutureGen Project would be capable of using various coals. The proposed Jewett Power Plant Site sits in the middle of a vast belt of lignite coal that stretches from Louisiana, across Texas, and into northern Mexico. The site itself sets atop of a lignite mine. For purposes of analysis, the following coals were evaluated:

- Northern Appalachian Pittsburgh seam;
- Illinois Basin from the states of Illinois, Indiana, and Kentucky; and
- PRB from Wyoming.

Coal consumption would vary depending on the gasification technology and type of coal. Table 6.16-3 provides the range of values based on the conceptual design for the FutureGen facility. The Case 3B option is a smaller, side-stream power train that would enable more research and development activities than the main train of the power plant. To estimate the operating parameters for analysis of impacts in this EIS, DOE assumed this smaller system could be paired with any of the other designs under consideration. For these fuel types, the maximum coal consumption rate would be approximately 254 tons (230 metric tons) per hour (FG Alliance, 2007) or up to 1.89 million tons (1.71 MMT) per year based on 85 percent availability (FG Alliance, 2006e). This represents 1.9 percent of the 101 million tons (91.6 MMT) of coal of all types consumed by electric utilities within the state in 2005 (EIA, 2006). Coal would be delivered to the proposed Jewett power plant site by rail and stored in two coal piles, each providing storage capacity for approximately 15 days of operation (FG Alliance, 2006e). If required, run-off from the coal storage areas would be collected and treated in the plant's zero liquid discharge (ZLD) wastewater treatment system.

Table 6.16-3. Coal Consumption

Coal Gasification Technology	Type of Coal (pounds [kilograms] per hour)		
	Pittsburgh	Illinois Basin	Powder River Basin
Case 1	224,745 (101,943)	248,370 (112,659)	281,167 (127,535)
Case 2	213,287 (96,745)	244,153(110,746)	353,809 (160,485)
Case 3A	208,425 (94,540)	238,577 (108,217)	342,790 (155,487)
Case 3B (optional)[1]	97,625 (44.282)	111,791 (50,708)	154,349 (70,012)

[1]Case 3B is an optional add-on to the other technology cases (1, 2, 3A) but is considered unlikely to be implemented.
Source: FG Alliance, 2007.

The estimated consumption of process chemicals by the proposed power plant is presented in Table 6.16-4. The table also provides the estimated on-site storage requirements assuming a 30-day chemical supply would be maintained at the power plant site. Potential impacts from storage of the chemicals are discussed in Section 6.17. These chemicals are commonly used in industrial facilities and widely available from national suppliers. The materials needed in the largest quantities are for sulfuric acid, sodium hypochlorite, and lime. The polymer and antiscalants and stabilizers needed for the cooling tower, makeup water, and wastewater systems are not specified and a variety of products are available from national suppliers. A large producer of water treatment specialty chemicals is Ciba (Ciba, 2006).

Table 6.16-4. Process Chemicals Consumption and Storage

Chemical	Annual Consumption (tons [metric tons])	Estimated Storage On Site (gallons [liters])
Selective Catalytic Reduction (NO_x emission control)		
Aqueous Ammonia (19 percent)	1,333 (1,209)	28,700 (108,641)
Cooling Tower		
Sulfuric Acid (98 percent)	8,685 (7,879)	94,200 (356,586)
Antiscalant	0.47 (0.42)	8 (30)
Sodium Hypochlorite	1,684 (1,527)	32,900 (124,540)
Make-up Water and Wastewater Treatment Demineralizers		
Sodium Bisulfite	12 (10.9)	155 (587)
Sulfuric Acid	106 (95.8)	1,150 (4,353)
Liquid Antiscalant & Stabilizer	27 (24.5)	443 (1,677)
Clarifier Water Treatment		
Lime	1,237 (1,122)	7,380 (27,963)
Polymer	295 (268)	5,020 (19,003)
Acid Gas Removal		
Physical Solvent	11,300 gallons (42,775 liters)	940 (3,588)

Source: FG Alliance, 2007.

The coal gasification process would annually consume approximately 8,790 tons (7,974 metric tons) of sulfuric acid, 1,680 tons (1,524 metric tons) of sodium hypochlorite, and 1,240 tons (1,125 metric tons) of lime. As discussed in Section 6.16.2.3, the sulfur market is expected to have a surplus for the next few years as production increases, so additional demand would not adversely impact the sulfur market. Sodium hypochlorite has producers located across the U.S. including Illinois, Indiana, Michigan, and Missouri. The U.S. sodium hypochlorite production capacity is vastly underused. Industrial sodium hypochlorite production capacity is estimated at 1.55 billion gallons (5.87 billion liters) per year (TIG, 2003). The current (2006) demand is projected to be 292 million gallons (1.1 billion liters), less than 20 percent of the production capacity (TIG, 2003). Worldwide production of lime was 141 million tons (128 MMT) in 2005, with the U.S. producing 22 million tons (20 MMT) (USGS, 2006a). Chemical Lime, one of the ten largest lime producers in the U.S., operates plants in Texas, including nearby Bosque County (USGS, 2006b). Given that the chemicals required to operate the FutureGen facility are common industrial chemicals that are widely available and produced in large quantities in the U.S., the chemical consumption impact would be minimal.

The by-products generated by the proposed power plant would be sulfur bottom slag, and ash. As previously discussed, there are established markets and demand for these materials.

Sulfur production would depend on the gasification technology and the type of coal used. The maximum amount of sulfur generated would be 133 tons (121 metric tons) per day (FG Alliance, 2007) for an annual maximum of 41,232 tons (37,406 metric tons) based on 85 percent availability. The U.S. production of sulfur in 2002 was 13.6 million tons (12.4 MMT). The maximum potential FutureGen sulfur production represents 0.30 percent of the U.S. production. Supply of sulfur exceeds demand; however, new uses of sulfur are being promoted by sulfur producers that should help balance supply and demand of sulfur. The worldwide supply was estimated to exceed demand by up to 12.1 million tons (11 MMT) in 2011 without the development of new markets. The FutureGen maximum production would increase this surplus by less than 0.34 percent.

As previously noted, operation of the FutureGen Project would require a source of sulfuric acid. Assuming a complete conversion to sulfuric acid, the sulfur produced by the facility would be sufficient to generate about 126,000 tons (114,305 metric tons) per year of sulfuric acid. This would be sufficient to meet the demand for sulfuric acid at the power plant site.

The FutureGen facility would generate an estimated 96,865 tons (87,875 metric tons) of bottom slag or ash annually based on the three primary technology cases (1, 2, and 3A) (FG Alliance, 2007). If Case 3B were implemented, the amount of slag or ash would increase by approximately 49 percent over the base case. Nearly all of the bottom slag (96.6 percent) produced in the U.S. enters the market and is beneficially used, and the availability of bottom slag is expected to decrease (ACAA, 2006). Based on the 2006 statistics from the ACAA for beneficial use of slag, 3.4 percent of the bottom slag that would be generated annually would be disposed as waste (see Table 6.16-5). Further characterization would be necessary to determine whether the quality of the slag produced by the proposed power plant would support this level of reuse. Based on the average of the ACAA (2006) statistics for bottom ash and fly ash, 58.1 percent of the ash that would be generated annually would be disposed as waste (see Table 6.16-5). The recycled bottom slag and ash produced by the proposed power plant is not expected to have an adverse impact on the market with the supply being expected to be equal or less than the demand.

Much of the industrial waste generated by FutureGen would likely be Class 2 or 3 and eligible for disposal in Type 1 municipal solid waste landfills. Other waste generated by FutureGen such as environmental controls waste (e.g., clarifier sludge) could potentially be classified as a Class 1 industrial waste and would be eligible for disposal in Type 1 municipal landfills that are approved for Class 1 industrial waste disposal by TCEQ. Table 6.16-2 lists the area landfills and their disposal capabilities. The estimated waste generation for the Jewett Power Plant is presented in Table 6.16-5. In addition to the waste listed in Table 6.16-5, the FutureGen facility may generate small amounts of hazardous waste such as solvents and paints from maintenance activities.

Table 6.16-5. Waste Generation

Waste	Annual Quantity (tons [metric tons])	Classification
Unrecycled bottom slag (Cases 1, 2, 3B)	3,290 (2,985) [1]	Special waste (Coal combustion product)
Unrecycled ash (if non-slagging gasifiers are used)	56,280 (51,056)[2]	Special waste (Coal combustion byproduct)
ZLD (wastewater system) clarifier sludge	1,545 (1,402)	Special waste
ZLD filter cake	5,558 (5,042)	Special waste
Sanitary solid waste (office and break room waste)[3]	336 (305)	Municipal solid waste

[1] Based on ACAA (2006) statistics, DOE assumed that all but 3.4 percent of total slag production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[2] Based on ACAA (2006) statistics, DOE assumed that 41.9 percent of total ash production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[3]Quantity estimated for 200 employees using an industrial waste generation rate of 9.2 pounds (4.2 kilograms) per day per employee (CIWMB, 2006).
Source: FG Alliance, 2007, except as noted.

Chemical waste would be generated by periodic cleaning of the heat recovery steam generator and turbines. This waste would consist of alkaline and acidic cleaning solutions and wash water. They are likely to contain high concentrations of heavy metals. Chemical cleaning would be performed by outside contractors who would be responsible for the removal of associated waste products from the site. Precautions would be taken to prevent releases by providing spill containment for tankers used to store cleaning solutions and waste.

Other waste would include solids generated by water and wastewater treatment systems, such as activated carbon used in sour water treatment. Sulfur-impregnated activated carbon would be used to remove mercury from the synthesis gas. This mercury sorbent would be replaced periodically and the spent carbon would likely be hazardous waste. The spent carbon would be regenerated and reused at the site. It could also be returned to the manufacturer for treatment and recycling or transferred to an off-site hazardous waste treatment facility. Used oils and used oil filters would be collected and transported off site by a contractor for recycling or disposal.

The FutureGen facility would have the option of disposing of its nonhazardous waste in an on-site landfill, if one was developed. In addition, the operator could dispose of its industrial waste streams (Class 2 and 3) in a municipal landfill. Class 1 nonhazardous industrial waste could be disposed at area municipal landfills accepting that waste. TCEQ concluded that the Heart of Texas Council of Governments region (the 6-county region adjacent to Leon County) had 89 years of remaining landfill capacity at the 2005 rate of disposal (TCEQ, 2006b). Capacity at hazardous waste landfills is also substantial. The closest hazardous waste landfill has remaining capacity of over 500,000 cubic yards (380,000 cubic meters) and is pursuing a permit to increase that capacity by more than 2 million cubic yards (1.5 million cubic meters). Given the sanitary and hazardous waste disposal capacities available in the region, the impact of disposal of FutureGen-generated waste would be minimal. Given the small amount of hazardous waste (e.g., paints and solvents) that would be generated and the availability of commercial treatment and disposal facilities, the on-site waste management activities are not expected to require a RCRA permit.

Sequestration Site

During normal operations, the sequestration site components would generate minimal waste due to routine maintenance and workers presence. The waste could be special/hazardous (e.g., lubricants and oils), industrial waste (e.g., old equipment), and sanitary waste (e.g., packaging and lunch waste). The minimal waste quantities would not impact disposal capacities of area landfills and waste collection services.

Several pre-injection hydrologic tests would be performed during site characterization to establish the hydrologic storage characteristics and identify the general permeability characteristics at the sequestration site. The following water-soluble tracers may be used:

- Potassium bromide (as much as 220 lb [100 kg])
- Fluorescein (as much as 132 lb [60 kg])
- 2,2-dimethyl-3-pentanol (as much as 4.4 lb [2.0 kg])
- Pentafluorobenzoic acid (as much as 8.8 lb [4.0 kg])

A suite of gas-phase tracers would be co-injected with the CO_2 to improve detection limits for monitoring. The tracers expected to be used include:

- Perfluoromethylcyclopentane (as much as 330 lb [150 kg])
- Perfluoromethylcyclohexane (as much as 2,646 lb [1,200 kg])

- Perfluorodimethylcyclohexane (as much as 330 lb [150 kg])
- Perfluorotrimethylcyclohexane (as much as 2,646 lb [1,200 kg])
- Sulfur hexafluoride (SF_6) (as much as 66 lb [30 kg])
- Helium-3 (^{3}He) (as much as 0.033 lb [15 g])
- Krypton-78 (^{78}Kr) (as much as 0.44 lb [200 g])
- Xenon-124 (^{124}Xe) (as much as 0.088 lb [40 g])

The last three are stable, non-radioactive, isotope noble gas tracers. Tracers are a key aspect of the planned monitoring activities for the FutureGen sequestration site. The tracers would 1) contact the CO_2, water, and minerals, 2) limit the problem of interference from naturally occurring CO_2 background concentrations, and 3) provide a statistically superior monitoring and characterization method because of the redundancy built in by using multiple tracers. Tracers would be purchased in the required amounts and would be consumed (injected into the subsurface) as a result of the site characterization and monitoring activities.

Utility Corridors

During normal operations, the utility corridors and pipelines would not require additional materials and would not generate waste other than cleared vegetation, if necessary, that could be disposed of at a non-hazardous waste landfill.

Transportation Corridors

Roads

On-site roads would require periodic re-surfacing at a frequency dependent on the level of use and weathering. Asphalt removed from the road surface would be recycled. Road re-surfacing would involve heavy equipment that would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor.

Rail

Maintenance of the rail loop would consist of replacing the rails and equipment at a frequency dependent on the level of use and weathering. Replacement materials would be obtained in the correct sizes and quantities from established suppliers and the small amount of waste remaining after materials are reused or recycled would be disposed of in a permitted facility. Any special or hazardous waste (e.g., oils and coolants) generated during rail replacement would be managed by the contractor.

6.17 HUMAN HEALTH, SAFETY, AND ACCIDENTS

6.17.1 INTRODUCTION

This section describes the potential human health and safety impacts associated with the construction and operation of the proposed project. The health and safety impacts are evaluated in terms of the potential risk to both workers and the general public. The level of risk is estimated based on the current conceptual design of the proposed project, applicable health and safety and spill prevention regulations, and expected operating procedures.

Federal, state, and local health and safety regulations would govern work activities during construction and operation of the proposed project. Additionally, industrial codes and standards also apply to the health and safety of workers and the general public.

6.17.1.1 Region of Influence

The ROI for human health, safety, and accidents is the area within 10 miles (16.1 kilometers) of the boundaries of the proposed power plant site, sequestration site, and CO_2 pipeline. At the proposed Jewett Sequestration Site, modeling of the deep saline formation with an injection rate of 2.8 million tons (2.5 MMT) per year for 20 years produced a CO_2 plume radius of 1.7 miles (2.7 kilometers) (FG Alliance, 2006c). Because this is a first of its kind research project, 10 miles (16.1 kilometers) was chosen as a conservative distance in terms of the ROI for the proposed sequestration site.

6.17.1.2 Method of Analysis

DOE performed analyses to evaluate the potential effects of the proposed power plant and sequestration activities on human health safety, and accidents. The potential for occupational or public health impacts was based on the following criteria:

- Occupational health risk due to accidents, injuries, or illnesses during construction and normal operating conditions;
- Health risks (hazard quotient or cancer risk) due to air emissions from the proposed power plant under normal operating conditions;
- Health risks due to unintentional releases associated with carbon sequestration activities; and
- Health risks due to terrorist attack or sabotage at the proposed power plant or carbon sequestration site.

Potential occupational safety impacts were estimated based on national workplace injury, illness, and fatality rates. These rates were obtained from the U.S. Bureau of Labor Statistics (USBLS) and are based on similar industry sectors. The rates were applied to the anticipated numbers of employees for each phase of the proposed project. From these data, the projected numbers of Total Recordable Cases (TRCs), lost work day (LWD) cases, and fatalities were calculated. These analyses are presented in Section 6.17.2.

The calculated cancer risks and hazard quotients for the air emissions under normal operating conditions are summarized in Section 6.17.3.1. Potential hazards from the accidental release of toxic/flammable gas for different plant components were evaluated by Quest (2006). This study addressed failure modes within the proposed plant boundary and was performed to identify any systems or individual process unit components that would produce a significantly larger potential for on-site or off-site impact based on different plant configurations. The results are summarized in Section 6.17.3.2.

Potential health effects were evaluated for workers and the general public who may be exposed to releases of captured gases (CO_2 and H_2S) during pre- and post-sequestration conditions. Gas releases were evaluated at the proposed plant, during transport via pipeline, at the sequestration site, and during subsurface storage (Tetra Tech, 2007). The results of these risk analyses are summarized in Section 6.17.4.

The potential impacts from a terrorism or sabotage event were determined by examining the results of the accident analysis of major and minor system failures or accidents at the proposed plant site and gas releases along the CO_2 pipeline(s) and at injection wells. The results of this analysis are provided in Section 6.17.5.

6.17.2 OCCUPATIONAL HEALTH AND SAFETY

6.17.2.1 Typical Power Plant Health and Safety Factors and Statistics

Power Plant Construction

Table 6.17-1 shows the injury/illness and fatality rates for the most recent year (2005) utility related construction. These rates are expressed in terms of injury/illness per 100 worker-years (or 200,000 hours) for TRCs, LWDs, and fatalities.

Power Plant Operation

Because of the gasification and chemical conversion aspects of the proposed power plant, it would operate more like a petrochemical facility rather than a conventional power plant. As a result, occupational injury/illness rates for the petrochemical manufacturing sector were used in the analysis of the proposed power plant operation (Table 6.17-1). These rates are presented for TRCs, LWDs, and fatality rates.

Table 6.17-1. Occupational Injury/Illness and Fatality Data for Project Related Industries in 2005

Industry	2005 Average Annual Employment (thousands)[1]	Total Recordable Case Rate (per 100 workers)[1]	Lost Workday Cases (per 100 workers)[1]	Fatality Rate (per 100 workers)[2]
Utility system construction	388.2	5.6	3.2	0.028
Petrochemical Manufacturing	29.2	0.9	0.4	0.001
Electric power transmission, control, and distribution	160.5	5.1	2.4	0.0062
Natural Gas Distribution	107.0	5.9	3.2	0.0025

[1]Source: USBLS, 2006a.
[2]Source: USBLS, 2006b.

Transmission Lines and Electro-Magnetic Fields

Magnetic fields are induced by the movement of electrons in a wire (current); and electric fields are created by voltage, the force that drives the electrical current. All electrical wiring, devices, and equipment, including transformers, switchyards, and transmission lines, produce electromagnetic fields (EMF). The strength of these fields diminishes rapidly with distance from the source. Building material, insulation, trees, and other obstructions can reduce electric fields, but do not significantly reduce magnetic fields. Electrical field strength is measured in kilovolts per meter, or kV/m. Magnetic field strength is expressed as a unit of magnetic induction (Gauss) and is normally expressed as a milligauss (mG), which is one thousandth of a Gauss. The average residential electric appliance typically has an electrical field of less than 0.003 kV/ft (0.01 kV/m). In most residences, when in a room away from electrical appliances, the magnetic field is typically less than 2 mG. However, very close to an appliance carrying a high current, the magnetic field can be thousands of milligauss.

Electric fields from power lines are relatively stable because line voltage does not vary much. However, magnetic fields on most lines fluctuate greatly as current changes in response to changing loads (consumption or demand).

Transmission lines contribute a relatively small portion of the electric and magnetic fields to which people are exposed. Nonetheless, over the past two decades, some members of the scientific community and the public have expressed concern regarding human health effects from EMF during the transmission of electrical current from power plants. The scientific evidence suggesting that EMF exposures pose a health risk is weak. The strongest evidence for health effects comes from observations of human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults (NIEHS, 1999). The National Institute of Environmental Health Sciences report concluded that, "extremely low-frequency and magnetic field exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard" (NIEHS, 1999). While a fair amount of uncertainty still exists about the EMF health effects issue, the following determinations have been established from the information:

- Any exposure-related health risk to an individual would likely be small;
- The types of exposures that are most biologically significant have not been established;
- Most health concerns relate to magnetic fields; and
- Measures employed for EMF reduction can affect line safety, reliability, efficiency, and maintainability, depending on the type and extent of such measures.

CO_2 and Natural Gas Pipeline Safety

More than 1,500 miles (2,414 kilometers) of high-pressure long distance CO_2 pipelines exist in the U.S (Gale and Davison, 2004). In addition, numerous parallels exist between CO_2 and natural gas transport. Most rules and regulations written for natural gas transport by pipeline include CO_2. These regulations are administered and enforced by DOT's Office of Pipeline Safety (OPS). States also may regulate pipelines under partnership agreements with the OPS. The rules are designed to protect the public and the environment by ensuring safety in pipeline design, construction, testing, operation, and maintenance. Risks associated with pipeline activities are determined to be low (IOGCC, 2005). However, in pipelines that carry captured CO_2 for sequestration, other gases may be captured and transported as well, and could affect risks posed to human health and the environment. For the proposed FutureGen Project, the captured gases might contain up to 100 parts per million by volume (ppmv) of H_2S in the pipeline on a routine basis, and should any of the captured gases escape to the environment, risks from exposure to H_2S would have to be estimated, as well as risks from CO_2 exposure.

Table 6.17-1 shows the occupational injury/illness and fatality rates for 2005 for operation of natural gas distribution systems. These rates are expressed in terms of injury/illness rate per 100 workers (or

200,000 hours) for TRCs, LWDs, and fatality rates. These rates are used to indicate occupational injuries associated with pipelines, although the properties and types of hazards of natural gas are different from those of CO_2. Because natural gas is highly flammable, these rate are determined to be conservative in relation to CO_2 pipelines.

6.17.2.2 Impacts

This subsection describes potential occupational health and safety risks associated with construction and operation of the proposed project. Features inherent in the design of project facilities as well as compliance with mandatory regulations, plans, and policies to reduce these potential risks are summarized within each risk category.

Construction

Power Plant Site

Potential occupational health and safety risks during construction of the proposed power plant and facilities are expected to be typical of the risks for major industrial/commercial construction sites. Health and safety concerns include: the movement of heavy objects, including construction equipment; slips, trips, and falls; the risk of fire or explosion from general construction activities (e.g., welding); and spills and exposures related to the storage and handling of chemicals and disposal of hazardous waste.

Risk of Fire or Explosion from General Construction Activities

Contractors experienced with the construction of coal and gas-fired electricity generating plants and refineries would be used on the proposed project. Construction specifications would require that contractors prepare and implement construction health and safety programs that are intended to control worker activities as well as establish procedures to prevent and respond to possible fires or explosions. The probability of a significant fire or explosion during construction of the proposed project has been determined to be low. With implementation of BMPs and procedures described in the following paragraphs, health and safety risks to construction workers and the public would also be low.

During construction, small quantities of flammable liquids and compressed gases would be used and stored on site. Liquids would include construction equipment fuels, paints, and cleaning solvents. Compressed gases would include argon, acetylene, helium, nitrogen, and O_2 for welding. Potential risk hazards associated with the use of flammable liquids and compressed gases would be reduced by compliance with a construction health and safety program and proper storage of these materials when not in use, in accordance with all applicable federal, state, and local regulations. The construction health and safety program would include the following major elements:

- An injury and illness prevention program;
- A written safety program (including hazard communication);
- A personnel protection devices program; and
- On-site fire suppression and prevention plans.

Storage and Handling of Hazardous Materials, Fuels, and Oils

Hazardous materials used during construction would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of materials would be stored in a flammable storage locker, and drums and tanks would be stored in a secondary containment. Storage of the various types of chemicals would conform to Occupational Safety and Health Administration (OSHA) and applicable state guidelines. Construction personnel would be trained in handling chemicals, and would be alerted to the dangers associated with the storage of chemicals. An on-site Environmental Health and Safety Representative would be designated to implement the construction health and safety program and to contact emergency response personnel and the local hospital, if necessary. MSDS for each chemical would be kept on site, and construction employees would be made aware of their location and content.

To limit exposure to uncontrolled releases of hazardous materials and ensure their safe handling, specific procedures would be implemented during construction, including:

- Lubrication oil used in construction equipment would be contained in labeled containers. The containers would be stored in a secondary containment area to collect any spillage.
- Vehicle refueling would occur at a designated area and would be closely supervised to avoid leaks or releases. To further reduce the possibility of spills, no topping-off of fuel tanks would be allowed.
- If fuel tanks are used during construction, the fuel tank(s) would be located within a secondary containment with an oil-proof liner sized to contain the single largest tank volume plus an adequate space allowance for rainwater. Other petroleum products would be stored in clearly labeled and sealed containers or tanks.
- Construction equipment would be monitored for leaks and undergo regular maintenance to ensure proper operation and reduce the chance of leaks. Maintenance of on-site vehicles would occur in a designated location.
- All paint containers would be sealed and properly stored to prevent leaks or spills. Unused paints would be disposed of in accordance with applicable state and local regulations.

Overall, BMPs would be employed that would include good housekeeping measures, inspections, containment maintenance, and worker education.

Spill Response and Release Reporting

Small quantities of fuel, oil, and grease may leak from construction equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations. If a large spill from a service or refueling truck were to occur, a licensed, qualified waste contractor would place contaminated soil in barrels or trucks for off-site disposal.

The general contractor’s responsibility would include implementation of spill control measures and training of all construction personnel and subcontractors in spill avoidance. Training would also include appropriate response when spills occur, and containment, cleanup, and reporting procedures consistent with applicable regulations. The primary plan to be developed would describe spill response and cleanup procedures. In general, the construction contractor would be the generator of waste oil and miscellaneous hazardous waste generated during construction and would be responsible for compliance with applicable federal, state, and local laws, ordinances, regulations, and standards. This would include licensing, personnel training, accumulation limits, reporting requirements, and record keeping.

During construction, the potential exists for a major leak during the chemical cleaning of equipment or piping before it is placed into service. This method of cleaning could consist of an alkaline degreasing step (in which a surfactant, caustic, or NH_3 solution is used), an acid cleaning step, and a passivation step. Most of the solution would be contained in permanent facility piping and equipment. The components of the process that would be most likely to leak are the temporary chemical cleaning hoses, pipes, pump skids, and transport trailers. The cleaning would be within curbed areas, and spills would be manually cleaned up and contaminated materials disposed of in accordance with the applicable regulations.

Due to the limited quantities and types of hazardous materials used during construction, the likelihood of a spill reaching or affecting off-site residents would be low.

Medical Emergencies during Construction

Selected construction personnel would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid or stabilization of the victim(s) until professional medical attention could be attained. Any injury or illness that would require treatment beyond first aid would be referred to the local hospital.

Worker Protection Plan

The construction contractor would develop, implement, and maintain a Worker Protection Plan. This plan would implement OSHA requirements (1910 and 1926) and would define policies, procedures, and practices implemented during the construction process to ensure protection of the workforce, environment, and the public. The minimum requirements addressed by the Worker Protection Plan would include:

- Environment, Safety, and Health Compliance
- Working Surfaces
- Scaffolding
- Powered Platforms, Manlifts, and Vehicle-Mounted Platforms
- Fall Protection
- Cranes, Derricks, Hoists, Elevators, and Conveyors
- Hearing Conservation
- Flammable and Combustible Liquids
- Hazardous Waste Operations
- Personal Protective Equipment
- Respiratory Protection
- Confined Space Program
- Hazardous Energy Control
- Medical and First Aid
- Fire Protection
- Compressed Gas Cylinders
- Materials Handling and Storage
- Hand and Portable Powered Tools
- Welding, Cutting and Brazing
- Electrical Safety
- Toxic and Hazardous Substances
- Hazardous Communications
- Heat Stress

Industrial Safety Impacts

Based on data for the construction of similar projects, the construction workforce would average about 350 employees, with a peak of about 700 during the most active period of construction. Since the nature of the activities to be performed across all areas of the proposed project would be similar in scope, industrial safety impacts were calculated for the proposed project and not for each construction sector. Based on the employment numbers during the construction phase, the TRCs, LWDs, and fatalities presented in Table 6.17-2 would be expected. As shown in Table 6.17-2, based on the estimated number of workers during construction, no fatalities would be expected (calculated number of fatalities is less than one).

Table 6.17-2. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Construction

Construction Phase	Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
Average	350	20	11	0.098
Peak	700	39	22	0.196

Sequestration Site

Accidents are inherently possible with any field or industrial activities. Well drilling can lead to worker injuries due to: being struck with or pinned by flying or falling parts and equipment; trips and falls; cuts, bruises, and scrapes; exposure to high noise; and muscle strains due to overexertion. Catastrophic accidents could involve well blowouts, derrick collapse, exposure to hydrogen sulfide and other hazardous gases, fire, or explosion. Although catastrophic accidents frequently involve loss of life as well as major destruction of equipment, they represent only a small percentage of the total well drilling occupational injury incidence and severity rates. Most well drilling injuries (60 to 70 percent) were reported by workers with less than six months of experience (NIOSH, 1983). To avoid well drilling accidents, a worker protection plan and safety training (particularly for new workers) would be instituted, covering all facets of drilling site safety.

Utility Corridors

Risks and hazards associated with construction of power lines, substations, and pipelines would be addressed through the Worker Protection Plan. Many of these types of construction activities may be undertaken by public utilities or companies specializing in this type of work and would be governed by their worker protection programs.

Transportation Infrastructure Corridors

Risks and hazards associated with construction activities for access roads, public road upgrades, and the rail loop would be addressed through the Worker Protection Plan. Construction activities on public roads may be undertaken by city or county public works departments and would be governed by their worker protection programs.

Operational Impacts

Two categories of accidents could occur that would pose an occupational health and safety risk to individuals at the proposed power plant, on the CO_2 pipeline, at the CO_2 sequestration site, or in the proposed project vicinity; risk of fire or explosion either from general facility operations or specifically from a gas release (e.g., syngas, hydrogen, natural gas, H_2S, or CO_2); and risk of a hazardous chemical release or spill. Risk assessments evaluating accidents (e.g., explosions and releases) were performed to evaluate potential impacts for both workers and the public. The results of these assessments are summarized in Sections 6.17.3.2 and 6.17.4.

Power Plant Site

The operation of any industrial facility or power plant holds the potential for workplace hazards and accidents. To promote the safe and healthful operation of the proposed power plant, qualified personnel would be employed and written safety procedures would be implemented. These procedures would provide clear instructions for safely conducting activities involved in the initial startup, normal operations, temporary operations, normal shutdowns, emergency shutdowns, and subsequent restarts. The procedures for emergency shutdowns would include the conditions under which such shutdowns are required and the assignment of emergency responsibilities to qualified operators to ensure that procedures are completed in a safe and timely manner. Also covered in the procedures would be the consequences of operational deviations and the steps required to correct or avoid such deviations. Employees would be given a facility plan, including a health and safety plan, and would receive training regarding the operating procedures and other requirements for safe operation of the proposed power plant. In addition, employees would receive annual refresher training, which would include the testing of their understanding of the procedures. The operator would maintain training and testing records.

The proposed power plant would be designed to provide the safest working environment possible for all site personnel. Design provisions and health and safety policies would comply with OSHA standards and consist of, but not be limited to, the following:

- Safe egress from all confined areas;
- Adequate ventilation of all enclosed work areas;
- Fire protection;
- Pressure relief of all pressurized equipment to a safe location;
- Isolation of all hazardous substances to a confined and restricted location;
- Separation of fuel storage from oxidizer storage;
- Prohibition of smoking in the workplace; and
- Real-time monitoring for hazardous chemicals with local and control room annunciation and alarm.

Industrial Safety Impacts

The operational workforce is expected to average about 200 employees. As shown in Table 6.17-3, the number of calculated fatalities for operation of this facility would be less than one.

Table 6.17-3. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
200	2	1	0.002

Risk of Fire or Explosion

Operation of the proposed facility would involve the use of flammable and combustible materials that could pose a risk of fire or explosion. The potential for fire or explosion at the proposed power plant would be minimized through design and engineering controls, including fire protection systems. The risks of fire and explosion could be minimized also through good housekeeping practices and the proper storage of chemicals. Workers would consult MSDS information to ensure that only compatible chemicals are stored together. Impacts of a potential large or catastrophic explosion are discussed in Section 6.17.3.2.

Risk of Hazardous Chemical Release or Spill

Chemicals and hazardous substances would be delivered, used, and stored at the proposed project site during operation. Petroleum products used on site during operation would be stored following the same guidelines described for construction. During operation, the worst-case scenario would be a major leak during chemical cleaning of equipment and associated piping.

The presence of hazardous environments during normal operations is not anticipated. Plant equipment would be installed, maintained, and tested in a manner that reduces the potential for inadvertent releases. Scheduled and forced maintenance would be planned to incorporate engineering and administrative controls to provide worker protection as well as mitigate any possible chemical releases. Facility and spot ventilation would provide for the timely removal and treatment of volatile chemicals. Worker practices and facility maintenance procedures would provide for the containment and cleanup of non-volatile chemicals. Personnel and area monitoring will provide assurance that worker exposures are maintained well below regulatory limits.

Seven chemical compounds are identified that could produce harmful effects in exposed individuals. The severity of these effects is dependent on the level of exposure, the duration of the exposure, and individual sensitivities to the various chemical compounds. Table 6.17-4 describes chemical exposure limits, potential exposure routes, organs targeted by the compounds, and the range of symptoms associated with exposures to these chemicals. The occupational exposure limits are defined in Table 6.17-5. Potential public exposures to accidental releases of these chemicals are described in Section 6.17.3.2.

While some of the chemicals listed in Table 6.17-4 would be generated during proposed power plant operation, others would be stored on site and the potential for personnel exposure as the result of minor spills or leaks, while low, exists.

Table 6.17-5. Definitions of Occupational Health Criteria

Hazard Endpoint	Description
NIOSH REL C	NIOSH recommended exposure limit (REL). A ceiling value. Unless noted otherwise, the ceiling value should not be exceeded at any time.
NIOSH REL ST	NIOSH REL. Short-term exposure limit (STEL), a 15-minute TWA exposure that should not be exceeded at any time during a workday.
NIOSH REL TWA	NIOSH REL. TWA concentration for up to a 10-hour workday during a 40-hour work week.
OSHA PEL C	Permissible exposure limit (PEL). Ceiling concentration that must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure.
OSHA PEL TWA	PEL. TWA concentration that must not be exceeded during any 8-hour work shift of a 40-hour workweek.
IDLH	Airborne concentration from which a worker could escape without injury or irreversible health effects from an IDLH exposure in the event of the failure of respiratory protection equipment. The IDLH was evaluated at a maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection should be permitted. In determining IDLH values, NIOSH evaluated the ability of a worker to escape without loss of life or irreversible health effects along with certain transient effects, such as severe eye or respiratory irritation, disorientation, and incoordination, which could prevent escape. As a safety margin, IDLH values are based on effects that might occur as a consequence of a 30-minute exposure.

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.

The FutureGen Project would use aqueous NH_3 in a selective catalytic reduction process to remove NO_X and thousands of pounds could be stored on-site. Three scenarios for the accidental release of NH_3 were evaluated using the EPA's ALOHA model: a leak from a tank valve, a tanker truck spill, and a tank rupture. (See Appendix F for summary of how the model was used, a description of input data, and the results of sensitivity analyses.) Health effects from inhalation of NH_3 can range from skin, eye, throat, and lung irritation; coughing; burns; lung damage; and even death. Impacts of NH_3 releases on workers and the public depends on the location of the releases, the meteorological conditions (including atmospheric stability and wind speed and direction) and other factors. The criteria used to examine potential health effects, are defined in Table 6.17-6 and Table 6.17-7.

Table 6.17-6. Hazard Endpoints for Individuals Potentially Exposed to an Ammonia Spill

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
1 hour	NH_3	Adverse effects	30	AEGL 1
		Irreversible adverse effects	160	AEGL 2
		Life Threatening	1,100	AEGL 3

[1]See Table 6.17-7 for descriptions of the AEGL endpoints.
AEGL = Acute Exposure Guideline Level.

Table 6.17-7. Description of Hazard Endpoints for Ammonia Spill Receptors

Hazard Endpoint	Description
AEGL 1	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
AEGL 2	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.
AEGL 3	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

AEGL = Acute Exposure Guideline Level.
Source: EPA, 2007

Leakage of 400 pounds (180 kilograms) of aqueous NH_3 solution (19 percent NH_3) from a tank, through a faulty valve, was selected as a plausible upper-bound accidental spill. It was assumed that this release would create a one-centimeter deep pool, with a surface area of 211 square feet (19.6 square meters). The temperature of the solution was assumed to be 104°F (40°C), based on the maximum daily air temperature in Jewett for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 2,858 feet (871 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 6.17-8). Individuals exposed within a distance of 1,295 feet (395 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur only within 548 feet (167 meters) of the spill. Thus, only workers (assumed to be within 250 meters of a release) could potentially be exposed to life-threatening levels of atmospherically dispersed $NH_{3.}$. The peak concentrations are predicted to last about 10 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 250 meters.

For the tanker truck spill scenario, it was assumed that all 46,200 pounds (20,956 kilograms) of the 19 percent NH_3 solution in the truck may be spilled on the ground surface. It was assumed that this release would create a ten-centimeter deep pool, with a surface area of 2,454 square feet (228 square meters). The temperature of the solution was assumed to be 104°F (40°C), based on the maximum daily air temperature in Jewett for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 15,092 feet (4,600 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 6.17-8). Individuals within a distance of 5,577 feet (1,700 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,969 feet (600 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters), but not inside a building.

For the tank rupture spill scenario, it was assumed that all 104,355 pounds (13,400 kilograms) of the 19 percent NH_3 solution in one of two on-site storage tanks may be released within the diked area around the tank. The tank discharge was assumed to create a 92-centimeter deep pool with a surface area of 601 square feet (55.8 square meters). Again the temperature of the solution was conservatively assumed to be 104°F (40°C). The same atmospheric conditions as above, and EPA's ALOHA model with a source duration of 1 hour were used to calculate downwind atmospheric NH_3 concentrations. Concentrations within 8,530 feet (2,600 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 6.17-8). Individuals within a distance of 3,140 feet (957 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,079 feet (329 meters) of the spill. Thus, workers and the general public (assumed to be located 820 feet [250 meters] at least from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters).

The meteorological conditions specified for these analyses (F stability class) result in conservative estimates of exposure. At Jewett, this stability class occurs about 21 percent of the time. Simulations of the other six stability classes showed that the predicted distances to a given criteria were no more than 35 percent of the distance for the conservative stability class F. The stability class (D8), which gave the second highest results, occurs about 8.4 percent of the time. Since NH_3 produces a distinct, pungent odor at low concentrations (approximately 17 ppmv (AIHA, 1997), it is expected that most workers and the public in the vicinity of an accident would quickly evacuate under the scenarios discussed above. Depending on the size and location of the accident, the public would be alerted to the appropriate response such as shelter-in-place procedures or evacuation for the public living near the accident.

Sections 6.17.3.2 and 6.17.4 discuss scenarios involving equipment failure or rupture at the proposed power plant site, along utility corridors, and at the injection site.

Medical Emergencies

All permanent employees at the facility would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid treatment or stabilization of the victim(s) until professional medical attention is obtained. Any injury or illness that requires treatment beyond first aid would be referred to the plant's medical clinic or to a local medical facility.

Coal Storage

The National Fire Protection Association (NFPA) identifies hazards associated with storage and handling of coal, and gives recommendations for protection against these hazards. NFPA recommends that any storage structures be made of non-combustible materials, and that they be designed to minimize the surface area on which dust can settle, including the desirable installation of cladding underneath a building's structural elements.

Table 6.17-8. Effects of an Ammonia Spill at the Proposed Power Plant

Release Scenario	Gas	Effect[1]	Distance (feet [meters])
NH_3 leaky valve (400 pounds, 19 percent solution)	NH_3	Adverse Effects	2,857 (871)
		Irreversible adverse effects	1,296 (395)
		Life threatening effects	548 (167)
NH_3 tanker truck spill (46,200 pounds, 19 percent solution)	NH_3	Adverse Effects	15,092 (4600)
		Irreversible adverse effects	5,577 (1700)
		Life threatening effects	1,969 (600)
NH_3 tank rupture (104,355 pounds, 19 percent solution)	NH_3	Adverse Effects	8,530 (2600)
		Irreversible adverse effects	3,140 (957)
		Life threatening effects	1,079 (329)

Multiply distance in feet by 0.3048 to convert to meters.
[1] See Table 6.17-6 and Table 6.17-7 for an explanation of the effects.

Coal is susceptible to spontaneous combustion due to heating during natural oxidation of new coal surfaces. Also, coal dust is highly combustible and an explosion hazard. If a coal dust cloud is generated inside an enclosed space and an ignition source is present, an explosion can ensue. Dust clouds may be generated wherever loose coal dust accumulates, such as on structural ledges; or if there is a nearby impact or vibration due to wind, earthquake, or even maintenance operations. Because of coal's propensity to heat spontaneously, ignition sources are almost impossible to eliminate in coal storage and handling, and any enclosed area where loose dust accumulates is at great risk. Further, even a small conflagration can result in a catastrophic "secondary" explosion if the small event releases a much larger dust cloud.

A Quonset hut-type building for on-site coal storage is being examined (FG Alliance, 2006e). This structure would protect the pile from rain and wind, which would otherwise foster spontaneous combustion in open-air piles and cause air and runoff pollution. Internal cladding would prevent dust accumulation on the structure. A breakaway panel may provide for accidental overloading and ventilation at the base, and exhaust fans or ventilation openings ensure against methane or smoke buildup. Dust suppression/control techniques would be employed. Fire detection and prevention systems may also be installed.

The surfaces of stored coal can be unstable, and workers can become entrapped and subsequently suffocate while working on stored coal piles (NIOSH, 1987). NIOSH recommendations for preventing entrapment and suffocation would be followed.

Sequestration Site

Industrial Safety Impacts

The operational workforce for the proposed sequestration site would be up to 20 employees. Since this proposed site would not be a permanently staffed facility, these personnel would be rotated from the permanent site pool. Based on these employment numbers, during operation of the proposed power plant, the TRCs, LWDs, and fatalities presented in Table 6.17-9 would be expected. As shown in Table 6.17-9, the number of calculated fatalities for operation of this facility would be less than one.

Table 6.17-9. Calculated Annual Occupational Injury and Fatality Cases for Sequestration Site Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Utility Corridors

Risk of Fire or Explosion

The proposed transmission line connector would be located high above ground (typically between 50 to 100 feet [15.2 to 30.5 meters] high). Only qualified personnel would perform maintenance on the proposed transmission lines. Sufficient clearance would be provided for all types of vehicles traveling under the proposed transmission lines. The operator of the line would establish and maintain safe clearance between the tops of trees and the proposed transmission lines to prevent fires. Ground and counterpoise wires would be installed on the proposed transmission system, providing lightning strike protection and thereby reducing the risk of explosion. However, a brush fire could occur in the rare event that a conductor parted and one end of the energized wire fell to the ground, or perhaps in the event of lightning strikes. Under these rare circumstances, the local fire department would be called upon.

Releases or Potential Releases of Hazardous Materials to the Environment

Hazardous materials used during maintenance of the proposed transmission facilities would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of fuel, oil, and grease may leak from maintenance equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations.

Industrial Safety Impacts

The operational workforce for the proposed utility corridors would be less than 20 employees. As with the proposed sequestration site, the majority of these workers would not be on permanent assignment and would be drawn from the plant pool. Based on these employment numbers, during operation and maintenance of utility corridors, the TRCs, LWDs, and fatalities presented in Table 6.17-10 would be expected. As shown in Table 6.17-10, the number of calculated fatalities for operation of this facility would be less than one.

Table 6.17-10. Calculated Annual Occupational Injury and Fatality Cases for Utility Corridors Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Transportation Corridors

Facility personnel would not be involved in activities associated with these infrastructure operations. Rail and road transportation activities would be performed by non-facility employees and vendors. Hazards related to the proposed transportation corridor operation would not be different from those posed by the normal transportation risks associated with product delivery.

6.17.3 AIR EMISSIONS

6.17.3.1 Air Quality – Normal Operations

Air quality impacts on human health were evaluated for HAPs potentially released during normal operation of the proposed Jewett Power Plant and proposed sequestration site. HAP emissions from the FutureGen Project were estimated based on the Orlando Gasification Project. The methods used to analyze impacts are described in Section 6.2.3 with supporting materials in Appendix E. Assessment of the potential toxic air pollutant emissions demonstrated that all ambient air quality impacts for air toxics would be below the relevant EPA recommended exposure criteria. This section of the report provides a summary of the results of potential air quality impacts.

As described in Section 6.2.3 regarding the modeling approach, estimated emissions of HAPs were based on data taken from the Orlando Gasification Project (DOE, 2007). Although the Orlando project is an IGCC power plant, there are differences from the proposed project. Consequently, the Orlando project data were scaled, based on relative emission rates of VOCs and particulate matter, to produce more appropriate estimates of stack emissions from the proposed project.

Airborne HAP concentrations were determined by modeling the impact of 1 g/s emission rate using AERMOD. Table 6.17-11 shows representative air quality impacts for several metallic and organic toxic air pollutants. Each of these airborne concentrations was evaluated using chronic exposure criteria (expressed as inhalation unit risk factors and reference concentrations) obtained from the EPA Integrated Risk Information System (IRIS) (EPA, 2006a). As appropriate, an inhalation unit risk factor was multiplied by the maximum annual average airborne concentration for each HAP to calculate a cancer risk. Hazard coefficients were calculated by dividing the maximum annual average airborne concentration for each HAP by the appropriate reference concentration taken from the EPA IRIS (EPA, 2006a). The cancer risks and hazard coefficients calculated for each HAP were then summed and compared to the EPA criteria for evaluating HAP exposures. The results of this analysis, as indicated in Table 6.17-11, show that predicted exposures are safely well below the EPA exposure criteria.

Normal Air Quality and Asthma

Asthma is a chronic respiratory disease characterized by attacks of difficulty breathing. It is a common chronic disease of childhood, affecting over 6.5 million children in the U.S. in 2005 and contributing to over 12.8 million missed school days annually (DHHS, 2006). In 2005, the prevalence of asthma among children in the U.S. was 8.9 percent. Asthma prevalence rates among children remain at historically high levels after a large increase from 1980 until the late 1990s.

Asthma-related hospitalizations followed a trend similar to those for asthma prevalence, rising from 1980 through the mid-1990s, remaining at historically high plateau levels. Asthma-related mortality rates in the U.S. have declined recently after a rising trend from 1980 through the mid-1990s (DHHS, 2006).

It remains unknown why some people get asthma and others do not (DHHS, 2006). Asthma symptoms are triggered by a variety of things such as allergens (e.g., pollen, dust mites, and animal dander), infections, exercise, changes in the weather, and exposure to airway irritants (e.g., tobacco smoke and outdoor pollutants). Although extensive evidence shows that ambient air pollution (based on measurements of NO_2, particulate matter, soot, and O_3) exacerbates existing asthma, a link with the development of asthma is less well established (Gilmour et al., 2006).

Table 6.17-11. Summary Analysis Results — Hazardous Air Pollutants

Chemical Compound	CT/HRSG Emissions[1]		Inhalation Unit Risk Factor[2] ($\mu g/m^3)^{-1}$	Reference Concentration[2] ($\mu g/m^3)^{-1}$	Cancer Risk[3]	Hazard Coefficient[4]
	(lb/hr)	(g/s)				
2-Methylnaphthalene	1.99E-04	2.51E-05	n/a	n/a	n/a	n/a
Acenaphthyalene	1.44E-05	1.81E-06	n/a	n/a	n/a	n/a
Acetaldehyde	9.99E-04	1.26E-04	2.20E-06	9.00E+00	7.28E-12	3.68E-07
Antimony	**5.59E-03**	**7.04E-04**	n/a	**2.00E-01**	n/a	**9.27E-05**
Arsenic	**2.94E-03**	**3.70E-04**	**4.30E-03**	**3.00E-02**	**4.19E-08**	**3.25E-04**
Benzaldehyde	1.61E-03	2.03E-04	n/a	n/a	n/a	n/a
Benzene	2.69E-03	3.39E-04	7.80E-06	3.00E+01	6.97E-11	2.98E-07
Benzo(a)anthracene	1.28E-06	1.61E-07	1.10E-04	n/a	4.65E-13	n/a
Benzo(e)pyrene	3.05E-06	3.84E-07	8.86E-04	n/a	8.94E-12	n/a
Benzo(g,h,i)perylene	5.26E-06	6.63E-07	n/a	n/a	n/a	n/a
Beryllium	**1.26E-04**	**1.59E-05**	**2.40E-03**	**2.00E-02**	**1.00E-09**	**2.09E-05**
Cadmium	**4.06E-03**	**5.12E-04**	**1.80E-03**	**2.00E-02**	**2.42E-08**	**6.73E-04**
Carbon Disulfide	2.49E-02	3.14E-03	n/a	7.00E+02	n/a	1.18E-07
Chromium[5]	**3.78E-03**	**4.76E-04**	**1.20E-02**	**1.00E-01**	**1.50E-07**	**1.25E-04**
Cobalt	**7.97E-04**	**1.00E-04**	n/a	**1.00E-01**	n/a	n/a
Formaldehyde	1.85E-02	2.33E-03	5.50E-09	9.80E+00	3.36E-13	n/a
Lead	**4.06E-03**	**5.12E-04**	n/a	**1.50E+00**	n/a	**8.98E-06**
Manganese	**4.34E-03**	**5.47E-04**	n/a	**5.00E-02**	n/a	**2.88E-04**
Mercury	**1.27E-03**	**1.60E-04**	n/a	**3.00E-01**	n/a	**1.41E-05**
Naphthalene	2.95E-04	3.72E-05	3.40E-05	3.00E+00	n/a	3.26E-07
Nickel	**5.45E-03**	**6.87E-04**	**2.40E-04**	**9.00E-02**	**4.34E-09**	**2.01E-04**
Selenium	**4.06E-03**	**5.12E-04**	n/a	**2.00E+01**	n/a	**6.73E-07**
Toluene	4.12E-04	5.19E-05	n/a	4.00E+02	n/a	3.41E-09
TOTAL					2.22E-07	1.75E-03
Risk Indicators					1.00E-06	1.00E+00
Percent of Indicator					22.2 percent	0.17 percent

[1] Emission rates scaled by the ratio of VOC or particulate emissions from Orlando EIS to FutureGen.
[2] Provided by EPA Integrated Risk Information System (IRIS).
[3] Unit risk factor multiplied by maximum annual average impact of 0.0263 $\mu g/m^3$ determined by AERMOD at a 1 g/s emission rate.
[4] Maximum AERMOD annual average impact divided by reference concentration.
Notes:
CT/HRSG = combustion turbine/heat recovery steam generator; lb/hr = pounds per hour; g/s = grams per second; $\mu g/m^3$ = micrograms per cubic meter; n/a = not available.
[5] Conservatively assumed all chromium to be hexavalent.
Compounds that are considered to be particulate matter in **bold** text.

A 2006 workshop sponsored by the EPA and the National Institute of Environmental Health Sciences (Selgrade et al., 2006) found that there are a number of scientific questions that need to be answered in order to make appropriate regulatory decisions for ambient air, including which air pollutants are of greatest concern and at what concentrations. Nevertheless, IGCC power plants that are currently in operation have achieved the lowest levels of criteria air pollutant (SO_2, CO, O_3, NO_2, Pb, and respirable particulate matter) emissions of any coal-fueled power plant technologies (DOE, 2002). Tables 6.2-1 and 6.2-2 also show that the IGCC technology under evaluation for the proposed project would exceed the performance of technologies used at more conventional types of coal-fueled power plants of comparable size. Furthermore, based on evaluations conducted for this site (as described in Section 6.2), the maximum predicted concentrations of the criteria air pollutants would not exceed the National Ambient Air Quality Standards and would not significantly contribute to existing background levels. Based on these determinations, it is unlikely that the proposed project would be a factor in asthma-related health effects.

6.17.3.2 Hazard Analysis

The Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations (referred to hereafter as the Quest Study) was conducted to define creditable upperbound impacts from potential accidental releases of toxic and flammable gas from the proposed systems (Quest, 2006). Risks associated with gas releases include asphyxiation, exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions.

A particular concern associated with the release of gas is exposure to a toxic component within the dispersing gas cloud. Many of the process streams of the proposed power plant could contain one or more toxic components. The Quest Study evaluated the extent of exposure to gas clouds containing NH_3, CO, Cl_2, HCl, H_2S, and SO_2. Additional analyses were performed to define the extent of potential asphyxiation hazard associated with exposure to high concentrations of CO_2.

The hazard of interest for flash fires was direct exposure to flames. Flash fire hazard zones were determined by calculating the maximum size of the flammable gas cloud before ignition. The LFL of the released hydrocarbon mixture was used as a boundary. The hazard of interest for the torch fires (ignition of a high velocity release of a flammable fluid, such as a hydrogen deflagration) was exposure to thermal radiation from the flame (Quest, 2006). For vapor clouds explosions, the hazard of interest was the overpressure created by the blast wave. For toxic components, potential impacts were determined by calculating the maximum distance at which health effects could occur.

Plant System Configurations

For the purposes of the analysis, the facility was assumed to be located in an area of reasonably flat terrain with limited vertical obstructions. This provided the bounding conditions that allow for the most conservative hazard impact analysis (Quest, 2006).

For the base case evaluation, the main process components for each of the proposed power plant configurations were laid out in a rectangular area approximately 75 acres (30 hectares) in size. This area was surrounded by the rail line used to deliver the coal. The total area required for the proposed project would consist of a minimum of 200 acres (81 hectares) (Quest, 2006).

Three other cases were also evaluated. Assuming the proposed facility is placed in the middle of a 200-, 400-, or 600-acre (81-, 162-, or 243-hectare) site, it was determined whether any explosion would extend beyond the boundaries of each site configuration.

Summary of Results

A full evaluation of the hazards associated with the preliminary designs of the four proposed gasifier systems for use in the proposed project was performed. This analysis was composed of the following three primary tasks:

- Task 1: Determine the maximum credible potential releases, for each process unit within each proposed system configuration for each candidate coal source.
- Task 2: For each release point identified in Task 1, determine the maximum downwind travel for harmful, but not fatal, consequences of the release under worst-case atmospheric conditions.

- Task 3: Using the results of Task 2 and the available general layout information for the proposed system configurations, develop a methodology to rank the potential impacts to the workers on site and the potential off-site public population.

Hazards Identification

In general, all four of the gasifier systems evaluated for the FutureGen Project are composed of similar equipment. All gas processing equipment downstream of the gasifier is in common use in the petroleum industry and does not provide any unique hazards (Quest, 2006).

Upperbound-Case Consequence Analysis

The Quest Study evaluated the largest releases to determine the extent of possible flammable and toxic impacts under maximum (upperbound) release conditions. The analysis included a combination of four gasifiers and three types of coal (12 gasifier/coal combinations). The impacts were defined as those that could cause injury to workers or members of the public.

None of the flammable hazards were found to have impacts that extended beyond the proposed plant property. The largest flash fire impact zones extended less than 200 feet (61.0 meters) from the point of release. Areas within the process units in each of the four project system designs would have the potential to be impacted by flammable releases. This result is not unexpected for a facility handling similar materials (Quest, 2006).

The upperbound for toxic impacts associated with the 12 gasifier/candidate coal combinations evaluated would have the potential to extend past the proposed project property line. The toxic impacts would be dominated by releases of H_2S and SO_2 from the Claus process unit. The resulting plumes could extend from 0.3 to 1.4 miles (0.5 to 2.3 kilometers) from the point of release. There are no family residences or farm home sites within the 1.4-mile (2.3-kilometer) plume release radius. However, portions of the Limestone generating station and the Jewett Mine properties are within this footprint. The total number of workers potentially affected by these releases is not certain, although 373 workers are reportedly employed at the Jewett Mine (Texas Westmoreland Coal Co., 2005).

The longest downwind toxic impact distance associated with any of the four gasifiers is due to the CO in the syngas process stream. These streams can produce toxic CO impacts extending from 0.4 to 0.6 mile (0.6 to 1.0 kilometer) from the point of release (Quest, 2006). There are no family residences, farm home sites or commercial properties within the 0.6-mile (1.0-kilometer) release footprint radius.

The potential health risks to these receptors are discussed in more detail in Section 6.17.5.

Hazard Ranking

Using the results from Tasks 1 and 2, a framework for ranking the flammable and toxic impacts associated with the upperbound release was designed as a function of the location of a worker or member of the public relative to the facility process units. Four zones were developed; two for the workers inside the property line and two for the public outside of the property lines (Quest, 2006).

Since none of the flammable hazards were found to have impacts that extended past the property line, there would be no off-site or public impacts due to flammable releases within the facility process units (Quest, 2006).

The upperbound for toxic impacts associated with all 12 gasifier/coal candidate combinations would have the potential to extend past the proposed project property line. In 11 of the 12 gasifier/candidate coal combinations, toxic impacts associated with the Claus unit would be greater than the impacts from any other process unit (Quest, 2006).

In general, all 12 gasifier/candidate coal systems would have the potential to produce toxic impacts that could extend into a public area outside of the property line for the 200-acre (81-hectare) base case layout. By this measure, all four gasifier systems, regardless of candidate coal, have the potential to produce similar worst-case impacts and thus, are ranked equally. This conclusion is also true for a 400-acre (162-hectare) layout and is true for 11 of the 12 gasifier/candidate coal systems assuming a 600-acre (243-hectare) site (Quest, 2006).

Conclusions

The identification and evaluation of the largest potential releases associated with the four gasifier system designs for the proposed project results in the following findings:

- There are no flammable hazard impacts that extend off the proposed project property.
- All four gasifier designs produce similar toxic hazards. No design demonstrates a clear advantage over others in this respect.
- The potential toxic impacts associated with the four gasifier system designs are dominated by releases of H_2S and SO_2 from the Claus unit that is included in each design.
- All three candidate coals, when used as feed to any of the four gasifier designs, have the potential to produce off-site toxic impacts. The Powder River Basin coal, used in any of the gasifiers, produces slightly smaller toxic impact distances strictly due to its lower sulfur content, and thus, lower H_2S flow rates to the Claus unit (Quest, 2006).

6.17.4 RISK ASSESSMENT FOR CO_2 SEQUESTRATION

The "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement" (Tetra Tech, 2007) describes the results of the human health risk assessment conducted to support the proposed project. The risk assessment addresses the potential releases of captured gases at the proposed power plant, during transport via pipeline to the proposed geologic storage site, and during subsurface storage.

The approach to risk analysis for CO_2 sequestration in geologic formations is still evolving. However, a substantial amount of information exists on the risks associated with deep injection of hazardous waste and the injection of either gaseous or supercritical CO_2 in hydrocarbon reservoirs for enhanced oil recovery. There are also numerous projects underway at active CO_2 injection sites that are good analogs to determine the long-term fate of CO_2. The FutureGen Project assessment relies heavily on the findings from these previous and ongoing projects.

6.17.4.1 CO_2 Sequestration Risk Assessment Process

The human health risk assessment is presented in five sections: conceptual site models (CSMs); toxicity data and benchmark concentration effect levels; pre-injection risk assessment; the post-injection risk assessment; and the risk screening and performance assessment. The results of the risk screening of CO_2 sequestration activities are presented in 6.17.4.2.

Conceptual Site Models

A central task in the risk assessment was the development of the CSMs. Potential pathways of gas release during capture, transport, and storage were identified for the pre- and post-injection periods. Site-specific elements of the Jewett Site were described in detail based on information from the EIVs provided by the FutureGen Alliance (FG Alliance, 2006a - d). These data provided the basis for the CSM parameters and the analysis of likely human health exposure routes.

Toxicity Data and Benchmark Concentration Effect Levels

The health effect levels were summarized for the identified exposure pathways. The toxicity assessment provides information on the likelihood of the chemicals of potential concern to cause adverse human-health effects. These data provided the basis for the comparison of estimated exposures and the assessment of potential risks.

Risk Screening and Performance Assessment

Pre-Injection Risk Assessment

This assessment evaluated the potential risks associated with the proposed plant and aboveground facilities for separating, compressing, and transporting CO_2 to the proposed injection site. The risk assessment for the pre-injection components was based on qualitative estimates of fugitive releases of captured gases and quantitative estimates of gas releases from aboveground sources under different failure scenarios. Failure scenarios of the system included: pipeline rupture, pipeline leakage through a puncture (3-square-inch [19.4-square-centimeter] hole), and rupture of the wellhead injection equipment. The volumes of gas released for the pipeline scenarios were calculated using site-specific data for the four sites and the equations for gas emission rates from pipelines (Hanna and Drivas, 1987).

In general, the amount of gas released from a pipeline rupture or puncture was the amount contained between safety valves, assumed to be spaced at 5-mile (8.0-kilometer) intervals. The amount of gas released by a wellhead rupture was assumed to be the amount of gas contained within the well casing itself. The atmospheric transport of the released gas was simulated using the SLAB model (Ermak, 1990), with the gas initially in a supercritical[1] state (pressure ~2000 psi, temperature ~90°F [32.2°C]). The evaluation was conducted for the case with CO_2 at 95 percent and H_2S at 100 ppmv. The predicted concentrations in air were used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors.

Post-Injection Risk Assessment

The post-injection risk assessment describes the analysis of potential impacts from the release of CO_2 and H_2S after the injection into the subsurface CO_2 storage formation. A key aspect of the analysis was the compilation of an analog database that included the proposed site characteristics and results from studies performed at other CO_2 storage locations and from sites with natural CO_2 accumulations and releases. The analog database was used for characterizing the nature of potential risks associated with surface leakage due to caprock seal failures, faults, fractures, or wells. CO_2 leakage from the proposed project storage formation was estimated using a combination of relevant industry experience, natural analog studies, modeling, and expert judgment.

Qualitative risk screening of the proposed site was based upon a systems analysis of the site features and scenarios portrayed in the CSM. Risks were qualitatively weighted and prioritized using procedures identified in a health, safety, and environmental risk screening and ranking framework developed by Lawrence Berkeley National Laboratory for geologic CO_2 storage site selection (Oldenburg, 2005). In addition, further evaluation was conducted by estimating potential gas emission rates and durations using the analog database for a series of release scenarios. Three scenarios could potentially cause acute effects: upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells.

---

[1] A supercritical fluid occurs at temperatures and pressures where the liquid and gas phases are no longer distinct. The supercritical fluid has properties of both the gaseous and liquid states; normally its viscosity is considerably less than the liquid state, and its density is considerably greater than the gaseous state.

Six scenarios could potentially cause chronic effects: upward leakage through caprock and seals by gradual failure; release through existing faults due to effects of increased pressure; release through induced faults due to effects of increased pressure (local over-pressure)' upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells. For the chronic-effects case for the latter three well scenarios, the gas emission rates were estimated to be at a lower rate for a longer duration. The predicted concentrations in air were then used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors. Other scenarios including catastrophic failure of the caprock and seals above the sequestration reservoir and fugitive emissions are discussed, but were not evaluated in a quantitative manner.

6.17.4.2 Consequence Analysis

Risk Screening Results for Pre-Sequestration Conditions (CO_2 Pipeline and Injection Wellheads)

As with all industrial operations, accidents can occur as part of the CO_2 transport and sequestration activities. Of particular concern is the release of CO_2 and H_2S. The CO_2 sequestration risk assessment (Tetra Tech, 2006) identified three types of accidents that could potentially release gases into the atmosphere before sequestration. Accidents included ruptures and punctures of the pipeline used to transport CO_2 to the injection sites and rupture of the wellhead equipment at these sites. The frequency of these types of accidents along the pipelines or at the wellheads is expected to be low. The amount of gas released depends on the severity and the location of the accident (i.e., pipeline or wellhead releases).

Health effects from inhalation of high concentrations of CO_2 gas can range from headache, dizziness, sweating, and vague feelings of discomfort, to breathing difficulties, increased heart rate, convulsions, coma, and possibly death. Exposure to H_2S can cause health effects similar to those for CO_2, but at much lower concentrations. In addition H_2S can cause eye irritation, abnormal tolerance to light, weakness or exhaustion, poor attention span, poor memory, and poor motor function.

Impacts of CO_2 and H_2S gas releases on workers and the public depends on the location of the releases, the equipment involved, the meteorological conditions (including atmospheric stability and wind speed and direction), the directionality of any release from a puncture (e.g., upwards and to the side), and other factors. The effects to workers near a ruptured or punctured pipeline or wellhead are likely to be dominated by the physical forces from the accident itself, including the release of gases at high flow rates (3,000 kilograms per second) and at very high speeds (e.g., ~ 500 mph [804.7 kmph]). Thus, workers involved at the location of an accidental release would be impacted, possibly due to a combination of effects, such as physical trauma, asphyxiation (displacement of O_2), toxic effects, or frostbite from the rapid expansion of CO_2 (2,200 psi to 15 psi). Workers near a release up to a distance of 640 feet (195 meters) could also be exposed to very high concentrations of CO_2 (e.g., 170,000 ppm) for short durations of one minute, which would be life-threatening.

Accident Categories and Frequency Ranges

Likely: Accidents estimated to occur one or more times in 100 years of facility operations (frequency ≥ 1×10^{-2}/yr).

Unlikely: Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from 1×10^{-2}/yr to 1×10^{-4}/yr).

Extremely Unlikely: Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency from 1×10^{-4}/yr to 1×10^{-6}/yr).

Incredible: Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1×10^{-6}/yr).

For this evaluation, risks to workers were evaluated at two distances: involved workers at a distance of 66 feet (20.1 meters) of a release and other workers at a distance of 820 feet (249.9 meters). For all ruptures or punctures these individuals may experience adverse effects up to and including irreversible effects when concentrations predicted using the SLAB model (Ermak, 1990) exceed health criteria. The criteria used for this determination were the RELs established as occupational criteria for exposures to CO_2 and H_2S, consisting, respectively, of a ST exposure limit (averaged over 15 minutes) for CO_2 and a ceiling concentration for H_2S that should not be exceeded at any time during a workday (NIOSH, 2007). Each of these criteria is listed in Table 6.17-4. Table 6.17-12 summarizes locations where pipeline and wellhead accidents create gas concentrations exceeding allowable levels for facility workers. Workers would be expected to be affected by CO_2 concentrations equal to or greater than 30,000 ppm from a pipeline rupture out to a distance of 663 feet (202 meters) or to a distance of 449 feet (137 meters) from a pipeline puncture. H_2S concentrations would exceed worker criteria at least out to a distance of the proposed plant boundary 820 feet (249.9 meters) for both the pipeline rupture and puncture.

Table 6.17-12. Exceedance of Occupational Health Criteria[1] for Workers

Release Scenario	Frequency Category[2]	Exposure Time	Gas	Area of Exceedance
Pipeline Rupture	U	Minutes	CO_2	Near pipeline only[3]
			H_2S	Within plant boundaries[4]
Pipeline Puncture[5]	L to U	Approximately 4 hours	CO_2	Near pipeline only[3]
			H_2S	Near pipeline only[3]
Wellhead Rupture	EU	Minutes	CO_2	None
			H_2S	Near wellhead only[3]

[1] Occupational health criteria used were the NIOSH reference exposure levels (REL), short-term (ST), and NIOSH REL ceiling (C) for CO_2 and H_2S, respectively. See Table 6.17-4.
[2] U(unlikely)=frequency of 1x 10^{-2}/yr to 1x 10^{-4}/yr; L (likely) = frequency of ≥ 1x 10^{-2}/yr ;EU (extremely unlikely)=frequency of 1x10^{-4}/yr to 1x 10^{-6}/yr.
[3] Distances are 663 feet (202 meters) for pipeline rupture; 449 feet (137 meters) for pipeline puncture; at least 161 feet (49 meters) for wellhead rupture.
[4] Within 820 feet (250 meters) of release.
[5] 3-inch by 1-inch rectangular opening in pipe wall.

A 2006 workshop sponsored by the EPA and the National Institute of Environmental Health Sciences (Selgrade et al., 2006) found that a number of scientific questions that need to be answered in order to make appropriate regulatory decisions for ambient air, including which air pollutants are of greatest concern and at what concentrations. Nevertheless, IGCC power plants that are currently in operation have achieved the lowest levels of criteria air pollutant (SO_2, CO, O_3, NO_2, Pb, and respirable particulate matter) emissions of any coal-fueled power plant technologies (DOE, 2002). Tables 6.2-1 and 6.2-2 also show that the IGCC technology under evaluation for the proposed project would exceed the performance of technologies used at more conventional types of coal-fueled power plants of comparable size. Furthermore, based on evaluations conducted for this site (as described in Section 6.2), the maximum predicted concentrations of the criteria air pollutants would not exceed the National Ambient Air Quality Standards and would not significantly contribute to existing background levels. Based on these determinations, it is unlikely that the proposed project would be a factor in asthma-related health effects.

There is also interest in whether ruptures or punctures may affect non-involved workers. Non-involved workers are those workers present within the proposed plant boundary distance, but employed in activities distant from the release point. The effects for non-involved workers were evaluated at a distance of 820 feet (249.9 meters) from the release point. The same occupational health criteria were used to determine the potential effects to the non-involved workers. Potential effects were determined by comparing SLAB model calculated concentrations with health criteria at the distances of concern. As shown in Table 6.17-12, no worker-related criteria were exceeded for non-involved worker exposures to CO_2 from any of the evaluated accidental releases. Alternatively, H_2S could possibly affect non-involved workers exposed to releases from a pipeline rupture, but not a pipeline puncture or wellhead rupture.

Health Effects from Accidental Chemical Releases

The impacts from accidental chemical releases were estimated by determining the number of people who might experience adverse effects and irreversible adverse effects.

Adverse Effects: Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as headache or sweating (associated with lower chemical concentrations) to irreversible (permanent) effects, including death or impaired organ function (associated with higher concentrations).

Irreversible Adverse Effects: A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system damage), and other effects that impair everyday functions.

Life Threatening Effects: A subset of irreversible adverse effects where exposures to high concentrations may lead to death.

Accidental releases from the pipeline or wellhead, although expected to be infrequent, could potentially have greater consequences and affect the general public in the vicinity of a release. To determine potential impacts to the public, the CO_2 sequestration risk assessment (Tetra Tech, 2007) evaluated potential effects to the public for accidental releases of gases from the pipelines and wellheads. The CO_2 pipeline failure frequency was calculated based on data contained in the on-line library of the Office of Pipeline Safety (OPS, 2007). Accident data from 1994-2006 indicated that 31 accidents occurred during this time period. DOE categorized the two accidents with the largest CO_2 releases (4,000 barrels and 7,408 barrels) as rupture type releases, and the next four highest releases (772 barrels to 3,600 barrels) as puncture type releases. For comparison, 5 miles (8.0 kilometers) of FutureGen pipeline contains about 6,500 barrels, depending on the pipeline diameter. Assuming the total length of pipeline involved was approximately 1,616 miles (2,600 kilometers) based on data in Gale and Davison (2004), the rupture and puncture failure frequencies were calculated to be 5.9×10^{-5}/(km-yr) and 1.18×10^{-4}/(km-yr), respectively. Puncture failure frequencies are reported in failure events per unit length and time based on data for a particular length of pipeline and period of time.

The pipeline failure frequencies are only one component of the exposure frequency. The total exposure frequency also considered the percent of time the wind was blowing in the direction of the receptor, the percent of time the wind stability was the greatest, and the section of the pipeline that would have to fail to possibly allow the release to reach the exposed population.

The failure frequencies for pipeline ruptures and punctures are calculated as the product of the pipeline length at the site and the failure frequencies presented above (ruptures: 5.92×10^{-5}/km-yr; punctures: 1.18×10^{-4}/km-yr) (Gale and Davison, 2004). The failure rate of wellhead equipment during operation is estimated as 2.02×10^{-5} per well per year based on natural gas injection-well experience from an IEA GHG Study (Papanikolau et al., 2006). These failure frequencies provide the basis for the frequency categories presented in Tables 6.17-12 and Table 6.17-15.

The predicted releases, whether by rupture or puncture are classified as extremely unlikely: the frequencies for ruptures is between 9.9×10^{-3} and 1.1×10^{-2}, the frequency for punctures is between 5.0×10^{-3} and 5.6×10^{-3}, and the frequency for a wellhead rupture 1×10^{-6} to 2×10^{-5}/year. The criteria used to examine potential health effects, including mild and temporary as well as permanent effects are defined in Tables 6.17-7 and 6.17-13. The CO_2 and H_2S exposure durations that could potentially occur for the three types of release scenarios are noted in Table 6.17-14.

Table 6.17-13. Description of Hazard Endpoints for Public Receptors

Hazard Endpoint	Description
RfC	An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
TEEL 1	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
TEEL 2	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
TEEL 3	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

RfC = Inhalation Reference Concentration.
TEEL = Temporary Emergency Exposure Limits.
Sources: EPA, 2006a; DOE, 2006.

Table 6.17-14. Hazard Endpoints for Public Receptors

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
Minutes (Pipelines)	CO_2	Adverse effects	30,000	TEEL 1
		Irreversible adverse effects	30,000	TEEL 2
		Life Threatening	40,000	TEEL 3
	H_2S	Adverse effects	0.51	TEEL 1
		Irreversible adverse effects	27	TEEL 2
		Life Threatening	50	TEEL 3
Minutes (Explosions[2])	H_2S	Irreversible adverse effects	41	AEGL 2 (10 minute)
		Life threatening	76	AEGL 3 (10 minute)
	SO_2	Irreversible adverse effects	0.75	AEGL 2 (10 minute)
		Life threatening	42	AEGL 3 (10 minute)[3]
Hours/Days	CO_2	Adverse effects	20,000	Headache, etc.[4,5]
		Life Threatening	70,000	Headache, etc.[4,5,6]
	H_2S	Adverse effects	0.33	AEGL 1 (8 hour)
		Irreversible adverse effects	17	AEGL 2 (8 hour)
		Life Threatening	31	AEGL 3 (8 hour)
Years	CO_2	Adverse effects	40,000	Headache, etc.[4,7]
		Life Threatening	70,000	Headache, etc.[4,6,7]
	H_2S	Irreversible adverse effects	0.0014	RfC

[1] See Tables 6.17-7 and 6.17-13 for descriptions of the TEEL and AEGL endpoints.
[2] Used by Quest, 2006 to evaluate releases from explosions.
[3] Quest, 2006.
[4] EPA, 2000.
[5] Headache and dyspnea with mild exertion.
[6] Unconsciousness and near unconsciousness.
[7] Headache, dizziness, increased blood pressure, and uncomfortable dyspnea.
TEEL = Temporary Emergency Exposure Limits.
AEGL = Acute Exposure Guideline Level.
RfC = Inhalation Reference Concentration.

Simulation models were used to estimate the emission of CO_2 for the aboveground release scenarios when the gas is in a supercritical state. The SLAB model developed by the Lawrence Livermore National Laboratory and approved by U.S. EPA was used to simulate denser-than-air gas releases for both horizontal jet and vertically elevated jet scenarios. The model simulations were conducted for the case with CO_2 at 95 percent and H_2S at 100 parts per million by volume (ppmv). The state of the contained captured gas prior to release is important with respect to temperature, pressure, and the presence of other constituents. Release of CO_2 under pressure would likely cause rapid expansion and then reduction in temperature and pressure, which can result in formation of solid-phase CO_2, as explained in Appendix C-III of the risk assessment (Tetra Tech, 2007). The estimated quantity of solid-phase formed was 26 percent of the volume released; therefore 74 percent of the volume released from a pipeline rupture or puncture was used as input to the SLAB model for computing atmospheric releases of CO_2 and H_2S. Carbon dioxide is heavier than air and subsequent atmospheric transport and dispersion can be substantially affected by the temperature and density state of the initially released CO_2. The meteorological conditions at the time of the release would also affect the behavior and potential hazard of such a release.

The potential effects of CO_2 and H_2S releases from pipeline ruptures and punctures were evaluated using an automated "pipeline-walk" analysis. The methodology (described briefly in Appendix D and in detail in Section 4.4.2 and Appendix C-IV of the risk assessment) estimates the maximum expected number of individuals from the general public potentially affected by pipeline ruptures or punctures at each site. The analysis takes into account the effects of variable meteorological conditions and the location of pipeline ruptures or punctures. For wellhead ruptures the potential impact zones corresponding to health-effects criterion values for H_2S and CO_2 were determined using the SLAB model and assuming meteorological conditions that resulted in the highest potential chemical exposures (i.e., assuming wind speeds of 2 meters per second and stable atmospheric conditions). The number of individuals potentially affected within the impact zone was determined from population data obtained from the 2000 U.S. Census.

This modeling approach to assess potential chemical exposures is based on the assumption that the population size and locations near the proposed project would not change during the time period assessed for this proposed project (i.e., 50 years for releases during the operation phase and 5,000 years for releases of sequestered gases).

Among the three types of accidental releases, the postulated accident that would result in the largest number of people with adverse health effects (including mild and temporary as well as permanent effects) is a pipeline rupture 3 miles (4.8 kilometers) east of where segment F-H crosses the Trinity River. If this type of accident occurred along this segment, it is estimated that up to 52 members of the general public might experience adverse effects, primarily from H_2S exposure (mild and temporary effects, such as headaches or exhaustion) (see Table 6.17-15). A pipeline puncture at this location could cause adverse effects to one member of the general public. Since the pipeline would extend approximately 52 to 59 miles (84 to 95 kilometers) from the proposed power plant to the injection wellheads (FG Alliance, 2006c), more of the public are likely to be affected than workers at the proposed power plant.

The postulated accident that would cause irreversible health effects to the largest number of individuals is a pipeline rupture. It is calculated that one member of the general public might experience irreversible adverse effects (e.g., poor memory or poor attention span) or life-threatening effects.

As shown in Table 6.17-15, the number of individuals in the general public potentially with adverse effects from other types of accidents would be less, with four affected by a wellhead rupture. No fatalities were projected for a pipeline puncture or wellhead rupture.

Although the potential for releases from pipelines or wellheads may be low, any releases from the pipeline or wellheads could be high consequence events. For this reason, there are well-established measures for preventing or reducing impacts of accidental releases. These include design recommendations (e.g., increasing pipeline wall thickness, armoring pipelines in specific locations such as water body and road crossings); use of newer continuous pipeline monitors and computer models to rapidly interpret changes in fluid densities, pressures, etc.; use of safety check valves at closer intervals (e.g., 1 to 3 miles [1.6 to 4.8 kilometers] instead of 5 miles [8 kilometers] in populated areas) that can quickly isolate damaged section of the pipeline; operational procedures (e.g., activating “bleed” valves to control location and direction of releases should a puncture occur); and emergency response procedures (e.g., notifying the public of events requiring evacuation). In high consequence areas such as areas with high population densities, the pipeline could be buried at a deeper depth, valves could be buried in underground vaults, and the pipeline and wellhead locations could be marked and protected with chain link fences and posts. The pipeline could be routed to maximize the distance to sensitive receptors and to allow a buffer between the pipeline and the nearest residence or business. In some cases it may be possible to further reduce the concentrations of effect-causing substances being transported (e.g., H_2S). These measures would be implemented, as appropriate.

Risk Screening Results for Post-sequestration Conditions

Under post-sequestration conditions, a slow continuous leak through a deep well was determined to be the only scenario that may cause adverse health effects to the general public (Tetra Tech, 2007). Since the deep wells within the vicinity of the proposed CO_2 injection wells would be properly sealed before initiation of CO_2 sequestration, and since the proposed CO_2 injection well(s) would also be properly sealed after their use, it is extremely unlikely that the proposed project would create a gas release of consequence from the subsurface (Table 6.17-16). However, if this type of release occurred at the proposed sequestration site, it is estimated that up to 26 members of the public might experience irreversible adverse effects from H_2S exposures (i.e., nasal lesions). This estimate is based on the assumption that the future population would be the same as current conditions. Also, this evaluation is based on the EPA RfC criterion for chronic (i.e., long-term and low level) exposures that incorporates a safety factor of 300 to be protective of sensitive individuals. The RfC criterion value for H_2S is an extremely low concentration: 0.0014 ppm.

Since CO_2 sequestration is a relatively new technology, a series of mitigation and monitoring measures have been developed for these activities. In addition to plugging and properly abandoning wells, monitoring plans include use of remote sensing methods, atmospheric monitoring techniques, methods for monitoring gas concentrations in the subsurface and surface environments, and processes for monitoring subsurface phenomena associated with the injection reservoir and the caprock (FG Alliance, 2006a-d). A specific schedule for different types of monitoring has been proposed for the proposed Jewett Sequestration Site and surrounding areas that would occur before and during sequestration activities (FG Alliance, 2006c). Also, after the cessation of injection monitoring, activities would be used to identify any long-term, post-closure changes in land surface conformation, soil gas, and atmospheric fluxes of CO_2.

Table 6.17-16. Number of Individuals with Adverse Effects from Potential Exposure to Post-Sequestration H_2S Gas Releases

Release Scenario	Frequency Category[1]	Number Affected[2]
Upward slow leakage through CO_2 injection well	EU	
Travis Peak		0.4
Woodbine		0.4
TDCJ		26
Upward slow leakage through deep oil and gas wells	EU[3]	
Travis Peak and Woodbine		0.4
TDCJ		26
Upward slow leakage through other existing wells	EU[3]	
Travis Peak and Woodbine		0.4
TDCJ		26

[1] EU(extremely unlikely)=frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[2] Potentially irreversible adverse effects could occur within 745 feet of the release point; instances presented here are converted from meters, which were used in the risk assessment (see Appendix D). Also, assumed future population density would remain the same as current conditions, with the Coffield State Prison Farm on the periphery of the sequestration plume footprint.
[3] Assumes that the other wells potentially within the sequestration plume footprint have been properly sealed before sequestration begins.
TDCJ = Texas Department of Criminal Justice.

6.17.5 TERRORISM/SABOTAGE IMPACT

As with any U.S. energy infrastructure, the proposed power plant could potentially be the target of terrorist attacks or sabotage. In light of two recent decisions by the U.S. Ninth District Court of Appeals (*San Luis Obispo Mothers v. NRC, Ninth District Court of Appeals, June 2, 2006; Tri Valley Cares v. DOE, No. 04-17232, D.C. No. CV-03-03926-SBA, October 16, 2006),* DOE has examined potential environmental impacts from acts of terrorism or sabotage against the facilities being proposed in this EIS.

Although risks of sabotage or terrorism cannot be quantified because the probability of an attack is not known, the potential environmental effects of an attack can be estimated. Such effects may include localized impacts from releases from the proposed power plant and associated facilities, assuming that such releases would be similar to what would occur under an accident or natural disaster (such as a tornado). To evaluate the potential impacts of sabotage/terrorism, failure scenarios are analyzed without specifically identifying the cause of failure mechanism. For example, a truck running over a wellhead at the proposed sequestration site would result in a wellhead failure, regardless of whether this was done intentionally or through mishap. Therefore, the accident analysis evaluates the outcome of catastrophic events without determining the motivation behind the incident. The accident analyses evaluated potential releases from pipelines, wellheads, and major and minor system failures/accidents at the proposed power plant site. These accidents could also be representative of the impacts from a sabotage or terrorism event.

Various release scenarios were evaluated including: pipeline rupture, pipeline puncture, and wellhead equipment rupture. Gaseous emissions were assumed to be 95 percent CO_2 and 0.01 percent H_2S. Table 6.17-15 provides effects levels for individuals of the public that could potentially be exposed to releases. Of these release scenarios at the proposed Jewett Site, a pipeline rupture would result in impacts to the public over the largest distance. For a release of the CO_2 gas from a pipeline rupture, no impacts from CO_2 would occur beyond 0.1 mile (0.2 kilometer) of the release, while impacts from the H_2S in the gas stream could occur within 0.4 mile (0.6 kilometer) of the release, tapering to no impact at a distance of

4.3 miles (6.9 kilometers). Under upperbound conditions such a release could cause up to one fatality and adverse health effects to 52 individuals.

For short-term CO_2 and H_2S co-sequestration testing over a two-week period, the concentration of H_2S in the sequestered gas would be two percent (20,000 ppmv) or 200 times greater than the base case, which assumed the H_2S concentration would be 100 ppmv. Thus, impacts to the public (both mild and life-threatening effects) could extend to greater distances than shown for the base case in Table 6.17-15. Although short-term testing of co-sequestration (CO_2 with H_2S) is examined for two weeks during the DOE-sponsored phase of the proposed project, no decision has been made yet to pursue co-sequestration over a longer period. However, co-sequestration cannot be ruled out as a possible operating scenario.

In general, ruptures or punctures of pipelines are rare events. Based on OPS nationwide statistics, 31 CO_2 pipeline accidents occurred between 1994 and 2006. None of these reported accidents were fatal nor caused injuries (OPS, 2006). Should a CO_2 pipeline rupture occur, it would be immediately detected by the pipeline monitoring system, alerting the pipeline operator. Once the flow of gas has stopped, the gas would dissipate and chemical concentrations at the source of the release would decline to non-hazardous levels in a matter of minutes for a pipeline rupture and several hours for a pipeline puncture. However, the released gas then migrates downwind, as described in the preceding sections.

The potential health effects from “upperbound” explosion and release scenarios at the proposed power plant (Section 6.17.3.2) can be contrasted with those associated with the pipeline. Hazardous events evaluated for the proposed power plant included: gas releases and exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions. Evaluations of these results indicate:

- Toxic releases from the Claus unit that could extend from 0.2 to 1.4 miles (0.3 to 2.3 kilometers) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are no family residences or farm homes within the maximum distance potentially impacted by releases from the Claus unit (i.e., 1.4 miles [2.3 kilometers] of the site) under current conditions (Quest, 2006). However, examination of population density estimates (see Section 6.17.4.2) suggests that such releases could potentially cause irreversible adverse effects in 1820 individuals exposed to SO_2, with five exposed to potentially life threatening concentrations of H_2S (Table 6.17-17). These results may, at least partially, be based on the observation that portions of the Limestone Generating Station and the Jewett Mine properties are within this release footprint (Quest, 2006). The total number of workers potentially affected by these releases is not certain, although 373 workers are reportedly employed at the Jewett Mine (Texas Westmoreland Coal Co., 2005).
- Toxic releases from the gasifier could extend from 0.2 to 0.6 mile (0.3 to 1.0 kilometer) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are no family residences, farm homes or commercial properties within this release footprint radius (Quest, 2006). However, examination of the population density estimates suggests that such a release could potentially cause irreversible adverse effects in 17 individuals exposed to CO, with two exposed to potentially life-threatening effects.
- Fire hazards at the plant site would not extend off site.
- Under all worst case scenarios, plant workers would be the most at-risk of injury or death.

Table 6.17-17. Effects to the Public from Explosions at the FutureGen Plant

Release Scenario	Gas	Effect[1]	Distance[2] (miles [kilometers])	Number Affected
Claus Unit failure (release duration = minutes)	H_2S	Irreversible adverse effects	0.5 (0.8)	12
		Life threatening	0.4 (0.6)	5
	SO_2	Irreversible adverse effects	1.4 (2.3)	92
		Life threatening	0.2 (0.3)	2
Gasifier release (release duration = minutes)	CO	Irreversible adverse effects	0.6 (1.0)	17
		Life threatening	0.2 (0.3)	2

[1] See Table 6.17-3 for an explanation of the effects.
[2] Distances taken from Quest, 2006.

As discussed, if an explosion occurred at the proposed plant site as the result of a terrorist attack, it is likely that hazardous gases would cause injury and death of workers within the proposed plant site and most likely the public located within 1.4 miles (2.2 kilometers) of the proposed plant site.

6.18 COMMUNITY SERVICES

6.18.1 INTRODUCTION

This section identifies the community services most likely to be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site in Freestone, Leon, and Limestone counties in Texas. This section addresses law enforcement, fire protection, emergency response, health care services, and the school system. Additionally, the potential effects that the construction and operation of the proposed FutureGen Project could have on those services, as well as any proposed mitigation measures that could reduce any adverse effects, are discussed.

6.18.1.1 Region of Influence

The ROI for community services includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site and sequestration site. The proposed sequestration site is located approximately 33 miles (53.1 kilometers) northeast of the proposed plant site. As shown in Figure 6.18-1, the 50-mile (80.5-kilometer) radius for the sequestration site and the 50-mile (80.5-kilometer) radius for the plant site largely overlap. The ROI for the proposed Jewett Power Plant Site and Sequestration Site includes all land area in Freestone County and some land area in the counties of Leon, Limestone, Anderson, Brazos, Falls, Houston, Madison, McLennan, Navarro and Robertson.

Community services data are reported county-wide because this format is most often used in public information. This includes counties that have only a relatively small portion of land lying within the 50-mile (80.5-kilometer) radius. Therefore, if only a minor portion of a county was touched by the 50-mile (80.5-kilometer) radius and two or fewer small communities fall within that minor portion of the county, then that county was excluded from the analysis as not materially affecting the aggregate community services in the ROI. Those counties with two or fewer small communities that were excluded from the ROI include Cherokee, Grimes, Henderson, Hill, Kaufman, Milam, Smith, Van Zandt, and Walker. Excluding these counties from the ROI makes the remaining data more meaningful for determining project effects.

Although the analysis in this section addresses the entire ROI, the affected environment and environmental consequences focus on the proposed power plant site located in Freestone, Leon and Limestone counties.

6.18.1.2 Method of Analysis

DOE evaluated the impacts to community services based on anticipated changes in demand for law enforcement, fire protection, emergency response, health care services, and schools using research provided in the Jewett EIV (FG Alliance, 2006c). In many cases, the change in demand would be directly related to the increased population.

DOE assessed the potential for impacts based on the following criteria:

- Affect on law enforcement;
- Conflict with local or regional management plans for law enforcement;
- Affect on fire protection;
- Conflict with local or regional management plans for fire protection;
- Affect on emergency response;
- Conflict with local or regional management plans for emergency response;

- Affect on health care services;
- Conflict with local or regional management plans for health care services;
- Affect on local schools; and
- Conflict with local or regional management plans for schools.

6.18.2 AFFECTED ENVIRONMENT

6.18.2.1 Law Enforcement

Freestone, Leon, and Limestone counties are served by eight municipal police departments located in Fairfield, Teague, Wortham, Buffalo, Jewett, Groesbeck and Mexia (UC, 2005 and FG Alliance, 2006c). Table 6.18-1 presents staffing levels of these police departments. A total of 67 officers work out of these eight departments in Freestone, Leon and Limestone counties, and each county in Texas is served by its own County Sheriff's Office (FG Alliance, 2006c; UC, 2005; and CD, 2002).

Anderson, Brazos, Falls, Houston, Madison, McLennan, Navarro and Robertson counties in Texas are served by a total of 24 municipal police departments (UC, 2005).

Table 6.18-1. Staffing Levels of Police Departments in Freestone, Leon, and Limestone Counties

County	Number of Police Officers
Freestone	27
Leon	12
Limestone	28
Total	**67**

Source: FG Alliance, 2006c and CD, 2002.

The U.S. has an average of 2.3 police officers per thousand residents (Quinlivan, 2003). In Freestone, Leon and Limestone counties, the ratio is approximately 1.1 officers per thousand residents based on the 2005 projected population and 67 full-time law enforcement officers. Although the ratio of officers is well below the national average, crime in Freestone, Leon and Limestone counties is extremely low. Index offenses, which include criminal sexual assault, robbery, aggravated assault, burglary, theft, motor vehicle theft and arson, are a way of measuring and comparing crime statistics (TDPS, 2003). The State of Texas averaged 5,153 index offenses per 100,000 residents in 2003, whereas Freestone, Leon and Limestone counties averaged 429 index offenses per 100,000 residents for the same year (TDPS, 2003).

6.18.2.2 Emergency and Disaster Response

In Texas, Councils of Government are organizations of local county governments working together to solve mutual community problems. Emergency response and fire protection are managed by the Councils of Government because Texas counties can be very rural and cover large land areas that can be more effectively served at a regional level. Freestone and Limestone counties are members of the Heart of Texas Council of Government's organization of 911 public safety answering points and, similarly, Leon County is served by the Brazos Valley Council of Government. These organizations oversee 911 emergency management and dispatch fire and rescue, ambulances and emergency medical personnel from the answering points located throughout its member counties. The ROI is served by 29 emergency medical and ambulance services, and four air ambulance services (FG Alliance, 2006c).

6.18.2.3 Fire Protection

Freestone, Leon and Limestone counties host a total of 32 fire departments with trained fire services personnel. The proposed Jewett Power Plant Site and Sequestration Site would be served by a total of 84 fire departments from within the Heart of Texas and Brazos Valley Councils of Government. As of May 2006, the State of Texas was in the process of developing a statewide mutual aid system (TFCA, 2006). The system, if implemented, would provide a mechanism for fire protection and emergency response assistance in case of a major emergency from organizations throughout the State of Texas.

6.18.2.4 Hazardous Materials Emergency Response

The proposed Jewett Power Plant Site and sequestration site would be served by two Hazardous Materials (HazMat) units located in Brazos and Limestone counties. HazMat units respond and perform functions to handle and control actual or potential leaks or spills of hazardous substances (OSHA, 1994).

6.18.2.5 Health Care Service

A total of 26 hospitals and medical clinics serve the ROI (FG Alliance, 2006c). Freestone, Leon and Limestone Counties are served by three hospitals and two medical clinics, which include East Medical Center in Fairfield, Limestone Medical Center in Groesbeck, Parkview Regional Hospital in Mexia, Leon Health Resource Center in Centerville, and St. Joseph-Normangee Family Health Center in Normangee. There are approximately 1,605 beds in the 26 hospitals in the ROI. Based on the 2005 total projected population, there are 2.6 beds per thousand people within the ROI.

6.18.2.6 Local School System

Freestone, Leon, and Limestone counties have 12 elementary schools, seven junior high schools, 11 high schools, four specialty schools, and as many as 12 private schools (FG Alliance, 2006c and TEA, 2005). Table 6.18-2 indicates the expenditure per pupil per school year and the student-teacher ratio for the State of Texas and the U.S in 2005.

Table 6.18-2. School Statistics for Texas and the U.S. in 2005

	Expenditure Per Pupil Per School Year ($)	Pupils Per Teacher (Elementary/Secondary)
Texas	7,142	14.9/14.9
Nationwide	8,287	15.4/15.4

Source: CPA, 2006; USCB, 2006; and NCES, 2005.

6.18.3 IMPACTS

6.18.3.1 Construction Impacts

As discussed in Section 6.19, the need for construction workers would be limited in duration, but would likely cause an influx of temporary residents. Construction workers could be drawn from a large labor pool within the ROI; however, some temporary construction workers with specialized training and workers employed by contractors from outside the ROI would also likely be employed to construct the facilities. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period.

Law Enforcement

The temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. The increased temporary population could affect the working capacities of individual local police departments, depending on where the workers chose to reside. The affected locations would depend on the degree to which the construction workers would be dispersed throughout the communities within the ROI. As discussed in Section 6.19, temporary construction workers would likely reside in short-term housing. Freestone, Leon and Limestone counties do not have enough hotel rooms, when occupancy rates are taken into account, to accommodate all of the temporary workers (FG Alliance, 2006c). Therefore, it is anticipated that the availability of local lodging would effectively disperse workers throughout communities within the ROI and law enforcement would not be affected.

The population in the ROI is expected to grow on average by 12.1 percent, or approximately 71,653 people, by 2010 (FG Alliance, 2006c). Additional police and other law enforcement services would be required to accommodate the growing population, especially in Brazos, Freestone, and Navarro counties, which have the highest projected growth rates. Although the number of law enforcement officers is below the U.S. average, county crime rates are extremely low, which is an indication that law enforcement is appropriately staffed (FG Alliance, 2006c; CD, 2002; and Quinlivan, 2003). The number of construction workers and their families who would temporarily relocate to the area for the proposed project is unknown, but any additional population is not anticipated to create a permanent unsustainable increase in the demand for law enforcement.

Construction activities would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 6.17, construction of the proposed facility would involve the use of flammable and combustible materials that pose an overall increase in risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during construction of the proposed project is low. Incidents during construction of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Texas fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site and sequestration site. Currently, 84 fire departments are located within the Heart of Texas and Brazos Valley Councils of Government. Any of these fire departments would be available to assist in a fire emergency if needed.

Emergency and Disaster Response

As discussed in Section 6.17, it is anticipated that construction of the proposed facilities would result in an average of 19.6 total recordable injury cases per year with a peak maximum of 39.2 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site and sequestration site would be adequately served in an emergency. Freestone, Leon and Limestone counties and the entire ROI are served by 29 ambulance services and four air ambulance services. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond current available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

The 350 to 700 temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. Currently, the ROI has a health care capacity that is less than the national average, with 2.6 hospital beds per thousand residents. The U.S. average is 2.9 hospital beds per thousand residents. However, even if all 700 temporary workers relocated within the ROI, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 2.6 and, therefore, no impacts are expected.

The **Hill-Burton Act of 1946** established the objective standard for the number of hospitals, beds, types of beds, and medical personnel needed for every 1,000 people, by county (Everett, 2004). It called for states to "afford the necessary physical facilities for furnishing adequate hospital, clinic, and similar services to all their people." The Hill-Burton standard is 4.5 beds per thousand residents (Everett, 2004). However, the U.S. average in 2001 was 2.9 beds per thousand residents, which is about 24 percent fewer beds per thousand residents than the current ratio within the ROI (Everett and Baker, 2004).

Local School System

Although some portion of the temporary construction workers may relocate to the ROI with their families, a large influx of school-aged children would not be anticipated. Because construction of the proposed facilities would create temporary work, it is unlikely that the construction workers would relocate with their families. It is more likely that temporary workers, who permanently reside outside of the ROI, would seek short-term housing for themselves during the work week. As a result, any influx of school-aged children would result in a minimal impact to local schools and their resources.

Project construction would not displace existing school facilities or conflict with school system plans.

6.18.3.2 Operational Impacts

As discussed in Section 6.19, the operational phase of the proposed facilities would require approximately 200 permanent staff. Although the exact number of permanent staff who would relocate to the ROI is unknown, the increase in population would be very small, even if all 200 positions were filled by staff relocating to the ROI. Based on the 2005 projected population and the average family size within the ROI, the relocation of 200 workers would result in a population increase of 612 people, representing a 0.1 percent increase in population within the ROI.

Law Enforcement

Law enforcement in the ROI would be sufficient to handle the 0.1 percent increase in population during facility operation. A 0.1 percent increase in population in Freestone, Leon and Limestone counties would result in an imperceptibly small decrease, less than 0.02, in the ratio of law enforcement officers per thousand residents. In addition, the average crime rate in Freestone, Leon, and Limestone counties, which is consistent with crime rates in rural communities in Texas, is well below the national average. This is an indication that law enforcement is appropriately staffed and would be sufficient to handle a minor increase in population.

Project operation would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 6.17, operation of the proposed power plant would involve the use of flammable and combustible materials that pose an overall increase to risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during operation of the proposed project is low. Incidents during the operational phase of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Texas fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site. There are currently 84 fire departments within the Heart of Texas and Brazos Valley Councils of Government. Any of these fire departments could assist in a fire emergency if needed.

Emergency and Disaster Response

As indicated in Section 6.17, it is anticipated that the operational phase of the proposed facilities would result in an average of 6.6 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site and sequestration site would be adequately served in an emergency. Freestone, Leon and Limestone counties and the entire ROI are served by 29 ambulance services and four air ambulance services. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond the existing available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

It is anticipated that the 200 permanent jobs created by FutureGen Project operations could cause an influx of permanent residents to the communities within the ROI. This influx would result in an increase in population of 0.1 percent, representing approximately 612 new residents. The ROI currently has a health care capacity that is less than the national average, with 2.6 hospital beds per thousand residents. The U.S. average is 2.9 hospital beds per thousand residents. Although the proposed project would increase the number of residents requiring medical care, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 2.6 and, therefore, no impacts are expected.

Local School System

While the actual number of the 200 permanent staff who would relocate to the ROI with their families to work at the facility is unknown, based on the average family size and the percent of school-aged children in the population, it can be estimated that a maximum of 170 new school-aged children could relocate within the ROI (FG Alliance, 2006c). The 2005 public school enrollment for the counties within the ROI was 76,168 for kindergarten through 12th grade (FG Alliance, 2006c). An additional 170 new school-aged children would represent a 0.2 percent increase in the number of students who would share the current schools' resources.

Project operation would not displace existing school facilities or conflict with school system plans.

6.19 SOCIOECONOMICS

6.19.1 INTRODUCTION

This section addresses the region's socioeconomic resources most likely to be affected by the construction and operation of the proposed FutureGen Project. This section discusses the region's demographics, economy, sales and tax revenues, per capita and household incomes, sources of income, housing availability, and the potential effects that the construction and operation of the proposed project could have on socioeconomics.

6.19.1.1 Region of Influence

The ROI for socioeconomics includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors. As shown in Figure 6.18-1, the ROI for the proposed FutureGen Project includes all land area in Freestone County and some land area in Leon, Limestone, Anderson, Brazos, Falls, Houston, Madison, McLennan, Navarro, and Robertson counties. Therefore, this section focuses on the socioeconomic environment at the county level rather than by the proposed sites and utility and transportation corridors.

A few counties have a relatively small portion of land within the ROI and were, therefore, excluded from the analysis as not materially affecting the aggregate socioeconomics of the ROI. Cherokee, Grimes, Henderson, Hill, Kaufman, Milam, Smith, Van Zandt, and Walker counties contain no more than two small communities and were also excluded from the ROI. Although the analysis addresses the entire ROI, the affected environment and environmental consequences focus more on the proposed power plant site located in Freestone, Leon, and Limestone counties.

6.19.1.2 Method of Analysis

DOE reviewed U.S. Census data, the Alliance EIVs, and other information to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Displace existing population or demolish existing housing;
- Alter projected rates of population growth;
- Affect the housing market;
- Displace existing businesses;
- Affect local businesses and the economy;
- Displace existing jobs; and
- Affect local employment or the workforce.

6.19.2 AFFECTED ENVIRONMENT

6.19.2.1 Regional Demographics and Projected Growth

The regional demographics for the ROI are provided in Table 6.19-1. In 2000, the total population for the counties within the ROI was 592,119 (FG Alliance, 2006c). The total population for the ROI is anticipated to increase by approximately 12.1 percent by 2010 to 663,772 (FG Alliance, 2006c).

The 2000 Texas population was 20,851,820 and is anticipated to increase by 9.4 percent by 2010 to 22,802,947 (USCB, 2000a). The 2000 U.S. population was 282,125,000 and is anticipated to increase by approximately 9.5 percent by 2010 to 308,936,000 (USCB, 2005a). Thus, the ROI is anticipated to grow at a faster rate than the U.S. and Texas (FG Alliance, 2006c). Freestone, Leon, and Limestone counties had a combined population of 55,253 in 2000 (FG Alliance, 2006c). Within the ROI, Freestone, Leon, and Limestone counties account for 9.3 percent of the total population. The growth in these counties is anticipated to average 15.1 percent from 2000 to 2010, which is higher than the ROI's expected average growth. The median age of residents in 2000 was 35.3 years for the U.S., 32.3 years for Texas, and 39.1 years in Freestone, Leon, and Limestone counties (USCB, 2000b and USCB, 2000c).

Table 6.19-1. Population Distribution and Projected Change for Counties Containing Land Area Within the ROI

County	Year 2000					2010 Projected Total Population	Projected Change 2000 to 2010 (percent)
	Total	Under 18	18-64	65 and over	Average Family Size		
Freestone	17,867	4,683	10,252	2,932	3.0	20,906	3,039 (17.0)
Leon	15,335	4,074	8,191	3,070	3.0	17,737	2,402 (15.7)
Limestone	22,051	6,149	12,288	3,614	3.0	24,809	2,758 (12.5)
Anderson	55,109	12,650	36,027	6,432	3.1	59,439	4,330 (7.9)
Brazos	152,415	46,689	95,503	10,223	3.2	178,714	26,299 (17.3)
Falls	18,576	5,676	9,767	3,133	3.2	20,098	1,522 (8.2)
Houston	23,185	5,963	13,055	4,167	3.0	24,371	1,186 (5.1)
Madison	12,940	3,031	8,103	1,806	3.1	14,075	1,135 (8.8)
McLennan	213,517	56,830	129,238	27,449	3.1	232,648	19,131 (9.0)
Navarro	45,124	13,969	24,668	6,487	3.1	53,311	8,187 (18.1)
Robertson	16,000	4,911	8,374	2,715	3.1	17,664	1,664 (10.4)
Total or Average	**592,119**	**164,625**	**355,466**	**72,028**	**3.1**	**663,772**	**71,653 (12.1)**
Texas	**20,851,820**					**22,802,947**	**1,951,127 (9.4)**
U.S.	**282,125,000**					**308,936,000**	**2,681,000 (9.5)**

Source: FG Alliance, 2006c.

6.19.2.2 Regional Economy

Income and Unemployment

Table 6.19-2 provides information about the workforce, and per capita and median household incomes for the counties located within the ROI. In July 2006, 19,542 persons were unemployed within the ROI and the average unemployment rate was 5.8 percent (FG Alliance, 2006c). In the same year, Freestone, Leon, and Limestone counties had a lower average unemployment rate of 5.1 percent (FG Alliance, 2006c). In July 2005, the average unemployment rate in the U.S. was 4.8 percent and 5.2 percent for Texas (USBLS, 2006a and USBLS, 2006b). Thus, Freestone, Leon, and Limestone counties and the ROI have an unemployment rate consistent with the average Texas rate and higher than the U.S. average.

Table 6.19-2. Employment and Income for Counties Within the ROI

County	Employment		Income	
	Total Employed (2004)	Unemployment Rate (July 2006) (percent)	1999 Per Capita Income	1999 Median Household Income
Freestone	10,156	4.4	$16,338	$31,283
Leon	9,141	5.7	$17,599	$30,981
Limestone	11,724	5.3	$14,352	$29,366
Anderson	25,665	6.7	$13,838	$31,957
Brazos	95,853	4.4	$16,212	$29,104
Falls	8,199	7.1	$14,311	$26,589
Houston	11,531	6.6	$14,525	$28,119
Madison	6,023	6.1	$14,056	$29,418
McLennan	127,050	5.4	$17,174	$33,560
Navarro	24,391	6.0	$15,266	$31,268
Robertson	7,192	5.6	$14,714	$28,886
ROI Total or Average	**336,925**	**5.8**	**$15,308**	**$30,048**
Texas	**9,968,309**	**5.2**	**$16,617**	**$39,927**
U.S.	**n/a**	**4.8**	**$21,587**	**$50,046**

n/a = not available.
Source: FG Alliance, 2006c; USCB, 2000d and USCB, 2000e.

In 1999, the average median household income for the ROI was $30,048 and the average per capita income was $15,308 (FG Alliance, 2006c), while the median household income for the U.S. was $50,046 and the per capita income was $21,587 (USCB, 2000f and USCB, 2000g). In 1999, Texas had a median household income of $39,927 and an average per capita income of $16,617 (USCB, 2000f and USCB, 2000g). That same year, Freestone, Leon, and Limestone counties had an average median household income of $30,543 and an average per capita income of $16,096 (FG Alliance, 2006c). Based on 2000 Census data, Freestone, Leon, and Limestone counties and the ROI have median household and per capita incomes less than both the Texas and U.S. averages.

In 2004, Freestone, Leon, and Limestone counties collected $20.8 million in property taxes and in 2005 collected $20.8 million in sales taxes (FG Alliance, 2006c). The counties located within the ROI each collected an average of $8.8 million in sales taxes in 2005 (FG Alliance, 2006c).

Table 6.19-3 provides 2003 average hourly wages for Freestone, Leon, and Limestone counties for trades that would be required for construction of the proposed project. The maximum and minimum rates for these trades were not available. Although actual wage costs would not be known until contractor selection, it is expected that wages for construction of the proposed FutureGen Project would be typical for construction trades in these three counties adjusted for inflation.

Table 6.19-3. Average Hourly Wage Rates in 2003 by Trade in Freestone, Leon, and Limestone Counties in Texas

Trade	Average Wage Rate
Cement Mason	$8.38
Electrician	$10.62
Iron Worker	$9.13
Laborer	$5.24
Plumber/Pipefitter	$9.65

Source: GPO, 2003.

Housing

Table 6.19-4 provides total housing and vacant units by county within the ROI. As of 2000, there were a total of 237,924 existing housing units within the ROI, with Freestone, Leon, and Limestone counties accounting for 26,162 of those (FG Alliance, 2006c). Of the existing housing units within the ROI, 11 percent, or 26,163, were vacant (FG Alliance, 2006c). In 2005, Texas reported that 32.4 percent of vacant units were for rent and 10.9 percent were for sale (USCB, 2005b). There were approximately 8,477 units for rent and 2,852 units for sale within the ROI, and 1,775 units for rent and 597 units for sale within Freestone, Leon, and Limestone counties (FG Alliance, 2006c). In addition, there were at least 8,768 short-term hotel and motel rooms within the ROI (FG Alliance, 2006c).

There are no residences on or adjacent to the proposed power plant site and sequestration site.

Table 6.19-4. Total Housing Units Within the ROI for the Year 2000

County	Total Housing Units	Vacant Units
Freestone	8,138	1,550
Leon	8,299	2,110
Limestone	9,725	1,819
Anderson	18,436	2,758
Brazos	59,023	3,821
Falls	7,658	1,162
Houston	10,730	2,471
Madison	4,797	883
McLennan	84,795	5,936
Navarro	18,449	1,958
Robertson	7,874	1,695
Total	**237,924**	**26,163**

Source: FG Alliance, 2006c.

6.19.2.3 Workforce Availability

Construction

In 2004, there were approximately 336,925 people within the ROI workforce (FG Alliance, 2006c). Because construction workers represented 8.6 percent of the workforce in Texas, there were approximately 29,100 construction workers within the ROI (USCB, 2005c and FG Alliance, 2006c). This indicates that there could be a large local workforce from which some or all of the construction workers could be drawn.

Operations

Utility workers made up 1.0 percent of the workforce in Texas in 2004, resulting in approximately 3,500 workers within the ROI (USCB, 2005c). Operations workers could be drawn from this workforce.

6.19.3 IMPACTS

6.19.3.1 Construction Impacts

Population

The need for construction workers would be limited to the estimated 44-month construction period, and a potential influx of temporary residents is not expected to cause an appreciable increase in the regional population. Monthly employment on the proposed power plant site would average 350 workers during construction, with a peak of 700 workers (FG Alliance, 2006c). Approximately 30,600 general construction workers residing within the ROI would provide a local workforce. Temporary construction workers with specialized training and workers employed by contractors from outside the ROI could also be employed to construct the proposed power plant. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period. Although it is not known how many workers would relocate, the required number of construction workers represents less than 0.1 percent of population within the ROI. Therefore, impacts on population growth within the ROI would be small.

Employment, Income, and Economy

Construction of the proposed facilities could result in 350 to 700 new jobs in Freestone, Leon, and Limestone counties. These new jobs would represent a 1.1 to 2.3 percent increase in the number of workers employed in these three counties (FG Alliance, 2006c). These workers would be paid consistent with wages in the area for similar trades. Wages for trades associated with power plant construction for 2003 are presented in Table 6.19-3, although it is likely that actual wages could be higher than those presented because of inflation. Therefore, a direct, but small, positive impact on employment rates and income could occur within the ROI during the construction period.

Texas and Freestone, Leon, and Limestone counties could benefit from temporarily increased sales tax revenue resulting from the project-related spending on payroll and construction materials. It is anticipated that construction workers would spend their wages on short-term housing, food, and other personal items within the ROI. Additional sales tax revenues would result from taxes embedded in the price of consumer items such as gasoline. Therefore, an indirect and positive impact could be expected for the local economy from increased spending and related sales tax revenue.

Texas and Freestone, Leon, and Limestone counties could also benefit from increased property tax revenue associated with properties acquired for the proposed FutureGen Project. Property taxes are applied to construction sites on the basis of an evaluation of work completed to date in each year. The amount paid would depend not only on levy rates at the time the construction is under way, but also on the construction schedule relative to the evaluation's timing. The facility's property tax would be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue could be in the millions of dollars each year. This increase would have a direct and positive impact to the total property tax revenue for Freestone, Leon, and Limestone counties and Texas. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance.

Housing

A potential influx of construction workers may increase local housing demand, which would have a beneficial short-term impact on the regional housing market. The ROI has approximately 8,477 vacant housing units for rent, with Freestone, Leon, and Limestone counties accounting for approximately 1,775 of these units. There are also at least 8,768 hotel rooms within the ROI, with Freestone, Leon, and Limestone counties accounting for approximately 750 of these rooms. In 2005, it is estimated that Texas had an average occupancy rate of 57.6 percent in 2005 (HO, 2005). Therefore, depending upon the percentage of construction jobs that could be filled by existing residents, the influx of workers from outside the region could increase the occupancy rate within the ROI by as much as 8 percent. This increase would result in a hotel occupancy rate of 65.6 percent and a positive, direct impact for the hotel industry within the ROI.

Power Plant Site

There are no existing residences or buildings on the proposed power plant site; therefore, no existing population would be displaced.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site; therefore, no existing population would be displaced.

6.19.3.2 Operational Impacts

Population

Operation of the proposed power plant could result in a very small increase in population growth. It is anticipated that power plant operation could require approximately 200 permanent workers. Based on the 2005 projected population and average family size within the ROI, the relocation of 200 workers could result in a population increase of 612 people. This would represent a 0.1 percent increase in population within the ROI and a 1.0 percent increase in population in Freestone, Limestone, and Leon counties.

Employment, Income, and Economy

The operational phase of the proposed FutureGen Project could have a direct and positive impact on employment by creating 200 permanent jobs in Freestone, Leon, and Limestone counties. These new jobs could represent a 0.06 percent increase in the total number of workers employed in these three counties (FG Alliance, 2006c).

Each new direct operations job created by the proposed FutureGen Project could generate both indirect and induced jobs. An indirect job supplies goods and services directly to the plant site. An induced job results from the spending of additional income from indirect and direct employees. A job multiplier is used to determine the approximate number of indirect and induced jobs that would result. An Economic Impact Analysis (EIA) was issued for Ford Park in Beaumont, Texas, in 2004 and reported a job multiplier of 1.6 (IDS, 2004). A job multiplier of 1.6 means that, for every direct job, 0.6 indirect or induced jobs could result. Based on this multiplier, the proposed FutureGen Project could have an indirect impact on employment by creating approximately 113 indirect or induced jobs in and around the ROI.

The proposed FutureGen Project would also have annual operation and maintenance needs that could benefit Freestone, Leon, and Limestone counties. Local contractors could be hired to complete specialized maintenance activities that could not be undertaken by permanent staff, and items such as repair materials, water, and chemicals could be purchased within the ROI. The 200 employees who would fill new jobs created by the proposed FutureGen Project could generate tax revenues from sales and use taxes on plant materials and maintenance. The property tax from the facility would be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue could be in the millions of dollars each year. This increase would have a direct and positive impact on the total property tax revenue for Freestone, Leon, and Limestone counties and Texas. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance. Texas would likely benefit from a public utility tax it levies when power is produced by the proposed FutureGen Project.

Housing

During operation of the proposed power plant, employees relocating to the area would likely be distributed between owned and rental accommodations. Although it is not known how many of the permanent staff would relocate within the ROI, if all 200 permanent employees relocated, the increased demand for housing would be small. In Texas, approximately 64.7 percent of housing units are owner-occupied (USCB, 2005d). Using this value, operation of the proposed facilities could result in a 4.5 percent decrease in residences for sale and a 0.8 percent decrease in residences for rent within the ROI.

Power Plant Site

There are no existing residences or buildings on the proposed power plant site; therefore, no existing population would be displaced.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site; therefore, no existing population would be displaced.

6.2 AIR QUALITY

6.2.1 INTRODUCTION

This section describes existing local and regional air quality and the potential impacts that may occur from constructing and operating the FutureGen Project at the Jewett Power Plant Site and sequestration site. The FutureGen Project would use integrated gasification combined-cycle (IGCC) technology and would capture and sequester carbon dioxide (CO_2) in deep underground formations. Chapter 2 provides a discussion of the advancements in IGCC technology associated with the FutureGen Project that would reduce emissions of air pollutants. Because of these technologies, emissions from the FutureGen Project would be lower than emissions from existing IGCC power plants and state-of-the-art (SOTA), conventional coal-fueled power plants.

6.2.1.1 Region of Influence

The ROI for air quality includes the area within 50 miles (80.5 kilometers) of the boundaries of the proposed Jewett Power Plant Site and within 50 miles (80.5 kilometers) of the boundaries of the proposed Jewett Sequestration Site. Sensitive receptors that have been identified within the ROI are discussed in Section 6.2.2.3.

6.2.1.2 Method of Analysis

DOE reviewed available public data and also studies performed by the Alliance to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Result in emissions of criteria pollutants and hazardous air pollutants (HAPs);
- Result in mercury (Hg) emissions and conflict with the Clean Air Mercury Rule (CAMR) as related to coal-fueled electric utilities;
- Cause a change in air quality related to the National Ambient Air Quality Standards (NAAQS);
- Result in consumption of Prevention of Significant Deterioration (PSD) increments as defined by the Clean Air Act (CAA), Title I, PSD rule;
- Affect visibility and cause regional haze in Class I areas;
- Result in nitrogen and sulfur deposition in Class I areas;
- Conflict with local or regional air quality management plans;
- Result in emissions of greenhouse gases (GHGs);
- Cause solar loss, fogging, icing, or salt deposition on nearby residences; and
- Discharge odors into the air.

> **Plant upset** is a serious malfunction of any part of the IGCC process train and usually results in a sudden shutdown of the combined-cycle unit's gas turbine and other plant components.

Based on the above criteria, DOE assessed potential air quality impacts from construction and operational activities related to the FutureGen Project at the proposed Jewett Power Plant Site and sequestration site. For impacts related to FutureGen Project operations, DOE conducted air dispersion modeling for criteria pollutants using EPA's refined air dispersion model, AERMOD (American Meteorological Society/EPA Regulatory Model). Details on the air modeling protocol are presented in Appendix E. To establish an upper bound for potential impacts, DOE used the FutureGen Project's estimate of maximum air emissions, which was developed by the Alliance and reviewed by DOE, for the air dispersion modeling based on 85 percent plant availability and unplanned restarts as a result of plant upset (also called unplanned outages) (see Table 6.2-1). The estimate of maximum air emissions was developed using the highest pollutant emission rates for various technology options being considered for the FutureGen Project (see Section 2.5.1.1). Surrogate data from similar existing or permitted units (e.g., the Orlando Gasification Project [Orlando Project]) were used for instances where engineering details and emission data were not available due to the early design stage of the FutureGen Project (DOE, 2007).

Table 6.2-1 presents expected emissions of air pollutants from the FutureGen Project during the 4-year research and development period and beyond. Emissions from the first year of the proposed power plant operation, which are expected to be highest, represent the upper bound for potential air emissions and were modeled for this EIS. Emissions would be expected to decrease each year, as learning and experience would reduce the frequency and types of unplanned restart events from an estimated 29 in the first year to 3 in the fifth year and beyond (see Appendix E). Consequently, annual emissions would be expected to decrease progressively from the first year of operation to the fourth year of operation and beyond. Because emissions of some criteria pollutants are projected to exceed 100 tons per year (tpy) (90.7 metric tons per year [mtpy]) (even with less than 3 restarts per year), the FutureGen Project would be classified as a major source under Clean Air Act regulations.

Table 6.2-1. Yearly Estimates of Maximum Air Emissions from the FutureGen Project[1] (tpy [mtpy])

Pollutant	Year 1	Year 2	Year 3	Year 4	Year 5 Onward[2]
Sulfur Oxides[3] (SO_x)	543 (492)	322 (292)	277 (251)	255 (231)	100 (90.7)
Nitrogen Oxides[4] (NO_X)	758 (687)	754 (684)	753 (683)	753 (683)	750 (680.4)
Particulate Matter[5] (PM_{10})	111 (100)	111 (100)	111 (100)	111 (100)	111 (100.7)
Carbon Monoxide[5] (CO)	611 (554)	611 (554)	611 (554)	611 (554)	611 (554.3)
Volatile Organic Compounds[5] (VOCs)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)
Mercury[5] (Hg)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)

[1] Because the FutureGen Project would be a research and development project, DOE assumes that the maximum facility annual availability would be 85 percent. Values are estimated based on maximum emissions rates for design Case 1, 2, or 3A, plus maximum emissions rates for design Case 3B and includes emissions from unplanned restarts (upset conditions).
[2] Year 1 to Year 4 calculated based on information provided by the Alliance. Year 5 estimated by DOE, not provided by the Alliance.
[3] SO_x emissions from coal combustion systems are predominantly in the form of sulfur dioxides (SO_2).
[4] NO_x emissions from coal combustion are primarily nitric oxide (NO); however, for the purpose of the air dispersion modeling, it was assumed that all NO_x emissions are nitrogen dioxides (NO_2). One of the technologies being considered for the FutureGen Project is post-combustion selective catalytic reduction (SCR), which would reduce the annual NO_X emissions to 252 tpy (228.6 mtpy).
[5] Values for PM_{10}, CO, VOCs, and Hg would remain constant between Year 1 through 5 because unplanned restarts would not affect these emissions. Conversely, SO_2 and NO_2 emissions would decrease each year due to expected decrease in restart events. See Appendix E, Tables E-2 and E-3.
tpy = tons per year; mtpy = metric tons per year.
Source: FG Alliance, 2007.

In addition to assessing impacts of criteria pollutant emissions, DOE assessed impacts of HAP emissions by estimating the annual quantities of HAPs that would be emitted from the proposed FutureGen Power Plant. These estimates were developed based on emissions predicted for the Orlando

Project, which would burn a carbon-rich syngas (DOE, 2007). The estimated HAPs may be overstated since the FutureGen Project would include new technologies that would produce syngas that would contain lower levels of carbon. The estimated emissions are presented in Section 6.2.3.2.

DOE also assessed the potential for impacts to local visibility from the vapor plume using qualitative measures because engineering specifications needed to conduct quantitative modeling for vapor plume sources (e.g., cooling towers) were not available. Class-I-related modeling, including pollutant dispersion and air-quality-related values (AQRV), were reviewed for their applicability. Potential effects to soil, vegetation, animals, human health, and economic development were also reviewed.

6.2.2 AFFECTED ENVIRONMENT

6.2.2.1 Existing Air Quality

The Texas Commission on Environmental Quality's (TCEQ) Monitoring Operations Division has monitoring sites throughout the state, which monitor ambient air quality and designate areas or regions that either comply with all of the NAAQS or fail to meet the NAAQS for one or more criteria pollutants. The NAAQS specify the maximum allowable concentrations of six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and inhalable particles, which are also known as respirable particulate matter (PM). The PM_{10} standard covers particles with diameters of 10 micrometers or less and the $PM_{2.5}$ standard covers particles with diameters of 2.5 micrometers or less. Areas that meet the NAAQS for a criteria pollutant are designated as being in "attainment" for that pollutant, and areas where a criteria pollutant concentration exceeds the NAAQS are designated as "non-attainment" areas. Where insufficient data exist to determine an area's attainment status, the area is designated as unclassifiable. Maintenance areas are those non-attainment areas that have been redesignated as attainment areas and are under a 10-year monitoring plan to maintain their attainment status.

The proposed Jewett Power Plant Site is located at the juncture of Leon, Freestone, and Limestone counties in Texas. The surface extent of the proposed sequestration site is located within Freestone and Anderson counties. Leon, Freestone, and Limestone counties are part of the Austin-Waco Intrastate Air Quality Control Region (AQCR) and Anderson County is part of the Shreveport-Texarkana-Tyler Interstate AQCR. No ambient air quality monitors are in operation within the ROI of the proposed Jewett Power Plant Site (FG Alliance, 2006c). Although monitors were placed within the ROI in both Bell County (in the Austin-Waco Intrastate AQCR) and Anderson County during 2005, these monitors collected O_3 data and were deactivated in 2006; however, the Austin-Waco Intrastate and Shreveport-Texarkana-Tyler Interstate AQCRs have no history of non-attainment for the six criteria pollutants. The nearest permanent NAAQS monitors are located in Dallas County (Metropolitan Dallas-Fort Worth Interstate AQCR), Harris County (Metropolitan Houston-Galveston Intrastate AQCR), and Smith County (Shreveport-Texarkana-Tyler Interstate AQCR). These monitors are all located in O_3 non-attainment areas or near non-attainment areas. These permanent monitors are influenced by local sources, and may not be representative of conditions in and around the proposed power plant site (FG Alliance, 2006c). The closest $PM_{2.5}$ monitor within an attainment area is in Harris County. The most recent available data from monitoring stations nearest to the project site are presented in Table 6.2-2.

While the ROI for the proposed project is currently designated as in attainment or unclassified, air moving from nearby non-attainment areas could likely contribute to the air quality within the region of the proposed Jewett Power Plant Site. The proposed power plant site is more than 58 miles (93.3 kilometers) away from the border of the nearest designated non-attainment area. Site-specific monitoring to collect representative background data for all criteria pollutants could be required at the proposed project site as part of the PSD permit application process (EPA, 1990). The Alliance may choose to conduct site-specific monitoring for criteria pollutants as appropriate for development of a detailed site characterization if the proposed Jewett Site is selected.

Table 6.2-2. Monitoring Stations and Ambient Air Quality Data

Monitoring Site Location	Distance from Proposed Site (miles [kilometers])	Pollutant and Averaging Time	Monitored Data[1]	Primary/ Secondary Standard[1]
Tyler Airport, Tyler, TX Smith County Shreveport-Texarkana-Tyler Interstate AQCR	85 (136)	O_3 (1-hour) O_3 (8-hour) NO_2 (Annual)	0.104 0.089 0.004	0.12 0.08 0.053
Dallas North, TX Dallas County Metropolitan Dallas-Fort Worth Intrastate AQCR	105 (169)	O_3 (1-hour) O_3 (8-hour) NO_2 (Annual)	0.103 0.091 0.009	0.12 0.08 0.053
Houston – Aldine, TX Harris County Metropolitan Houston-Galveston Intrastate AQCR	115 (185)	O_3 (1-hour) O_3 (8-hour) NO_2 (Annual) $PM_{2.5}$ (Annual)[2] $PM_{2.5}$ (24-hour)[2]	0.153 0.111 0.015 13.7 29.3	0.12 0.08 0.053 15 35

[1] Units for $PM_{2.5}$ are in micrograms per cubic meter (μg/m^3), units for O_3 and NO_2 are in parts per million (ppm). To determine representative background data for both PM_{10} and $PM_{2.5}$ 24 hours and annual averaging periods, the monitored data are averaged over a period of three years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values each year for a period of three years (2003 to 2005) is used (see Appendix E).
Source: EPA, 2006a.

6.2.2.2 Existing Sources of Air Pollution

Emissions from the proposed FutureGen Project and potential environmental consequences must be considered in the context of both regional air quality and existing local sources of emissions. Existing sources of emissions outside and within the ROI are discussed. Additionally, local sources (i.e., within 1 mile [1.6 kilometers] of the proposed Jewett Power Plant Site and sequestration site) are discussed.

Outside the Region of Influence

Traffic-related pollution and pollution from existing industrial sources associated with nearby large cities are some of the causes of non-attainment areas in several locations near the margin of the ROI. The proposed Jewett Power Plant Site and sequestration site have the large cities and urban areas of Dallas and Fort Worth to the north-northwest, Waco to the west, Austin to the southwest and Houston to the south-southeast, all of which are outside the ROI. These urban areas could likely impact air quality within the ROI and probably account for some portion of the background concentrations of pollutants.

Inside the Region of Influence

The only large population areas within the ROI include the City of Corsicana and small portions of the cities of Waco and College Station. The remainder of the ROI contains small towns and communities distributed throughout the rural region. The types and quantities of air pollutants emitted from existing sources located within 10 miles (16.1 kilometers) of the proposed power plant site may contribute to the background concentrations of pollutants within and surrounding the ROI. According to the 2004 Air Emissions Inventory, the major sources of criteria pollutants and HAPs within a 10-mile (16.1-kilometer) radius are the Nucor's Jewett Steel Mill, NRG Limestone Electric Generating Station, and XTO Energy Freestone Central Station (FG Alliance, 2006c). These existing sources, also considered major sources, provide a context for understanding the potential emissions and associated air quality impacts from the proposed project.

A **major source** is a unit that emits any one criteria pollutant in amounts equal to or greater than thresholds of 100 tpy (90.7 mtpy) or one HAP in amounts greater than or equal to 10 tpy (9.1 mtpy) or a combination of HAPs in amounts greater than or equal to 25 tpy (22.7 mtpy). Additionally, an electric generating unit is one of the 28 categories defined by the PSD rule. For sources that are not in one of the 28 categories, the threshold is 250 tpy (226.8 mtpy) of criteria pollutants (40 Code of Federal Regulations [CFR] 52.21, 2006).

Local

There are several existing sources within 1 mile (1.6 kilometers) of the proposed Jewett Power Plant Site. The vicinity of the proposed power plant site is mostly rural with a low to very low population density, and light to very light traffic loads on nearby roads. The Texas Westmoreland Coal Company's Jewett Surface Lignite Mine (Jewett Mine) operates along the southeastern side of the proposed power plant site, extending along a line running from southwest to northeast. Much of the mine land is reclaimed, but active surface mining is ongoing at a pit located 0.7 mile (1.1 kilometers) or more to the south and southwest of the proposed Jewett Power Plant Site. An active coal mine haul road traverses the southeastern border of the proposed power plant site, connecting the active pits with a rail loading facility and with the mine maintenance shop and office complex located across FM 39 from the proposed plant site. Fugitive dust (i.e., PM_{10}) and diesel emissions (i.e., PM_{10}, CO, NO_X, SO_2, and VOCs) are generated in these areas. The 766-MW lignite-fueled NRG Limestone Electric Generating Station, Units 1 and 2, is a major source and is located 0.8 mile (1.3 kilometers) west of the proposed Jewett Power Plant Site. The Limestone Electric Generating Station stores ash in a large pile located 0.4 mile (0.6 kilometer) or more to the north, and this pile likely constitutes a local source of dust. Gas wells and unpaved service roads are scattered across the landscape surrounding the proposed power plant site. Traffic on these unpaved roads, along with other unpaved roads that provide farm and residential access, constitute a source of fugitive dust. Relatively little agriculture occurs in this area, though some ranching occurs. Agriculture and ranching appear to be relatively minor fugitive dust contributors.

CO_2 sequestration would use at least three injection sites totaling approximately 1,550 acres (626 hectares) over two properties. Eight small communities or towns exist within the area, but most of the land is characterized as forest and grasslands. The vicinity of the proposed CO_2 sequestration activities is mostly ranchland, with some forest land and few residences. Some roads, especially ranch roads, are unpaved. Both the ranching and local traffic likely constitute a source of fugitive dust emissions.

6.2.2.3 Sensitive Receptors (Including Class I Areas)

There are no residences within 0.3 mile (0.5 kilometer) of the proposed Jewett Power Plant Site. One small church is located approximately 0.3 mile (0.5 kilometer) north of the northern corner of the proposed power plant site. The church building appears to have very limited use, and it is unclear whether this church building continues to serve as a place of regular worship services. Within 1 mile (1.6 kilometers) of the power plant site, the density of residences is very low, and no sensitive receptors were identified other than the church. There are no sensitive receptors within 1 mile (1.6 kilometers) of the proposed sequestration site.

Within the 10-mile (16.1-kilometer) radius of the proposed Jewett Power Plant Site, there are five schools (FG Alliance, 2006c). Within 10 miles (16.1 kilometers) of the proposed Jewett Sequestration Site, there are 16 sensitive receptors (see Figure 6.2-1), including four schools, one university campus, three day care centers, two hospitals, one retirement center, and five prisons (FG Alliance, 2006c).

Class I Areas

For areas that are already in compliance with the NAAQS, the PSD requirements provide maximum allowable increases in concentrations of pollutants, which are expressed as increments. Allowable PSD increments currently exist for three pollutants: SO_2, NO_2, and PM_{10}. They apply to the three types of areas classified under the PSD regulations: Classes I, II, and III, where the smallest allowable increments correspond to Class I areas (Table 6.2-3).

Table 6.2-3. Allowable PSD Increments (μg/m^3)

Pollutant, averaging period		Class I Area	Class II Area	Class III Area
SO_2	3-Hour	25	512	700
	24-Hour	5	91	182
	Annual	2	20	40
NO_2	Annual	2.5	25	50
PM_{10}	24-Hour	8	30	60
	Annual	4	17	34

μg/m^3 = micrograms per cubic meter.
Source: EPA, 2005.

Class I areas, which are those areas designated as pristine, require more rigorous safeguards to prevent deterioration of the air quality, and include many national parks and monuments, wilderness areas, and other areas as specified in 40 CFR 51.166(e). The closest Class I area is 240 miles (386.2 kilometers) from the proposed Jewett Power Plant Site and sequestration site (see Table 6.2-4), which is well beyond the 62-mile (100-kilometer) distance required to consider impacts to Class I areas under the PSD regulations. All other clean air regions are designated Class II areas, with moderate pollution increases allowed (FWS, 2007). The proposed Jewett Power Plant Site and sequestration site are located in Class II areas.

Table 6.2-4. Nearest Class I Areas to Proposed Jewett Power Plant Site

Class I Area/Location	Distance (miles)	Distance (kilometers)	Direction
Caney Creek Wilderness Area, Arkansas	240	386.2	NE
Wichita Mountains Wilderness Area, Oklahoma	265	426.5	NE

Source: FG Alliance, 2006c.

6.2.2.4 Air Quality Management Plans

The CAA requires states to develop federally approved regulatory programs, called State Implementation Plans (SIPs), for meeting the NAAQS throughout the state. These plans aim to limit emissions from sources as necessary to achieve and maintain compliance. In part, SIPs focus on new major stationary sources and modifications to existing major stationary sources. A state's New Source Review (NSR)/PSD review program is defined and codified in its SIP. The Texas SIP is available from the TCEQ.

The FutureGen Project would be required to undertake the NSR/PSD permit application process after a host site is selected. State and local governmental officials contacted during the development of this EIS and the supporting Environmental Information Volume (EIV) indicate that there are no local air quality management plans currently in existence for the ROI (FG Alliance, 2006c). Additionally, these officials have no knowledge of specific local needs or concerns for air quality management at the proposed Jewett Power Plant Site and sequestration site.

6.2.3 IMPACTS

6.2.3.1 Construction Impacts

Construction at the proposed power plant site, sequestration site, utility corridors, and transportation corridors would result in localized increases in ambient concentrations of SO_2, NO_X, CO, VOCs, and PM. These emissions would result from the use of construction equipment and vehicles including trucks, bulldozers, excavators, backhoes, loaders, dump trucks, forklifts, pumps, and generators. In addition, fugitive dust emissions (i.e., PM emissions) would occur from various construction-related activities, including earth moving and grading, material handling and storage, and vehicles traveling over dirt and gravel areas.

Given the size of the proposed site and the short duration of the construction period, potential impacts would be localized and temporary in nature. Construction impacts would be minimized through the use of best management practices (BMPs), such as wetting the soil surfaces, covering trucks and stored materials with tarps to reduce windborne dust, and using properly maintained equipment (see Section 3.4).

Power Plant Site

DOE assumed that up to 200 acres (81 hectares) of the proposed 400-acre (162-hectare) site would be directly affected for the purposes of the air impact analysis. DOE estimates that construction of the proposed Jewett Power Plant would take 44 months. PM concentrations would be localized because of the relatively rapid settling of larger dust particles and impacts to off-site receptors would be temporary. In addition, PM emissions would decrease with the total amount of land disturbed, as PM emissions were calculated on the basis of site acreage. Impacts of the SO_2, NO_X, CO, and VOC emissions from vehicular sources would be temporary in nature and could cause minor to moderate short-term degradation of local air quality. The air pollutant emissions would be minimized through the use of BMPs, such as limiting the amount of vehicle trips, wetting the soil surfaces, covering trucks, limiting vehicle idling, and properly maintaining equipment.

Sequestration Site

While the proposed sequestration site would occur on two properties consisting of approximately 1,550 acres (626 hectares) (FG Alliance, 2006c), only a very small fraction (10 acres [4 hectares]) of the land area would be disturbed by either exploratory investigations (e.g., geophysical surveys) or construction of the sequestration facilities. Construction-related impacts on air quality at the proposed sequestration site would be limited to preparation of well drilling sites and the drilling of wells, as discussed in Chapter 2. Exploratory wells would be installed to sample and test the underground reservoir systems, and injection wells and monitoring wells would be installed to inject CO_2 and monitor its fate. Site preparation and construction activities would involve grading and surface preparation by earth-moving equipment that would result in localized fugitive dust air emissions during construction. Impacts would be localized and temporary in nature and could cause minor to moderate short-term degradation of air quality in the areas where construction is taking place.

Utility Corridors

The proposed utility corridors could include a natural gas pipeline, process water pipeline, potable water pipeline, sanitary wastewater pipeline, and electric transmission line. Construction of the utility corridors would require less acreage, use less equipment, and take less time than the construction of the proposed power plant. The duration of utility corridor construction would range from one week for the process water pipeline to 45 weeks for the other pipelines. The emissions from construction would include SO_2, NO_X, PM, CO, and VOCs. Impacts from emissions of these pollutants would be localized and temporary in nature and could cause minor to moderate short-term degradation of air quality in the areas where construction is taking place.

Transportation Corridors

Access to the proposed Jewett Power Plant Site would be primarily via FM 39, which intersects U.S. Highway (US) 79 and State Highway (SH) 164 within 10 miles (16.1 kilometers) of the site boundary. Additionally, the Burlington Northern Santa Fe Railroad runs along the northeastern border of the proposed Jewett Power Plant Site. Delivery to and from the proposed site could be accomplished by either railway or roadway; therefore, construction of additional roadways or railways would not be required, and no impact would be expected. Travel on existing roadways during construction of the proposed facility and associated corridors are discussed above.

6.2.3.2 Operational Impacts

Power Plant Site

Sources of Air Pollution

Primary sources of air emissions associated with the FutureGen Project would be the combustion turbine, flare, gasifier preheat, cooling towers, and sulfur recovery system (see Figure 2-18). DOE and the Alliance have estimated the maximum potential emissions that would be expected (see Table 6.2-1) using data from equipment typical of an IGCC power plant. However, because the FutureGen Project is in the early stages of design, specific engineering and technical information on the equipment that would ultimately be used is not available. Other sources of air emissions could include mobile sources such as plant vehicular traffic and personnel vehicles, which would be equipped with standard pollution-control devices to minimize emissions.

Local traffic within the proposed power plant site would be expected to emit small amounts of criteria pollutants. In addition, coal delivery trains (five trains per week) would emit a small amount of criteria pollutants from the train exhaust, and potentially PM during coal unloading and handling. However, coal handling emissions are not expected to appreciably change air quality because the emissions would be reduced by minimizing points of transfer of the material, enclosing conveyors and loading areas, and installing control devices such as baghouses and wetting systems.

Clean Air Act General Conformity Rule

Section 176(c)(1) of the Clean Air Act requires that federal actions conform to applicable SIPs for achieving and maintaining the NAAQS for the criteria air pollutants. In 1993, EPA promulgated a rule titled "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," codified at 40 CFR Parts 6, 51, and 93. The rule is intended to ensure that criteria air pollutant emissions and their precursors (e.g., VOCs and NO_X) are specifically identified and accounted for in the attainment or maintenance demonstration contained in a SIP. The conformity rule applies to proposed federal actions that would cause emissions of criteria air pollutants above certain levels in locations designated as non-attainment or maintenance areas for the emitted pollutants. Under the rule, an agency must engage in a conformity review process and, depending on the outcome of that review, conduct a conformity determination.

DOE conducted a conformity review to assess whether a conformity determination (40 CFR Part 93) is needed for the proposed FutureGen Project. As discussed in Section 6.2.2.1, Leon, Freestone, Limestone, and Anderson counties are in attainment or unclassified with the NAAQS for all pollutants. Additionally, the counties are not designated as a maintenance area. Consequently, no conformity determination is needed (see Section 6.2.2.4).

Criteria Pollutant Emissions

DOE conducted refined modeling using AERMOD. Table 6.2-5 presents the results of the AERMOD modeling for the operational phase of the proposed Jewett Power Plant. Limited amounts of background air concentration data for the Jewett area were available for use in this EIS. For all pollutants, DOE used background data from monitors that were outside the ROI but within attainment areas to represent ambient concentrations for those pollutants. To determine representative background data for both PM_{10} and $PM_{2.5}$ 24-hour and annual averaging periods, DOE took the average of the second-highest monitored data over a period of 3 years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values of each year for the period of 3 years (2003 to 2005) was used (see Appendix E).

Table 6.2-5 shows that concentrations of pollutants during the operational phase combined with background concentrations would be below their respective NAAQS during normal operation and plant upset. Additionally, the proposed FutureGen Project would not exceed the Class II PSD allowable increments; however, short-term 3-hour and 24-hour SO_2 concentrations could approach Class II PSD increment limits during plant upset from emissions associated with unplanned restart events. These unplanned restart emissions of SO_2 would typically be higher than steady-state SO_2 emissions, because syngas would be directly flared without the benefit of the sulfur recovery unit (see Appendix E). The probabilities of the proposed power plant exceeding the 3-hour and 24-hour SO_2 Class II PSD increments at the proposed Jewett Power Plant Site during periods of plant upset are 1.7 and 0.2 percent, respectively, and zero percent during normal operating scenarios. Maximum concentrations of the pollutants would be limited to a radius of less than 1.4 miles (2.3 kilometers) from the center of the proposed Jewett Power Plant Site. Currently, there are no residences within 10 miles (16.1 kilometers) of the proposed power plant site; however, there are other sensitive receptors located within the 10-mile radius. These sensitive receptors would be impacted.

Table 6.2-5. Comparison of Maximum Concentration Increases with NAAQS and PSD Increments

Pollutant	Maximum Concentration FutureGen Project Alone[1] (µg/m³)	Maximum Concentration FutureGen Project + Background (µg/m³)	NAAQS (µg/m³)	Class II PSD Increments (µg/m³)	PSD Increment Consumed by FutureGen Project (percent)	Distance of Maximum Concentration (miles [kilometers])
SO_2 (normal operating scenario)[2]						
3-hour	0.82	34.85	1,300	512	0.16	0.58 (0.93)
24-hour	0.42	13.51	365	91	0.46	1.32 (2.12)
SO_2 (upset scenario)[3]						
3-hour	511.91	545.94	1,300	512	99.98	0.58 (0.9)
24-hour	89.50	102.59	365	91	98.35	0.58 (0.9)
SO_2 Annual [4]	0.48	3.10	80	20	2.42	1.37 (2.2)
NO_2[4, 5]						
Annual	0.67	27.01	100	25	2.70	1.37 (2.2)
PM/PM_{10}[4, 6]						
24-hour	0.83	55.83	150	30	2.76	1.32 (2.1)
Annual	0.10	26.10	50	17	0.58	1.37 (2.2)
PM/$PM_{2.5}$[4, 6]						
24-hour	0.83	30.16	35	n/a	n/a	1.32 (2.1)
Annual	0.10	13.80	15	n/a	n/a	1.37 (2.2)
CO[7]						
1-hour	10.45	4,018.62	40,000	n/a	n/a	0.89 (1.4)
8-hour	7.88	1,954.70	10,000	n/a	n/a	1.27 (2.0)

[1] Value based on site-specific meteorological and terrain data. Except for the 3-hour and 24-hour SO_2 during the upset scenario, the highest maximum predicted concentrations are provided for all pollutants and corresponding averaging times, based on the worst-case emissions rates, meteorological data, and terrain data. For the 3-hour SO_2 averaging time, the 618th highest maximum predicted concentration is provided. Although the highest maximum three-hour SO_2 concentration could exceed the PSD increment during the upset scenario, the 3-hour increment would not be exceeded at least 98.34 percent of the time. For the 24-hour SO_2 averaging time during the upset scenario, the 88th highest maximum predicted concentration is provided. Although the highest maximum 24-hour SO_2 concentration could exceed the PSD increment during the upset scenario, the 24-hour increment would not be exceeded at least 99.8 percent of the time. The highest maximum predicted concentrations for the other pollutants and corresponding averaging times would not be expected to exceed the PSD Class II increment at any time.
[2] The normal operating scenario is based on steady-state emissions and is a period when the plant is operating without flaring, sudden restarts, or other upset conditions (see Appendix E).
[3] The upset scenario is based on unplanned restart emissions and is a period when a serious malfunction of any part of the IGCC process train usually results in a sudden shutdown of the combined-cycle units gas turbine and other plant components (see Appendix E).
[4] Annual impacts are based on maximum annual emissions (see Appendix E) over 7,446 hours per year.
[5] There are no short-term NAAQS for NO_2.
[6] There are no unplanned restart emissions of PM_{10} and $PM_{2.5}$ pollutants; therefore, short-term impacts (24-hour) are based on steady-state emissions.
[7] Although there are unplanned restart emissions of CO pollutants, the short-term impacts (1-hour and 8-hour) are based on steady-state emissions because steady-state CO emissions are larger than unplanned restart CO emissions.
n/a = not applicable; µg/m³ = micrograms per cubic meter.
Source: AERMOD modeling result (see Appendix E).

Hazardous Air Pollutants

HAP emissions from the FutureGen Project were estimated based on the Orlando Project, a recent IGCC power plant that was determined to provide the best available surrogate data (DOE, 2007). DOE scaled the Orlando Project data based on relative emission rates of VOCs and PM to produce more appropriate estimates of emission rates for the FutureGen Project. However, only emissions from the gas turbine were considered to account for differences between the Orlando design and the FutureGen Project. These differences include the FutureGen Project's use of oxygen (O_2) in the gasifier instead of air, the use of a catalytic shift reactor to convert CO to CO_2, and CO_2 capture and sequestration features.

Predicted HAP emissions are presented in Table 6.2-6. This data indicates that the FutureGen Project would not emit any individual HAP above the 10-tpy (9.1-mpty) major source threshold. Additionally, at 0.32 tpy (0.3 mtpy) of combined HAPs, the proposed FutureGen Project would not be a major source of HAPs as defined under the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Health hazards and risks associated with these HAP emissions and other air toxins are discussed in Section 6.17.

Table 6.2-6. Annual Hazardous Air Pollutant Emissions[1]

Chemical Compound	Combustion Turbine Emissions	
	tpy	mtpy
2-Methylnaphthalene	7.41E-04	6.72E-04
Acenaphthyalene	5.36E-05	4.86E-05
Acetaldehyde	3.72E-03	3.37E-03
Antimony[2]	2.08E-02	1.89E-02
Arsenic[2]	1.09E-02	9.93E-03
Benzaldehyde	5.99E-03	5.44E-03
Benzene	1.00E-02	9.09E-03
Benzo(a)anthracene	4.77E-06	4.32E-06
Benzo(e)pyrene	1.14E-05	1.03E-05
Benzo(g,h,i)perylene	1.96E-05	1.78E-05
Beryllium[2]	4.69E-04	4.26E-04
Cadmium[2]	1.51E-02	1.37E-02
Carbon Disulfide	9.27E-02	8.41E-02
Chromium[2, 3]	1.41E-02	1.28E-02
Cobalt[2]	2.97E-03	2.69E-03
Formaldehyde	6.89E-02	6.25E-02
Lead[2]	1.51E-02	1.37E-02
Manganese[2]	1.62E-02	1.47E-02
Mercury[2]	4.73E-03	4.29E-03
Naphthalene	1.10E-03	9.96E-04
Nickel	2.03E-02	1.84E-02
Selenium	1.51E-02	1.37E-02
Toluene	1.53E-03	1.39E-03
TOTAL	**3.21E-01**	**2.91E-01**

[1] Emission rates scaled by the ratio of VOC or PM emissions from Orlando Gasification Project EIS to the FutureGen Project. Orlando Project's VOC emissions were multiplied by a factor of 0.2727, based on 30 tpy (27.2 mtpy) VOC for the FutureGen Project divided by 110 tpy (99.8 mtpy) VOC for the Orlando Project. The Orlando Project's PM emissions were multiplied by a factor of 0.6894, based on 111 tpy (100.7 mtpy) PM for the FutureGen Project divided by 161 tpy (146.1 mtpy) PM for the Orlando Project.
[2] Compounds which are considered to be PM are in bold text.
[3] Conservatively assumed all chromium to be hexavalent.
tpy=tons per year; mtpy=metric tons per year.
Source: DOE, 2007.

Mercury

The CAMR establishes standards of performance, limiting Hg emissions from new and existing coal-fueled power plants that produce more than 25-MW equivalent output and that would sell at least a portion of the electricity. The CAMR also creates a cap-and-trade program.

New coal-fueled power plants (commencing after January 30, 2004) in Texas would need to meet the EPA New Source Performance Standards (NSPS) for Hg (which vary based on the type of coal utilized) and cannot contribute to an exceedance of the Texas Hg cap. Based on 2005 Hg emissions, Texas has exceeded its State Hg cap and will utilize a cap and trade strategy to bring existing and new sources under this limit (TCEQ, 2006). The FutureGen Project would emit Hg levels far below the NSPS for all coal types but may need to buy Hg credits to comply with the state cap mandate.

The maximum potential emissions of Hg from the FutureGen Project of 0.011 tpy (0.01 mtpy) would be well below the major source threshold for Hg of 10 tpy (9.1 mtpy) and significant emissions rate of 0.1 tpy (0.09 mtpy). The AERMOD analysis predicted that a negligible annual concentration of Hg (9.93×10^{-6} micrograms per cubic meter) would be deposited within 1.37 miles (2.2 kilometers) of the proposed power plant site.

Greenhouse Gases

GHGs include water vapor, CO_2, methane, NO_X, O_3, and several chlorofluorocarbons. Water vapor is a naturally occurring GHG and accounts for the largest percentage of the greenhouse effect. Next to water vapor, CO_2 is the second-most abundant GHG. Uncontrolled CO_2 emissions from power plants are a function of the energy output of the plants, the feedstock consumed and the power plants' net efficiency at converting the energy in the feedstock into other forms of energy (e.g., electricity, useable heat, and hydrogen gas). Because CO_2 is relatively stable in the atmosphere and essentially uniformly mixed throughout the troposphere and stratosphere, the climatic impact of CO_2 emissions does not depend upon the CO_2 source location on the earth (DOE, 2006a). Although regulatory agencies are taking actions to address GHG effects, there are currently no Texas or federal standards or regulations limiting CO_2 emissions and concentrations in the ambient air.

The proposed FutureGen Project would produce electricity and hydrogen fuel while emitting CO_2. DOE estimates that up to 0.28 million tons (0.25 million metric tons [MMT]) per year of CO_2 would be released into the atmosphere. A goal of the FutureGen Project is to capture and permanently sequester at least 90 percent of the CO_2 generated by the proposed power plant at a rate of 1.1 to 2.8 million tons (1.0 to 2.5 MMT) per year. By sequestering the CO_2 in geologic formations, the FutureGen Project aims to prove one technological option that could virtually eliminate future CO_2 emissions from similar coal-based power plants.

DOE's Energy Information Administration (EIA) report (DOE, 2006a) indicates that U.S. CO_2 emissions have grown by an average of 1.2 percent annually since 1990 and energy-related CO_2 emissions constitute as much as 83 percent of the total annual CO_2 emissions. DOE reviewed EPA's Emissions and Generation Resource Integrated Database (eGRID) to gain an understanding of the scale of the estimated CO_2 emissions from the proposed FutureGen Project compared to existing coal-fueled plants (EPA, 2006b). eGRID provides information on the air quality indicators for almost all of the electric power generated in the U.S.

The most recent data that can be accessed electronically is for the year 2000. A review of the database yielded the following information:

- In 2000, CO_2 emissions from all coal-fueled plants in Texas equaled 152.7 million tons (138.6 MMT). The average emissions rate of these coal plants was 2,292 pounds (1,039 kilograms) per megawatt-hour.
- Based on the average CO_2 emissions rates of nine representative coal plants in the size range of 153 to 508 MW, a conventional 275-MW coal-fueled power plant would emit 2.17 million tons (2.0 MMT) per year at an 85 percent capacity factor. This is in the same range as the estimated amount of CO_2 (1.1 to 2.8 million tons [1.0 to 2.5 MMT] per year) that would be sequestered by the proposed FutureGen Project.

Carbon capture and sequestration, if employed widely throughout the U.S in future power plants or retrofitted existing power plants, could help reduce and possibly reverse the growth in national annual CO_2 emissions.

Acid Rain Requirements

Acid rain or acid deposition can occur when acid precursors (such as SO_2 and NO_X) are released into the atmosphere, and they react with O_2 and water to form acids (EPA, 2007). Acid rain can cause soil degradation; increase acidity of surface water bodies; and reduce growth, injure, or even cause death of forests and aquatic habitats. The Acid Rain Program, established under Title IV of the CAA, requires electric generating units greater than 25 MW to obtain a Phase II Acid Rain Permit and meet the objectives of the program, which are achieved through a system of marketable allowances. The FutureGen Project would be required to obtain a Phase II Acid Rain Permit and would operate in a manner that is consistent with EPA's overall efforts to reduce emissions of acid precursors. Continuous emissions monitoring for SO_2, NO_X, and CO_2, as well as volumetric gas flow and opacity, is a part of the acid rain regulations, which include requirements for monitoring, recordkeeping, and reporting. Upon facility startup, the FutureGen Project would need to obtain SO_2 allowances each year in an amount equal to the actual SO_2 emissions from the facility.

Odors

Operation of the FutureGen Project may cause noticeable odors. The chemical components that could cause noticeable odors are hydrogen sulfide (H_2S) and ammonia (NH_3). H_2S is formed during the gasification of coal containing sulfur. The FutureGen Project would use an acid gas removal system that would potentially remove 99 percent of the sulfur in the syngas stream, thereby reducing the amount of H_2S emitted and reducing the impact from H_2S odors. For the FutureGen Project, the fuel stock would be blown into the gasifier using O_2; therefore, the NH_3 in the syngas would be formed from fuel bound nitrogen. Additionally, NH_3 would used in a Selective Catalytic Reduction (SCR) system, a potential component of the FutureGen Project, which controls NO_X emissions. While the current FutureGen Project design configurations include an SCR system, current research activities sponsored under the DOE Fossil Energy Turbine Program are investigating technologies that can achieve the NO_X emissions goals through combustion modifications only, thereby eliminating the need for post-combustion SCR (DOE, 2006b). The Alliance estimates that approximately 1,333 tons (1,209 metric tons) of NH_3 per year would be consumed in the FutureGen SCR process (FG Alliance, 2006e).

Both gases would normally only be emitted as small quantities of fugitive emissions (e.g., through valve or pump packing); however, if an accidental large release were to occur, such as a pipe rupture in the Claus Unit (the sulfur recovery unit) or from on-site NH_3 storage, a substantial volume of odor would be noticeable beyond the plant boundary. Other odors could be emitted from activities such as equipment maintenance, coal storage, and coal handling; however, these potential odors should be limited to the immediate site area and should not affect off-site areas. Texas regulates H_2S odors in the ambient air (i.e., beyond the fence line) under nuisance laws. There are no odor regulations for NH_3. Depending on the wind direction, even small volumes of H_2S and NH_3 odor could be a nuisance for receptors near the proposed Jewett Power Plant Site.

Local Plume Visibility, Shadowing, Fogging, and Water Deposition

The proposed Jewett Power Plant would have two main sources of water vapor plumes: the gas turbine exhaust stack and the cooling towers. The height of the cooling tower is typically less than the height of the gas turbine exhaust stack, which for the FutureGen Project is estimated to be 250 feet (76.2 meters) (FG Alliance, 2006e). Because of a reduced height, the cooling tower presents a greater concern than the gas turbine exhaust stack for impacts such as ground-level fogging, water deposition and solids deposition (including precipitates). Cooling tower “fogging” occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Potential deposition of solids would occur because the Jewett Site proposes to use groundwater that is generally highly saline (see Section 6.6.2.1). Effects from vapor plumes and deposition, would be most pronounced within 300 feet (91.4 meters) of the vapor source and would decrease rapidly with distance from the source. Both cooling towers and the gas turbine exhaust plume may cause some concern for shadowing and aesthetics. Plume shadowing is generally a concern only when considering its effect on agriculture, which, due to the attenuation of sunlight by the plume’s shadow, may reduce yield.

At the proposed Jewett Power Plant Site, nearby residences or agriculture could be impacted by fogging, water deposition, icing, or solid deposition under rare meteorological events; however, the impacts would be minimal. The greatest concern would be for traffic hazards created on FM-39, which borders the southwest side of the proposed power plant property. Because the proposed Jewett Site has 400 acres (162 hectares) and the FutureGen Project requires 60 acres (24 hectares), it is unlikely that the boundary of the power plant would be located within 300 feet (91.4 meters) of FM-39. If the location of the cooling tower and stack are more than 300 feet (91.4 meters) from the road, fog from the plant would dissipate and deposition of solids on the roads should not occur. Overall, solar loss, fogging, icing, or salt deposition from the proposed Jewett Power Plant would not interfere with quality of life in the area.

Effects of Economic Growth

Any air quality impacts due to residential growth would be in the form of automobile and residential (fuel combustion) emissions that would be dispersed over a large area. Commercial growth would be expected to occur at a gradual rate in the future, and any significant new source of emissions would be required to undergo permitting by the TCEQ. Impacts of economic growth on ambient air quality and PSD increments are unknown at this time. As part of the PSD permitting process, a determination of existing background concentrations of pollutants and additional modeling work would be required to estimate the maximum air pollutant concentrations that would be associated with the proposed Jewett Power Plant as a result of future economic growth. Section 6.19, provides detailed discussions of the impacts of economic growth from the FutureGen Project on the local resources.

Effects on Vegetation and Soils

Section 165 of the Clean Air Act requires preconstruction review of major emitting facilities to provide for the prevention of significant deterioration and charges federal managers with an affirmative responsibility to protect the AQRVs of Class I areas. Implementing regulations requires an analysis of the potential impairment to visibility, soils, and vegetation. Subsequently, EPA developed “A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals,” which specifies the air pollutant screening concentrations for which adverse effects may occur for various vegetation species and soils, depending on their sensitivity to pollutants (EPA, 1980). While the Jewett Power Plant Site is more than 62 miles (100 kilometers) from a Class I area, there may be sensitive vegetation that could be affected by the plant's air emissions. Therefore, DOE compared the power plant's predicted maximum air pollutant emissions with the EPA screening concentrations (Table 6.2-7). Based on this comparison, the power plant's emissions would be well below applicable screening concentrations. Emissions also would be well below the secondary NAAQS criteria, which are established to prevent unacceptable effects to crops and vegetation, buildings and property, and ecosystems.

Table 6.2-7. Screening Analysis for Effects on Vegetation and Soils

Pollutant	Averaging Period[1]	Maximum Total Concentration[2] ($\mu g/m^3$)	Screening Concentrations[3] ($\mu g/m^3$)	Secondary NAAQS ($\mu g/m^3$)
SO_2	3-hour	545.94	786	1,300
NO_2	Annual	27.01	94	100

[1] Maximum concentration for shortest averaging period available.
[2] Maximum concentration including background data (see Table 6.2-5).
[3] The most conservative values were utilized, based on the highest vegetation sensitivity category.
$\mu g/m^3$ = micrograms per cubic meter.
Source: EPA, 1980.

Effects on Animals

The secondary NAAQS were established to set limits to protect public welfare, including protection against harm to animals. The maximum predicted concentrations from the FutureGen Project estimated from the upperbound emissions of the FutureGen Project's estimate of maximum air emissions, in addition to the ambient background concentration, are below the secondary NAAQS for all pollutants.

Sequestration Site

The proposed CO_2 sequestration reservoir would be within bedrock layers located approximately 1 mile (1.6 kilometers) beneath the ground surface, far below the soil zone, water table aquifer, and overlying unsaturated zone (see Section 6.5 and Chapter 2). Because co-sequestration of H_2S and CO_2 is being considered as part of research and development activities for the FutureGen Project, minor air emissions of H_2S and CO_2 would occur during routine operations over the lifetime of the proposed injection period, which DOE expects to be between 20 to 30 years, and possibly up to 50 years. Sources of emissions during sequestration site operations could include:

- Injection wells, monitoring wells, and other wells; and
- Aboveground valves, piping, and well heads that comprise the transmission system.

Injection Wells, Monitoring Wells, and Other Wells

Wells provide the greatest opportunity for the escape of sequestered fluids. The injection well would extend into a target injection zone, with steel pipe inserted its full length and cemented into the bore hole to prevent upward escape of sequestered fluid around the outside of the pipe. Within the steel casing, tubing is installed from the well head down to the top of the injection zone, with the annular space sealed against the casing with a packer. The annular space is filled with heavy liquid, such as brine, to help control any accidental leakage into the annular space. This tubing could be removed and replaced should it become corroded or damaged over time. The technology is standard for constructing a well of this type and no measurable fugitive emissions from the well would be expected. Monitoring wells would be constructed in a similar manner as the injection wells, so they would be secure and could also be monitored for leaks and be repaired as needed. There should be no contact by CO_2 with the soils. The sequestration reservoir would be tested for assurance that no leak paths exist prior to project operations. Pre-existing oil wells that are not related to the FutureGen Project present a greater risk of leakage. If Jewett is selected to host the FutureGen Project, DOE anticipates that some means of identifying the locations of pre-existing wells over the plume and monitoring these wells for leakage would be employed at levels commensurate with the risks posed by the pre-existing wells. Wells that provide leakage points would be repaired or plugged to prevent leakage and emissions. All exploratory wells would be properly plugged with concrete and abandoned before operation of the sequestration facility if they are not used as injection wells or monitoring wells, preventing potential fugitive emissions from the sequestered CO_2.

Aboveground Valves, Piping, and Well Heads

The supercritical CO_2 that would be piped from the plant to the injection wells would enter each well through a series of valves attached to the underground steel pipe to ensure proper direction and control of flow. These valves would be above ground and easily accessible to workers for controlling well operation and conducting well maintenance. There would typically be four valves with flanged fittings for each well. Fugitive emissions from each valve were estimated based on a California South Coast Air Quality Management District (SCAQMD, 2003) valve emission factor of 0.0013 pound (0.6 gram) per hour for non-methane organic compounds. In addition to the expected fugitive emissions typical of gate valves, periodic well inspections, testing, and maintenance would be another source of emissions. The well valves would be periodically manipulated to allow insertion of inspection or survey tools to test the integrity of the system or to repair or replace system components. During each of those instances, some amount of CO_2 gas would be vented to the atmosphere.

The annual emissions estimate is based on the two injection wells required, accounting for the tubing volume and the number of evacuations that would occur each time a valve is opened. DOE estimates annual emissions of approximately 90.4 tons (82.0 metric tons) of CO_2. A number of tracers would also be used to track the fate and transport of the injected CO_2. Descriptions of these compounds are provided in Section 6.16. Fugitive emissions from valves, piping, and well heads may also contain very minute amounts of these tracers.

Utility Corridors

There are no planned operational activities along the proposed utility corridors that would cause air emissions impacts. Routine maintenance along the corridors would not result in fugitive emissions. However, if repairs were required and an underground line had to be excavated, there would be localized and temporary soil dust releases during the excavation process, which would be minimized through BMPs.

Transportation Corridors

During operation of the power plant, transportation-related air emissions would be produced from train and truck shipments to and from the plant and also from employee automobiles. Major pollutants emitted from automobiles, trucks, and trains include hydrocarbons (HC), NO_X, CO, PM, and CO_2. Trucks emit more HC and CO than trains on a brake horsepower per hour basis although they emit less NO_x and PM on the same basis. The higher values for HC and CO are caused by the differences in driving cycle—the truck driving cycle is much more dynamic than that of a train, which has more constant speed operations (Taylor, 2001). The FutureGen Project would aim to utilize train shipments for materials and waste to the greatest extent possible to increase transportation efficiency and reduce shipping costs but to also minimize related air pollution.

6.20 ENVIRONMENTAL JUSTICE

Specific populations identified under Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 *Federal Register* 7629), are examined here along with the potential of effects on these populations from construction and operation of the proposed FutureGen facility. In the context of this EIS, Environmental Justice refers specifically to the potential for minority and low-income populations to bear a disproportionate share of high and adverse environmental impacts from activities within the project area and the municipalities nearest to the proposed Jewett Power Plant Site, sequestration site and related corridors.

The U.S. Department of Energy defines "**Environmental Justice**" as: The fair treatment and meaningful involvement of all people—regardless of race, ethnicity, and income or education level—in environmental decision making. Environmental Justice programs promote the protection of human health and the environment, empowerment via public participation, and the dissemination of relevant information to inform and educate affected communities. DOE Environmental Justice programs are designed to build and sustain community capacity for meaningful participation for all stakeholders in DOE host communities (DOE, 2006).

6.20.1 INTRODUCTION

Executive Order 12898 directs federal agencies to achieve Environmental Justice as part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations. Minorities are defined as individuals who are members of the following population groups: Native American or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. To classify as a minority population, an area must have a population of these groups that exceeds 50 percent of the total population, or the minority population percentage of the affected area should be meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis (59 *Federal Register* 7629).

The Council on Environmental Quality (CEQ) guidance recommends that low-income populations in an affected area be identified using data on income and poverty from the U.S. Census Bureau (CEQ, 1997). Low-income populations are groups with an annual income below the poverty threshold, which was $19,971 for a family of four for calendar year 2006.

6.20.1.1 Region of Influence

The ROI includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, reservoir, and utility and transportation corridors. The proposed sequestration site is located approximately 33 miles (53.1 kilometers) north of the proposed plant site. The ROI includes the counties of Anderson, Brazos, Falls, Freestone, Houston, Leon, Limestone, Madison, McLennan, Navarro and Robertson. Section 6.19.1.1 describes the rationale for including these counties in the ROI.

6.20.1.2 Method of Analysis

DOE collected demographic information from the U.S. Census Bureau 2000 census to characterize low-income and minority populations within 50 miles (80.5 kilometers) of the proposed Jewett Power Plant Site and Sequestration Site. Census data are compiled at various levels corresponding to geographic areas and include, in order of decreasing size, states, counties, census tracts, block groups, and blocks. In order to accurately characterize and locate minority and low-income populations, DOE followed CEQ Guidance (CEQ, 1997) to determine minority and low-income characteristics using U.S., State of Texas, regional (defined by the 11-county ROI) and individual county data. The data presented in Table 6.20-1 show the overall composition and makeup of both minority and non-minority populations, and low-income populations within the ROI. Where available, DOE obtained U.S. Census data for local jurisdictions (i.e., towns and cities) to further identify the presence of minority or low-income populations. DOE used Census block group data (FG Alliance, 2006c) to examine the distribution of minority and low-income populations within the ROI.

DOE used potential environmental, socioeconomic, and health impacts identified in other sections of this EIS to assess potential impacts to Environmental Justice that could occur with the proposed construction and operation of the FutureGen Project.

DOE assessed the potential for impacts based on the following criteria:

- A significant and disproportionately high and adverse effect on a minority population; or
- A significant and disproportionately high and adverse effect on a low-income population.

Table 6.20-1. County, Regional and National Population and Low-income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-income (percent)
Counties Wholly Located Within the ROI								
Anderson	55,109	66.4	23.5	0.6	0.4	<0.1	12.2	16.5
Freestone	17,867	75.6	18.9	0.4	0.3	<0.1	8.2	14.2
Leon	15,335	83.5	10.4	0.3	0.2	<0.1	7.9	15.6
Limestone	22,051	70.8	19.1	0.5	0.1	<0.1	13.0	17.8
Madison	12,940	66.8	22.9	0.3	0.4	<0.1	15.8	15.8
Counties Partially Located Within the ROI								
Brazos	152,415	74.5	10.7	0.4	4.0	0.1	17.9	26.9
Falls	18,576	61.5	27.5	0.5	0.1	<0.1	15.8	22.6
Houston	23,185	68.6	27.9	0.3	0.2	0.1	7.5	21.0
McLennan	213,517	72.2	15.2	0.5	1.1	<0.1	17.9	17.6
Navarro	45,124	70.8	16.8	0.5	0.5	0.3	15.8	18.2
Robertson	16,000	66.2	24.2	0.4	0.2	0.1	14.7	20.6

Table 6.20-1. County, Regional and National Population and Low-income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-income (percent)
Regional and National Statistics								
11-County ROI	592,119	70.6	19.7	0.4	0.7	0.2	13.3	18.8
Texas	20,851,820	71.0	11.5	0.6	2.7	0.1	32.0	15.4
U.S.	281,421,906	75.1	12.3	0.9	3.6	0.1	12.5	12.4

[1] Some of the minority population counted themselves as more than one ethnic background, thus the counts do not add up to 100 percent.
Source: USCB, 2006.

6.20.2 AFFECTED ENVIRONMENT

6.20.2.1 Minority Populations

Table 6.20-1 compares the minority percentage and low-income percentage of county populations within the ROI with those of Texas and the nation. The 2000 Census revealed a more diverse population in Texas compared to the 1990 Census, especially regarding the Hispanic population. In 2000, 14.9 percent of Texas residents identified themselves as non-white (excluding Hispanic), down from 15.9 percent in 1990. During that same period, however, the percentage of population identifying themselves of Hispanic origin increased from 28.6 percent to 32 percent. With the exception of populations of Hispanic origin, the Texas population is less diverse than that of the nation.

Populations within the ROI have similar percentages (some counties slightly higher and some slightly lower) of people identifying themselves as white compared to overall Texas statistics, however, the ROI has a lower percentage of individuals of Hispanic origin when compared to the state. Populations within the ROI have non-minority populations (white) as the highest percentage (70.6 percent) compared to state (71.0 percent) and U.S. (75.1 percent) percentages. Although the populations within the ROI are greater than 50 percent non-minority, the counties within the ROI do have a higher percentage of minorities than state and national averages.

The proposed Jewett Power Plant Site would be located near the border of Limestone, Freestone and Leon counties, which have minority percentages of 27.8, 18.8 and 32.7 percent, respectively. Similar percentages would be expected for associated utility and transportation corridors.

The largest minority populations in the region are to the south and to the north of the proposed Jewett Sequestration Site and reservoir. This area includes state land managed by the Texas Department of Criminal Justice (Coffield State Prison, approximately 4,115 inmates), located within the western edge of Anderson County. The overall population of Anderson County identifies itself as 66.4 percent white, or non-minority, 24.5 percent as minority, and 12.2 percent as Hispanic or Latino origin of any race. The proposed sequestration site is also located within Freestone County which has a minority population of 19.6 percent with an additional 8.2 percent of the population identifying themselves as Hispanic or Latino of any race.

Due to the high percentage of individuals of minority origin near the proposed Jewett Sequestration Site, a “minority population” as characterized by CEQ does exist in the potentially affected area. No large percentages of minority populations are located near the proposed plant site or corridors.

6.20.2.2 Low-Income Populations

Most of the by-county percentages of low-income populations for individuals exceed the state percentage (15.4 percent) and all of them exceed the national percentage (12.4 percent) (Table 6.20-1). However, the majority (81.8 percent) of the ROI is at or above the poverty level (annual household income above $19,971).

6.20.3 IMPACTS

This section discusses the potential for disproportionately high and adverse impacts on minority and low-income populations associated with the proposed FutureGen Project. The CEQ’s December 1997 Environmental Justice Guidance (CEQ, 1997) provides guidelines regarding whether human health effects on minority populations are disproportionately high and adverse. CEQ advised agencies to consider the following three factors to the extent practicable:

- Whether the health effects, which may be measured in risks and rates, are significant (as defined by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.
- Whether the risk or rate of hazard exposure by a minority population, low-income population, or Native American tribe to an environmental hazard is significant (as defined by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority population, low-income population, or Native American tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Based on the definitions in Section 6.20.1, the criteria outlined above, and the findings regarding environmental and socioeconomic impacts throughout this EIS, the analysis for Environmental Justice in this EIS were performed in the following sequence:

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a minority population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 6.20.1, was determined.

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a low-income population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 6.20.1, was determined.

Using the impacts analyzed in Section 6.17, the potential for adverse health risks in a wider radius from project sites and corridors was compared with the potential adverse health risks that could affect a minority population or low-income population at a disproportionately high and adverse rate.

Using the impacts analyzed in Section 6.17, the potential for health effects in a minority population or low-income population affected by cumulative or multiple adverse exposures to environmental hazards was determined.

6.20.3.1 Construction Impacts

As discussed in Section 6.20.2.1, areas of minority populations, as defined by EO 12898, are located near the sequestration site. The sequestration site is located along the border of Freestone and Anderson counties. Anderson County (which includes the population at Coffield State Prison) has 33.6 percent of individuals identifying themselves as minority. This percentage is higher than regional (29.4 percent), state (29.0 percent) and national (24.9 percent) percentages, however, it is below the 50 percent threshold as defined in EO 12898. Due to some of the minority population counting themselves as belonging to more than one ethnic background, DOE calculated the percentages by subtracting the White population Census numbers from 100 percent (e.g., 100 percent – 66.4 percent = 33.6 percent for Anderson County). No disproportionately high and adverse impacts are anticipated to minority populations. Construction activities may cause temporary air quality, water quality, transportation and noise impacts to the general population (see Sections 6.2, 6.7, 6.13, and 6.14).

The proposed power plant would be located at the intersection of Limestone, Leon and Freestone counties, which predominantly have a higher percentage of low-income populations (at 17.8, 15.6, and 14.2 percent, respectively) in comparison to the state (15.4 percent) and national (12.4 percent) percentages. The proposed sequestration sites would be located in Freestone County, discussed above, and Anderson County which has a 16.5 percent low-income population. All of these percentages, however, are far below the 50 percent threshold as defined in EO 12898. No disproportionately high and adverse impacts are anticipated to low-income populations. Construction activities may cause temporary air quality, water quality, transportation and noise impacts to the general population (see Sections 6.2, 6.7, 6.13, and 6.14). Short-term beneficial impacts may include an increase in employment opportunities and potentially higher wages, or supplemental income through jobs created during facility construction.

6.20.3.2 Operational Impacts

Aesthetics and noise impacts (see Sections 6.12 and 6.14) resulting from operations were determined not to have a disproportionately high and adverse effect to minority or low-income populations.

One of the proposed sequestration sites would potentially be located within the Coffield State Prison complex. The potential risks to health were determined to be from the unlikely event of a pipeline rupture or puncture, the extremely unlikely event of a wellhead equipment rupture, and a catastrophic accident, terrorism, or sabotage, which cannot be predicted (Section 6.17). The injection well would be located away from the prison facility. This potential for pipeline rupture or puncture would be uniform across the general population along the CO_2 utility corridors. Therefore, no disproportionately high and adverse impacts are anticipated.

Long-term beneficial impacts would be anticipated due to an increase in employment opportunities and potentially higher wage jobs associated with facility operation.

INTENTIONALLY LEFT BLANK

6.21 REFERENCES

6.1 Chapter Overview

Energy Information Administration (EIA). 2000. *Energy Policy Act Transportation Rate Study: Final Report on Coal Transportation.* Accessed January 1, 2007 at ftp://ftp.eia.doe.gov/pub/pdf/coal.nuclear/059700.pdf

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

6.2 Air Quality

40 CFR 6. "Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 51.166. "Requirements for Preparation, Adoption and Submittal of Implementation Plans: Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 52.21. "Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 93. "Determining Conformity of Federal Actions to State or Federal Implementation Plans." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FG Alliance. 2007. "Initial Conceptual Design Report."

South Coast Air Quality Management District (SCAQMD). 2003. *Guidelines for Fugitive Emissions Calculations*. Accessed January 3, 2007 at www.ecotek.com/aqmd/2006/forms_and_instructions_pdf/2003_fugitive_guidelines.pdf

Taylor, G. W.R. 2001. *Trucks and Air Emissions, Final Report*. Prepared for Transportation Systems Branch, Air Pollution Prevention, Environmental Protection Service, Environment Canada. March 2001. Accessed April 9, 2007 at http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/trucks/trucktoc.htm (last updated December 11 2002).

Texas Commission on Environmental Quality (TCEQ). 2006. *Mercury in Texas: Background, Federal Rules, Control Technologies, and Fiscal Implications; Implementation of Section 2, HB 2481 (79th Legislature)—A Report to the Texas Legislature*. Accessed April 3, 2007 at http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/sfr/085.pdf

U.S. Department of Energy (DOE). 2006a. "Emissions of Greenhouse Gases in the United States 2005." Washington, DC.

DOE. 2006b. *The Turbines of Tomorrow*. Accessed January 5, 2007 at http://www.fe.doe.gov/programs/powersystems/turbines/index.html (last updated November 9, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1980. "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals." Washington, DC.

EPA. 1990. "New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting." Draft, October 1990. Washington, DC.

EPA. 2005. "Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations." Washington, DC.

EPA. 2006a. *Air Data. Monitor Values Report – Criteria Air Pollutants*. Accessed December 28, 2006 at http://www.epa.gov/air/data/monvals.html (last updated September 26, 2006).

EPA. 2006b. *eGRID – Emissions and Generation Resource Integrated Database (eGRID)*. Accessed December 1, 2006 at http://www.epa.gov/cleanenergy/egrid/index.htm (last updated October 30, 2006).

EPA. 2006c. *National Ambient Air Quality Standards (NAAQS)*. Accessed November 8, 2006 at http://www.epa.gov/air/criteria.html (last updated October 13, 2006).

EPA. 2007. *Acid Rain Program*. Accessed April 27, 2007 at http://www.epa.gov/airmarkets/progsregs/arp/index.html (last updated February 2, 2007).

U.S. Fish and Wildlife Service (FWS). 2007. *Permit Application, PSD Overview*. Accessed January 27, 2007 at http://www.fws.gov/refuges/AirQuality/permits.html (last updated August 14, 2006).

6.3 Climate and Meteorology

Blue Planet Biomes. 2006. *World Climates*. Accessed December 1, 2006 at http://www.blueplanetbiomes.org/climate.htm (last updated November 7, 2006).

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

National Climatic Data Center (NCDC). 2006. *Storm Events*. Accessed December 2, 2006 at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

National Oceanic and Atmospheric Administration (NOAA). 2006. *Storm Events*. Accessed December 2, 2006 at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms (updated daily).

The Tornado Project. 1999. *The Fujita Scale*. Accessed December 1, 2006 at http://www.tornadoproject.com/fscale/fscale.htm

6.4 Geology

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Illinois State Geological Survey (ISGS). 1995. *Damaging Earthquakes in Illinois*. Accessed October 5, 2006 at http://www.isgs.uiuc.edu/earthquakes/Articles/qk-fct-damag.pdf (last updated November 30, 1999).

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Louie, J. 1996. *What is Richter Magnitude?* Accessed October 5, 2006 at http://www.seismo.unr.edu/ftp/pub/louie/class/100/magnitude.html (last updated October 9, 1996).

U.S. Geological Survey (USGS). 2006. *NEIC: Earthquake Search Results. U. S. Geological Survey Earthquake Database*. Accessed October 6, 2006 at http://eqint.cr.usgs.gov/neic/cgi-bin/epic/epic.cgi?SEARCHMETHOD=3&SLAT2=0.0&SLAT1=0.0&SLON2=0.0&SLON1=0.0&FILEFORMAT=4&SEARCHRANGE=HH&CLAT=39.737&CLON=-88.3&CRAD=193&SUBMIT=Submit+Search&SYEAR=&SMONTH=&SDAY=&EYEAR=&EMONTH=&EDAY=&LMAG=&UMAG=&NDEP1=&NDEP2=&IO1=&IO2=

University of Texas at Austin (UTA). 2006. "Response to FutureGen Alliance Geohydrologic Conceptual Model Data Request Package." Austin, TX.

6.5 Physiography and Soils

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Heart of Brazos FutureGen Site, Leon, Limestone, and Freestone Counties, Texas." Austin, TX.

University of Texas at Austin (UTA). 2006. *Physiography of Texas*. Accessed October 9, 2006 at http://www.lib.utexas.edu/geo/physiography.html (last updated July 24, 2006).

6.6 Groundwater

30 TAC 331. "Underground Injection Control." *Texas Administrative Code*.

Caldwell, C. 2006. Personal communication. Email from Craig Caldwell, Texas Water Development Board, Austin, TX, to Lisa Guizar, R. W. Harden & Associates, Inc. Austin, TX. August 25, 2006.

FutureGen Alliance (FG Alliance). 2006c. “Heart of Brazos Site Environmental Information Volume.”

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

R.W. Harden and Associates. 2006. “Carrizo-Wilcox Aquifer.” Austin, TX.

Texas Commission on Environmental Quality (TCEQ). 2006. *Joint Groundwater Monitoring and Contamination Report, 2005*. *SFR 056/05*. Accessed December 17, 2006 at http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/sfr/056_05_index.html (last updated July 20, 2006).

Texas Water Development Board (TWDB). 1972. “Report 150: Ground-Water Conditions in Anderson, Cherokee, Freestone, and Henderson Counties, Texas.” Austin, TX.

TWDB. 1997. *1997 State Water Plan*. Accessed January 23, 2007 at http://rio.twdb.state.tx.us/publications/reports/State_Water_Plan/1997/Ch_3.2_Regions.pdf

TWDB. 2003. “Groundwater Availability Model for the Central Part of the Carrizo-Wilcox Aquifer in Texas.” Austin, TX.

TWDB. 2006a. *Well Location Data and GIS Data Layers*. Accessed September 1, 2006 and October 5, 2006 at http://www.twdb.state.tx.us/mapping/gisdata.asp

TWDB. 2006b. “GAM Run 06-05.” Austin, TX.

TWDB. 2006c. *2007 State Water Plan*. Accessed January 23, 2007 at http://rio.twdb.state.tx.us/publications/reports/State_Water_Plan/2007/2007StateWaterPlan/2007StateWaterPlan.htm

U.S. Environmental Protection Agency (EPA). 2006a. *Designated Sole Source Aquifers in EPA Region VI*. Accessed December 15, 2006 at http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg6.pdf

EPA. 2006b. *Underground Source of Drinking Water*. Accessed March 11, 2007 at http://www.epa.gov/safewater/uic/usdw.html (last updated February 28, 2006).

EPA 2007. *Using the Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects. UIC Program Guidance (UICP #83), Underground Injection Control Program, Geologic Sequestration of Carbon Dioxide*. Accessed March 20, 2007 at http://www.epa.gov/safewater/uic/index.html (last updated March 2, 2007).

University of Texas at Austin (UTA). 1985. “The Wilcox Group and Carrizo Sand (Paleogene) in East-Central Texas: Depositional Systems and Deep-Basin Lignite.” Austin, TX.

6.7 Surface Water

Benson, S., R. Hepple, J. Apps, C. Tsang and M. Lippman. 2002. "Lessons Learned from Natural and Industrial Analogues for Storage of Carbon Dioxide in Deep Gas Formations." Earth Sciences Division, E.O. Lawrence Berkeley National Laboratory, Berkeley, CA.

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Holloway, S. 1996. "The Underground Disposal of Carbon Dioxide." British Geological Survey, Keyworth, Nottingham, UK.

Reichle, D., J. Houghton, B. Kane and J. Ekmann. 1999. "Carbon Sequestration Research and Development." U.S. Department of Energy, Office of Science, Office of Fossil Energy, Oak Ridge, TN.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

Texas Commission on Environmental Quality (TCEQ). 2004. *Brazos River Basin: 2004 Assessment (Segment 1252 – Lake Limestone)*. Accessed November 28, 2006 at http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/04twqi/basins/brazos.html (last updated May 25, 2006).

TCEQ. 2006a. *Trinity River Basin (08) and Portion of Bays and Estuaries (24)*. Accessed November 28, 2006 at http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/gi/gi-16/basin08-Trinity-PBE_233986.pdf (last updated May 8, 2006).

TCEQ. 2006b. *Class III Injection Wells Regulated By The TCEQ: Technical Guideline III: Fluid Handling*. Accessed January 24, 2007 at http://www.tceq.state.tx.us/permitting/waste_permits/uic_permits/UIC_Guidance_Class_3.html (last updated June 13, 2006).

Texas Natural Resource Conservation Commission (TNRCC). 2000. *Chapter 307, Texas Surface Water Quality Standards. Trinity River Basin, Segment 0804, Trinity River above Lake Livingston*. Accessed January 15, 2007 at http://www.tceq.state.tx.us/permitting/water_quality/wq_assessment/standards/WQ_standards_2000.html

Trinity River Authority (TRA). 2006. *Map of the Trinity River Watershed (Water Quality Data Viewer)*. Accessed December 5, 2006 at http://www.trinityra.org/BasinPlan/CRP/viewer/ViewMap.asp

U.S. Department of Agriculture (USDA). 1989. "Soil Survey of Leon County, Texas." Washington, DC.

USDA. 1998. "Soil Survey of Limestone County, Texas." Washington, DC.

USDA. 2002. "Soil Survey of Freestone County, Texas." Washington, DC.

6.8 Wetlands and Floodplains

10 CFR 1022. "Compliance with Floodplain and Wetland Environmental Review Requirements." U.S. Department of Energy, *Code of Federal Regulations*.

42 *Federal Register* 26951. "Executive Order 11988 – Floodplain Management." Federal Register. May 24, 1977.

42 *Federal Register* 26961. "Executive Order 11990 – Protection of Wetlands." Federal Register. May 24, 1977.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States." U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Emergency Management Agency (FEMA). 1977. "Flood Insurance Rate Map (FIRM) Panel Nos. 4812490004A and 4812490005A, Ector County, Texas." Jessup, MD.

FEMA. 1978. "Flood Insurance Rate Map (FIRM) Panel No. FM4808220010A; Freestone County, Texas." Jessup, MD.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Kantor, T. L. 2006. Letter from T. L. Kantor, Engineer and Floodplain Administrator, Limestone County Road and Bridge Department, Groesbeck, TX to Scott W. Tinker, Director, Bureau of Economic Geology, The University of Texas at Austin, Austin, TX.

Natural Resources Conservation Service (NRCS). 2006. *Soil Data Mart*. Accessed October 19, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

U.S. Fish and Wildlife Service (FWS). 1988. "National Wetlands Inventory Maps for Buffalo, Butler, Jewett, Donie, Keechi, Lanely, Long Lake, Tennessee Colony, Turlington, and Yard, Texas, quadrangles." Washington, DC.

6.9 Biological Resources

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

6.10 Cultural Resources

16 USC 470. “The National Historic Preservation Act of 1966, as amended through 2000. U.S.” Federal Government, *U.S. Code*.

36 CFR 60. “National Register of Historic Places.” U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 62. “National Natural Landmarks Program.” U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 800. “Protection of Historic Properties.” U.S. Department of the Interior, Advisory Council on Historic Preservation, *Code of Federal Regulations*.

FutureGen Alliance (FG Alliance). 2006c. “Heart of Brazos Site Environmental Information Volume.”

King, T. F. 1998. “Cultural Resource Laws and Practice.” AltaMira Press, Walnut Creek, CA.

Mercado-Allinger, P. A., N. A. Kenmotsu and T. K. Perttula. 1996. “Archeology in the Central and Southern Planning Region, Texas: A Planning Document.” Texas Historical Commission, Austin, TX.

Miller, M. and S. W. Yost. 2006. “Cultural Resource Overview of Proposed FutureGen Heart of Brazos, Leon, Limestone, and Freestone Counties, Texas.” El Paso, TX.

National Park Service (NPS). 2004. *National Natural Landmarks, NNL Guide*. Accessed December 2, 2006 at http://www.nature.nps.gov/nnl/Registry/USA_Map/index.cfm (last updated February 5, 2004).

NPS. 2006a. *National Register Information System*. Accessed December 3, 2006 at http://www.cr.nps.gov/nr/research/nris.htm (last updated August 18, 2006).

NPS. 2006b. *Native American Consultation Database*. Accessed December 6, 2006 at http://home.nps.gov/nacd/ (last updated March 31, 2006).

Patterson, P.E. 2001. “Native American Territorial Ranges in the Central Region of Texas: A Report Prepared to Support NAGPRA Consultation.” Fort Worth, TX.

Texas Historical Commission (THC). 2006. *Texas Archaeological Sites Atlas*. Accessed December 2, 2006 at http://nueces.thc.state.tx.us/

University of Texas at Austin (UTA). 1970. “Geologic Atlas of Texas, Waco Sheet.” Austin, TX.

UTA. 1996. “Physiographic Map of Texas.” Austin, TX.

6.11 Land Use

14 CFR 77. “Objects Affecting Navigable Airspace.” Federal Aviation Administration, *Code of Federal Regulations*.

De Figueiredo, M. A., D. M. Reiner and H. J. Herzog. 2005. "Framing the Long-Term In Situ Liability Issue for Geologic Carbon Storage in the United States." *Mitigation and Adaptation Strategies for Global Change* 10 (4): 647-657.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Heart of Brazos FutureGen Site, Leon, Limestone, and Freestone Counties, Texas." Austin, TX.

Karriker, J. 2006. Personal communication. Discussions and On-Site Meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Jerry Karriker, Farm Programs Specialist II, Coffield and Beto Units Agriculture, Texas Department of Criminal Justice, Agribusiness, Land & Minerals, Tennessee Colony, Texas. November 28, 2006.

National Resources Conservation Service (NRCS). 2000. *National Resource Inventory*. *Illinois Highlights. 1997 National Resources Inventory*. Accessed October 16, 2006 at http://www.il.nrcs.usda.gov/technical/nri/highlights.html (last updated December 2000).

NRCS. 2006. *Soil Data Mart*. Accessed August 24, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

Texas Parks and Wildlife Department (TPWD). 2006. *State Parks and Destinations*. Accessed August 24, 2006 at http://www.tpwd.state.tx.us/spdest/

Trouart, J. 2006. Personal communication. Discussions and On-Site meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Joel Trouart, Vice President, State Government Relations, Westmoreland Mining LLC, Jewett, Texas. November 27, 2006.

6.12 Aesthetics

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Herrera, T. 2006. Personal communication. E-mail from Theresa Herrera, Bureau of Land Management, U.S. Department of the Interior, Santa Fe, NM, to Abby Peyton, Horizon Environmental Services, Inc., Austin, TX. September 6, 2006.

King, T. F. 1998. "Cultural Resource Laws and Practice." AltaMira Press, Walnut Creek, CA.

Texas Legislation Online (TLO). 2006. *Texas Statutes*. Accessed August 24, 2006, at http://www.capitol.state.tx.us/ (last updated May 16, 2006).

Texas Parks and Wildlife Department (TPWD). 2006. *State Parks and Destinations*. Accessed August 24, 2006 at http://www.tpwd.state.tx.us/spdest/

U.S. Department of Agriculture, Farm Service Agency, Aerial Photography Field Office (USDA-FSA-APFO). 2004. "Digital Aerial Photography: Freestone, Limestone, and Leon Counties, Texas."

U.S. Department of Energy (DOE). 2006a. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

DOE. 2006b. *FutureGen – Tomorrow's Pollution-Free Power Plant*. Accessed December 28, 2006 at http://www.fossil.energy.gov/programs/powersystems/futuregen/ (last updated December 14, 2006).

Wilkinson, T. 2006. Telephone conversation of Tom Wilkinson, Executive Director, Brazos Valley Council of Governments, with M. Archambeault. August 24, 2006.

6.13 Transportation and Traffic

American Association of State Highway and Transportation Officials (AASHTO). 2004. "A Policy on Geometric Design of Highways and Streets." Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

Texas Department of Transportation (TxDOT). 2005. *Texas Rail System Plan*. Accessed December 11, 2006 at http://www.txdot.gov/services/transportation_planning_and_programming/rail_plan.htm

TxDOT. 2006a. *TxDOT Transportation Studies*. Accessed November 17, 2006 at http://www.dot.state.tx.us/mis/mis.htm

TxDOT. 2006b. *Texas Highway Designation Files*. Accessed November 17, 2006 at http://www.dot.state.tx.us/tpp/search/query.htm

TxDOT. 2006c. *Roadway Design Manual*. Accessed May 1, 2007 at ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/rdw.pdf

Transportation Research Board (TRB). 2000. "Highway Capacity Manual." Washington, DC.

Walden, S., 2006. Personal communication. Email from Steve Walden, Steve Walden Consulting, Austin, TX, to Lucy Schwartz, Battelle Memorial Institute, Aberdeen, MD. December 14, 2006.

6.14 Noise

Barksdale. 1991. "The Aggregate Handbook." National Stone Association. Washington, DC.

Bolt, Beranek, and Newman 1971. "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances." Prepared for the U.S. Environmental Protection Agency, Washington, DC.

Bolt, Beranek, and Newman. 1973. "Fundamentals of Abatement and Highway." Federal Highway Administration.

Bolt, Beranek and Newman. 1984. "Electric Power Plant Environmental Noise Guide. Volume 1, 2nd edition." Prepared for Edison Electric Institute.

Cowan, J. P. 1994. "Handbook of Environmental Acoustics." John Wiley & Sons, Inc.

Federal Highway Administration (FHWA). 1992. ***Highway Traffic Noise***. Accessed December 27, 2006 at http://www.fhwa.dot.gov/environment/htnoise.htm (last updated December 14, 2006).

Federal Transit Administration (FTA). 2006. "Transit Noise and Vibration Impact Assessment." Harris Miller Miller and Hanson, Inc. Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

New York State Department of Environmental Conservation (NYSDEC). 2000. "Assessing and Mitigating Noise Impacts." Albany, NY.

U.S. Department of Energy (DOE). 2006. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

VIBCO. Undated-a. "High Frequency Silent Models." Wyoming, RI.

VIBCO. Undated-b. "Silent Pneumatic CC Series." Wyoming, RI.

Western Safety Products. 2007. *Aldon Rail Safety Page 6.* Accessed April 3, 2007 at http://www.westernsafety.com/aldon/aldonpage6.html (last updated March 28, 2007).

6.15 Utility Systems

Electric Reliability Council of Texas (ERCOT). 2006a. "*2005 Annual Report*." Austin, TX.

ERCOT. 2006b. "Future Generation Interconnection Security Screening Study, Leon and Ector County Locations." Austin, TX.

Energy Information Administration (EIA). 2006. "Annual Energy Outlook 2006 with Projections to 2030." Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

North American Electric Reliability Council (NERC). 2006. "2006 Long-Term Reliability Assessment: The Reliability of the Bulk Power Systems in North America." Princeton, NJ.

6.16 Materials and Waste Management

30 TAC 330.3. "Definitions." *Texas Administrative Code*.

30 TAC 330.5. "Classification of Municipal Solid Waste Facilities." *Texas Administrative Code*.

30 TAC 330.173 "Operational Standards for Municipal Solid Waste Landfill Facilities." *Texas Administrative Code*.

30 TAC 335.5 "Deed Recordation of Waste Disposal." *Texas Administrative Code*.

30 TAC 335.6 "Notification Requirements." *Texas Administrative Code*.

American Coal Ash Association (ACAA). 2006. *2005 Coal Combustion Product (CCP) Production and Use Survey*. Accessed November 4, 2006 at http://www.acaa-usa.org/PDF/2005_CCP_Production_and_Use_Figures_Released_by_ACAA.pdf

Best, S. 2006. *New Grimes County Landfill*. Telecon Record, S. Best, Brazos Valley Development Council Landfill Supervisor, and M. Hoganson, TtNUS. December 11,2006.

California Integrated Waste Management Board (CIWMB). 2006. *Estimated Solid Waste Generation Rates for Industrial Establishments*. Accessed November 9, 2006 at http://www.ciwmb.ca.gov/WasteChar/WasteGenRates/Industrial.htm (last updated December 7, 2004).

Ciba. 2006. *Water Treatment*. Accessed November 6, 2006 at http://www.cibasc.com/index/ind-index/ind-water_treatment.htm

Energy Information Administration (EIA). 2006. *U.S. Coal Consumption by End Use Sector, by Census Division and State*. Accessed December 7, 2006 at http://www.eia.doe.gov/cneaf/coal/page/acr/table26.html

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FG Alliance. 2007. "Initial Conceptual Design Report."

FutureGen Site Proposal (Jewett, Texas). 2006. "Proposal for FutureGen Host Site." Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Heart of Brazos FutureGen Site, Leon, Limestone, and Freestone Counties, Texas." Austin, TX.

Morris, R. J. 2003. *Sulphur Surplus in the Making Impacts Refineries*. Accessed October 30, 2006 at http://www.sulphurinstitute.org/Morris.NPRApaper.pdf

Railroad Commission of Texas (RRC). 2004. *Coal Mining Locations*. Accessed December 15, 2006 at http://www.rrc.state.tx.us/divisions/sm/sm_info/forms/TXCoalOp.pdf.

Texas Commission on Environmental Quality (TCEQ). 2006a. Letter from Dan Eden, Deputy Director, TCEQ, Austin, TX, to Scott W. Tinker, Director, Bureau of Economic Geology, The University of Texas at Austin, Austin, TX. April 27, 2006.

TCEQ. 2006b. *Municipal Solid Waste in Texas: A Year in Review. FY 2005 Data Summary and Analysis*. Accessed November 27, 2006 at http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/as/187_06.pdf (last updated October 16, 2006).

TCEQ. 2006c. *Storm Water Permits*. Accessed October 15, 2006 at http://www.tceq.state.tx.us/nav/permits/sw_permits.html

The Innovation Group (TIG). 2002. *Chemical Profiles: Sulfur*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sulfur.htm

TIG. 2003. *Chemical Profiles: Sodium Hypochlorite*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sodium%20Hypochlorite.htm

U.S. Environmental Protection Agency (EPA). 2003. *Wastes. 2003 National Biennial Report*. Accessed December 4, 2006 at http://www.epa.gov/epaoswer/hazwaste/data/br03/index.htm (last updated February 23, 2006).

U.S. Geological Survey (USGS). 2006a. *Mineral Commodity Summaries– Lime*. Accessed December 4, 2006 http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/lime_mcs06.pdf

USGS. 2006b. *Mineral Industry Surveys – Directory of Lime Plants in the United States in 2005*. Accessed December 4, 2006 http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/limedir05.pdf

6.17 Human Health, Safety and Accidents

American Industrial Hygiene Association (AIHA), 1997. "Odor Thresholds for Chemicals with Established Occupational Health Standards." Fairfax, VA.

Department of Health and Human Services (DHHS). 2006. "The State of Childhood Asthma, United States, 1980–2005." National Center for Health Statistics. Advance Data from Vital and Health Statistics. Number 381. Revised December 29, 2006.

Ermak, D. L. 1990. "User's Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air Releases." Report UCRL-MA-105607, University of California, Lawrence Livermore National laboratory, Livermore, CA.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006d. "Odessa Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project EIS Project Description Data Needs Table Operational Parameters and Assumptions Unplanned Starts."

Gale, J. and J. Davison. 2004. "Transmission of CO_2 – Safety and Economic Considerations." *Energy* 29 (9-10): 1319-1328.

Gilmour, M I., M. S. Jaakkola, S. J. London, A. E. Nel and C. A. Rogers. 2006. "How Exposure to Environmental Tobacco Smoke, Outdoor Air Pollutants, and Increased Pollen Burdens Influences the Incidence of Asthma." *Environmental Health Perspectives* 114: 627-633.

Hanna, S. R. and P. J. Drivas. 1987. "Guidelines for Use of Vapor Cloud Dispersion Models." Center for Chemical Process Safety, American Institute of Chemical Engineers. NY.

Interstate Oil and Gas Compact Commission (IOGCC). 2005. "Carbon Capture and Storage: A Regulatory Framework for States - Summary of Recommendations." Oklahoma City, OK. January 24, 2005.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Mills, W. B., D. B. Porcella, M. J. Ungs, S. A. Gherini, K. V. Summers, L. Mok, G. L. Rupp, G. L. Bowie and D.A. Haith. 1985. "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water." Volume 1. EPA/600/6-85/002a. U.S. Environmental Protection Agency, Washington, DC.

National Institute of Environmental Health Sciences (NIEHS). 1999. "Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields." NIH Publication No. 99-4493.

National Institute of Occupational Health (NIOSH). 1983. *Comprehensive Safety Recommendations for Land-Based Oil and Gas Well Drilling Publication No. 83-127*. Accessed April 5, 2007 at http://www.cdc.gov/niosh/83-127.html

NIOSH. 1987. "Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Material." NIOSH Publication No. 88-102.

NIOSH. 2007. *Pocket Guide to Chemical Hazards*. NIOSH Publication No. 2005-149. Accessed March 13, 2007 at http://www.cdc.gov/niosh/npg/npgsyn-a.html

Office of Pipeline Safety (OPS). 2006. *Hazardous Liquid Pipeline Accident Summary by Commodity*. 1/1/2006-12/05/2006. Accessed March 13, 2007 at http://ops.dot.gov/stats/LQ06_CM.HTM

OPS. 2007. *FOIA On-line Library*. Accessed March 12, 2007 at http://ops.dot.gov/stats/IA98.htm (last updated January 22, 2007).

Oldenburg, C. M. 2005. *Health, Safety, and Environmental Screening and Ranking Framework for Geologic CO_2 Storage Site Selection*. Accessed July 21, 2006 at http://repositories.cdlib.org/cgi/viewcontent.cgi?article=4279&context=lbnl

Papanikolau, N., B. M. L. Lau, W. A. Hobbs and J. Gale. 2006. "Safe Storage of CO_2: Experience from the Natural Gas Storage Industry." In *Proceedings of the 8th International Conference on Greenhouse Gas Control Technologies (GHGT-8)*, 19 - 22 June 2006. Trondheim, Norway.

Quest Consultants Inc. (Quest). 2006. "Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations." November 28, 2006. Norman, OK.

Scherer, G. W., M. A. Celia, J-H Prevost, S. Bachu, R. Bruant, A. Duguid, R. Fuller, S. E. Gasda, M. Radonijic and W. Vichit-Vadkan. 2005. "Leakage of CO_2 through Abandoned Wells: Role of Corrosion of Cement, in Carbon Dioxide Capture for Storage in Deep Geologic Formations." In *Carbon Dioxide Capture for Storage in Deep Geologic Formations – Results from the CO_2 Capture Project, Vol 2 – Geologic Storage of Carbon Dioxide with Monitoring and Verification*. Elsevier Science, London.

Selgrade, M. K., R. F. Lemanske Jr., M. I. Gilmour, L. M. Neas, M. D.W. Ward, P. K. Henneberger, D. N. Weissman, J. A. Hoppin, R. R. Dietert, P. D. Sly, A. M. Geller, P. L. Enright, G. S. Backus, P. A. Bromberg, D. R. Germolec and K. B. Yeatts. 2006. "Induction of Asthma and the Environment: What We Know and Need to Know." *Environmental Health Perspectives* 114: 615-619.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

Texas Westmoreland Coal Co. 2005. East Texas Electric Generating Facility Rules (Rule Log No. 2006-002-117-EN). Letter from M.K. Seglem (Vice President and General Manager) and J. Trouart (Vice President) to K. Hill, Air Quality Planning and Implementation Division, Texas Commission on Environmental Quality. December 7, 2005.

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/osh/os/ostb1619.pdf

USBLS. 2006b. *Fatal Occupational Injuries to Private Sector Wage and Salary Workers, Government Workers, and Self-employed Workers by Industry. All United States, 2005*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/cfoi/cftb0207.pdf

U.S. Census Bureau. 2006. *Topologically Integrated Geographic Encoding and Referencing Database*. Accessed March 13, 2007 at: http://www.census.gov/geo/www/census2k.html

U.S. Department of Energy (DOE). 2002. "Major Environmental Aspects of Gasification-Based Power Generation Technologies." Final Report. December 2002. Washington, DC.

DOE. 2004. "ALOHA Computer Code Application Guidance for Documented Safety Analysis, Final Report." Report DOE-EH-4.2.1.3-ALOHA Code Guidance, June 2004, Office of Environment, Safety and Health, Washington, DC.

DOE. 2006. *Temporary Emergency Exposure Limits (TEELs) [Revision 21 of AEGLs, ERPGs and TEELs for Chemicals of Concern]*. Accessed March 13, 2007 at http://www.eh.doe.gov/chem_safety//teel.html (last updated on October 16, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1995. "SCREEN3 Model User's Guide." EPA-454/B-95-004. Research Triangle Park, NC.

EPA. 2000. "Carbon Dioxide as a Fire Suppressant: Examining the Risks." EPA430-R-00-002. February 2000.

EPA. 2006a. *IRIS Database for Risk Information*. Accessed March 13, 2007 at http://www.epa.gov/iris/

EPA. 2006b. *Acute Exposure Guideline Levels (AEGLs)*. Accessed March 12, 2007 at http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (last updated January 9, 2007).

EPA. 2007. *Acute Exposure Guideline Levels (AEGLs): Ammonia Results*. Accessed April 16, 2007 at http://www.epa.gov/oppt/aegl/pubs/results88.htm (last updated August 28, 2006).

6.18 Community Services

City Data (CD). 2002. *City Data*. Accessed December 1, 2006 at http://www.city-data.com/

Everett, L. 2004. *VA Losing the Ability to Care 'For Him Who Has Borne the Battle'*. Accessed November 30, 2006 at http://www.larouchepub.com/other/2004/3118v_a_hosptls.html

Everett, L. and M. M. Baker. 2004. *LaRouche: Reverse the Policy that Created the Flu Crisis*. Accessed November 30, 2006 at http://www.larouchepub.com/eiw/public/2004/2004_40-49/2004-42/pdf/04-13_41_ecoflu.pdf

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

National Center for Educational Statistics (NCES). 2005. *Public and Private Elementary and Secondary Teachers, Enrollment, and Pupil/Teacher Ratios: Selected Years, Fall 1955 through Fall 2014*. Accessed December 3, 2006 at http://nces.ed.gov/programs/digest/d05/tables/dt05_063.asp

Occupational Safety and Health Administration (OSHA). 1994. *Members of a HAZMAT Team.* Accessed December 3, 2006 at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21384

Quinlivan, J. T. 2003. *Burden of Victory: The Painful Arithmetic of Stability Operations*. Accessed December 2, 2006 at http://www.rand.org/publications/randreview/issues/summer2003/burden.html (last updated August 2, 2006).

Texas Comptroller of Public Accounts (CPA). 2006. *Major Challenges Facing Texas Education Today*. Accessed December 3, 2006 at http://www.cpa.state.tx.us/comptrol/wwstand/wws0512ed/

Texas Department of Public Safety (TDPS). 2003. *Texas Crime by Jurisdiction: Texas Crime Summary*. Accessed December 3, 2003 at http://www.txdps.state.tx.us/administration/crime_records/docs/cr2003/cit03ch9.pdf

Texas Education Agency (TEA). 2005. *Texas Public Schools: District and School Directory for County*. Accessed December 3, 2006 at http://askted.tea.state.tx.us/org-bin/school/SCHOOL_RPT?Y::County::Directory

Texas Fire Chiefs Association (TFCA). 2006. *Texas Fire Chiefs Association: Letter dated May 18, 2006*. Accessed December 3, 2006 at http://www.dshs.state.tx.us/emstraumasystems/StakeholderLetter.pdf

U.S. Census Bureau (USCB). 2006. *National Spending per Student Rises to $8,287*. Accessed November 29, 2006 at http://www.census.gov/Press-Release/www/releases/archives/economic_surveys/006685.html

USACOPS (UC). 2005. *Texas Police Departments*. Accessed December 1, 2006 at http://www.usacops.com/tx/pollist.html

6.19 Socioeconomics

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

Hotel-Online (HO). 2005. *Arlington Convention & Visitors Bureau Reports 2004. Increases in Hotel Occupancy and Average Daily Rate*. Accessed December 1, 2006 at http://www.hotel-online.com/News/PR2005_1st/Feb05_ArlingtonTX.html

Impact DataSource (IDS). 2004. *A Report of the Economic Impact of Ford Park in Beaumont, Texas*. Accessed December 2, 2006 at http://www.co.jefferson.tx.us/eco_dev/fordpark-economicimpactanalysis-full.pdf

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Unemployment Rate (National Unemployment Rates 1996 to 2006)*. Accessed December 3, 2006 at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=LNS14000000

USBLS. 2006b. *Regional and State Employment and Unemployment: July 2006*. Accessed December 2, 2006 at http://www.bls.gov/news.release/archives/laus_08182006.pdf

U.S. Census Bureau (USCB). 2000a. *Projected Population of the United States, by Age and Sex: 2000 to 2050*. Accessed December 1, 2006 at http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf (last updated August 26, 2004).

USCB. 2000b. *Annual Estimates of the Population by Sex and Five-Year Age Groups for the United States: April 1, 2000 to July 1, 2005*. Accessed December 2, 2006 at http://www.census.gov/popest/national/asrh/NC-EST2005/NC-EST2005-01.xls (last updated June 8, 2006).

USCB. 2000c. *Median Age: 2000. Texas by County*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF1_U_M00022&-ds_name=DEC_2000_SF1_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=4001|zf=0.0|ms=thm_def|dw=10.50392852716582|dh=6.0589838038

31548|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-89.504051|cy=39.739275000000006|zl=8|pz=8|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=04000US17|ds=DEC_2000_SF1_U|sb=50|tud=false|db=050|mn=27.5|mx=42.1|cc=1|cm=1|cn=5|cb=|um=Years|pr=1|th=DEC_2000_SF1_U_M00022|sf=N|sg=

USCB. 2000d. *Per Capita Income in 1999: 2000, Texas by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF3_U_M00270&-ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=1.9557697048764706E7|dh=1.4455689123E7|dt=gov.census.aff.domain.map.LSRMapExtent|if=gif|cx=-1159354.4733499996|cy=7122022.5|zl=10|pz=10|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=01000US|ds=DEC_2000_SF3_U|sb=50|tud=false|db=040|mn=8185|mx=28766|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00270|sf=N|sg=

USCB. 2000e. *Median Household Income in 1999: 2000, Texas by County*. Accessed December 24, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF3_U_M00024&-ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=27.393417839603167|dh=17.698715125323893|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-100.0765285|cy=31.170218499999997|zl=9|pz=9|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=04000US48|ds=DEC_2000_SF3_U|sb=50|tud=false|db=050|mn=7069|mx=33345|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00270|sf=N|sg=

USCB. 2000f. *Per Capita Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000g. *Median Household Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00024&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2005a. *Population Pyramids of Texas*. Accessed December 1, 2006 at http://www.census.gov/population/projections/14PyrmdTX1.pdf (last updated April 20, 2005).

USCB. 2005b. *Texas: Physical Housing Characteristics for Vacant Housing Units*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=04000US48&-qr_name=ACS_2005_EST_G00_S2505&-ds_name=ACS_2005_EST_G00_&-redoLog=false

USCB. 2005c. *Texas: Industry by Sex and Median Earnings in the Past 12 Months (In 2005 Inflation-Adjusted Dollars) for the Civilian Employed Population 16 Years and Over*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-

geo_id=04000US48&-qr_name=ACS_2005_EST_G00_S2403&-ds_name=ACS_2005_EST_G00_&-redoLog=false

USCB. 2005d. *Percent of Occupied Housing Units that are Owner-Occupied: 2005. United States by State*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=01000US&-tm_name=ACS_2005_EST_G00_M00621&-ds_name=ACS_2005_EST_G00_&-_MapEvent=displayBy&-_dBy=040#?388,250

U.S. Government Printing Office (GPO). 2003. *General Decision: TX20030083 TX83 (Average Wages for Trades in Freestone, Leon and Limestone Counties, Texas)*. Accessed December 1, 2006 at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=Davis-Bacon&docid=TX20030083

6.20 Environmental Justice

59 *Federal Register* 7629. "Executive Order Number 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." February 11, 1994. Federal Register [Volume 59, No. 32].

Council on Environmental Quality (CEQ). 1997. "Environmental Justice Guidance under the National Environmental Policy Act." Executive Office of the President. December 10, 1997. Washington, DC.

FutureGen Alliance (FG Alliance). 2006c. "Heart of Brazos Site Environmental Information Volume."

U.S. Census Bureau (USCB). 2006. *American FactFinder*. Accessed November 12, 2006 at http://factfinder.census.gov

U.S. Department of Energy (DOE). 2006. *Environmental Justice Definition*. Accessed November 12, 2006 at http://www.lm.doe.gov/env_justice/definition.htm (last updated December 13, 2006).

6.3 CLIMATE AND METEOROLOGY

6.3.1 INTRODUCTION

This section addresses the region's climate and meteorology and the potential impacts on construction and operation of the proposed FutureGen Project.

6.3.1.1 Region of Influence

The ROI for climate and meteorology includes the proposed Jewett Power Plant Site, sequestration site, and the utility and transportation corridors.

6.3.1.2 Method of Analysis

DOE reviewed the Jewett EIV (FG Alliance, 2006c) report to assess the potential impacts of climate and meteorology on the proposed FutureGen Project. Factors identified in this section include normal and extreme temperatures, and severe weather events such as tornadoes and floods. There were no uncertainties identified in relation to climate and meteorology at the proposed Jewett Site.

DOE assessed the potential for impacts based on the following criteria:

- Potential for aspects of the project to fail or cause safety hazards due to temperature variations and extremes; and
- Potential for aspects of the project to fail or cause safety hazards due to a high probability for severe weather events.

6.3.2 AFFECTED ENVIRONMENT

This section describes the east-central Texas region's climate and provides information on climate, meteorology, and severe weather events for Leon, Limestone, Freestone, and Anderson counties.

6.3.2.1 Local and Regional Climate

The **Köppen Climate Classification System** is the most widely used system to classify world climates. Categories are based on the annual and monthly averages of temperature and precipitation. The Köppen System recognizes five major climatic types, and each type is designated by a capital letter (A through E). Additional information about this classification system is available at http://www.blueplanetbiomes.org/climate.htm (Blue Planet Biomes, 2006).

The proposed Jewett Power Plant Site is located at the intersection of Freestone, Leon, and Firestone counties, just north of the town of Jewett in east-central Texas, and about halfway between Dallas and Houston. The proposed sequestration sites are located 33 miles (53.1 kilometers) northeast of the proposed power plant site in Freestone and Anderson counties. This entire region has a mid-latitude, subtropical climate consistent with the Köppen Climate Classification "Cfa." The Köppen Climate Classification System recognizes five major climate types based on annual and monthly temperature and precipitation averages. Each major type is designated by a capital letter A through E. The letter "C" refers to humid, mid-latitude climates where land/water differences play a large part. These climates have warm, dry summers and cool, wet winters. Further subgroups are designated by a second, lowercase letter which distinguishes seasonal temperature and precipitation characteristics. The letter "f" refers to moist climates with adequate precipitation in all months and no dry season. This letter usually accompanies A, C, and D climates. To further denote variations in climate, a third letter was added to the code. The letter "a" refers to hot summers where the warmest month is over 72°F (22°C). These can be found in C and D climates. Maximum precipitation occurs in the spring and fall, and minimum precipitation occurs in the summer. Average annual precipitation is about 15 inches (38.1 centimeters), and measurable precipitation occurs about 80 days per year. Average annual winter snowfall is 1.4 inches (3.6 centimeters) (FG Alliance, 2006c).

Winters in the region are generally mild with average high and low January temperatures around 56.1°F (13.4°C) and 45.2°F (7.3°C), respectively. On average, the temperature falls below 32°F (0°C) 33 days a year. In the summer, the maximum high temperature is 95.6°F (35.3°C) and the minimum low temperature is 73.0°F (22.8°C). High temperatures reach 90°F (32.2°C) more than 25 times each summer on average, and around 11 times during the spring and fall. Table 6.3-1 summarizes representative temperature, precipitation, and wind speed data. Climate data for this table were based on 30 years of weather data from 1971 to 2000, and was assembled from data obtained by the Waco Regional Airport and Huntsville Municipal Airport weather stations located 61 miles (99 kilometers) west-northwest and 60 miles (96 kilometers) southeast of the proposed power plant site, respectively (FG Alliance, 2006c).

Table 6.3-1. Seasonal Weather Data

Weather Parameter	Spring	Summer	Fall	Winter
Average Daily Temperature, °F (°C)	71 (21.6)	84 (28.9)	59 (15.0)	52 (11.1)
Precipitation, inches (centimeters)	4 (10.1)	2.9 (7.3)	4 (10.1)	3.3 (8.3)
Average Wind Speed, miles per hour (kilometers per hour)	11.6 (18.6)	9.8 (15.7)	10.2 (16.4)	11.7 (18.8)

°F = degrees Fahrenheit; °C = degrees Celsius.
Source: FG Alliance, 2006c.

A wind rose is a graph created to show the directional frequencies of wind. Representative wind rose data for 2005 were presented in Figure 6.3-1. The wind rose is representative of the percent of time that the wind blows at a particular speed and direction. The concentric circles on the wind rose represent percentage of time. The wind rose is based on combined climate data from the Waco Regional Airport and Huntsville Municipal Airport weather stations. As the wind rose indicates, the most common wind directions are from the south and the south-southeast, and from the north to a lesser extent. The average annual wind speed is about 10.8 mph (17.4 kmph).

Average seasonal wind speeds vary from of 11.7 mph (18.8 kmph) in the winter to a low of 9.8 mph (15.7 kmph) in the summer (FG Alliance, 2006c). For the proposed FutureGen Project, the primary use of wind rose data is for evaluating potential hazardous material releases to estimate plume transport times and determine potential population exposure.

The proposed power plant site and sequestration site are located in the east-central region of Texas, which historically experiences a wide spectrum of weather phenomena including cold and hot days, high winds, heavy rainfalls, thunderstorms, localized floods, and tornadoes. Based on historical norms, the 1,000-square-mile (2,600-square-kilometer) region around the proposed site could expect one tornado greater than F1 intensity every 5 years (FG Alliance, 2006c).

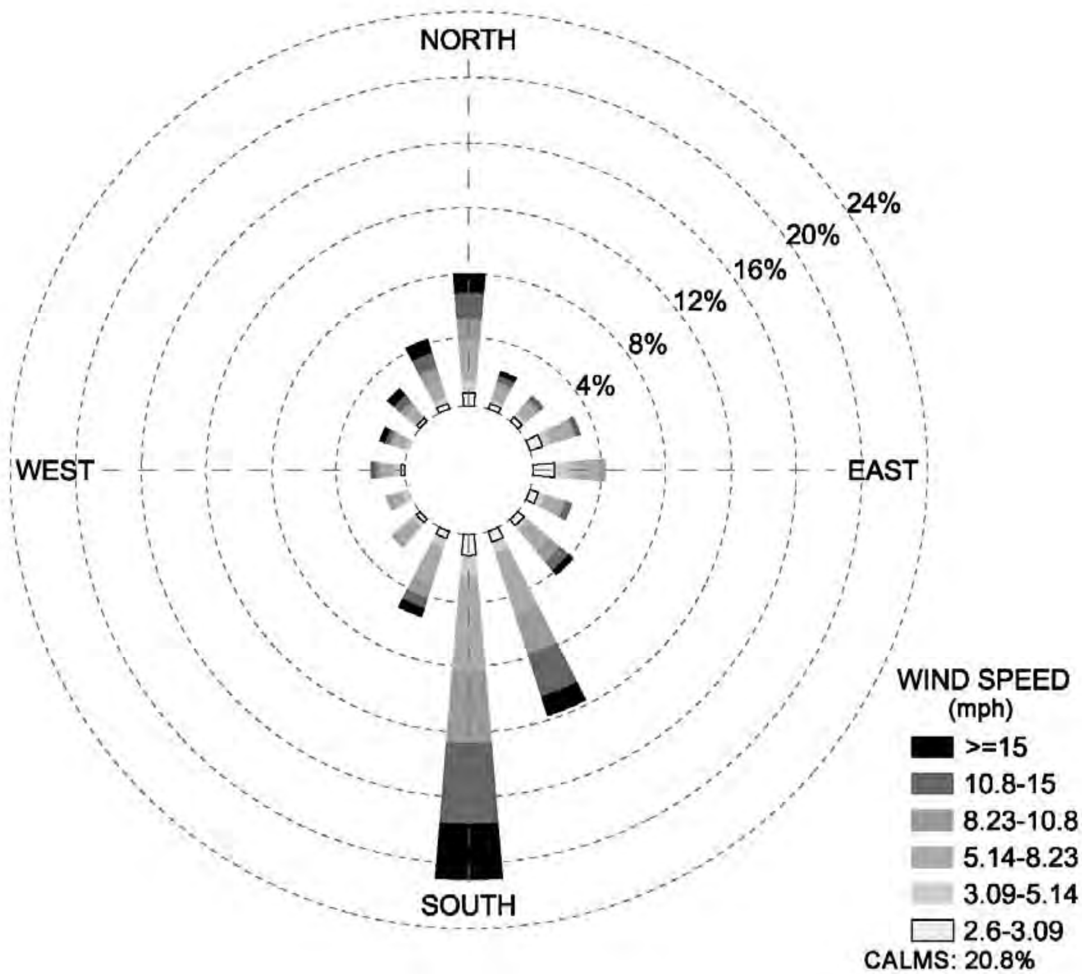


Figure 6.3-1. Wind Rose for the Jewett Region

6.3.2.2 Severe Weather Events

Relevant severe weather events for the ROI include tornadoes, floods, and drought. The proposed project site is located more than 100 miles (161 kilometers) inland from the Gulf Coast. For this reason, coastal hurricanes do not occur within the region and have been excluded from discussion.

Tornadoes

The National Oceanic Atmospheric Administration (NOAA) documents tornado activity for each Texas county (NOAA, 2006). The Fujita Scale is a standard qualitative metric to characterize tornado intensity based on the damage caused. This scale ranges from F0 (weak) to F6 (violent). From 1950 to 2006, 39 tornados were reported in the three-county region of the proposed project site (Freestone, Leon, and Limestone counties). Of the 39

> The most common metric for tornado strength is the **Fujita Scale**. There are six categories on this scale. F0 and F1 are considered weak, F2 and F3 are strong, and F4 through F6 are violent. Each category represents a qualitative level of damage and an estimated range of sustained wind speed delivered by the tornado. Additional information about the Fujita Scale is available at http://www.tornadoproject.com/fscale/fscale.htm (The Tornado Project, 1999).

tornadoes reported, 20 caused property damage totaling $34 million. Over the same time span, there were 30 tornadoes reported in Anderson County, and 23 caused a total of $30.4 million in property damage. Table 6.3-2 summarizes the number of various tornadoes reported and how many caused property damage (FG Alliance, 2006c). Collectively, these four counties span 3,929 square miles (10,176 square kilometers).

Table 6.3-2. Regional Tornado Activity, 1950 to 2006

	Freestone, Leon, and Limestone Counties		Anderson County	
Fujita Intensity	**Quantity**	**Caused Property Damage**	**Quantity**	**Caused Property Damage**
F0	16	4	6	2
F1	10	5	16	14
F2	11	10	4	4
F3	1	1	4	3
F4	1	0	0	0
F5	0	0	0	0
Total	**39**	**20**	**30**	**23**

Source: National Climatic Data Center (NCDC), 2006.

Floods

The proposed power plant site is located outside of the 500-year floodplain. The CO_2 pipeline corridors extend from the Brazos River Basin to the northeast across the Trinity River Basin. There are approximately 30 significant water bodies (creeks and streams) along the proposed CO_2 pipeline corridor. Multiple segments of the CO_2 pipeline corridor and about one-fourth of the land area inside the proposed sequestration site would be within the 100-year floodplain. Portions of the proposed utility corridors and proposed transportation infrastructure corridors would also be within the 100-year floodplain. From 1993 to 2006, 57 flood events were reported in the three-county region of the proposed project site (Freestone, Leon, and Limestone counties). Property damage was reported for only six of these floods, and the maximum damage from any single flood was $50,000. Twenty flood events have been documented in Anderson County since 1994, with minimal damage reported (FG Alliance, 2006c).

Drought

Texas has suffered notable period of drought since the 1930s with extended periods of severe to extreme drought in 1933 to 1935, 1950 to 1957, 1962 to 1967, 1988 to 1990, 1996, and 1998 to 2002. These droughts were more common and widespread in the Rio Grande Basin in the western part of the state. A statewide network of data collection sites, operated by state and federal agencies, has been established to monitor drought conditions. These sites provide real-time climate, steam flow, aquifer, and reservoir information to water management professionals to develop drought mitigation and response plans. Additional information on the State of Texas Drought Preparedness Plan can be found at http://www.txwin.net/DPC/State_Drought_Preparedness_Plan.pdf.

6.3.3 IMPACTS

6.3.3.1 Construction Impacts

Power Plant Site

Severe temperature or weather conditions may temporarily delay construction at the proposed power plant site. Some aspects of construction could not be performed in the rain or snow, or when temperatures are too low, so delays could potentially arise due to unusually cold or wet weather conditions. These conditions could delay material deliveries to and from the construction site. However, it is anticipated that the impacts would be relatively minor and temporary, as the region's climate is relatively mild.

A strong thunderstorm, flood, or tornado could also cause construction delays; however, the probability that these adverse climate conditions would compromise construction schedules would be small. In addition, the statistical probability of a tornado greater than F1 intensity would be about once every 5 years for the 1,000-square-mile (2,600-square-kilometer) region around the power plant site. Because the proposed power plant site would cover about 0.6 square mile (1.6 square kilometers), the probability that a strong tornado would affect the site during construction would be low. The risks posed to construction safety by climate and severe weather would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements (FG Alliance, 2006c).

Severe or extreme drought conditions could increase the potential for wildfires in the area. Drought conditions would also increase the number of water trucks needed to reduce fugitive dust emissions and to support other construction activities. In dry, hot weather, construction workers may need to wear a dust mask and work for shorter time intervals between breaks.

Sequestration Site

Severe temperature or weather conditions could temporarily delay construction at the proposed sequestration site. Portions of the proposed sequestration site would be within the 100-year floodplain, so there would be a possibility for flood conditions during construction. However, because construction activities at the proposed sequestration site would be performed over a relatively short time, the potential impact of flood on construction activities would be minimal.

It would also be possible for a strong tornado to impact construction activities at the proposed sequestration site. However, because construction activities would occur over a relatively small area and for a limited time span, and because the statistical probability of for a tornado greater than F1 intensity is once every 5 years, it is unlikely that a strong tornado would have a direct or indirect impact on construction activities at the proposed sequestration site.

Utility Corridors

Severe temperature or weather conditions could temporarily delay construction at the proposed utility corridors. The electrical corridor would span several miles and portions of the corridor would be within the 100-year floodplain. The sequestration corridor would span as much as 59 miles (95 kilometers) across regions within the 100-year floodplain. Accordingly, the construction activities along these corridors could be affected by flood conditions in the region. However, because only portions of the corridors would cross the 100-year floodplain, and given the limited time of construction along any portion of the corridor, the possibility that a flood would have direct or indirect impacts on construction would be low.

It would also be possible for a strong tornado to impact corridor construction activities. However, because construction activities would occur over a relatively small area and for a limited time, and the probability for a tornado greater than F1 intensity is once every 5 years, it is unlikely that a strong tornado would have a direct or indirect impact on utility corridor construction activities.

Transportation Corridors

There would be no direct or indirect impact of climate or severe weather on transportation infrastructure corridors because new roads or rail lines would not be required.

6.3.3.2 Operational Impacts

Power Plant Site

It is unlikely that operations at the proposed power plant site would be directly or indirectly affected by temperature or snowfall extremes in the region. Historically, summer temperatures are very warm, winters are mild, and significant snowfalls are rare. The proposed power plant site would be designed to operate under the expected range of temperature and snowfall conditions.

Topographic features around the proposed power plant emissions stack could potentially influence the effect of stack emissions downwash. In addition, water vaporization from cooling tower operation would potentially contribute to local fog conditions. Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Although this potential impact is referred to as fogging, cooling tower plume touchdown or fogging is usually a temporary event for only a few operational hours. Section 6.2 provides further discussion.

The possibility of a strong tornado in the region poses the potential for both direct and indirect impacts on power plant operations. A strong tornado could directly impact plant operations if sufficient damage were incurred at the plant site. Indirect impacts could occur if a strong tornado struck nearby communities and affected the ability of workers or supplies to reach the site. However, the probability of a tornado greater than F1 intensity in the 1,000-square-mile (2,600-square-kilometer) region around the proposed power plant site would be once every 5 years. Because the proposed power plant site occupies less than 1 square mile (2.6 square kilometers), the probability that a strong tornado would impose significant direct or indirect impacts on operations would be low (FG Alliance, 2006c).

It is also very unlikely that a flood would cause a direct or indirect impact on operations at the proposed power plant site because the site would be located outside of the 500-year floodplain. The risks posed on operational safety would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements.

Severe or extreme drought conditions could increase the potential for wildfires in the area. Ready availability of water is crucial for both fire protection and daily power plant operations. Because severe to extreme drought conditions are likely over the planned life of the facility, contingency plans and design features must be established to address these conditions to ensure that the necessary water is always available.

Sequestration Site

Operations at the proposed sequestration sites could be affected by climate and severe weather conditions in the region. The Trinity River flows through two of the three proposed sequestration sites, so there would be a possibility for flood conditions. To mitigate potential impacts, injection equipment would be installed at topologically favorable locations (those outside of floodplain areas) within these proposed sequestration sites.

It would also be possible for a strong tornado to affect operations at the proposed sequestration site. However, because the total area of the proposed sequestration site would be relatively small, and because the statistical chance for a tornado greater than F1 intensity is only once every five years in a 1,000-square mile (2,600-square kilometer) region around the proposed power plant site, it is unlikely that a strong tornado would have a direct or indirect impact on operations.

Utility Corridors

Climate or severe weather would not impact operations of utilities that would be installed underground. However, severe weather would potentially affect operations of the utility corridor components installed above ground (e.g., electrical transmission lines, pump stations). Portions of the utility corridors would be located within the 100-year floodplain, so there would be some potential for impact due to a flood. This could be mitigated through engineering design and placement of equipment in topologically favorable locations.

A strong tornado could sever transmission lines and support structures or damage other aboveground utility equipment. However, because the aboveground utilities cover a relatively small area, and because the chance for a tornado stronger than F1 intensity in the region would be once every 5 years, the potential impact of a tornado on the utility corridors would be low.

Transportation Corridors

Operation of the transportation corridors could be affected by severe weather conditions in the region. Cold weather, snow, and icy conditions could interfere with the material deliveries to and from the site by road or rail. However, because the region's climate is generally mild and snowfall is rare, the potential impact of these conditions would be low.

Because portions of the transportation corridors would be within the 100-year floodplain, road and rail travel could be interrupted by localized flood conditions; however, these effects would most likely be small and temporary. The probability that a tornado stronger than F1 intensity would strike the region would be once every 5 years. Because the transportation corridor would represent only a small fraction of this area, the statistical probability that a strong tornado would have direct or indirect impact on operations would be low.

6.4 GEOLOGY

6.4.1 INTRODUCTION

The geologic resources of the proposed Jewett Power Plant Site, sequestration site, and related infrastructure corridors are described in this section, followed by a discussion of the potential impacts to these resources.

6.4.1.1 Region of Influence

There are three ROIs for geologic resources. The first ROI includes the land area on the surface that could be directly affected by construction and operation of the FutureGen Project at the proposed Jewett Power Plant Site and sequestration site. The second ROI includes the subsurface geology related to the radius of the injected CO_2 plume. Numerical modeling indicates that the plume radius associated with injecting 2.8 million tons (2.5 MMT) of CO_2 per year for 20 years would be 1.7 miles (2.7 kilometers), equal to an area of 5,484 acres (2,220 hectares) (FG Alliance, 2006c). The plume radius and land area above the CO_2 plume are shown in Figure 6.4-1. The third ROI is a wider area (100 miles [160.9 kilometers]) that was evaluated to include potential effects from seismic activity.

6.4.1.2 Method of Analysis

The geologic setting includes the near-surface geology of the entire project and all deeper strata that make up the proposed sequestration reservoir. DOE evaluated the potential effects of the construction and operation of the proposed project on specific geologic attributes. In addition, DOE assessed the potential for impacts on the project due to geologic forces (e.g., earthquakes). The potential for impacts was based on the following criteria:

- Occurrence of local seismic destabilization (induced seismicity) and damage to structures;
- Occurrence of geologic-related events (e.g., earthquake, landslides, sinkholes);
- Destruction of high-value mineral resources or unique geologic formations, or rendering them inaccessible;
- Alteration of geologic formations;
- Migration of sequestered CO_2 through faults, inadequate caprock or other pathways such as abandoned or unplugged wells;
- Human exposure to radon gas; and
- Noticeable ground heave or upward vertical displacement of the ground surface.

DOE based its evaluation on a review of reports from state geologic surveys and information provided in the Jewett EIV (FG Alliance, 2006c).

DOE identified uncertainties in relation to geological resources at the Jewett Site. These include the porosity and permeability of the target formation where CO_2 would be sequestered. Analog well data was analyzed; however, site-specific test well data was not collected. Detailed geologic mapping has been conducted at the proposed Jewett Sequestration Site, and a fault has been identified in the subsurface ROI. Although it appears that this is a “sealing” fault, as opposed to a transmissive one, there is uncertainty concerning the transmissivity of this fault, and the potential presence of other faults in the area. In this case, regional geologic maps and tectonic stress regimes were analyzed using best professional judgment to determine the likelihood of other faults in the area.

6.4.2 AFFECTED ENVIRONMENT

6.4.2.1 Geology

The proposed Jewett Power Plant Site is 400 acres (162 hectares) in size. The entire site consists of land reclaimed after the mining of lignite coal. The elevation of the proposed site varies from a high of 492 feet (150 meters) above mean sea level (AMSL) to a low of 426 feet (130 meters) AMSL.

The Jewett area is located within the East Texas Salt Basin, one of the basins that formed marginally to the Gulf of Mexico during the early Mesozoic. About 3.7 miles (6 kilometers) of Mesozoic and Tertiary sediment was deposited in this basin.

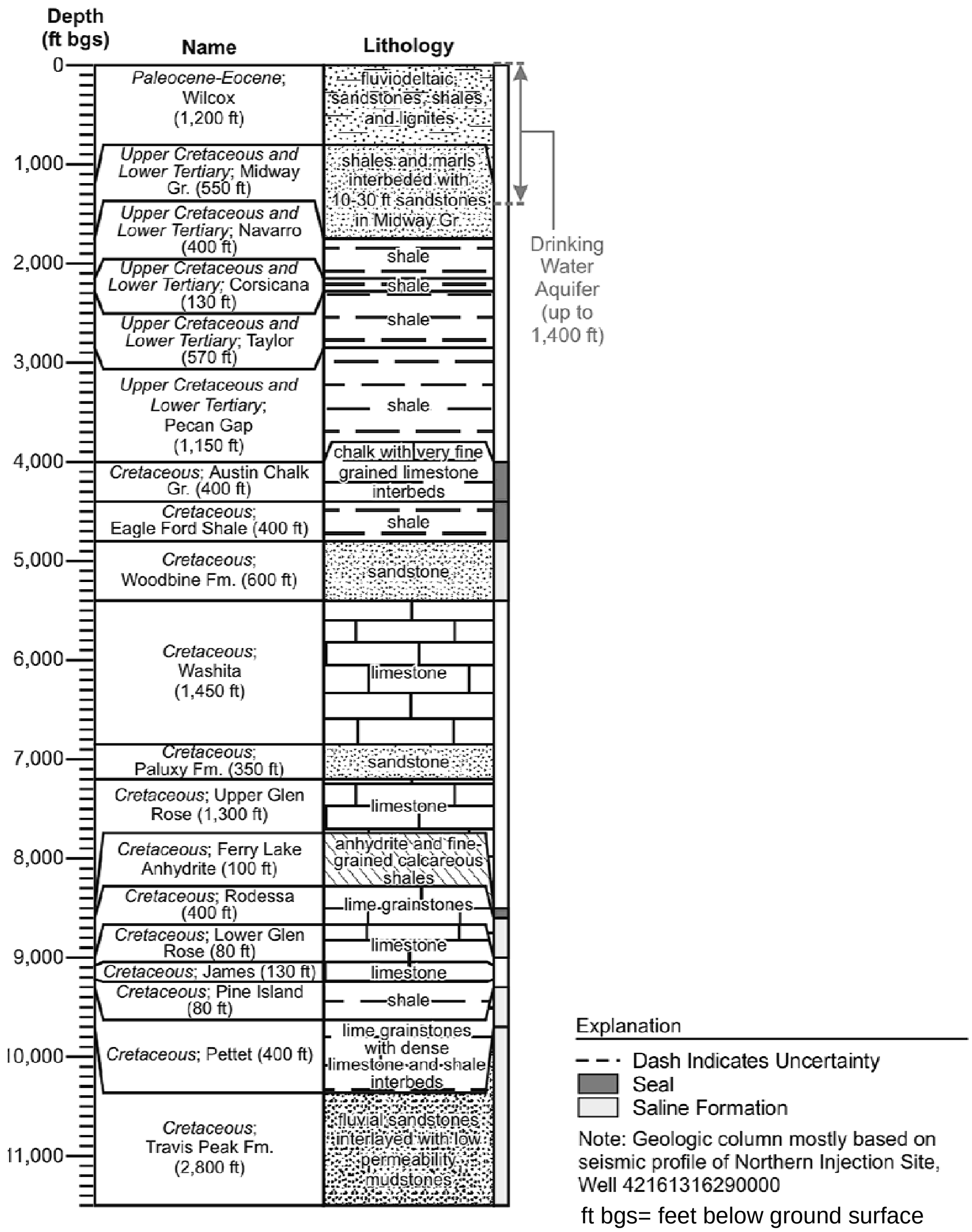
Figure 6.4-2 is a stratigraphic column of the geology beneath the proposed Jewett Sequestration Site. The bedrock at the proposed power plant site is the Paleocene-Eocene-age Calvert Bluff formation, which is part of the Wilcox Group. This formation consists mostly of mudstone with various amounts of sandstone, lignite, and ironstone concretions. The lignite seams are typically 1 to 20 feet (0.3 to 6.1 meters) thick and occur mostly in the lower part of the formation (FG Alliance, 2006c). The geology at the proposed plant site and other areas where construction would occur is similar. The Wilcox Group strata are estimated to be approximately 0.2 mile (0.3 kilometer) thick at the proposed injection site and are underlain by approximately 0.8 mile (1.3 kilometers) of primarily shale, with some minor sandstone and chalk/limestone.

Lying below these strata is the proposed primary target formation (or sequestration reservoir) for CO_2 injection, the Cretaceous-age Woodbine formation. This formation is brine saturated and is 500 feet (152.4 meters) thick below the project site. The Woodbine is a quartzarenite sandstone, or a “clean” sandstone consisting of greater than 95 percent quartz. It is overlain by 400 feet (121.9 meters) of low permeability shales of the Eagle Ford Shale formation, which is the primary seal for the sequestration reservoir.

The Cretaceous-age Travis Peak formation is proposed as an optional target reservoir of low permeability for additional research purposes. It occurs at a depth of 2 miles (3.2 kilometers) below the earth’s surface (see Figure 6.4-2). At the Jewett Site, the Travis Peak is estimated to consist of up to 0.4 miles (0.6 kilometers) of sandstones interbedded with mudstones (FG Alliance, 2006c).

Structural dip on the Woodbine and Travis Peak formations is less than one degree. The principal tectonic features of the region include down-to-the coast normal faults southeast and northwest of the injection sites, and various salt tectonic features. The Mexia-Talco fault zone is located 30 to 35 miles (48.1 to 56.3 kilometers) west of the injection site, and is the location of the nearest major faults to the proposed Jewett Sequestration Site. This area is outside of the subsurface ROI, and also contains significant hydrocarbon accumulations indicating that faults in that area act as seals.

Within 10 miles (16.1 kilometers) of the proposed injection wells, surface faults are present and are clustered around salt domes located south and east of the injection wells. Throws (i.e., distance of fault slippage, or movement) for most of these surface faults are not large, with generally less than 200 feet (61 meters) of displacement. These faults generally trend southwest to northeast. A larger fault with a throw of about 600 feet (183 meters) is associated with the Butler salt dome, about 10 miles (16.1 kilometers) south and east of the proposed sequestration site. Also within 10 miles (16.1 kilometers) of the sequestration site are other salt tectonic features related to growth of the salt domes. East-west trending graben structures are also present that are expected to have 50 to 200 feet (15.2 to 61 meters) of throw.



Source: FG Alliance, 2006c

Figure 6.4-2. Stratigraphy of the Jewett Injection Area

A south-dipping normal fault, trending almost directly west to east, is present within the subsurface ROI. Three-dimensional seismic data reveal the fault's presence at the southern margin of the proposed injection zone. The injection well as proposed would be located to the north of this fault and would not be cut by the fault. The fault has been interpreted as having a throw of approximately 200 feet (61 meters) at the stratigraphic level of the Rodessa carbonates, and it has been concluded that because the Eagle Ford Shale is 400 feet (122 meters) thick in the immediate area of the fault, the fault places shale against shale and should act as a competent seal. In addition, there are small normal faults that cut the Woodbine within the sequestration site, but it is reported that they do not offset the Eagle Ford formation caprock seal (FG Alliance, 2006c). These faults are still potential planes of weakness within the subsurface ROI.

Because of the presence of faults in the area, a regional geologic stress analysis was conducted for this EIS to yield insight into the orientation of open fractures and possible transmissive faults. The stress trend, or principle direction, is southwest to northeast. Stress values are dependant on depth and vertical stresses are greater than the horizontal stresses. The proposed injection site is in an overall normal-fault type extensional stress regime. Faults and fractures parallel, or sub-parallel, to the greatest principal stress in this setting are known to be more likely to be transmissive, assuming the stress differentials between the vertical overburden and the minimum horizontal principal stress are large enough to generate the critical shear stress necessary for opening/movement (FG Alliance, 2006c); and faults or fractures not parallel to this direction are more likely to be sealing. As mentioned above, most faults within 10 miles (16.1 kilometers) of the proposed Jewett sequestration site trend southwest to northeast and are thus more likely to be transmissive. However, the west to east trending normal fault present at the sequestration site is not parallel or sub-parallel to the greatest principal stress direction, and therefore is likely to be sealing. However, if this fault is not sealed, it could act as a pathway to potentially more transmissive southwest to northeast-trending faults.

Geological Resources in the Jewett Area

The geologic resources present in the overall project area (inclusive of the proposed power plant site, sequestration site, and utility and transportation corridors) are coal (lignite) and oil and gas. The proposed power plant site and portions of the corridors are located on reclaimed land of a former lignite mine. Several active gas wells are located within the proposed pipeline corridor.

The project area should not be affected by subsidence (sinking or lowering of the ground surface), because most factors known to cause subsidence are not present in the project area. Such factors include undermining by coal or other mines, and withdrawal of large quantities of water from aquifers, although groundwater is planned as the source of supply for the power plant.

Over 1,200 oil and gas wells exist within the vicinity (i.e., within 10 miles [16 kilometers]) of the proposed Jewett Sequestration Site (refer to Figure 6.4-1). Of these, 275 are of unknown depth. The total depth of the remaining 934 wells ranges from 527 feet to 3.4 miles (160.6 meters to 5.5 kilometers) (UTA, 2006). Wells that penetrate the primary seal are of primary importance because they pose the highest risk for CO_2 leakage. The primary seal for the Travis Peak formation is the Ferry Lake formation, a regional seal of low permeability anhydrite and fine-grained calcareous shale that occurs at a depth of approximately 1.6 miles (2.6 kilometers) below the ground surface. The primary sequestration reservoir at this site is the Woodbine formation, which is overlain by the Eagle Ford Shale occurring at a depth of approximately 0.8 mile (1.3 kilometers) below ground surface. It is reported that up to 57 known wells penetrate the Eagle Ford Shale that lie within the footprint of the 20-year 2.8 million tons (2.5 MMT) per year plume (radius of 2.21 miles [3.6 kilometers]) (FG Alliance, 2006c).

6.4.2.2 Seismic Activity

The proposed Jewett Site is located roughly 400 miles (644 kilometers) southwest of an area of seismic activity known as the New Madrid Fault Zone, which is located in the general area of the common borders of southern Illinois, western Kentucky and Tennessee, and southeastern Missouri. This area has spawned the most powerful earthquakes recorded in the continental United States (Richter magnitudes of 8.0). However, the proposed Jewett location is far enough away that earthquakes are not commonly felt.

The closest earthquake to the proposed power plant site occurred in 1932 and was centered about 50 miles (81 kilometers) northwest of the project area. It had a Richter magnitude of 4.0, and was likely induced by oil production (FG Alliance, 2006c). Earthquakes registered at this magnitude cause indoor items to shake, but significant damage to well built structures is rare.

A search of the United States Geological Survey (USGS) database of historic earthquakes shows that since 1974, four earthquakes have occurred within 100 miles (161 kilometers) of the approximate midway point between the proposed power plant and sequestration sites. The Richter magnitude of the earthquakes ranged from 2.3 to 3.4. The most recent seismic event, on May 31, 1997, was a 3.4 magnitude earthquake centered 110 miles (177 kilometers) from the midpoint between the power plant and sequestration site (USGS, 2006).

East Texas is not seismically active. As discussed previously, minor earthquakes are known to occasionally occur (with associated damage on the order of items falling from shelves). Devastating earthquakes (i.e., almost complete destruction over large areas) are very rare in the central U.S., occurring about once every 700 to 1,200 years. The last strong earthquake to strike the Midwest happened on October 31, 1895. The quake, centered just south of Illinois in Charleston, Missouri, had an estimated magnitude of 6.8 on the Richter scale. Although this quake was widely felt throughout the mid-continental United States, it caused serious damage only in the immediate Charleston area (ISGS, 1995).

6.4.2.3 Target Formation Properties

Characteristics

Depth

The proposed sequestration site is underlain by a deep saline formation with four main injection zones: the Woodbine sandstone, the Rodessa and Pettet lime grainstones, and the Travis Peak formation, which are all located beneath a primary seal, the Eagle Ford Shale.

The primary target formation is the Woodbine formation that extends from 1.0 mile (1.6 kilometers) to 1.1 miles (1.8 kilometers) below the ground surface, while the Travis Peak and associated overlying rocks (the Rodessa and Pettet lime grainstones) extend from 1.7 miles (2.7 kilometers) to approximately 2.1 miles (3.4 kilometers) below the ground surface.

Injection Rate Capacity

Due to their previous depositional environment (wave-dominated delta), the Woodbine sandstones are known to be locally very permeable. The depositional environment affects lateral changes in Woodbine porosity and permeability that would affect well plume geometry. Although numerical modeling indicates that the proposed injection rate could be met by a single Woodbine well, two primary injection wells separated by approximately 6 miles (9.6 kilometers) have been proposed to avoid plume interference caused by potential lateral changes in Woodbine porosity and permeability. The second well helps to reduce plume size and provides backup capacity during well maintenance and monitoring activities (FG Alliance, 2006c). A third well is proposed to be an experimental well in the Travis Peak formation, which has a much lower permeability than the Woodbine formation.

Because of the Travis Peak formation’s low reservoir permeabilities and rapid lateral pinch-outs of individual sand bodies, the injection rate here is limited by the maximum pressure that can be safely maintained without causing reservoir fracturing. Site-specific data collection would be necessary to determine the maximum safe injection pressure.

Storage Capacity

The Woodbine formation is a 500-foot (152.4-meter) thick clean sandstone composed of greater than 95 percent quartz. Lower Woodbine sandstones typically have porosity values of 25 percent, with permeability values of several hundreds of milidarcies (md) to 1,200 md. Upper Woodbine sandstones are more porous (25 to 30 percent), with permeability values of greater than 3,000 md.

The Travis Peak formation, the optional secondary target sequestration formation, consists of 0.5 mile (0.8 kilometer) of stacked fluvial sandstones interbedded with low-permeability mudstones, comprising 800 to 900 feet (243.8 to 274.3 meters) of net sandstone, with porosity ranging from 5 percent to 8 percent. The Pettet carbonate grainstone overlies the Travis Peak, is approximately 400 feet (122 meters) thick, and consists of lenticular, porous limestones with dense limestones and thin shale interbeds. The Pettet's permeability is reported to be up to 125 md. The Rodessa carbonate, below the Ferry Lake Anhydrite, is 350 to 400 feet (106.7 to 121.9 meters) thick with 10- to 40-foot (3- to 12-meter) thick zones of permeability up to 125 md (FG Alliance, 2006c).

Numerical modeling indicates that the target formations would have adequate capacity. However, modeling indicates that the Travis Peak formation would hold 5.5 million tons (5.0 MMT) of CO_2 during 20 years of injection and after that time CO_2 would reach the proposed production/pressure relief wells (FG Alliance, 2006c). To increase reservoir capacity, four brine production wells would be located around the injection well to this formation.

Seals, Penetrations, and Faults

Primary Seal

The ultimate or primary caprock seal for the Jewett Sequestration Site is the Eagle Ford Shale. The Eagle Ford is the main seal for some of the largest oilfields in East Texas and is approximately 400 feet (122 meters) thick and has a permeability greater than or equal to 0.01 md in the CO_2 sequestration area. Over 0.4 mile (0.6 kilometers) of low permeability carbonates and shales above the Eagle Ford provide additional barriers to vertical migration of CO_2.

Secondary Seal

Another minor seal for the Travis Peak formation optional reservoir, the Ferry Lake formation, is located approximately 0.6 mile (1.0 kilometers) below the Woodbine. The Ferry Lake consists of interbedded anhydrite, and low permeability carbonates and cemented quartz sandstone. Anhydrites are known to have low permeability and also tend to heal if fractured. The Rodessa formation, directly underlying the Ferry Lake, often has a well-developed anhydrite section that would also retard vertical flow (FG Alliance, 2006c).

Existing well bores are potential pathways for vertical migration of CO_2, especially if they are known to penetrate the primary seal and are not properly abandoned. Fifty-seven wells that penetrate the primary seal are located within the maximum plume footprint of the two Woodbine CO_2 injection wells. Twenty-nine of these wells have abandonment records on file at the Railroad Commission of Texas (FG Alliance, 2006c).

One of the proposed CO_2 injection wells would be located to the north of a south-dipping normal fault that intersects the primary seal, but it is interpreted to be a sealing fault as it does not offset the Eagle Ford Shale, but instead places shale against shale.

Relation of Primary Seal to Active or Transmissive Faults

As discussed previously, the known fault in the subsurface ROI (located within the proposed sequestration reservoir, the Woodbine formation) is thought to be a sealing fault. The area is not seismically active and no active or transmissive faults are expected to be present in the area.

6.4.2.4 Geologic Sequestration Studies, Characteristics and Risk Assessment

Currently, there are four CO_2 injection sites worldwide under detailed study. These are the Rangely, Weyburn, In Salah, and Sleipner projects. They are located in the United States, Canada, Algeria, and Norway, respectively. Rangely and Weyburn involve enhanced oil recovery (EOR), In Salah involves enhanced gas recovery (EGR) and saline reservoir injection, and Sleipner is a storage project located off shore in the North Sea.

A database of these and other geologic storage facilities was created and used in conducting the human health risk assessment for this EIS (Section 6.17). These studies of natural and industrial analogs for geologic storage of CO_2 (i.e., sites in similar geologic and hydraulic settings with similar anthropogenic influences) provide evidence for the feasibility of geologic containment over the long-term and for characterizing the nature of potential risks from surface leakage, should it occur. A more detailed description of these studies, their characteristics, and the state of risk assessment for geologic sequestration of CO_2 is provided in Section 6.17 and Appendix D.

6.4.3 IMPACTS

6.4.3.1 Construction Impacts

Power Plant Site

The surficial geology of the power plant site includes sandstones and mudstones. There are no geologic features present that would affect construction of the power plant infrastructure. There would be no noticeable impact to the availability of lignite coal in the area from construction of the power plant and other facilities. However, aggregate and other geologic resources (e.g., sand) would be required to support construction activities; these resources are readily available near the proposed plant site and the quantities required for construction of the power plant would not have a noticeable effect on their availability. Additional discussion of the availability of construction materials is addressed in Section 6.16.

The relatively flat surface topography of the power plant site precludes any potential impacts from landslides or other slope failures during construction. Similarly, because the area is not seismically active and most of the earthquakes in eastern Texas have a Richter magnitude below 3.0, it is not expected that seismic activity would affect construction of the power plant.

Sequestration Site

Potential impacts to geologic resources and impacts from geologic processes or features such as earthquakes or landslides would be the same for construction at the sequestration site as discussed above for the power plant site. Each injection well (and any deep monitoring wells placed in the target formation – see discussion below in Section 6.4.4) would penetrate approximately 1 mile (1.6 kilometers) of bedrock to the primary target formation (or 2.1 miles [3.4 kilometers] for the secondary target formation). It is believed that mineral resources would not be impacted by the installation of the injection wells or deep monitoring wells.

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed transportation infrastructure corridors as discussed above for the power plant site.

6.4.3.2 Operational Impacts

Power Plant Site

During power plant operations, no additional impacts to geologic resources would be expected. The power plant site's relatively flat surface topography and lack of karst geology precludes any potential impacts from landslides, other slope failures, or sinkhole development during operation. Similarly, because the area is not seismically active and only minor earthquakes have affected the project area, it is not expected that seismic activity would affect operation of the power plant.

Sequestration Site

The potential impacts to geologic resources, and impacts to the sequestration site from geologic processes, during operation are discussed below.

When CO_2 is injected into a deep brine-saturated (saline) permeable formation in a liquid-like (i.e., supercritical) dense phase, it is immiscible in, and less dense than, water. This would be the case at the Jewett Sequestration Site. The CO_2 would displace some of the brine. In addition to displacement of brine, CO_2 may dissolve in or mix with the brine thereby causing a slight acidification of the water, a reaction with the mineral grains, or be trapped in the pore spaces by capillary forces. Some combination of these processes is likely, depending on the specific conditions encountered in the reservoir.

Geochemical modeling of the potential pH changes was conducted for this EIS. The modeling showed that the pH of the brine in the Woodbine and Travis Peak formations would be expected to drop from about 6.5 to 3.3 over many years, creating acidic brine. However, the Woodbine is made up of quartz-rich sandstone that is extremely resistant to chemical changes. Therefore, acidification of the brine solution would not be expected to substantially alter the Woodbine formation. The Travis Peak formation would be more susceptible to geochemical reactions over very long periods of time (hundreds to thousands of years).

CO_2 emitted from the power plant would include some H_2S. Because of the significant expense required to separate these two elements, it is possible that the Alliance may conduct tests where greater concentrations of H_2S are included in the gas stream to be sequestered. Therefore, geochemical modeling of the potential changes that could occur to the Eagle Ford Shale (caprock) from the introduction of H_2S into the reservoir formation was conducted. It was concluded that the most significant effect is that the H_2S concentration in the sequestered gas mixture would be reduced with only very small (less than 1 percent) changes to the permeability of the Eagle Ford seal, due to precipitation of minerals contacting H_2S that would reduce the porosity of the formation.

Increases in pore pressure associated with the injection of CO_2 can decrease friction on existing faults, and may cause the faults to become transmissive or to slip, particularly in areas where the regional stress regime is extensional as opposed to compressive. Induced seismic activity due to oil production activities may have caused a 4.0 magnitude earthquake approximately 30 miles (48 kilometers) west-southwest of the proposed Jewett Injection Site between Mexia and Wortham in 1932 (FG Alliance, 2006c). Because the regional stress regime is extentional, decrease of friction on fault surfaces due to CO_2 injection is a concern at the Jewett Sequestration Site. The risk assessment conducted for this EIS (Appendix D) estimates, however, a very low probability of induced seismicity (1 in 10,000 over 5,000 years).

Although injection-induced seismicity is unlikely, monitoring methods discussed in Section 6.4.4 would further reduce the possibility of accidentally inducing seismicity on a scale larger than micro-scale (measuring -4 to 0 on the Richter scale).

The injection pressures that would cause new or existing fractures to open in the target reservoir and caprock are not known and would need to be determined as part of the permitting process. Requiring injection pressures to be substantially below the fracture opening and fracture closure pressures would greatly lower the risk of accidental overpressure and induced fracturing of the formation, the seal, or cements in wellbores, as well as lowering the risk of opening existing fractures. Site-specific injection pressure limits may be established as part of the permitting process.

Numerical modeling was conducted to estimate the potential CO_2 plume migration if an undetected transmissive fracture zone or fault was present that through-cuts the Eagle Ford Shale above the injection point in the Woodbine formation. This fracture zone or transmissive fault was assumed to be 0.6 mile (1 kilometer) long, with permeabilities well in excess of the permeability of the Eagle Ford Shale (four cases were modeled with permeabilities ranging from 0.01 to 1,000 md). Only narrow faults were evaluated because fracture/ fault zones larger than 33 feet (10.1 meters) wide could be detected through geophysical methods and investigated before initiation of an injection program. Injection wells would be relocated, if necessary, to avoid such faults.

The results of the numerical modeling of the fault leakage scenario for the Jewett Site indicate that, for permeabilities of 1 md and higher, the amount of CO_2 leakage through the fault would be relatively small, as measured by the CO_2 flux rates, extent of the plume, and CO_2 gas pressure at the base of the overlying Pecan Gap formation. The steady-state flux rate for the higher permeability cases was about 157 million tons of CO_2 per year or 0.006 percent of the 2.8 million tons (2.5 MMT) per year injection rate. The maximum plume extent occurred for the higher permeability faults and was 830 feet (253 meters) after 1,000 years. The plume extent for the 0.01 md case was zero for the first 600 years and did not exceed approximately 50 feet (15 meters) after 1,000 years; significant permeation of the Eagle Ford shales is clearly unlikely to occur at permeabilities less than 0.01 md (FG Alliance, 2006c).

The potential for leakage of CO_2 from the sequestration reservoir by means other than faults would be a potential impact of concern. The injection wells themselves (and any deep monitoring wells placed in the target formation) would be one of the likely paths for CO_2 migration from the reservoir, as by their nature they perforate all the seals present. Unknown wells and improperly plugged existing well bores within the ROI could potentially leak CO_2. The Jewett Site subsurface ROI is surrounded by operating and abandoned petroleum exploration and production wells, with over 1,000 within 10 miles (16.1 kilometers) of the sequestration injection site. Fifty-seven wells are reported to penetrate the primary seal, the Eagle Ford Shale (FG Alliance, 2006c). In addition to these known wells, there may be other undocumented wells located within the subsurface ROI that may or may not be properly abandoned. However, as part of the site-specific assessment to be conducted on the selected site, geophysical surveys will be conducted to locate existing wells, and if found to be improperly abandoned, such wells could be properly sealed and abandoned to meet state regulations and prevent leakage. The risk assessment estimates the probability of leakage from such wells (Appendix D).

An earthquake has the potential to affect the injection wells. If a fault was penetrated by the well bore, the injection well's casing could be sheared if movement occurred on that fault during a seismic event. However, vibrations from an earthquake would not likely cause faulting or affect the integrity of the well. Minor earthquakes do occur in eastern Texas, but the project area is not seismically active. Eastern Texas lies in a stable continental area where there is little risk of new faulting. Thus, it is unlikely that the well's casings would be sheared by natural earthquakes.

There are several sequestration features that indicate that CO_2 would be retained in the proposed injection formation, the Woodbine sandstone, including:

- The Woodbine formation is 500 feet (152.4 meters) thick and is composed of very permeable sandstone and modeling shows that more than adequate storage capacity exists in the proposed sequestration reservoirs.
- Approximately 3,000 feet (914 meters) of low permeability carbonates and shales above the Eagle Ford should act as multiple barriers to the upward migration of CO_2.
- The dominantly quartz mineralogy of the Woodbine formation would cause geochemical reactions to be primarily simple dissolution of the CO_2 in the brine formation water.
- The primary seal, the Eagle Ford Shale, is a low-permeability shale with a thickness of approximately 400 feet (122 meters) in the subsurface ROI area that is also the main seal for some of the largest oil fields in Texas.

There are many variables that affect the potential to increase pore pressure enough to cause vertical displacement. Collection of site-specific data including porosity, permeability and mean effective stress would allow for future modeling of the predicted pressure increases and subsequent potential for ground heave at the Jewett Sequestration Site and surrounding area. If a potential problem is identified, injection pressures could be maintained below the levels that would cause heaving.

The U.S. EPA has mapped most of Texas, including the Jewett area, as an area with a low potential for radon to exceed the recommended upper limit for air concentrations within buildings. Thus, it is unlikely that if CO_2 were to escape the sequestration reservoir and increase pore pressures in the vadose zone (near surface unsaturated soils above the water table), there would be radon present that could potentially be displaced and forced into buildings. As discussed above, several sequestration features indicate that CO_2 should be retained in the sequestration reservoir. If CO_2 were to leak, however, radon transport induced by CO_2 leakage would be highly localized over the point of CO_2 leakage. The risk assessment conducted for this EIS addressed the potential for adverse impacts from radon displacement (Appendix D). Data concerning potential existing radon levels from state and local sources were used as the baseline. Using conservative assumptions on increases of radon via displacement by CO_2, it was concluded that the situation with respect to radon would remain unchanged as to whether EPA-established action levels would be exceeded. This indicates that there would be no incremental risks above background from radon at the Jewett Site.

An offer has been made for a 50-year lease on the sequestration site with 100 percent surface access and a waiver of mineral and water rights for at least three injection sites totaling approximately 1,550 acres (627 hectares) in two locations (FG Alliance, 2006c). All mineral rights needed to conduct sequestration would be acquired. Conflicts with commercial accessibility to high-value mineral resources or unique geologic formations would be dealt with as part of the acquisition of mineral rights.

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed transportation infrastructure corridors as discussed above for the power plant site.

6.4.3.3 Fate and Transport of Injected/Sequestered CO_2

As mentioned above, in saline formations, supercritical CO_2 is less dense than water, which creates strong buoyancy forces that drive CO_2 upwards. After reaching the top of the reservoir formation, CO_2 could continue to migrate as a separate phase until it is trapped as residual CO_2 saturation or in local structural or stratigraphic traps within the sealing formation. In the longer term, significant quantities of CO_2 (up to 30 percent) would dissolve in the formation water and then migrate with the groundwater. Reservoir studies and simulations for the Sleipner Project have shown that CO_2-saturated brine would eventually become denser and sink, thereby eliminating the potential for long-term leakage. These reactions, however, may take hundreds to thousands of years (IPCC, 2005).

Numerical modeling indicates that the plume radius for each injection well from injecting 2.8 million tons (2.5 MMT) of CO_2 per year for 20 years would be 1.7 miles (2.7 kilometers), equal to an area of 5,484 acres (2,220 hectares) (FG Alliance, 2006c). These sequestration footprints are shown in Figure 6.4-1.

Most geological characteristics of the area (simple sedimentary structure with a low rate of dip; a deep reservoir in a formation consisting of up to 500 feet [152.4 meters] of very permeable quartz-rich sandstone overlain by up to 400 feet [121.9 meters] of low permeability shale; and over 3,000 feet [914 meters] of overlying mostly fine grained carbonate rock that also includes many sequences of more and less permeable zones) indicate that it would be unlikely that CO_2 would migrate vertically for any significant distance.

However, due to the presence and orientation of fractures within 10 miles (16 kilometers) of the proposed Jewett Sequestration Site, transmissive fractures could be present in the subsurface ROI. If present, CO_2 could migrate along such paths. Horizontal open fractures within the Woodbine could cause the CO_2 to migrate farther laterally than the numerical modeling predicts. Vertical open fractures are more likely at depth than horizontal ones. Thus, if such fractures are present in the Eagle Ford formation within the ROI, they could promote vertical migration of CO_2. In order for the CO_2 to reach shallow potable groundwater or the biosphere, such fractures would need to penetrate and be open through, or connect in networks through, over 4,400 feet (1,341 meters) of various types of rock. Given the detailed knowledge of the geologic setting of the subsurface ROI at the Jewett Site, it is unlikely that such fractures are present; however, further site-specific geologic investigations would be necessary to verify this before initiating injection of CO_2. See Section 6.17 for a discussion of CO_2 transport assumptions and potential associated risks.

6.5 PHYSIOGRAPHY AND SOILS

6.5.1 INTRODUCTION

This section describes the physiography and soils associated with the proposed Jewett Power Plant Site, sequestration site, and related corridors.

6.5.1.1 Region of Influence

The ROI for physiography and soils is defined as a 1-mile (1.6-kilometer) radius around the boundaries proposed power plant site, sequestration site, reservoir, and utility corridors.

6.5.1.2 Method of Analysis

DOE reviewed reports from the U.S. Department of Agriculture (USDA), information provided in the Jewett EIV (FG Alliance, 2006c), and other available public data to assess the potential impacts of the proposed FutureGen Project on physiographic and soil resources. DOE assessed the potential for impacts based on the following criteria:

- Potential for permanent and temporary soil removal;
- Potential for soil erosion and compaction;
- Soil contamination due to spills of hazardous materials; and
- Potential to change soil characteristics and composition.

Some uncertainties were identified in relation to soil resources at the proposed Jewett Site such as the porosity and permeability of the various soils where the project infrastructure would be located. Uncertainties, based on the absence of site-specific data, are discussed as appropriate in the following analysis. Prime farmland is discussed in Section 6.11.

6.5.2 AFFECTED ENVIRONMENT

6.5.2.1 Physiography

The proposed Jewett Power Plant Site is located within the Gulf Coastal Plains physiographic province (UTA, 2006). The Gulf Coastal Plains include three subprovinces: the Coastal Prairies, the Interior Coastal Plains, and the Blackland Prairies. The Coastal Prairies begin at the Gulf of Mexico shoreline. Young deltaic sands, silts, and clays erode to nearly flat grasslands that form almost nonexistent slopes to the southeast. Trees are uncommon except locally along streams and in Oak mottes, growing on coarser underlying sediments of ancient streams. Minor steeper slopes, from 1.0 foot (0.3 meters) to as much as 9.0 feet (2.7 meters) high, have resulted from subsidence of deltaic sediments along faults over geologic time (thousands of years). Between Corpus Christi and Brownsville, broad sand sheets pocked by low dunes and blowouts forming ponds dominate the landscape (UTA, 2006).

The Interior Coastal Plains, where the proposed Jewett Power Plant Site is located, consist of alternating belts of resistant uncemented sands among weaker shales that erode into long, sandy ridges.

On the Blackland Prairies of the innermost Gulf Coastal Plains, chalks and marls weather to deep, black, fertile clay soils, in contrast with the thin red and tan sandy and clay soils of the Interior Gulf Coastal Plains. The blacklands have a gentle undulating surface, cleared of most natural vegetation and cultivated for crops (UTA, 2006).

From sea level at the Gulf of Mexico, the elevation of the Gulf Coastal Plains increases northward and westward. In the Austin San Antonio area, the average elevation is about 800 feet (244 meters). South of Del Rio, the western end of the Gulf Coastal Plains has an elevation of about 1,000 feet (305 meters).

6.5.2.2 Soils

The following section describes the different predominant soils at the power plant site, sequestration site, and utility and transportation corridors. Descriptions of the soil type characteristics and uses are presented in Table 6.5-1.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Arenosa fine sand (ArC)	• Deep, gently sloping to undulating (1 to 8 percent slopes), and somewhat excessively drained. It is on broad uplands. Rapid permeability and low available water capacity, results in very slow runoff and a very slight risk of water erosion. Soil blowing is a severe hazard in bare areas and at construction sites. • Included with this soil in mapping are small areas of Padina and Silstid soils, both on a landscape similar to this mapping unit.	• Used as rangeland, and is generally not used for crops due to droughtiness, low available water capacity, the soil's sandy surface layer, and the steepness of slope. This soil is well suited to roads, streets, and buildings.
Axtell fine sandy loam (AxB)	• Deep, gently sloping (1 to 5 percent), and moderately well drained on uplands and old terraces. Slow permeability and moderately available water capacity result in medium to rapid runoff and a severe risk of a water erosion hazard. • Included with this soil in mapping are areas of Crockett, Lufkin, Rader, and Tabor soils. Crockett and Tabor soils are in positions similar to those of the Axtell soil. Lufkin and Rader soils are in slightly lower positions.	• Primarily used as pasture or hayland with the possibility of use as rangeland.
Cuthbert fine sandy loam (CtE)	• Strongly sloping to moderately steep (5 to 15 percent) soil on upland side slopes. The surfaces are plane to slightly convex. Areas are irregular in shape and are generally parallel to drainageways. This soil is well drained and permeability is moderately slow. Combined with moderate available water capacity this soil type is characterized by its rapid surface runoff and severe water erosion hazard. • Included with this soil in mapping are small areas of Kirvin and Wolfpen soils.	• Used mainly as pasture and wildlife habitat. It is not suitable for cropland due to the combination of slope and surface runoff that creates a severe hazard of erosion. This soil is moderately suited for use as woodland and recreation. It is poorly suited for most urban uses and for growing native grasses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Cuthbert gravelly fine sandy loam (CvF)	• Moderately steep to steep (15 to 30 percent) soil on upland side slopes. The surfaces are mainly slightly convex. This soil is well drained with moderately slow permeability. With moderate available water capacity, this soil type is characterized by its medium to high surface runoff and moderate water erosion hazard. • Included with this soil in mapping are small areas of Kirvin and Wolfpen soils. Also included are Cuthbert soils with more than 35 percent gravel in the surface layer or with up to 10 percent of the surface covered by stones.	• Used mainly as wildlife habitat, and is not suitable for pasture or cropland because of slope and the hazard of erosion. This soil is moderately used as woodland and is poorly suited to growing native grasses and for urban uses.
Cuthbert gravelly fine sandy loam (CzG)	• Moderately steep to steep soil on low hills on the highest parts of the landscape. The surfaces are mostly slightly convex. Ironstone rocks, ranging from 3 inches (8 centimeters) to 4 feet (1.2 meters) across, cover 2 to 10 percent of the soil surface. This soil is well drained with moderately slow permeability. With moderate available water capacity, this soil type is characterized by its high surface runoff and severe water erosion hazard. • Included with this soil in mapping are small areas of Kirvin and Wolfpen soils. The Kirvin soils are on the gently sloping tops of hills. The Wolfpen soils are in lower, more convex areas. Also included are areas of Cuthbert soils that do not have stones on the surface and a few small areas that have been mined for gravel.	• Mainly used as wildlife habitat, and is not suitable for cropland due to slope, hazard of erosion, and large stones. This soil is moderately suited to use as woodland, and poorly suited to growing native grasses and for urban uses.
Cuthbert soils, graded (CxE)	• Strongly sloping to moderately steep soil on uplands. The surfaces are slightly convex. The soil is well drained with moderately slow permeability and moderate available water capacity, resulting in medium to high surface runoff and a moderate risk of a water erosion hazard. • Included with this soil in mapping are small areas of Kirvin soils and undisturbed Cuthbert soils. Also included are areas of graded Cuthbert soils that have a thin layer of original surface material and areas of Cuthbert soils that have slopes of more than 15 percent.	• Soil is used mainly as wildlife habitat, and poorly suited to pastures of Coastal Bermuda grass, growing commercial timber, growing native grasses, and for most urban and recreational uses. This Cuthbert soil is not suitable for cropland due to slope and the hazard of erosion.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Derly-Rader complex, 0 to 1 percent slopes (DrA)	• These nearly level soils are on stream terraces. Derly • The Derly soils are found in flat areas between mounds. These soils are poorly drained with low surface runoff and very slow permeability. The available water capacity is high and the water table can be found within a depth of 12 inches (31 centimeters) during the winter and spring. The soils have a slight water erosion hazard as well. Rader • Rader soils are on low ridges that meander through the low areas. They are moderately well drained soils with low surface runoff, very slow permeability, and they have a high water capacity. There is a slight water erosion hazard for these soils. • Included with this soil in mapping are areas of Axtell, Raino, and Styx soils.	• The soils are used mainly as pasture and wildlife habitat and are moderately suited to use as cropland. Leaving crop residue on or near the surface helps to reduce soil erosion and maintain organic matter content. Suitability is poor for most urban uses and moderate for most recreational uses. The main limitations are wetness, very slow permeability, and potential for shrinking and swelling with changes in moisture.
Dutek loamy fine sand (DuC)	• Deep, gently sloping to strongly sloping (1 to 8 percent) and well drained on broad uplands and high stream terraces. Moderate permeability and moderately available water capacity result in slow runoff. Water erosion is therefore a moderate hazard, and soil blowing is a sever hazard if the soil is left bare. • Surface layer: pale brown loamy fine sand approximately 4 inches (10 centimeters) thick. • Upper subsoil (5 to 31 inches [13 to 79 centimeters]): light yellowish brown loamy fine sand. • Middle subsoil (32 to 51 inches [81 to 130 centimeters]): yellowish red sandy clay loam. • Substratum (52 to 84 inches [132 to 213 centimeters]): reddish yellow fine sandy loam in upper part and very pale brown loamy fine sand in the lower part. • Included with this soil in mapping are areas of Padina and Silstid soils.	• Used as pasture or hayland and also as rangeland. This soil is well suited for urban uses, but is generally not used for crops due to droughtiness and erosion hazards.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Edge fine sandy loam, 1 to 5 percent slopes (EgB)	• Moderately well drained soils formed on broad interstream divides with smooth or slightly convex surfaces. The slopes range from 1 to 5 percent the potential for surface runoff is medium to high and permeability is very slow. The hazard for water erosion is moderate. • Included with this soil in mapping are small areas of Crockett, Gasil, Silstid, and Tabor soils. Overseeding legumes such as vetch, singletary peas, arrowleaf clover, and bermudagrass helps to reduce erosion, lengthens the grazing season, and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed for optimum grass production.	• Used mainly as pasture. It is poor for cropland because of the hazard of erosion. However, leaving crop residue on or near the surface aids in water infiltration, and helps to reduce soil erosion and maintain organic matter content. Terraces and contour farming are needed to control runoff and reduce erosion for these soils. • Moderately suited to growing native grasses, and is well suited to wildlife habitat. • Suitability is poor for most urban uses, but well suited to most recreational uses. The main limitations are very slow permeability and the potential for shrinking and swelling with changes in moisture.
Edge fine sandy loam, 5 to 12 percent slopes (EgE)	• Well drained soils formed on upland side slopes with surfaces that are plane to slightly convex and generally follow along drainageways. Slopes range from 5 to 12 percent potential for surface runoff is very high, permeability is very slow, and the available water capacity is moderate. This combination creates a severe water erosion hazard. • Included with this soil in mapping are areas of Axtell, Silawa, and Silstid soils.	• Used mainly as pasture and wildlife habitat. It is poorly suited to growing pasture grasses, but is moderately suited to growing native grasses. It is moderately suited to wildlife habitat. This soil is not suitable for cropland because of slope and the hazard of water erosion. Suitability is poor for most urban and recreational uses. • Main limitations are low strength, very slow permeability, corrosivity to uncoated steel, slope, and the potential for shrinking and swelling with changes in moisture.
Gasil fine sandy loam (GfB)	• Well drained soils formed on upland interstream divides that have plane or slightly convex surfaces. Slopes range from 1 to 5 percent potential for surface runoff is low and permeability is moderate. The hazard of water erosion is moderate. • Included with this soil in mapping are areas of Edge, Rader, Silstid, and Tabor soils.	• Used mainly as pasture. Overseeding legumes into the bermudagrass lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of a complete fertilizer are needed for optimum grass production. Applications of lime are needed in some areas, especially where a high rate of fertilizer is applied. This soil is moderately suitable for cropland. Leaving crop residue on or near the surface helps to reduce soil erosion and maintain organic matter content. • Moderately suited to growing native grasses, well suited for wildlife habitat, and well suited for most urban and recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Gladewater clay, frequently flooded (Gh)	• This nearly level soil is on the flood plains of the Trinity River and its larger tributaries. The surfaces are mainly smooth or slightly concave. Flooding generally occurs once or twice a year from November through May for a period of a few days to a week. Slopes range from 0 to 1 percent. • This poorly drained soil has low surface runoff, very slow permeability, and high available water capacity. The water-erosion hazard is slight and the water table is generally within a depth of 2 feet (0.6 meters) during the winter and spring. • Included with this soil in mapping are small areas of Kaufman, Nahatche, Pluck, and Whitesboro soils.	• This Gladewater soil is used mainly as pasture and wildlife habitat. This soil is not suitable for cropland and poorly suited to growing native grasses because of the hazard of flooding. • Suitability is poor for most urban and recreational uses because of wetness, the hazard of flooding, and the potential for shrinking and swelling with changes in moisture.
Hatliff fine sandy loam (Ha)	• Deep, nearly level, and moderately well drained on bottom lands. Slopes are 0 to 1 percent. This soil is subject to flooding more than once every 2 years. Permeability is moderately rapid. The available water capacity is low, but the soil is saturated with water for periods of a few days to a few weeks in winter and early in spring in most years. Runoff is slow. A high water table is within 2 feet (0.6 meters) of the surface during winter. • Included with this soil in mapping are areas of Nahatche and Nugent soils. Nahatche soils are in positions similar to those of the Hatliff soil and they have a fine loamy control section. Nugent soils are in slightly higher positions and are sandy throughout the profile.	• Primarily used as woodland, and moderately suited for use as pasture or hayland. It can be used in some areas as rangeland, and is poorly suited to crop production and urban uses.
Hearne fine sandy loam (HeB)	• Deep, gently sloping (1 to 5 percent), and well drained on ridgetops on uplands. Slow permeability and moderately available water capacity result in medium runoff and a severe risk of a water erosion hazard. • Included with this soil in mapping are areas of Marquez, Padina, Robco, and Silstid soils.	• Primarily used as pasture or hayland, also being used as rangeland. It is limited in its use for urban purposes, and is generally not used for crop production due to the severe hazard of erosion and the droughtiness.
Hearne fine sandy loam (HeE)	• Strongly to moderately steep, and normally occurs on upland side slopes. The surfaces are plane to slightly convex with slopes ranging from 5 to 15 percent. This soil is well drained and available water capacity is moderate, but due to slow permeability, surface runoff is high and the water-erosion hazard is severe. • Included in this soil mapping unit are small areas of Edge and Silstid soils.	• Primarily used as pasture and wildlife habitat and is mostly unsuitable for any other uses other than as recreational land.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Hearne fine sandy loam, stony (HsE)	• Strongly sloping to moderately steep (5 to 20 percent), and well drained on long, narrow knolls and upper side slopes on uplands. Stones and boulders of sandstone cover 5 to 10 percent of the surface. Slow permeability and low available water capacity result in rapid runoff and a severe risk of a water erosion hazard. • Included with this soil in mapping are some areas of Hearne soils that do not have stones on the surface or in the surface layer and a soil similar to Hearne soil except it has gravel on the surface or in the surface layer.	• Despite its poor suitability for the use, Hearne soil is mainly used as rangeland. This soil is not suited to crop or pasture production and has many limitations for urban uses.
Kaufman clay, frequently flooded (Kc)	• Nearly level soil on floodplains that are unprotected from flooding. This soil is covered by shallow, slow-moving floodwater at least once each year. Flooding is usually during the spring and lasts five to 60 days. • Included in this soil in mapping are areas of Trinity soils and of Kaufman soils.	• Used for pasture. It is not suitable for cultivation.
Kaufman clay, frequently flooded (Kd)	• This nearly level soil is located on flood plains of the Trinity River and its larger tributaries. Flooding occurs once or twice in most years, most likely from November through May. Slopes are less than 1 percent. These somewhat poorly drained soils have low surface runoff, very slow permeability, high water capacity, and a slight water erosion hazard. • Included with this soil in mapping are small areas of Gladewater, Nahatche, Trinity, and Whitesborosoils.	• This Kaufman soil is used mainly as pasture and wildlife habitat. Wetness and the clayey texture limit equipment use during certain times of the year and cause severe seedling mortality and plant competition. Suitability is poor for most urban and recreational uses. Flooding occurs frequently. The soil shrinks and swells with changes in moisture and has a clayey surface layer.
Keechi loamy fine sand (Kh)	• Located on nearly level floodplains of streams that drain watersheds. The surfaces are mainly concave. Flooding occurs once or twice in most years for a period of one to five days, mainly from December through May. Slopes range from 0 to 1 percent. This soil is poorly drained with slow permeability and moderate available water capacity, resulting in low surface runoff and a slight risk for a water erosion hazard. A water table is generally within a depth of 12 inches (30 centimeters) during the winter and spring. • Included with this soil in mapping are areas of Hatliff, Leagueville, Nahatche, and Pluck soils. The Hatliff soils are on natural levees along stream channels. The Leagueville soils are on foot slopes of adjacent uplands. The Nahatche soils are in slightly higher positions on the landscape. The Pluck soils are in positions similar to those of the Keechi soil.	• Primarily used as wildlife habitat and is moderately suited for this purpose along with pastures. It is poorly suited to woodland and urban uses. This soil is not suitable to cropland due to flooding.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Kirvin fine sandy loam (KrB)	• Gently sloping soil located on upland interstream divides. The surfaces are plane to slightly convex. This soil is well drained with moderately slow permeability and moderate available water capacity, resulting in low surface runoff and a moderate risk for a water erosion hazard. • Included with this soil in mapping are small areas of Cuthbert, Oakwood, and Wolfpen soils. The Cuthbert soils are in positions on the landscape similar to those of the Kirvin soils. The Oakwood soils are in areas that have lower and smoother slopes. The Wolfpen soils are in slightly higher positions on the landscape. Also included is a Kirvin soil that has a gravelly fine, sandy loam surface layer. This soil is in higher, more convex areas.	• Used mainly as pasture, but is well suited to woodland, wildlife habitat, urban, and recreational uses. This soil is poorly suited to growing native grasses, and is moderately suitable for cropland.
Kirvin gravelly fine sandy loam (KyC)	• Gently sloping to strongly sloping (2 to 8 percent) soil on uplands. The surfaces are mainly convex. Areas are mainly elliptical, occupying narrow interstream divides or low sloping knolls. This soil is well drained with moderately slow permeability and moderate available water capacity, resulting in low to medium surface runoff and a slight risk of a water erosion hazard. • Included with this soil in mapping are small areas of Cuthbert, Oakwood, and Wolfpen soils. The Cuthbert soils are in positions on the landscape similar to those of the Kirvin soils. The Oakwood soils are in areas that have lower, smoother slopes. The Wolfpen soils are in slightly higher positions on the landscape. Also included are small areas of a Kirvin soil that has more than 35 percent gravel in the surface layer and a Kirvin soil that has as much as 5 percent of the surface covered by stones. The very gravelly and stony Kirvin soils are along the highest parts of narrow ridges.	• Used mainly as pasture and wildlife habitat. The soil is poorly suited to cropland, growing native grasses, and has moderate suitability for most urban uses. The soil is well suited to woodland and wildlife habitat.
Marquez gravelly fine sandy loam (MrB)	• Gently sloping (1 to 5 percent), and well drained on small knobs and ridges on uplands. Slow permeability and moderate available water capacity result in medium to rapid runoff and a severe risk for a water erosion hazard. • Included with this soil in mapping are areas of Gasil and Hearne soils. Gasil soils are in slightly lower positions on the landscape than the Marquez soil. Hearne soils are on the steeper side slopes.	• Primarily used as pasture or hayland and alternatively used for rangeland to which it is well suited. Generally not used for crops due to the gravelly surface layer and the hazard of erosion. It is also limited in its use for urban purposes.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Marquez very fine sandy loam (MkB)	• Deep, gently sloping (1 to 5 percent), and well drained on broad ridges and side slopes on uplands. Slow permeability, and moderately available water capacity result in medium to rapid runoff with a severe risk of a water erosion hazard. • Included with this soil in mapping are areas of Gasil and Hearne soils. Gasil soils are in slightly lower positions on the landscape than the Marquez soil. Hearne soils are on steeper side slopes.	• Primarily used as pasture or hayland and alternatively used for rangeland to which it is well suited. The Marquez soil is generally not used for crops due to droughtiness and the severe hazard of erosion, but crops such as corn, cotton, and grain sorghum are suitable. It is also limited in its use for urban purposes.
Nahatche clay loam, frequently flooded	• Nearly level soil on flood plains of large creeks. Flooding occurs one to three times in most years, mainly from November through May, for a period of one to four days after heavy rains. Slopes range from 0 to 1 percent. This soil is somewhat poorly drained with moderate permeability and high available water capacity, resulting in negligible surface runoff and a slight risk of a water erosion hazard. A water table is generally within a depth of 3 feet (1 meter) during the winter and spring. • Included with this soil in mapping are areas of Hatliff and Pluck soils. The Hatliff soils are on natural levees along stream channels and on alluvial fans adjacent to surrounding uplands. The Pluck soils are in depressions and old sloughs. Also included is a soil similar to the Nahatche soil, except that it has a coarser texture.	• Used mainly as pasture and wildlife habitat, and not suitable for cropland due to flooding and wetness. This soil is well suited to wildlife habitat, moderately suited to growing native grasses and producing hardwood timber, and poorly suited for most urban and recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Nahatche-Hatliff Association, frequently flooded (NH)	• Nearly level, loamy soils on the floodplains of local streams. They are characterized by frequent flooding, mainly between November and May. Slopes range from 0 to 1 percent. • The Nahatche soils occupy backwater areas of floodplains. Hatliff soils are located on natural levees along stream channels, alluvial fans, and pointbars. Included with these soils in mapping are small areas of Pluck soils in old sloughs and depressions. Also included is a soil closely similar to the Hatliff soil, except it has a coarser texture. Nahatche • Poorly drained, but due to the moderate permeability and high available water capacity, surface runoff is negligible and the risk for water-erosion hazard is slight. A water table is generally within a depth of 12 inches (30 centimeters) during winter and spring. Hatliff • Soils are moderately well drained with moderately rapid permeability and moderately available water capacity, resulting in negligible surface runoff and a slight hazard for water-erosion. A water table is generally within a depth of 2 feet (0.6 meters) during the winter.	• Not suitable for cropland or urban and recreational uses due to flooding, but are moderately suited to growing native grasses and well suited to wildlife habitat.
Oakwood fine sandy loam (OkB)	• Gently sloping (1 to 5 percent) soil on broad upland divides. The surfaces are smooth or slightly convex. This soil is moderately well drained with moderately slow permeability and high available water capacity, resulting in low surface runoff and a moderate risk of a water erosion hazard. • Included with this soil in mapping are small areas of Kirvin, Raino, and Wolfpen soils. The Kirvin and Wolfpen soils are in slightly higher positions on the landscape. The Raino soils are in depressions and on lower foot slopes.	• Used mainly as pasture and is moderately suitable for cropland and growing native grasses. It is well suited to woodlands, wildlife habitat, and most urban and recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Padina loamy fine sand (PaB)	• Well drained soils formed on uplands with mainly smooth or convex surfaces. Slopes range from 1 to 5 percent potential for surface runoff is very low and permeability is rapid in the surface and subsurface layers and moderate in the subsoil. The available water capacity is low and the hazard of water erosion is moderate. A perched water table is generally within a depth of 5 feet (1.5 meters) during the winter. • Included with this soil in mapping are small areas of Arenosa, Robco, and Silstid soils. The Arenosa and Silstid soils are in positions on the landscape similar to those of the Padina soils, and the Robco soils are in concave depressions and at the heads of drainageways. Also included is a soil closely similar to the Padina soil, except it is very strongly acidic in the subsoil. The included soils make up less than 20 percent of the map unit (FG Alliance, 2006c).	• Used mainly as pasture, and is moderately suited to pastures of Coastal Bermudagrass and Lovegrass. This soil is moderately suited to crops such as corn, peas, and watermelons. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. Applications of lime and a complete fertilizer are needed for optimum yields. It is moderately suited to growing native grasses, poorly suited for wildlife habitat, and moderately suited for most urban and recreational uses. • Overseeding legumes such as vetch or Arrowleaf Clover into the pasture grass, lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production (FG Alliance, 2006c).

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Padina loamy fine sand (PaC)	• Very deep, well drained soils formed on uplands and high terraces with smooth or convex surfaces. Slopes range from 1 to 5 percent permeability, is rapid in the surface and subsurface, moderate in the subsoil, and available water capacity is low and runoff is negligible. The water erosion hazard is moderate and the shrink-swell potential is very low. There is no water table within a depth of 6 feet (1.8 meters) and there is no bedrock within a depth of 6 feet (1.8 meters). • Included with this soil in mapping are small areas of Edge, Gasil, Personville, Robco, Silawa, Silstid, and Styx soils.	• Used mainly as rangeland and is moderately suited to this use with the main limitations being the very low natural fertility, and the low available water capacity which causes droughty conditions to occur more readily than in most other soils. • Moderately suited to pasture and hayland grasses. The most limiting features are very low natural fertility and low available water capacity. Fertilizer and controlled grazing are needed for improved yields of adapted grasses such as Coastal and common Bermudagrass. Some pastures are overseeded with legumes such as clovers and Singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity. • Generally not used for crops because of droughtiness and the hazard of water erosion. However, it is moderately suited to peanuts, watermelons, peas, and small grains. Soil blowing (erosion) is a hazard if this soil is cropped. Leaving crop residue on or near the surface helps control both wind and water erosion, conserves moisture, maintains fertility, and maintains organic matter. Cover crops, high residue crops, and green manure crops reduce erosion and help maintain fertility. Crops respond well to fertilization. • Moderately suited to most urban and recreational uses. The main limiting features are the sandy surface layer, droughtiness, sidewall sloughing, seepage, and soil blowing. Good design and proper installation can reduce the effects of these limitations (FG Alliance, 2006c).

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Padina loamy fine sand (PaD)	• Deep, gently sloping to strongly sloping (8 to 15 percent), and moderately well drained in broad, smooth to convex areas on uplands. Permeability is moderately slow, and the available water capacity is low. A perched high water table is present for short periods after heavy rainfall. Runoff is slow and water erosion is a moderate hazard. Soil blowing is a hazard in bare areas and on construction sites. • Included in this mapping are areas of Arenosa, Dutek, Hearne, Jedd, Robco, and Silstid soils.	• Mainly used as rangeland and is also used as pasture or hayland. It is not well suited to crop production due to severe hazard of erosion and steepness of slope.
Pickton loamy fine sand (PkC)	• Gently sloping to moderately sloping (1 to 8 percent) soil on broad upland divides. The surfaces are mainly convex. This soil is well drained with rapid permeability in the surface layers and moderate in the subsoil layers. These factors, combined with the low available water capacity results in low surface runoff and a moderate risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter. • Included with this soil in mapping are small areas of Leagueville, Tonkawa, and Wolfpen soils. The Leagueville soils are in concave depressions and at the heads of drainageways. The Tonkawa and Wolfpen soils are in positions on the landscape similar to those of the Pickton soils.	• Used mainly as pasture, and is poorly suited to growing native grasses. It is moderately suited to cropland, woodland use, and most urban and recreational uses.
Pickton loamy fine sand (PkE)	• Strongly sloping to moderately steep (8 to 15 percent) soil is on upland side slopes. The surfaces are mainly convex. This soil is well drained with moderate permeability and low available water capacity, resulting in low surface runoff and a severe risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter. • Included with this soil in mapping are small areas of Cuthbert, Tonkawa, and Wolfpen soils. The Cuthbert soils are on steeper upper slopes. The Wolfpen and Tonkawa soils are in positions on the landscape similar to those of the Pickton soils.	• Used mainly as pasture and is moderately suited to woodland use. It is poorly suited to cropland, growing native grasses, and most urban and recreational uses.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Pluck loam, frequently flooded (Pu)	• Nearly level soil located on flood plains of streams with surfaces that are mainly concave. Flooding occurs one to four times in most years, generally from November through May, for a period of one to six days after heavy rains. Slopes are less than 1 percent. • This poorly drained soil has negligible surface runoff, moderate permeability and water capacity and a slight water-erosion hazard. A water table is generally at or near the surface during the winter and early spring. • Included in mapping are small areas of Gladewater, Keechi, and Nahatche soils.	• Used mainly as pasture and wildlife habitat. This soil is moderately suited to wildlife habitat and not suitable for cropland because of flooding. Suitability is poor for most urban and recreational uses because of flooding and wetness.
Rader fine sandy loam (RaB)	• Nearly level to gently sloping (0 to 3 percent) and is found on stream terraces. The surfaces are mainly smooth. The soil is well drained with slow permeability and high water capacity, resulting in low to medium surface runoff and a slight risk for water erosion. A perched water table is generally within a depth of 3 feet (1 meter) during the winter. • Included within this soil mapping unit are small areas of Derly, Oakwood, and Styx soils.	• Used primarily as pasture, and is moderately suitable for cropland, growing native grasses, urban uses, and recreational development.
Raino fine sandy loam, 0 to 2 percent slopes (RnA)	• Nearly level to gently sloping soil located on upland foot slopes and saddles. They have surfaces that are smooth or slightly concave. These moderately well drained soils have low surface runoff, very slow permeability, and a low water capacity. The water-erosion hazard is slight and a perched water table is generally within a depth of 3 feet (1 meter) during the winter and spring. • Included with this soil in mapping are small areas of Derly, Oakwood, Rader, and Wolfpen soils.	• Used mainly as pasture, although applications of lime and a complete fertilizer are needed for optimum grass production. It is moderately suitable for cropland. This soil is well suited to woodland use and for wildlife habitat. The suitability is poor for most urban uses, mainly because of wetness and the potential for shrinking and swelling.
Silawa fine sandy loam (SaB)	• Deep, strongly sloping to moderately steep (1 to 5 percent), and moderately well drained on the narrow side slopes and ridge tops on uplands. Moderate permeability and available water capacity result in slow to medium runoff and a moderate risk for a water erosion hazard. • Included in this soil mapping are areas of Arenosa, Hearne, and Jedd soils. Arenosa soils are in slightly higher positions on the landscape than the Padina soil. Hearne and Jedd soils are in positions similar to those of the Padina soil. Also included is a soil similar to the Padina soil except the surface layer is fine sand.	• Used for rangeland and is well suited for this use. In a few areas, this soil is used for crops and is also well suited to sanitary facilities, dwellings, roads, and streets.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Silawa fine sandy loam (SaD)	• Very deep, well drained soils formed on high steam terraces that are mostly convex. Slopes range from 5 to 12 percent surface runoff potential is medium and permeability is moderate. Water capacity is moderate and water erosion hazard is severe. The shrink-swell potential is low. There is no water table within a depth of 6 feet (1.8 meters), and bedrock is not found within a depth of 6 feet (1.8 meters) (Leon County). • Included with these mapped soils are small areas of Edge, Lavender, Silstid, and Padina soils.	• Used mainly as pasture or rangeland. The most limiting features are the moderate available water capacity, medium runoff, and severe erosion hazard. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as Coastal Bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and Singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity. • Moderate available water capacity, medium runoff, and severe erosion hazard are limiting features for rangeland on these soils. • Moderately suited to urban and recreational uses. The limiting features are slope and seepage. Good design and proper installation can reduce the effects of these limitations.
Silawa fine sandy loam (SaE)	• Well drained soil found on side slopes of high stream terraces, and the surfaces are slightly convex. Slopes range from 5 to 12 percent, runoff potential is medium, permeability is moderate, and the available water capacity is moderate. The hazard of water erosion is severe.	• Used mainly as pasture and wildlife habitat. It is moderately suited to pastures especially with the practice of overseeding legumes into the Coastal Bermudagrass. This practice lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production. The soil is moderately suited to wildlife habitat. • Not suitable for cropland because of slope and the hazard of erosion. It is moderately suited to growing native grasses. Suitability is moderate for most urban and recreational uses, with the main limitation being slope.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Silstid loamy fine sand (SdB)	• Well drained soils formed in broad areas on uplands. Slopes range from 1 to 5 percent surface runoff is slow, permeability is moderate and available water capacity is moderate. Water erosion hazard is moderate and soil blowing is a hazard in bare areas and on construction sites. • Included with this soil in mapping are areas of Dutek, Gasil, Padina, and Robco soils.	• Used mainly as pasture or hayland. The main limitation for use as pasture or hayland is droughtiness. Pastures require light applications of fertilizer and lime at frequent intervals for high production. Legumes, such as vetch and Singletary peas, overseeded into the grass prolong the grazing season and improve the soil. • Used as rangeland with the main limitation being droughtiness. • Generally is not used for crops because of droughtiness and the hazard of erosion. This soil, however, is suited to peanuts, watermelons, peas, and sweet potatoes. Fertilizer and lime are essential for good yields. Cover crops, high residue crops, and green manure crops help control erosion and maintain fertility. This soil is well suited to most urban uses.
Silstid loamy fine sand (SsB)	• Well drained soils formed on gently sloping uplands with smooth or slightly convex surfaces. Slopes range from 1 to 5 percent, so surface runoff is very low; and permeability is rapid in the surface and subsurface layers and moderate in the subsoil. The available water capacity and the hazard of water erosion are both moderate. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and spring.	• Used mainly as pasture. Overseeding legumes, such as vetch or Arrowleaf Clover, into the Coastal Bermudagrass lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production. • Moderately suited to growing crops such as corn, peas, and watermelons. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. Applications of lime and a complete fertilizer are needed for optimum yields. • Moderately suited to growing native grasses. It is poorly suited to wildlife habitat, well suited to most urban uses, and moderately suited to most recreational uses. The sandy surface layer is the main limitation (FG Alliance, 2006c).

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Silstid loamy fine sand (SsD)	• Well drained soils formed on upland side slopes with slightly convex surfaces. Slopes range from 5 to 8 percent and surface runoff is low. Permeability is rapid in the surface and subsurface layers and moderate in the subsoil. The available water capacity is moderate and the hazard of water erosion is moderate. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and spring (for Limestone County).	• Used mainly as pasture, especially with the practice of overseeding legumes into the Coastal Bermudagrass. This practice lengthens the grazing season and increases soil fertility by adding nitrogen. Applications of lime and a complete fertilizer are needed to increase grass production. • Moderately suited to growing crops. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. Applications of lime and a complete fertilizer are needed to increase yields. • Moderately suited to growing native grasses and it is moderately suited to wildlife habitat. It is well suited to most urban uses and moderately suited to most recreational uses. The sandy surface layer and slope are the main limitations (FG Alliance, 2006c).
Styx loamy fine sand, 0 to 3 percent slopes (StB)	• This nearly level to gently sloping soil is on stream terraces. These well drained soils have negligible surface runoff, moderately rapid to moderate permeability and a moderate available water capacity. The water erosion hazard is slight and a perched water table is generally within a depth of 3.5 to 4.5 feet (1.1 to 1.4 meters) during the winter and spring. The surfaces are smooth or slightly convex. • Included with this soil in mapping are small areas of Bienville, Derly, and Rader soils.	• This Styx soil is used mainly as pasture. Applications of lime and a complete fertilizer are needed to increase grass production. This soil is moderately suited to growing crops such as corn, peas, and watermelons. Leaving crop residue on or near the surface helps to reduce erosion and maintain organic matter content. It is moderately suited to wildlife habitat. This soil is also well suited to most urban uses, and moderately suited to most recreational uses.
Tabor fine sandy loam (TaB)	• Gently sloping soil (1 to 3 percent) located on broad uplands and has mainly smooth surfaces. Moderately well drained with very slow permeability and high water capacity, resulting in medium surface runoff and a moderate risk for water erosion. • Included with this soil in mapping are areas of Edge, Gasil, Lufkin, and Silstid soils.	• Used mainly as pasture, and is well suited to growing native grasses, while being poorly suited for most urban uses. Moderately suited to growing cotton, grain sorghum, small grains, and corn.

Table 6.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Tonkawa fine sand, 1 to 8 percent slopes (ToC)	• Gently sloping to moderately sloping soil located on uplands with surfaces that are slightly convex. These excessively drained soils have negligible to very low surface runoff, rapid permeability, a slight water erosion hazard and low available water capacity. • Included with this soil in mapping are areas of Leagueville and Pickton soils.	• Used mainly as pasture. This soil is not suitable for cropland due to excessive drainage and low available water capacity. Leaving crop residue on or near the surface would help to reduce erosion, increase organic matter content, and improve the water holding capacity. It is poorly suited to wildlife habitat and growing native grasses due to droughtiness and available water capacity. Suitability is moderate for most urban uses and is poor for most recreational uses due to the sandy texture.
Trinity clay (Tr)	• Usually covered by shallow slow-moving floodwater at least once each year, but flooding lasts only a short time. • Included with this soil in mapping are small areas of Kaufman soils on lower parts of the flood plain.	• Most areas are in hardwood timber and are used mainly for pasture. This clayey soil is difficult to work. Flooding is a hazard if the soil is not protected by levees.
Wolfpen loamy fine sand (WoB)	• Gently sloping (1 to 5 percent) soil on uplands and the surfaces are slightly convex. This soil is well drained with rapid permeability in the surface and subsurface layers and moderate in the subsoil. These factors, combined with the moderate available water capacity, result in very low surface runoff and a moderate risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and early spring. • Included with this soil in mapping are areas of Kirvin, Leagueville, Oakwood, and Pickton soils. The Kirvin soils are in slightly higher positions on the landscape. The Leagueville soils are in depressions and on toe slopes and foot slopes. The Oakwood soils are in areas that have lower, smoother slopes. The Pickton soils are in positions on the landscape similar to those of the Wolfpen soil.	• Used mainly as pasture, and is well suited to most urban and recreation uses. It is moderately suited to cropland, woodland, and growing native grasses.
Wolfpen loamy fine sand (WoE)	• Strongly sloping (5 to 15 percent) to moderately steep soil on uplands. The surfaces are mainly convex. This soil is well drained with moderate permeability and moderate available water capacity, resulting in low surface runoff and a severe risk of a water erosion hazard. A water table is generally within a depth of 5 feet (1.5 meters) during the winter and early spring. • Included with this soil in mapping are small areas of Cuthbert and Pickton soils. The Cuthbert soils are on higher and steeper slopes. The Pickton soils are in positions on the landscape similar to those of the Wolfpen soil.	• Used mainly as pasture, and is not suitable for cropland or most urban uses. It is well suited for use as woodland, and moderately suited to growing native grasses.

Source: FG Alliance, 2006c.

Power Plant Site

Predominant soil types within the proposed power plant site include Gasil fine sandy loam (GfB), Padina loamy fine sand (PaB, PaC), Silawa fine sandy loam (SaD, SaE), and Silsted loamy fine sand (SdB, SsB) (FG Alliance, 2006c) (see Table 6.5-1).

A Phase I ESA was performed on the proposed power plant site in April of 2006 (Horizon Environmental Services, 2006). Areas were observed on the proposed site that indicated past surface spillage of petroleum-related substances resulting in stained soils. Metal storage sheds, diesel storage tanks, 55-gallon (208-liter) drums, waste/debris piles, tank trucks, chemical storage areas, storage areas for farm implements, and pipeline easements are on the proposed power plant site. The Phase I ESA concluded that any resulting contamination was not significant with respect to siting another industrial facility at this location. Further soil testing was recommended before site construction to determine if any soil contamination exceeds the Texas Commission on Environmental Quality Risk Reduction Standard for industrial sites (FG Alliance, 2006c).

Sequestration Site

Segment A-C

Predominant soils found along this segment include Padina loamy fine sand, 1 to 5 percent slopes (PaB); Edge fine sandy loam, 1 to 5 percent slopes (EgB); Edge fine sandy loam, 5 to 12 percent slopes (EgE); Gasil fine sandy loam, 1 to 5 percent slopes (GfB); Silstid loamy fine sand, 1 to 3 percent slopes (SsB); Silstid loamy fine sand, 3 to 8 percent slopes (SsD); Hearne fine sandy loam, 5 to 15 percent slopes (HeE); Nahatche-Hatliff association, frequently flooded (NH); Rader fine sandy loam, 0 to 3 percent slopes (RaB); and Tabor fine sandy loam, 1 to 3 percent slopes (TaB). Characteristics and uses of the remaining soils are presented in Table 6.5-1.

Segment B-C

Segment B-C of the proposed CO_2 pipeline corridor lies within Freestone and Leon counties. The predominant soils found in the area include Arenosa fine sand, 1 to 8 percent slopes (ArC); Axtell fine sandy loam, 1 to 5 percent slopes (AxB); Dutek loamy fine sand, 1 to 8 percent slopes (DuC); Hatliff fine sandy loam frequently flooded (Ha); Hearne fine sandy loam, 1 to 5 percent slopes (HeB); Hearne fine sandy loam, 5 to 20 percent slopes, stony (HsE); Gasil fine sandy loam, 1 to 5 percent slopes (GfB); Marquez very fine sandy loam, 1 to 5 percent slopes (MkB); Marquez gravelly fine sandy loam, 1 to 5 percent slopes (MrB); Nahatche-Hatliff association, frequently flooded (NH); Padina loamy fine sand, 1 to 5 percent slopes (PaB); Padina loamy fine sand, 1 to 8 percent slopes (PaC); Padina loamy fine sand, 8 to 15 percent slopes (PaD); Rader fine sandy loam, 1 to 3 percent slopes (RaB); Silawa fine sandy loam, 1 to 5 percent slopes (SaB); Silawa fine sandy loam, 5 to 8 percent slopes (SaD); Silawa fine sandy loam, 5 to 12 percent slopes (SaE); Silstid loamy fine sand, 1 to 5 percent slopes (SdB); Silstid loamy fine sand, 1 to 5 percent slopes (SsB); and Silstid loamy fine sand, 5 to 8 percent slopes (SsD). Characteristics and uses of the soils are presented in Table 6.5-1.

Segment C-D

Segment C-D of the proposed CO_2 pipeline corridor lies entirely within Freestone County. The predominant soils found in the mapping area include Arenosa fine sand, 1 to 8 percent slopes (ArC); Cuthbert fine sandy loam, 5 to 15 percent slopes (CtE); Cuthbert gravelly fine sandy loam, 15 to 30 percent slopes (CvF); Cuthbert soils, graded, 5 to 15 percent slopes (CxE); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Gasil fine sandy loam, 1 to 5 percent slopes

(GfB); Hearne fine sandy loam, 5 to 15 percent slopes (HeE); Keechi loamy fine sand, frequently flooded (Kh); Kirvin fine sandy loam, 1 to 5 percent slopes (KrB); Kirvin gravelly fine sandy loam, 2 to 8 percent slopes (KyC); Nahatche clay loam, frequently flooded (Na); Nahatche-Hatliff association, frequently flooded (NH); Oakwood fine sandy loam, 1 to 5 percent slopes (OkB); Padina loamy fine sand, 1 to 5 percent slopes (PaB); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Pickton loamy fine sand, 8 to 15 percent slopes (PkE); Pluck loam, frequently flooded (Pu); Raino fine sandy loam, 0 to 2 percent slopes (RnA); Rader fine sandy loam, 0 to 3 percent slopes (RaB); Silawa fine sandy loam, 5 to 12 percent slopes (SaE); Silstid loamy fine sand, 1 to 5 percent slopes (SsB); Silstid loamy fine sand, 5 to 8 percent slopes (SsD); Tonkawa fine sand, 1 to 8 percent slopes (ToC); Wolfpen loamy fine sand, 1 to 5 percent slopes (WoB); and Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE). Characteristics and uses of the soils are presented in Table 6.5-1.

Segment D-E

Segment D-E is no longer being evaluated for this EIS, therefore, soils are not addressed for this segment.

Segment D-F

Predominant soils along this segment include Cuthbert fine sandy loam, 5 to 15 percent slopes (CtE); Cuthbert gravelly fine sandy loam, 15 to 30 percent slopes (CvF); Cuthbert soils, graded, 5 to 15 percent slopes (CxE); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Keechi loamy fine sand, frequently flooded (Kh); Kirvin fine sandy loam, 1 to 5 percent slopes (KrB); Nahatche-Hatliff association, frequently flooded (NH); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Pickton loamy fine sand, 8 to 15 percent slopes (PkE); Tonkawa fine sand, 1 to 8 percent slopes (ToC); and Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE). (Table 6.5-1).

Segment F-G

Predominant soils along this segment include Nahatche-Hatliff association, frequently flooded (NH); Rader fine sandy loam, 0 to 3 percent slopes (RaB); Cuthbert fine sandy loam, 5 to 15 percent slopes (CtE); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Keechi loamy fine sand, frequently flooded (Kh); Oakwood fine sandy loam, 1 to 5 percent slopes (OkB); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Pickton loamy fine sand, 8 to 15 percent slopes (PkE); Wolfpen loamy fine sand, 1 to 5 percent slopes (WoB); Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE); Derly-Rader complex, 0 to 1 percent slopes (DrA); Kaufman clay, frequently flooded (Kd); and Styx loamy fine sand, 0 to 3 percent slopes (StB). (Table 6.5-1).

Segment F-H

Predominant soils along this segment include Nahatche-Hatliff association, frequently flooded (NH); Cuthbert gravelly fine sandy loam, 15 to 40 percent slopes, very stony (CzG); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE); Kaufman clay, frequently flooded (Kd); Gladewater clay, frequently flooded (Gh); Kaufman clay, frequently flooded (Kc); and Trinity clay (Tr) (Table 6.5-1).

Cuthbert gravelly fine sandy loam is described by 15 to 40 percent slopes, very stony (CzG); Nahatche-Hatliff association, frequently flooded (NH); Pickton loamy fine sand, 1 to 8 percent slopes (PkC); and Wolfpen loamy fine sand, 5 to 15 percent slopes (WoE) have been previously provided.

Flooding and shrink swell are hazards to be evaluated in the area of the proposed F-H CO_2 corridor.

Utility Corridors

Water Supply Corridor

Predominant soils found along the proposed water supply pipeline include Padina loamy fine sand, 1 to 5 percent slopes (PaB); Gasil loamy fine sand, 1 to 5 percent slopes (GfB); Padina loamy fine sand, 1 to 5 percent slopes (PaC); Silstid loamy fine sand, 1 to 3 percent slopes (SsB); and Silstid loamy fine sand, 3 to 8 percent slopes (SsD). Descriptions of these soils are presented in Table 6.5-1.

6.5.3 IMPACTS

6.5.3.1 Construction Impacts

Direct impacts that could be caused during construction of the proposed power plant and associated infrastructure include removal of soil, soil-blowing and erosion due to wind and motion of equipment, soil compaction, and change in soil composition. Soil removal disturbs soil properties such as permeability, horizon structure, and vegetation. Soil-blowing could cause the movement of soil, making it unstable as well as unsuitable for vegetation growth. Soil compaction could cause changes in soil characteristics such as permeability, water capacity, surface runoff, root penetration, and water capacity. Indirectly, impacts to soils could result in soil erosion due to runoff and wind, potential decline in nearby surface water quality due to increased sedimentation, potential soil contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. BMPs would be used to minimize impacts (see Section 3.1.5).

Groundwater contamination is unlikely to occur due to the moderately deep level of the water table. During the winter and early spring, many of the soils have a perched water table within a couple of feet of the surface. If a spill were to occur during this time the perched water table could easily be contaminated.

Power Plant Site

Construction at the proposed power plant site would impact up to 200 acres (81 hectares) of soil. Soil impacts would result from construction of the power plant, storage areas, associated processing facilities, research facilities, parking areas, access roads, and the on-site railroad loop. During construction, soil would be removed from areas where the foundations of the structures would be sited. This soil would be placed on a temporary storage site protected from erosion and runoff for reuse as topsoil replacement or as fill. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 200-acre (81-hectare) power plant footprint. Soils impacts would be permanent for areas converted into impervious surface areas (e.g., structure, pads, and parking). Temporary soil compaction would occur in areas of temporary road construction and heavy equipment storage, soil-blowing and localized erosion would be likely during construction from equipment movement. Construction-related impacts to soils in areas not converted to impervious surfaces would be temporary and these areas would be restored after construction is completed.

Chemical spills could potentially affect on-site soil. Chemicals commonly used during construction include oils, paints, solvents, lubricants and cement. The quantities of these chemicals expected on-site during construction are small. The use of segregation, storage, labeling, and adequate handling, as well as secondary containment and other spill prevention techniques, could minimize the potential for a spill to occur. Should a spill occur, it would be contained and would not be expected to permanently impact soil characteristics such as pH, porosity, humidity, and texture.

Soils present at the proposed site are abundant throughout the region; therefore, overall impacts would not be adverse. The potential for impacts to prime farmland soil is discussed in Section 6.11.

Sequestration Site

The construction of the injection wells at the proposed sequestration site would result in the removal of up to 10 acres (4 hectares) of soil. Direct impacts would include the removal of soil, soil blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sedimentation, groundwater contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. These impacts would be temporary. After completion of drilling, soil could be replaced using BMPs, as discussed in Section 3.1.5, or would be disposed of off site. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 10-acre (4-hectare) footprint.

Utility Corridors

Existing transmission line and natural gas pipeline corridors would require minimal to no construction and therefore no impacts to soils would be expected. Groundwater wells for potable and process water, would be located on or close to the proposed plant site and would require only a small distance of distribution pipeline and a negligible amount of soil disturbance.

The CO_2 pipeline corridor would be up to 59 miles (95 kilometers) long and approximately 20 to 30 feet (6 to 9 meters) wide. This would result in the disturbance and removal of up to 358 acres (145 hectares) of soil. Direct impacts from the pipeline construction would include removal of soil, soil-blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sedimentation, and potential groundwater contamination if a chemical spill occurred. Soil characteristics would not likely be altered by construction of the utility corridors. Soil could be replaced using BMPs to minimize impacts of removal, such as revegetation.

Transportation Corridors

The direct and indirect impacts due to the construction of the proposed transportation corridors would be relatively minor, consisting of the same types of impacts described for the proposed power plant site. Approximately 48 to 73 acres (19 to 30 hectares) of soil would be impacted by proposed road construction and improvements. Direct impacts would include removal of soil, soil-blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sedimentation, and potential groundwater contamination if a spill occurred. Soil characteristics would not likely be altered by construction of the utility corridors. Permanently removed soil could be used as on-site fill or disposed of off site.

6.5.3.2 Operational Impacts

Direct impacts that could occur from operations include soil contamination due to leaks and spills, increased CO_2 concentration in soils due to CO_2 pipeline failures, and soil erosion due to wind. Indirect impacts include a disruption in plant growth and subsurface organisms, and groundwater contamination. It is expected that the impacts during operations would remain at a minimum due to the limited extent and current vegetative status of the proposed site. During the winter and early spring when the perched water table is within a couple of feet of the surface, the potential for groundwater contamination would be increased, but still unlikely because a spill would be immediately contained and cleaned up before contaminants could reach groundwater resource.

Power Plant Site

No additional soil disturbance is anticipated. Revegetation of disturbed areas during operations would minimize potential for erosion. During operation of the proposed plant and associated facilities, depending on amount and duration, storage of hazardous materials, as well as ash and coal piles, could cause soil contamination if in direct contact with the soil. Utilization of BMPs and construction of proper storage areas (impervious surfaces) would minimize the potential for adverse impacts.

Sequestration Site

During operations of the proposed sequestration site, the soil would not be disturbed; therefore, there would be no impacts to soil. Potential impacts due to a pipeline, surface equipment, or well failure are to be minimal, as risk abatement and safety procedures would be in place. Though it is highly unlikely, an increase of CO_2 concentration in the soil due to leaks could lower pH which could in turn cause a disruption in plant growth and occurrence of subsurface organisms (Damen et al., 2003) (e.g., microbes occurring approximately 0.9 mile (1.4 kilometers) under ground; see Section 6.9). Some levels of ground subsidence and heave have been known to be caused by petroleum production/injection operations, disposal well operations, and natural gas storage operations. Since the CO_2 injection at the Jewett Site would be at great depth and into very well consolidated rocks, the risks of any significant ground movement are small. Furthermore, since differential heave occurs most commonly when the underlying strata are tilted, faulted, or discontinuous, and the underlying strata at the proposed Jewett Site is horizontal, un-faulted, and continuous, there is a very low potential for differential settlement. Thus, the impacts of a small amount of ground heave would be negligible.

Utility Corridors

During operations the soil would not be disturbed around the utility corridors; therefore, there would be no environmental impacts associated with operations or maintenance of vegetation around the utilities during operation. Access within the utility corridors would occur through existing access roads or through access points constructed and maintained for any potential new corridors.

Transportation Corridors

During operations there would be little or no impacts to the soil due to transportation infrastructure corridor use and maintenance. Impacts could include soil-blowing, soil compaction, and soil erosion.

6.6 GROUNDWATER

6.6.1 INTRODUCTION

This section addresses groundwater resources that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Jewett Power Plant Site, sequestration site, and related corridors.

6.6.1.1 Region of Influence

The ROI for groundwater resources includes aquifers that underlie the proposed power plant site, sequestration site, and aquifers that may be used to obtain water for construction and operations support. The horizontal extent varies, depending on the particular aspects of the groundwater resource, as follows:

- A distance of 1 mile (1.6 kilometers) from the proposed power plant site defines the general vicinity that could be affected by changes in groundwater quantity or quality due to the power plant footprint.
- A larger distance could be impacted by pumping to supply the water for the facility. The ROI for these wells depends on specific aquifer properties of the formations being used and well design.
- A distance of 1.7 miles (2.7 kilometers) from each sequestration injection well defines the area that could be affected by potential leaks of CO_2 from the target reservoir to overlying aquifers. This distance is based on modeling that indicates that CO_2 could migrate up to 1.7 miles (2.7 kilometers) from the site of each injection well.
- The facility footprint (including utility and transportation corridors) defines where construction or other land disturbances could take place. These areas could be susceptible to changes in groundwater infiltration, discharge, or quality. Damage to, or loss of use of, an existing well (including the potential need for well abandonment) could also occur within the facility footprint.

6.6.1.2 Method of Analysis

DOE reviewed reports from state water authorities and information in the Jewett EIV (FG Alliance, 2006c) to assess the potential impacts of the proposed FutureGen Project on groundwater resources.

Uncertainties identified in relation to groundwater resources at the Jewett Site include the porosity, brine saturation and permeability of the target formation where CO_2 would be sequestered. Analog well data was analyzed; however, site-specific test well data was not collected. Uncertainty also exists concerning the presence of transmissive faults or improperly abandoned wells in the area.

Because neither the specific aquifer to be used for the water supply nor well locations have yet been selected, the analysis addresses a number of aquifers that could be used.

DOE assessed the potential for impacts based on the following criteria:

- Depletion of groundwater supplies on a scale that would affect available capacity of a groundwater source for use by existing water rights holders, interference with groundwater recharge, or reductions in discharge rate to existing springs or seeps;
- Relationship to established water rights, allotments, or regulations protecting groundwater for future beneficial uses;

- Potential to contaminate a public water supply aquifer through acidification of the aquifer due to migration of CO_2; toxic metal dissolution and mobilization; displacement of groundwater with brine due to CO_2 injection; and contamination of aquifers due to chemical spills, well drilling, or well completion failures; and
- Conformance with regional or local aquifer management plans or goals of governmental water authorities.

6.6.2 AFFECTED ENVIRONMENT

This section describes groundwater resources in the project area. In general, this description applies to all proposed project areas, although site-specific data is presented where available and applicable.

6.6.2.1 Groundwater Quality

Groundwater would be the source of process water for the proposed power plant at the Jewett Site and the Carrizo-Wilcox aquifer system is the only source of groundwater beneath and within the ROI of the proposed power plant site (FG Alliance, 2006c). The well field is proposed to be located in Limestone County. No sole source aquifers have been designated in the vicinity of the proposed project area (EPA, 2006a).

The Carrizo-Wilcox aquifer system consists of many hydraulically distinct and diverse units. In the proximity of the ROI, four aquifer units are formally recognized. These units are, in ascending stratigraphic order, the Hooper, Simsboro, and Calvert Bluff formations of the Eocene Wilcox Group; and the Carrizo, the lowermost formation of the Eocene Claiborne Group. The Queen City aquifer is near the proposed injection site, but is too far to the east of the injection site to be considered part of the affected environment.

The Hooper is a sequence of fluvial and deltaic sand beds separated by low permeability silt and clay lenses that act as confining units. This sequence is about 600 feet (183 meters) thick below the proposed power plant site, and contains less than 100 feet (30.5 meters) of sand.

The Simsboro is generally composed of thick, laterally extensive, medium- and coarse-grained sand beds deposited in a mixed-load fluvial system. This unit is about 200 feet (61 meters) thick near the proposed power plant site.

The Calvert Bluff extends from the surface to a depth of about 800 feet (244 meters) and is composed of inter-bedded fluvial and deltaic sand, silt, clay, and lignite beds. Similar to the Hooper unit, these sand beds act as separate aquifers. At the proposed power plant site, the Calvert Bluff formation contains less than 100 feet (30.5 meters) of sand (UTA, 1985).

The Carrizo is typically massive, white, fine- to medium-grained quartz sand with some limited amounts of thin clay lenses (TWDB, 1972). In Leon County, the Carrizo ranges in thickness from 100 to 210 feet (30.5 to 64.0 meters).

6.6.2.2 Carrizo-Wilcox Aquifer Properties

Table 6.6-1 summarizes the typical range in physical properties of each of the units in the Carrizo-Wilcox aquifer system that may serve as a potential water supply for the proposed power plant.

Table 6.6-1. Typical Range of Physical Properties of Carrizo-Wilcox Aquifer Units that May Provide Water for the Proposed FutureGen Project

Property	Hooper	Simsboro	Calvert Bluff
Well Yield, gpm (L/s)	20 - 200 (1.26 - 12.6)	500 - 1000+ (31.5 - 63.1)	20 - 200 (1.26 - 12.6)
Hydraulic Conductivity of Sands, gpd/ft^2 (cm/s)	10 - 75 (0.00047 - 0.0035)	100 - 200 (0.0047 - 0.0095)	10 - 75 (0.00047 - 0.0035)
Specific Yield (dimensionless)	0.15	0.15	0.15
Artesian Storage Coefficient (dimensionless)	0.00005	0.00005	0.00005
Transmissivity, gpd/ft (L/day/meter)	2,000 - 10,000 (24,839 – 124,193)	20,000 - 40,000 (248,387 – 496,773)	2,000 - 10,000 (24,839 – 124,193)

Note: gpm = gallons per minute; gpd = gallons per day; ft^2 = cubic feet; L/s = liters per second; cm/s = centimeters per second.
Source: R. W. Harden & Associates, 2006.

The Carrizo-Wilcox aquifer system recharge is dependent on rainfall amounts as well as water levels in the outcrop area. These recharge rates are summarized in Table 6.6-2 and are the estimated maximum amount of water that infiltrates the surface.

Table 6.6-2. Estimated Recharge Rates for Carrizo-Wilcox Aquifer Units

Aquifer Unit	Recharge Rate, inches/year (centimeters/year)
Hooper	0.84 (2.1)
Simsboro	2.53 (6.4)
Calvert Bluff	1.01 (2.6)

Source: TWDB, 2003.

According to water quality data from wells within the ROI, groundwater from the Simsboro and Calvert Bluff aquifers is fresh, with all samples having total dissolved solids (TDS) concentrations less than 350 milligrams per liter. Table 6.6-3 shows a representative water quality analysis for the Simsboro unit. No water quality data were available for the Hooper aquifer, but it is known to produce fresh to brackish water in outcrop areas and brackish water in down dip areas. The available data shows that the groundwater in the Calvert Bluff and Simsboro aquifers meet state and federal drinking water standards for all constituents tested, and exists to depths of approximately 1,400 feet (427 meters).

Table 6.6-3. Representative Water Quality Analysis from the Simsboro Aquifer Adjacent to the Proposed Power Plant Site

Date Sampled	3/6/81
Bicarbonate (mg/L as HCO_3)	273
Calcium, Dissolved (mg/L as Ca)	2
Magnesium, Dissolved (mg/L as Mg)	2

Table 6.6-3. Representative Water Quality Analysis from the Simsboro Aquifer Adjacent to the Proposed Power Plant Site

Sodium Plus Potassium (mg/L)	113
Chloride, Dissolved (mg/L)	30
Sulfate, Dissolved (mg/L as SO_4)	17
Silica, Dissolved (mg/L as SIO_2)	11
Total Dissolved Solids (mg/L)	309
Fluoride (mg/L)	0.2

Note: mg/L = milligrams per liter; SO_4 = sulfate; SIO_2 = silica.
Source: TWDB, 2006a.

6.6.2.3 Groundwater Use

Table 6.6-4 shows the groundwater use from the Carrizo-Wilcox aquifer system in Freestone and Leon counties. Use information for each of the subdivisions of the aquifer system is not available.

Table 6.6-4. Groundwater Use in the Carrizo-Wilcox Aquifer System

Use	Limestone County	Freestone County	Leon County
	acre-feet per year (cubic meters per year)		
Municipal	1,781 ($2.1x10^6$)	2,511 ($3.1x10^6$)	1,424 ($1.7x10^6$)
Manufacturing	0	0	449 (553,833)
Power	852 ($1.0x10^6$)	99 ($1.2x10^5$)	0
Mining	35 ($4.3x10^5$)	35 ($4.3x10^5$)	1,067 ($1.3X10^6$)
Irrigation	0	0	0
Livestock	147 ($1.8x10^5$)	147 ($1.8x10^5$)	52 ($6.4x10^4$)
Total	**2,792 ($3.4x10^6$)**	**2,792 ($3.4x10^6$)**	**2,992 ($3.7x10^6$)**

Source: Caldwell, 2006.

Limestone County does not have a groundwater management plan or any requirements for drilling permits or groundwater production permits. According to the Texas Commission on Environmental Quality (TCEQ) records, there are no cases of contaminated groundwater in the vicinity of the proposed power plant site (TCEQ, 2006).

The primary injection zone (Woodbine formation) and secondary target (Travis Peak formation) are not known to have groundwater that has commercial, industrial, or other uses.

The proposed injection wells at the Jewett Site would penetrate the units of the Carrizo-Wilcox aquifer starting with the Carrizo unit followed by the Calvert Bluff, the Simsboro, and the Hooper units.

All of these aquifers could be classified as an Underground Source of Drinking Water (USDW) according to EPA's definition (EPA, 2006b) of an USDW, which includes any aquifer or part of an aquifer that:

- Supplies any public water system, or contains a sufficient quantity of groundwater to supply a public water system and currently supplies drinking water for human consumption or contains fewer than 10,000 milligrams per liter of TDS; and
- Is not an exempted aquifer.

Since the aforementioned aquifers could be classified as USDW according to EPA (440 CFR 144.3), any injection well construction must consider the protection of the resource. Section 6.6.2.2 addresses the water quality of these aquifers and Section 6.6.2.3 identifies the different uses of the resource by the local counties.

In March 2007, EPA published a Guidance (UICPG #83) determining that wells used for testing underground CO_2 sequestration technologies should be classified as Class V experimental technology wells (EPA, 2007). These wells would be subject to permitting from the State and EPA regions and this Guidance present factors that might be considered in this permitting process. These factors include the physical appropriateness of the injection sites, which include characteristics such as thickness, porosity, permeability, trapping mechanism, and confining systems. The Guidance also recommends considering the area of review based on the CO_2 plume extent and migration pathways. It also suggests that the area of review should take into account the probable pressure buildup predictions based on injection volume, depth of injection, duration of injection, and boundary conditions.

EPA also presents considerations for the construction, operation, monitoring, and closure of the wells, with the overall intent of protecting the human health and the quality of any USDW intersected or affected by the injection wells.

The State of Texas also regulates the construction, operation, monitoring, and closure of Class V wells under the Texas Administrative Code, Title 30 Part 1 Chapter 331 subchapters H and K (30 TAC 331). Under these regulations, Class V injection wells would require state permits and would be monitored as well.

6.6.3 IMPACTS

6.6.3.1 Construction Impacts

Power Plant Site

Construction activities would not be expected to disturb the groundwater resources beneath the plant or other facilities. While construction of impervious areas would hinder aquifer recharge in the immediate vicinity of the power plant site, this effect would be minimal, as the size of the aquifer recharge area is much larger than the area of impervious surface that would be created. Construction activities would not use groundwater, thus would not affect the quantity of available groundwater in the aquifer. Water for construction activities and dust control could be trucked to the site, so groundwater withdrawals would be unnecessary.

There would be no direct on-site discharge of wastewater to the subsurface. Appropriate Spill Prevention, Control, and Countermeasure (SPCC) plans would be employed to minimize the potential for spills of petroleum, oils, lubricants, and other materials used during construction and to ensure that waste materials are properly disposed of. In the event of a spill, it is unlikely that these materials would reach groundwater sources prior to cleanup. Section 6.5 provides further detail regarding soil properties, including permeability. In general, no impact on groundwater availability or quality would be anticipated due to the construction of the power plant.

Sequestration Site

The above discussion for the power plant site also applies to the sequestration sites, although considerably less impervious cover would be associated with CO_2 injection wells and equipment. The primary injection zone (Woodbine formation) is located at a depth of 1 to 1.1 miles (1.6 to 1.8 kilometers) and the secondary target (Travis Peak formation) is located 1.7 to 2.1 miles (2.7 to 3.4 kilometers). To reach these formations, the injection wells would be drilled through the Carrizo-Wilcox aquifer system and continue to the formation where CO_2 would be injected. The aquifer would be isolated by a series of conductor casings during drilling of the injection wells and thus no impacts to the shallow aquifers would be expected.

Utility and Transportation Corridors

Potential construction impacts are similar to those discussed for construction of the proposed power plant, with the exception that considerably less impervious area would be created in the corridors.

6.6.3.2 Operational Impacts

Power Plant Site

During operation of the power plant, petroleum, oils, lubricants, and other hazardous materials could be spilled onto the ground surface and potentially impact groundwater resources. However, appropriate SPCC plans would be employed to minimize the potential for such materials used during operation to be released to the surface or subsurface, and to ensure that waste materials are properly disposed of. Section 6.5 provides further detail regarding soil properties, including permeability.

The Heart of Texas region, which includes Limestone, Freestone, Hill, and Leon counties, is served by a combination of surface water and groundwater, including water from the Carrizo-Wilcox aquifer. According to planning scenarios developed by the Texas Water Development Board (TWDB), the demand for water would increase by 42 percent by year 2050 and the current combination of sources would satisfy this demand (TWDB, 1997).

A recent model developed by the state water authority (TWDB, 2006b) indicates that the regional water demand between 2010 to 2060 would increase by 38 percent (see Table 6.6-5), and the region's current water supply would be sufficient if the water management strategies are followed. These water management strategies include using a mixed supply of groundwater from different aquifers with surface water and a considerable investment in infrastructure and conservation policies. Considering that water demand for the FutureGen Project would be around 3,000 gallons (11,356 liters) per minute, or approximately 4,114 acre-feet ($5.1x10^6$ cubic meters) per year, assuming 85 percent availability, the incremental increase in water demand from the proposed project would represent less than 1 percent of the total regional demand from 2010 to 2060 (Table 6.6-5).

Table 6.6-5. Projected Water Demand[1] for 2010-2060

Category	2010 acre-feet (cubic meters)	2060 acre-feet (cubic meters)
Municipal	311,581 ($3.8x10^7$)	547,028 ($6.7x10^8$)
County-other	35,808 ($4.4x10^7$)	48,454 ($5.9x10^7$)
Manufacturing	19,787 ($2.4x10^7$)	31,942 ($3.9x10^7$)
Mining	36,664 ($4.5x10^7$)	21,243 ($2.6x10^7$)
Irrigation	232,541 ($2.9x10^8$)	208,386 ($2.6x10^8$)
Steam-electric	147,734 ($1.8x10^8$)	242,344 ($3.0x10^8$)
Livestock	51,576 ($6.3x10^7$)	51,576 ($6.3x10^7$)
FutureGen Power Plant	4,114 ($5.08x10^6$)	4,114 ($5.08x10^6$)

[1] Refers to Region I that includes Limestone County.
Source: TWDB, 2006c.

The TWDB estimated that the Carrizo-Wilcox aquifer could supply the demand for the resource well past the year 2050 without compromising the capacity to satisfy the needs of other users (TWDB, 2006b). The combined groundwater usage for Limestone, Freestone, and Leon counties is 8,576 acre-feet ($1.1x10^7$ cubic meters) per year (Table 6.6-4) and the estimated water availability from the Carrizo-Wilcox aquifer in the region is 108,531 acre-feet ($1.3x10^8$ cubic meters) in 2010 and 93,967 acre-feet ($1.2x10^8$ cubic meters) in 2060 (TWDB, 2006b). These estimates are consistent with the assertion that the quantity of water available for other users would not be in danger. Modeling by the TWDB, using the Texas groundwater availability model (GAM) for the Carrizo-Wilcox aquifer estimated water consumption of the plant (±3 percent) to assess the availability of groundwater from the Carrizo-Wilcox aquifer for this project (TWDB, 2006b). The simulations, as reported by the TWDB, indicate that the Carrizo-Wilcox aquifer in the immediate area of the proposed power plant site could supply the required facility water and all local demands, as well as additional demands past the year 2050. The modeling indicated that increased drawdown would occur in the vicinity of the pumping wells, though specific well locations have not been selected. Severe drought conditions are regional events that could affect the overall water supply for users in the area, but, since these events are foreseeable, their impact would be minimized through planning.

Sequestration Site

The potential impacts associated with CO_2 sequestration in geologic formations are largely associated with the possibility of leakage. The potential for leaks to occur would depend upon caprock integrity and the reliability of well-capping methods and, in the longer term, the degree to which the CO_2 eventually dissolves in formation waters or reacts with formation minerals to form carbonates. The mechanisms that could allow leakage of the injected CO_2 into shallower aquifers are:

- CO_2 exceeds capillary pressure and passes through the caprock;
- CO_2 leaks into the upper aquifer via a transmissive fault;
- CO_2 escapes through a fracture or more permeable zone in the caprock into a shallower aquifer;
- Injected CO_2 migrates up dip, and increases reservoir pressure and permeability of an existing fault; or
- CO_2 escapes via improperly abandoned wells or unknown wells.

CO_2 would be injected into the Woodbine formation at a depth of 1 to 1.1 miles (1.6 to 1.8 kilometers) and in the Travis Peak formation between 1.7 to 2.1 miles (2.7 to 3.4 kilometers) below the ground surface. Subsequently, it would mix with the saline groundwater in the formation. Because CO_2 is less dense than the surrounding groundwater, its buoyancy would cause it to move vertically into lower pressure zones until it reached less permeable strata which would act as a seal (e.g., caprock layer). Over time, the CO_2 would dissolve in the formation water and begin to move laterally with the groundwater flow, unless it found a more permeable conduit, such as a transmissive fault or an improperly abandoned well.

However, vertical migration of CO_2 to near-surface freshwater aquifers would be highly unlikely due to:

- The depth of the injection zones in the Woodbine and Travis Peak formations;
- The substantial primary seal provided by the Eagle Ford shale (400 feet [122 meters] thick);
- The presence of at least one secondary seal (Austin Chalk); and
- A total of over 0.8 mile (1.4 kilometers) of various strata (much of it being fine grained) between the injection zone and any potable water aquifers in the project area.

Each series of less permeable and more permeable sedimentary layers within the 4,000 feet (1,219 meters) of strata would be a barrier to upward migration of CO_2. Pressure would force the CO_2 through each layer with low permeability and then dissipate due to lateral flow of CO_2 in each layer with higher permeability. There are hundreds of these series, and as a result, extensive vertical movement to potable aquifers would not be likely.

Transmissive faults present in the subsurface ROI could also accelerate CO_2 migration. Detailed geologic mapping and investigation of the deep subsurface at the Jewett Sequestration Site has identified one fault within the subsurface ROI; however, it is interpreted as being a sealing fault (see Section 6.4). Other significant fractures have not been identified or suspected within the plume area of the sequestered CO_2. If there is a transmissive fracture in the subsurface ROI, it must penetrate and be open through over 0.8 mile (1.4 kilometers) of various types of rock to allow CO_2 migration to areas near potable aquifers or the land surface. DOE considers it unlikely that such fractures exist in the project area because detailed geologic mapping at the site does not show evidence of deep open fractures that could allow CO_2 to migrate.

Reservoir modeling indicates that the largest plume radius would be approximately 1.7 miles (2.7 kilometers) over 20 years of injection at a rate of 2.8 million tons (2.5 MMT) per year. CO_2 movement would be expected to be primarily horizontal, with very little upward migration out of the injection zone due to trapping beneath the caprock seal provided by the Eagle Ford shale. Brine in the formation would be displaced horizontally (and vertically) for an unknown lateral distance. However, the displaced brine would have to move vertically more than 0.9 mile (1.4 kilometers) to reach the Carrizo-Wilcox aquifer. As these brines move at a rate of a few centimeters a year, it is not expected that the Carrizo-Wilcox aquifer or other source of water would be affected.

In addition to displacing brine, CO_2 would also dissolve into the brine over time. In formations like the Woodbine and Travis Peak with slowly flowing water, reservoir-scale modeling for similar projects shows that, over tens of years, up to 30 percent of the CO_2 would dissolve (IPCC, 2005). Once CO_2 dissolves in the brine groundwater, it could be transported out of the injection site by regional scale circulation or upward migration, but the time scales of such transport are millions of years and are thus not considered an impact for this assessment (IPCC, 2005).

Reactions between the CO_2 and brine would produce carbonic acid, a weak acid that would react with the formation rock. This formation is quartz-rich and reacts with minerals very slowly, taking hundreds to thousands of years (IPCC, 2005). Toxic metal displacement and dissolution could be a concern in those areas where injected CO_2 reacts with brine. However, there is a lack of mineral deposits in the area that indicate the presence of heavy metals in the surrounding formations to provide a source of leaching and subsequent transport of metals.

Acidification of the aquifer due to dissolution of CO_2 into water would slightly lower the pH of the groundwater. At the Jewett Site, acidification of shallower groundwater sources would be very unlikely due to the hundreds of feet of separation between the injection target formation and these aquifers, as well as the limited pathways for CO_2 to travel upward and mix with groundwater. Similarly, it would be unlikely that the CO_2 injection would contaminate overlying aquifers by displacing brine, because this would require pathways, such as faults or deep wells that penetrate the primary seal, that are not present at the proposed site. However, monitoring methods could help detect CO_2 leaks before they migrated into an aquifer, and mitigation measures could minimize such impacts should they occur (see Section 3.4).

Improperly abandoned wells provide one of the primary flow paths for CO_2 to reach the surface or the shallower aquifers, serving as an escape route for the pressurized gases injected into the reservoir. These flow paths are of concern when they cut through the primary seal above the reservoir. Fifty-seven such wells are known to be located within the maximum plume footprint of the two Woodbine wells. The condition of these wells is not known (FG Alliance, 2006c).

In the hypothetical case that CO_2 and brine would reach any of the USDW identified in this section, users in Limestone, Freestone and Leon counties could be impacted since they use the Carrizo-Wilcox aquifer for municipal/potable purposes.

To alleviate excess formation pressures caused by the injection of CO_2 into the Travis Peak formation, groundwater extraction wells would likely be required. Conservatively, four extraction wells would collectively pump no more than 82 million gallons (310.4 million liters) a year of saline water from the Travis Peak formation, which would either be re-injected into a shallower formation or piped off site for use in oil recovery operations (through water flooding). The formation that would receive this water is unknown and would be determined during the design phase of the project. Both disposal options are common practices in Texas and the re-injection of the water would be subject to state Underground Injection Control (UIC) regulations and permitting.

Utility Corridors

The above discussion for the power plant site also applies to the proposed utility corridors, but to a lesser extent as hazardous materials would not be expected to be on site in the utility corridors unless maintenance activities were occurring.

Transportation Corridors

Traffic accidents could result in hazardous materials spills. The spill response measures discussed for the proposed power plant site would be executed to ensure rapid control and cleanup of any hazardous material spill from a traffic accident.

6.7 SURFACE WATER

6.7.1 INTRODUCTION

Ready access to an abundant supply of water is an important consideration in siting power plants, as water is necessary for steam generation and process water. Drinking water would also be required for the employees at the proposed power plant and sanitary wastewater would be generated by restrooms, sinks, and shower facilities. The proposed FutureGen Power Plant would not discharge any industrial wastewater; all process wastewater would be treated by the zero liquid discharge (ZLD) system and recycled back to the power plant. The following analysis evaluated short-term impacts from construction and long-term impacts from operations to surface water resources from the proposed FutureGen Project.

6.7.1.1 Region of Influence

The ROI consists of the proposed power plant site, sequestration site, areas within 1 mile (1.6 kilometers) of all related areas of new construction, and any surface water body above the sequestration reservoir.

The greatest potential for impacts to surface water resources is limited in most cases to the proposed power plant and sequestration site and related corridors. Because of the types of land disturbing activities that would occur during construction of the proposed power plant, injection wells, and supporting utilities and infrastructure, the disturbed areas would be susceptible to erosion and changes in surface water flow patterns. The area could also be affected by spills associated with construction or operations.

In some cases, the ROI for surface water extends beyond the proposed construction sites. Construction and operation activities would affect a larger area in cases where flow patterns were modified or if contamination could be carried downstream by surface water drainages.

6.7.1.2 Method of Analysis

DOE reviewed public data, research, and studies compiled in the Jewett EIV (FG Alliance, 2006c) to characterize the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Alter stormwater discharges, which could affect drainage patterns, flooding, and erosion and sedimentation;
- Alter infiltration rates, which could affect (substantially increase or decrease) the volume of surface water that flows downstream;
- Conflict with applicable stormwater management plans or ordinances;
- Contaminate public water supplies and other surface waters exceeding water quality criteria or standards established in accordance with the Clean Water Act (CWA), state regulations, or permits;
- Conflict with regional water quality management plans or goals;
- Affect capacity of available surface water resources;
- Conflict with established water rights or regulations protecting surface water resources for future beneficial uses;
- Alter floodway or floodplain or otherwise impede or redirect flows such that human health, the environment or personal property is impacted; or
- Conflict with applicable flood management plans or ordinances.

DOE reviewed reports from USGS, EPA and TCEQ, and reviewed information provided in the Jewett EIV (FG Alliance, 2006c) to assess the potential impacts of the proposed FutureGen Project on surface water resources. Surface water data analysis was limited to locations that had the potential for permanent impacts (i.e., power plant and sequestration site); however, site-specific surface water data for these areas were not collected. Data were evaluated from area discharge points and sample locations monitored by the agencies previously mentioned. Best professional judgment was applied to determine the likelihood of surface water impairments in the area. Uncertainties and unavailable data are discussed as appropriate in the following analysis.

To avoid or limit adverse impacts, emphasis is placed on adhering to applicable laws, regulations, policies, standards, directives, and BMPs. Most importantly, careful pre-planning of construction and operational activities would allow potential impacts to be minimized before they occur.

6.7.2 AFFECTED ENVIRONMENT

Power Plant Site

The proposed Jewett Power Plant Site consists of 400 acres (162 hectares) located approximately 6 miles (9.7 kilometers) from the Town of Jewett, Texas (FG Alliance, 2006c). Figure 6.7-1 shows the proposed power plant site, sequestration site, proposed utility corridors and surface water resources in the area. The nearest significant waterbody is Lake Limestone approximately 3 miles (4.8 kilometers) west of the proposed power plant site.

The proposed power plant site is located in the Texas-Gulf Region of the Trinity River Basin (TCEQ, 2006a). Figure 6.7-1 shows the surface water resources and topography of the site surrounding the proposed location. Lynn, Red Hollow, and Lambs Creeks, along with the Cottonwood Springs Branch are all intermittent (seasonal flow) creeks within the ROI of the power plant site. Red Hollow Creek follows along the southeast border of the proposed site and cuts across the northeast section of the proposed site. Lynn Creek parallels the northwest border of the site, but is between 0.08 and 0.38 mile (0.13 and 0.61 kilometer) away. Both creeks drain into Lambs Creek, which has an unnamed tributary that runs from the center of the proposed site; Lambs Creek eventually drains into Lake Limestone. The Cottonwood Springs Branch flows near the confluence of Red Hollow and Lambs Creek south until its termination approximately 2 miles (3.2 kilometers) south of the proposed site.

Sequestration Site

The land above the proposed sequestration site is approximately 33 miles (53 kilometers) northeast of the proposed plant site and is located in the Trinity River Basin and straddles the Trinity River (FG Alliance, 2006c). The following surface water bodies are located within the sequestration site ROI: Willow Creek, Edwards Creek, Rocky Branch, Indian Creek, Catfish Creek, Spring Creek, Lake Creek, Keechie Creek, Upper Keechi Creek, Town Creek, Gaston Branch, Saline Branch, Cedar Lake Slough, and Trinity River.

Utility Corridors

Review of USGS maps of the proposed water supply pipeline corridor revealed that several surface water bodies exist within the corridor. However, field investigations were not completed to confirm the presence or absence of flowing or intermittent areas.

Review of USGS maps for the proposed CO_2 pipeline corridor revealed that approximately 30 water resources occur within the corridor: Red Hollow Creek, Lynn Creek, Lambs Creek, Spring Branch, Needham Marsh, Nanny Branch, Thundering Springs, Silver Creek, Rena Branch, Bow Branch, Buffalo Creek, Whitney Branch, Fulks Dugout, Chandler Bottom, Browns Creek, Self Creek, Plum Creek, Upper Keechi Creek, Alligator Creek, Holly Branch, Brinkley Creek, Batsmith Creek, Edwards Creek, Willow Creek, Cold Springs Branch, Indian Creek, Alum Branch, Evans Lake, Cedar Lake Slough, Lake Creek and the Trinity River.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected surface waters. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.7.2.1 Surface Water Quality

The tributaries within the ROI of the proposed plant site are unclassified by the State of Texas and therefore no designated uses for them have been established (TCEQ, 2006a). Because there are no designated uses and no existing known contamination of these creeks, no water quality assessments have been made to determine if the creeks are impaired for any uses (FG Alliance, 2006c).

Lake Limestone is approximately 3 miles (4.8 kilometers) west of the proposed plant site and was assessed during the 2002 Texas Water Quality Survey for the period of 1996-2001. The aquatic life, contact recreation, public water supply, and general uses are fully supported and no impairment is listed; however, the fish consumption use of the lake was not assessed. Two concerns listed for Lake Limestone in 2002 were related to nutrient enrichment for nitrogen near the north-central portion of the lake above the confluence of Lambs Creek and also at the south end near the dam (TCEQ, 2004).

The Trinity River, above Lake Livingston, has designated uses (as established by TCEQ) for aquatic life, general contact recreation, and fish consumption. A segment of the Trinity River near the sequestration site was classified as a concern for nutrient enrichment and algal growth, due to high nitrogen and phosphorous levels during the 2002 Texas Water Quality Survey (TCEQ, 2004). No water quality standard is currently being exceeded and no regulatory action is required at this time (FG Alliance, 2006c). This segment was delisted from the State of Texas' 303(d) list for bacterial impairment (TCEQ, 2004). Water quality data for the remaining surface water bodies in the area of the sequestration site are not available.

The nearest water quality monitoring station to the proposed sequestration site is Trinity River Station ID#10919, located at U.S. Highway 79 Northeast of Oakwood, Texas. Recent water quality data were available through the Trinity River Authority and is shown in Table 6.7-1 (TRA, 2006). This station is located west of the proposed sequestration site and the reported monitoring data indicate that the quality of the Trinity River at the sampling point has been fairly consistent over the past 5 years.

6.7.2.2 Process Water Supply and Quality

No surface water would be used for the process water supply for the proposed power plant site. Process water would be provided by on-site or possibly off-site groundwater wells, as discussed in Section 6.6.

Table 6.7-1. Annual Average Water Quality Data for the Trinity River Station

Parameter	Unit	Year						Texas Surface Water Quality Stds
		2000	2001	2002	2003	2004	2005	
Temperature	°C	20.99	20.96	21.23	20.98	20.53	21.63	33.9
Conductance	µs/cm	582.83	539.78	507.47	619.92	480.00	642.50	NS
Dissolved Oxygen	mg/L	9.61	7.75	7.99	8.61	7.71	8.51	5.0
pH		7.85	7.67	7.84	7.97	7.89	8.03	6.5-9.0
Ammonia	mg/L	0.06	0.06	0.10	0.11	0.04	0.02	NS
Total Kjeldahl Nitrogen	mg/L	1.21	0.77	0.92	1.36	1.14	0.95	NS
Nitrites plus Nitrates	mg/L	7.10	5.54	4.88	5.28	3.02	7.35	NS
Total Phosphorous	mg/L	0.87	0.91	0.77	1.16	0.69	1.05	NS
Total Hardness	mg/L	171.00	168.50	175.17	187.92	171.67	173.83	NS
Sulfates	mg/L	70.00	64.00	61.67	82.80	N/A	N/A	NS
E. Coli	MPN/100mL	129.80	243.21	476.08	248.18	99.45	N/A	NS
Chlorophyll a	µg/L	12.39	15.23	11.04	20.79	11.42	19.78	NS

°C = degrees Celsius; µs/cm = microSiemens per centimeter; mg/L = milligrams per liter; MPN/100mL = most probable number; µg/L = micrograms per liter; NS = No Standard.
Source: TRA, 2006; TNRCC, 2000.

6.7.3 IMPACTS

6.7.3.1 Construction Impacts

Water would be required during construction for dust suppression and equipment washdown and would most likely be trucked to areas where needed; no water would be withdrawn from surface waters. BMPs would be used to contain water used for dust suppression and equipment washdown, and would have little to no impact to surface water quality. This activity would be addressed in a NPDES Permit (discussed below). Proposed grades in paved areas and for building first floor elevations would be as close to existing grade as feasible to minimize side slopes. All temporarily disturbed areas would be seeded to re-establish vegetative cover.

Because there would be over 1 acre (0.4 hectare) of disturbance, the construction contractor would need to apply for a general NPDES Permit No. TXR150000 from the TCEQ, which requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP). Part III of the general NPDES permit includes erosion control and pollution prevention requirements and refers to specific construction standards, material specifications, planning principles and procedures. The plans are required to include site specific BMPs. Operating stormwater pollution prevention restrictions and BMPs will be dictated by the NPDES permit.

A **Storm Water Pollution Prevention Plan** consists of a series of phases and activities to characterize the site and then select and carry out actions to prevent pollution of surface water drainages.

Impacts due to construction activities would likely include erosion due to equipment moving, surfacing and leveling activities, and alteration of surface structures resulting in effects on local (i.e., at the point of disturbance) hydrology. In addition, Clean Water Act Section 404 permits (hereafter referred to as Section 404) are required for jurisdictional waterbody (wetland) crossings and will be issued before construction. Section 404 permits require the use of BMPs during and after construction and oftentimes include mitigation measures for unavoidable impacts.

Power Plant Site

There are currently no major surface water reservoirs, lakes, or ponds within the 1-mile ROI (FG Alliance, 2006c). The closest significant waterbody is Lake Limestone, which is located approximately 3 miles (4.8 kilometers) west of the site (FG Alliance, 2006c). There are intermittent streams with small associated wetlands, as described in Section 6.8. During construction, increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation and subsequently increase the amount of stormwater runoff. Presently, area soils are moderately to well drained, so the likelihood that construction activities will significantly alter stormwater runoff patterns is low (USDA, 1989, 1998, 2002). It is expected that any potential impact to surface water quality from stormwater runoff would be mitigated by BMPs defined in the SWPPP required by the NPDES General Permit.

Sequestration Site

The sequestration site is minimally developed wooded and savannah habitat (FG Alliance, 2006c). The proposed sequestration site is northeast of the proposed power plant site and is located in the Trinity River Basin, straddling the Trinity River as shown in Figure 6.7-1. This area is characterized by numerous intermittent and perennial creeks, small ponds, and reservoirs (FG Alliance, 2006c).

The construction of injection wells would disturb minor amounts of land which could cause temporary indirect impacts to adjacent surface waters such as sedimentation and surface water turbidity from runoff. These impacts would be minimized or avoided through the use of BMPs.

Increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation and subsequently increase the amount of stormwater runoff. Presently, area soils are moderately to well drained, so the likelihood that construction activities would significantly alter stormwater runoff patterns is low (USDA, 1989, 1998, 2002). It is expected that any potential impact to surface water quality from stormwater runoff will be mitigated by BMPs defined in the SWPPP required by the NPDES General Permit for Construction Activities.

Utility Corridors

Construction activities associated with the construction of the process water pipeline and other underground utility lines are not anticipated to cross or impact surface water resources, except for the proposed CO_2 pipeline, described below. The construction of new pipelines for utility corridors would require hydrostatic testing of the lines to certify the material integrity of the pipeline before use. These tests consist of pressurizing the pipeline with water and checking for pressure losses due to pipeline leakage. Hydrostatic testing would be performed in accordance with U.S. Department of Transportation (DOT) pipeline safety regulations. The source and quantity of water for hydrostatic testing is further discussed in Section 6.6.

Water used for hydrostatic testing is required to be contained in approved fluid holding or disposal facilities. Hydrostatic pipe and well testing waters may not be discharged to the surface (TCEQ, 2006b).

No chemical additives would be introduced to the water used to hydrostatically test the new pipeline, and no chemicals would be used to dry the pipeline after the hydrostatic testing. Hydrostatic testing would be conducted in accordance with applicable permits.

The related areas of new construction associated with the proposed power plant include a proposed water supply pipeline corridor and six segments of proposed CO_2 pipeline corridor. A new CO_2 pipeline would be required to connect the proposed power plant site to the proposed sequestration site. The pipeline would be up to 59 miles (95 kilometers) in length and the ROW would be approximately 20 to 30 feet (6 to 9 meters) wide. The proposed CO_2 pipeline has been divided into the following common segments, except for segments A-C and B-C which are alternatives between the proposed plant site and the beginning of segment C:

- Segment A-C would begin on the western side of the proposed plant site and follow 2 miles (3.2 kilometers) of existing ROW owned by the Burlington Northern – Santa Fe Railroad. It would continue approximately 3 miles (4.8 kilometers) along new ROW until it intersects a section of natural gas pipeline ROW. The corridor would then follow this pipeline another 3 miles (4.8 kilometers) east until it joins a larger trunk of natural gas pipeline.
- Segment B-C would begin along the southern boundary of the proposed plant site and extend east approximately 2.5 miles (4.0 kilometers) along FM 39. It then would turn north and follow the existing ROW of a natural gas pipeline for another 4 miles (6.4 kilometers) until it joins a ROW for a larger trunk of natural gas pipeline that extends northward for approximately 8 miles (12.9 kilometers).
- Segment C-D would follow an existing natural gas line ROW northward for approximately 15 miles (24.1 kilometers).
- Segment D-F would continue northward along the existing natural gas line ROW for another 9 miles (14.5 kilometers).
- Segment F-G would extend in a straight line east along new ROW approximately 6 miles (9.7 kilometers) to the proposed sequestration wells on the Hill Ranch.
- Segment F-H would continue northward along the existing natural gas line corridor for almost 2 miles (3.2 kilometers) where it would cross Trinity River to the north side. It then would intersect another leg of natural gas pipeline ROW and continue east for approximately 6 miles (10 kilometers). The line would then turn and continue along county highway ROW and TDCJ land for approximately another 6 miles (9.7 kilometers) to the proposed injection well site on TDCJ land.

The utility lines would follow existing utility corridors; therefore, it is not expected that utility corridor construction would be required. Review of USGS maps of the proposed water supply pipeline corridor revealed that several surface water bodies exist within the corridor. However, field investigations were not completed to confirm the presence or absence of flowing or intermittent areas.

Review of USGS maps for the proposed CO_2 pipeline corridor revealed that several areas potentially subject to Section 404 jurisdiction exist within the corridor. Portions of all six segments of the proposed CO_2 pipeline corridor cross approximately 30 stream channels, including Red Hollow Creek, Lynn Creek, Lambs Creek, Spring Branch, Needham Marsh, Nanny Branch, Thundering Springs, Silver Creek, Rena Branch, Bow Branch, Buffalo Creek, Whitney Branch, Fulks Dugout, Chandler Bottom, Browns Creek, Self Creek, Plum Creek, Upper Keechi Creek, Alligator Creek, Holly Branch, Brinkley Creek, Batsmith Creek, Edwards Creek, Willow Creek, Cold Springs Branch, Indian Creek, Alum Branch, Evans Lake, Cedar Lake Slough, Lake Creek and the Trinity River. Site assessments would be necessary to determine the appropriate methods for stream crossing. Directional drilling could be used to avoid impacts to these surface water resources. Section 404 permits would be required for all stream crossings.

Transportation Corridors

No new transportation corridors are proposed; only upgrades to existing roads and new transportation spurs within the proposed power plant footprint. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

6.7.3.2 Operational Impacts

Potential operational impacts would consist largely of surface water runoff from the proposed power plant site and potential spills (i.e., fuel, chemicals, grease, etc.). Mitigation of runoff, recycling of materials, and pollution prevention measures would reduce or eliminate the potential for operational impacts to surface water. A pollution prevention program would be implemented to reduce the incidence of site spills (i.e., fuel, paint, chemicals, etc.). Adherence to applicable laws, regulations, policies, standards, directives and BMPs would avoid or limit potential adverse operational impacts to surface waters.

Stormwater runoff from the proposed plant site would be expected to have minimal impact on surface water resources. Stormwater could be collected and recycled into the process water to support the operations of the proposed power plant. Possible sedimentation due to soil and wind erosion could occur, but impacts to surface waters are considered to be negligible.

Power Plant Site

No impacts to surface water from water usage by the proposed facility would be expected because groundwater would be the primary source of the process and potable water supply. Potentially, the site could discharge sanitary sewer waste to the surface, reinject the water to groundwater, or recycle it back into the process water to support the operations of the proposed power plant. The method of on-site waste systems has not been determined (see discussion in Section 6.15). Appropriate permits would be secured before any discharges. Discharge frequency, quantity, and quality would be subject to permit requirements.

During operations, slag and coal piles would be stored on site. Although, the actual configuration has yet to be determined, for the purposes of this analysis, it is presumed that these storage areas would be stored in open air, lined areas. Implementation of BMPs and a stormwater management system would capture the runoff from the coal piles, and direct it to the zero liquid discharge system for on-site treatment. Further mitigation could include covering the slag and coal pile areas to prevent contact with precipitation and eliminate stormwater runoff. Minimal effects to downstream surface water resources would be anticipated because the proposed power plant would be a zero emissions facility.

Increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation. Runoff from the site due to industrial activities would require implementing a stormwater management program to reduce or eliminate any potential surface water quality impacts. The general NPDES Permit would include erosion control and pollution prevention requirements. Operating stormwater pollution prevention restrictions and BMPs would be dictated by the NPDES permit.

Sequestration Site

The operation of the proposed sequestration site is not expected to impact surface water resources within the ROI. In the event a CO_2 leak, an increased concentration of CO could occur within these surface waters. In surface waters lacking buffering capacity, such as freshwater and stably stratified waterbodies, the pH could be significantly altered by increases in CO_2 (Benson et al., 2002). The persistence and amount of CO_2 being leaked are primary factors which determine the severity of the impacts from increased CO_2 in the soil and surface water (Damen et al., 2003). The risk of a CO_2 leak from the sequestration reservoir is dependent upon the reservoir and other site specific variables, such as the integrity of the well and cap rock and the CO_2 trapping mechanism (Reichle et al., 1999). CO_2 sequestration is maintained via a sealed caprock, which can be compromised via, rapid release of CO_2 through natural events or unplugged wells, or slow leaks of CO_2 through rock fractures and fissures. These are influenced by the characteristics (e.g., porosity) of the caprock material. As discussed in Section 6.4, the potential for CO_2 leakage from the proposed Jewett Sequestration Reservoir is small, but it could occur. The sequestration reservoir would occur far below these surface water resources and any connected aquifers, preventing any point of contact. The intermittent and ephemeral nature of streams within the ROI would further reduce this risk to surface waters. A risk analysis was completed to assess the likelihood of such failures occurring, as discussed in Section 6.17 (Tetra Tech, 2007).

A CO_2 monitoring program would be implemented to detect a leak, should one occur. Seepage of sequestered gases from the reservoir would not impact surface water because the solubility of CO_2 in water would keep the concentration less than 0.2 percent (Tetra Tech, 2007). The monitoring for CO_2 leaks in the pipeline and caprock would enable the application of BMPs should a leak be detected.

Utility Corridors

Normal operations of the power transmission corridors and pipelines for the proposed site would not affect surface water resources. Occasional maintenance may require access to buried portions of the utilities; however, BMPs would be used to avoid any indirect impacts (e.g. sedimentation and turbidity) to adjacent surface waters.

Leakage from the proposed pipeline that would transport the CO_2 to the injection site could increase concentration of CO_2 in the soil, which would lower the pH and negatively affect the mineral resources in the affected soil, which in turn would lower the pH of the surface waters in the affected area, potentially resulting in calcium dissolution and alteration of the concentration of trace elements in the surface water (Damen et al. 2003; Benson et al., 2002; Holloway, 1996). The pipeline is expected to be buried to a depth of about 3.3 feet (1.0 meter), therefore, if a leak or rupture occurred, the released gas would first migrate into the soil gas and displace the ambient air, before being discharged into the surface water. A monitoring program would be implemented to monitor CO_2 to detect a leak, should one occur.

Transportation Corridors

Operation of the power plant would use existing transportation corridors, and therefore, would have no impact on surface water resources. Any upgrades to existing corridors would require a separate analysis.

6.8 WETLANDS AND FLOODPLAINS

6.8.1 INTRODUCTION

This section discusses wetlands and floodplains identified in the affected environment that may be affected by the construction and operation of the proposed FutureGen Project at the Jewett Power Plant Site, sequestration site, and related corridors. This section also provides the required floodplain and wetland assessment for compliance with 10 CFR Part 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements," and Executive Orders 11988, "Floodplain Management," and 11990, "Protection of Wetlands (May 24, 1977)."

6.8.1.1 Region of Influence

The ROI for wetlands and floodplains for the proposed Jewett Power Plant includes the proposed power plant site and the area within 1 mile (1.6 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors.

6.8.1.2 Method of Analysis

DOE reviewed research and studies in the Jewett EIV (FG Alliance, 2006c) to characterize the affected environment. DOE also conducted site visits in August and November 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause construction of facilities in, or otherwise impede or redirect flood flows in, a 100- or 500-year floodplain or other flood hazard areas;
- Conflict with applicable flood management plans or ordinances; and
- Cause filling of wetlands or otherwise alter drainage patterns that would affect wetlands.

6.8.2 AFFECTED ENVIRONMENT

6.8.2.8 Wetlands

All tributaries to Waters of the U.S., as well as wetlands contiguous to and adjacent to those tributaries, are subject to federal jurisdiction and potential permitting requirements under Section 404. These resources are referred to as jurisdictional, or regulated by federal and state agencies. To be contiguous or a tributary, a continuous surface water connection must be present between the Waters of the U.S. and the adjacent surface water body. This surface water connection can be either visible surface water flowing at regular intervals of time, or a continuum of wetlands between the two areas. Open water features (e.g., upland stock ponds) within the Federal Emergency Management Agency (FEMA) designated 100-year floodplain that have associated emergent vegetation fringe are also jurisdictional Waters of the U.S. Isolated wetlands are not jurisdictional unless protected under a local bylaw.

The local U.S. Army Corps of Engineers (USACE) Regulatory Branch makes jurisdictional determinations. Activities such as mechanized land clearing, grading, leveling, ditching, and redistribution of material require a permit from the USACE to discharge dredged or fill material into wetlands. Permit applicants must demonstrate that they have avoided wetlands, and have minimized the adverse effects of the project to the extent practicable. Compensation is generally required to mitigate most impacts that are not avoided or minimized.

Horizon Environmental Services identified jurisdictional wetlands in the proposed power plant site in 2006. National Wetland Inventory (NWI) mapping provided information on wetlands within the proposed sequestration site and utility corridors. Figure 6.8-1 shows the general location of mapped wetlands identified using the Cowardin et al. classification scheme (Cowardin et al., 1979).

Power Plant Site

Portions of jurisdictional features within the proposed power plant site have been previously disturbed as part of the Jewett Surface Lignite Mine operation. Most of the jurisdictional Red Hollow Channel along the eastern boundary of the proposed site has been modified for mine drainage, with the inclusion of two large constructed impoundments (ponds) for sedimentation control. Due to previous disturbance, this jurisdictional feature was low quality (FG Alliance, 2006c). The modifications were made in accordance with a USACE Section 404 permit issued to the Jewett Surface Lignite Mine.

Another jurisdictional feature is a portion of an original branch of the Red Hollow Channel that extends to a small, on-channel (jurisdictional) pond near the northern part of the proposed power plant site. This feature still exists in its natural state and is jurisdictional. Due to its undisturbed condition and ephemeral nature, this jurisdictional stream has moderate ecological value. A small, unnamed jurisdictional tributary is also in the central portion of the southern half of the site. This tributary extends toward another constructed mine sediment pond and has low ecological value due to previous disturbances. The jurisdictional nature of this sediment pond is dependent upon the final disposition of the pond following mining activity. Two small wetland areas are located in a pasture in the western part of the southern half of the proposed Jewett Power Plant Site. These wetlands are isolated and non-jurisdictional.

The total jurisdictional area is estimated to be 2 acres (0.8 hectare) of low-quality palustrine wetland, 0.14 acre (0.04 hectare) of medium-quality palustrine wetland, and 18 acres (7.3 hectares) of low-quality ponds of questionable jurisdictional status (FG Alliance, 2006c).

Further review of NWI maps indicated numerous potential jurisdictional areas within the 1-mile (1.6-kilometer) ROI of the proposed Jewett Power Plant Site. The majority of the features are categorized as upland man-made stock pond. These areas are generally of low quality due to the previous mining activities and are typically non-jurisdictional by USACE. However, both Lambs Creek and Lynn Creek are located within the ROI and would be jurisdictional by USACE, even though they have been modified due to mining activities. Five palustrine forested wetlands are identified with Lynn Creek. One palustrine emergent, seasonally flooded wetland feature is associated with Lambs Creek.

Sequestration Site

NWI mapping indicates over 43 areas potentially subject to Section 404 jurisdiction on the proposed sequestration site. Major watershed features within this area include the Trinity River, Spring Lake, Cedar Lake Slough, Big Lake, Evans Lake, Indian Creek Lake, Little Red Lake, Red Lake, Blue Lake, Harding Lake, Jelly Slough, and Upper Keechi Creek (FWS, 1988). Small herbaceous and forested wetlands associated with the creeks and tributaries, as well as on-channel stock ponds were identified, but a jurisdictional determination has not been performed. Field verification (wetland delineation) would be required to confirm the NWI mapping and determine the acreages and value of these resources.

Utility Corridors

The related areas of new construction associated with the proposed power plant include a proposed water supply pipeline corridor and six segments of proposed CO_2 pipeline corridor. A review of NWI maps of the proposed water supply pipeline corridor revealed that no potential wetlands or Waters of the U.S. exist within the corridor. However, field investigations were not completed and confirmation of the presence or absence of areas that are subject to Section 404 jurisdiction would be required for permit approval.

Review of NWI maps for the proposed CO_2 pipeline corridor revealed that over 90 areas potentially subject to Section 404 jurisdiction exist within the corridor. Portions of all six segments of the proposed CO_2 pipeline corridor cross approximately 30 stream channels including Red Hollow Creek, Lynn Creek, Lambs Creek, Spring Branch, Needham Marsh, Nanny Branch, Thundering Springs, Silver Creek, Rena Branch, Bow Branch, Buffalo Creek, Whitney Branch, Fulks Dugout, Chandler Bottom, Browns Creek, Self Creek, Plum Creek, Upper Keechi Creek, Alligator Creek, Holly Branch, Brinkley Creek, Batsmith Creek, Edwards Creek, Willow Creek, Cold Springs Branch, Indian Creek, Alum Branch, Evans Lake, Cedar Lake Slough, Lake Creek and the Trinity River. Quality of these waterbody crossings varies throughout the region. The segments also traverse forested, scrub-shrub, and emergent wetlands associated with these waterways and on-channel impoundments. Specifically, segment A-C crosses 6 wetlands; B-C crosses 19 wetlands; C-D crosses 20 wetlands; D-F crosses 12 wetlands; F-G crosses 18 wetlands; and F-H crosses over 11 wetlands. Field verification would be required to confirm the NWI mapping and determine the acreages and value of these resources.

Transportation Corridors

Because no new transportation corridors are proposed outside of the proposed power plant site, this EIS does not provide further description of wetlands. Any upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.8.2.2 Floodplains

Power Plant Site

FEMA flood insurance rate maps indicate that the proposed Jewett Power Plant Site within Limestone and Freestone counties is located outside of the 100- and 500-year floodplain boundaries (FEMA, 1977, 1978) (Figure 6.8-2).

The portion of the proposed power plant site that lies within Leon County has not been mapped for flood hazard areas. The Natural Resources Conservation Service (NRCS) Web Soil Survey indicates that soils on the proposed power plant site, including portions of Limestone, Freestone, and Leon counties, have a flooding frequency class of “none,” which means a zero percent chance of flooding in any given year, or less than one time in 500 years (NRCS, 2006). In a letter dated May 22, 2006, the Limestone County Engineer and Floodplain Administrator stated that, based upon the soil survey information for Leon County, the portion of the proposed Jewett Power Plant Site located within Leon County also lies outside of the 100-year floodplain (Kantor, 2006) (see Appendix A).

Sequestration Site

Approximately 25 percent of the proposed sequestration reservoir is located within the 100-year floodplain. The Trinity River, several creeks, sloughs, and a few small ponds and reservoirs make up this portion of the floodplain.

Utility Corridors

The related areas of new construction associated with the proposed power plant include a proposed water supply pipeline corridor and seven segments of proposed CO_2 pipeline corridor. The entire proposed water supply pipeline corridor is located outside of the 100- and 500-year floodplains.

Portions of all six segments of the proposed CO_2 pipeline corridor are located within a 100-year floodplain boundary. None are located within the 500-year floodplain. Locations within the 100-year floodplain include Bow Branch in the easternmost portion of Segment A-C; Rena Branch, Alligator Creek, and Bow Branch in the easternmost portion of Segment B-C; Buffalo Creek, Whitney Creek, Browns Creek, Self Creek, and Keechi Creek in Segment C-D; and Brinkley Creek, Batsmith Creek, Willow Creek, and Edwards Creek in Segment D-F. More than half of Segment F-G and almost all of Segment F-H are located within the 100-year floodplain.

The soil survey for the Leon County portion of Segment B-C that crosses Lambs Creek, Needham Marsh, Thundering Springs Branch, Silver Creek, and Rena Branch shows a flooding frequency class of "frequent," which means flooding is likely to occur (NRCS, 2006). The remaining soils within this portion of Segment B-C have a flooding frequency class of "none."

Transportation Corridors

Because no new transportation corridors are proposed outside of the proposed power plant site, this EIS does not include further description of floodplains. Any upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.8.3 IMPACTS

6.8.3.1 Construction Impacts

Direct impacts to wetland habitats would be related to heavy equipment and construction activities, and could include soil disturbance and compaction, dust, vegetation disturbance and removal, root damage, erosion, and introduction and spread of non-native species. The addition of silt, resuspension of sediment, or introduction of pollutants (e.g., fuels and lubricants) related to, and in the immediate vicinity of, construction activities could degrade the quality of native wetlands.

The proposed FutureGen Project could result in localized, direct, and adverse construction impacts to wetlands. Filling or modifying portions of wetlands, if avoidance is not feasible, would permanently alter hydrologic function and wetland vegetation, and result in direct habitat loss. Potential habitat degradation of wetlands and waters downstream could also occur if flow into adjacent areas is reduced. Construction impacts would be mitigated by minimizing the areas disturbed and preventing runoff from entering wetlands during construction. Section 404 jurisdiction would be required for permit approval.

The amount of mitigation required for the proposed power plant site and other project components (e.g., utility corridors) is not known at this time. Ratios have been established by the USACE regarding mitigation. For example, a 1:2 ratio would require 2 acres (0.8 hectare) of wetland creation for every acre (0.4 hectare) of wetland loss. Typical mitigation ratios for unavoidable impacts to wetlands would be 1:1 for open water and emergent wetlands, 1:5 for shrub wetlands, and up to 2:1 for forested wetlands. The appropriate type and ratio of mitigation would be determined through the Section 404 permitting process.

Power Plant Site

The proposed Jewett Power Plant Site contains three tributary streams potentially subject to Section 404 jurisdiction, two of which were previously modified and are of low value. The third tributary has not been previously modified, but is ephemeral in nature and is of moderate value. Three recently constructed sedimentation ponds related to the mine have questionable jurisdictional status; however, if they are later determined to be jurisdictional, they would likely be of low value. The total number of jurisdictional areas within the proposed power plant site is estimated to be 2 acres (0.8 hectare) of low-quality wetland, 0.1 acre (0.04 hectare) of moderate-quality wetland, and 18 acres (7.3 hectares) of low-quality ponds of questionable jurisdictional status. The jurisdictional status of these sediment ponds will depend upon the final disposition of the ponds following mining activity. If they are to remain as permanent impoundments, they would be jurisdictional. If they are to be removed following mine use, they would be temporary water treatment ponds and not subject to jurisdiction with the exception of the original creek channel.

The proposed Jewett Power Plant Site is located outside of the FEMA's 100- and 500-year floodplain boundaries.

Sequestration Site

NWI mapping indicates over 43 potential jurisdictional wetlands at the proposed sequestration site, including those associated with major watershed features such as rivers, lakes, and sloughs. These areas, however, are subject to field verification to verify their existence and identify any potential additional wetlands not included in the NWI mapping.

Impacts are not anticipated to these wetlands because the three proposed injection wells and associated disturbance could be placed to avoid wetland locations. Additionally, while the sequestration site is located within the 100-year floodplain, the construction of the injection wells would not directly impact the floodplain.

Utility Corridors

NWI mapping indicates no areas of wetlands within the proposed water supply pipeline corridor; however, this finding is subject to field verification (wetland delineation). The mapping also indicated that segments of all six proposed CO_2 pipeline corridors cross numerous stream channels (see Section 6.7) which include over 90 potential jurisdiction areas (forested, scrub-shrub, and emergent wetlands). These areas, however, are subject to field verification to verify their existence and identify any potential additional wetlands not included in the NWI mapping.

Temporary disturbances to these wetlands would result from construction equipment access and trenching of underground utilities; however, use of directional drilling would avoid impacts. Any impacts to wetlands that could not be avoided by use of existing corridors or directional drilling could be mitigated in-place, in-kind by replacing soil and planting appropriate vegetation. The impacts of this construction would be minimized by using standard pipeline construction methods, including sedimentation and erosion controls. The wetlands would be restored to their existing condition following construction.

Construction would only occur within the 100-year floodplain boundary in the areas located along the CO_2 pipeline corridor. Construction would require heavy and light construction equipment, and small vehicles and implements. Temporarily adding or excavating fill during construction within the floodplain would have no permanent impact on the lateral extent, depth, or duration of flooding in the floodplain areas traversed. Construction within floodplain areas would not result in increases of the 100-year flood elevation by any measurable amount because the floodway is unconstrained and there are no barriers to floodflow passage. The proposed water supply corridor is outside the 100- and 500-year floodplains.

Mitigation and protection measures to minimize direct impacts would include standard stormwater controls such as interceptor swales, erosion control compost, waddles, sod, diversion dikes, rock berms, silt fences, hay bales, or other erosion controls as necessary and as required by USACE permits.

Depending upon final site design and construction activities, other federal, state, and local authorities may have jurisdiction over dredging, filling, grading, paving, excavating, or drilling in the floodplain that would require permits. The USACE has authority to regulate the discharge of dredged or fill materials into waterways and adjacent wetlands through Section 404. Concurrent with its review of the proposed FutureGen Project to determine appropriate National Environmental Policy Act (NEPA) requirements, DOE would also determine the applicability of the floodplain management and wetlands protection requirements contained within 10 CFR Part 1022.

Transportation Corridors

No new transportation corridors are proposed outside of the proposed power plant site footprint. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen upgrades or new transportation corridors would require a separate analysis.

6.8.3.2 Operational Impacts

Power Plant Site

Operation of the proposed power plant would have no impact on wetlands or floodplains. All activities associated with the proposed power plant would occur on previously disturbed surfaces outside of wetland and floodplain areas.

Sequestration Site

Operations at the proposed sequestration site would have no impact on wetlands or floodplains. All activities would be outside of wetland and floodplain areas.

Utility Corridors

This operational maintenance of ROW would shift, to a small extent, the balance of wildlife habitat in the area away from wetland and forest toward shrub and brushland. During the permitting process, an acceptable wetland functional assessment methodology would be used to determine the loss of function resulting from the proposed impacts, including any wetland conversions resulting from ROW maintenance. The resulting vegetation communities on the proposed site and associated corridors would be similar to those on other ROWs in the vicinity. Maintenance within the utility corridors would likely be conducted using mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in proximity to streams and wetlands could constitute a damaging indirect effect on vegetation and aquatic resources. Following approved herbicide usage instructions, however, would likely reduce this concern. The proposed corridors would be allowed to revegetate with no impact from project operations to wetlands and floodplains.

Transportation Corridors

Operation of the proposed power plant would use existing transportation corridors, and therefore, would have no impact on wetlands or floodplains. Any upgrades to existing corridors would require a separate analysis.

6.9 BIOLOGICAL RESOURCES

6.9.1 INTRODUCTION

This section discusses both aquatic and terrestrial vegetation and habitats, as well as threatened, endangered, and protected species identified in the affected environment that may be impacted by the construction and operation of the proposed FutureGen Project.

6.9.1.1 Region of Influence

The ROI for biological resources is defined as 5 miles (8 kilometers) surrounding the proposed power plant site, sequestration site, and utility corridors.

6.9.1.2 Method of Analysis

DOE reviewed the results of research and studies compiled in the Jewett EIV (FG Alliance, 2006c) to characterize the affected environment. This information included data on wetland, aquatic, and threatened and endangered species. DOE also conducted site visits in August and November 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause displacement of terrestrial communities or loss of habitat;
- Diminish the value of habitat for wildlife or plants;
- Cause a decline in native wildlife populations;
- Interfere with the movement of native resident or migratory wildlife species;
- Conflict with applicable management plans for wildlife and habitat;
- Cause the introduction of noxious or invasive plant species;
- Alter drainage patterns causing the displacement of fish species;
- Diminish the value of habitat for fish species;
- Cause a decline in native fish populations;
- Interfere with the movement of native resident or migratory fish species;
- Conflict with applicable management plans for aquatic biota and habitat;
- Cause loss of a wetland habitat;
- Cause the introduction of non-native wetland plant species;
- Affect or displace special status species; and
- Cause encroachment on or affect designated critical habitat.

6.9.2 AFFECTED ENVIRONMENT

6.9.2.1 Vegetation

Aquatic

Power Plant Site

The only surface waters on the proposed power plant site are three small creeks and a few man-made holding ponds. No major creeks, rivers, or large impoundments are located within the immediate area, although two arms of Lake Limestone are within the outskirts of the ROI. Previous aquatic surveys outside of the proposed power plant site were conducted on behalf of the Jewett Lignite Mine within the ROI. These surveys provide aquatic habitat information that is comparable to what is expected within the creeks and man-made holding ponds on site. These surveys indicate that aquatic macrophytes within perennial streams and ponded areas in streams include seedbox (***Ludwigia*** sp.) and pondweed (***Potamogeton*** sp.). In general, the abundance of instream macrophytes is greater during the fall than in spring. Canopy cover at most sampling locations was dense with 60 to 90 percent cover. Macrophyte growth is common to abundant in ponds, generally consisting of wetland vegetation such as rushes and water-willows.

Sequestration Site

Numerous ephemeral streams occur at the proposed Jewett sequestration site. Fast-growing, opportunistic macrophytes should be expected when flow is present. Possible opportunistic taxa include alligator weed (*Alternanthera philoxeroides*) and seedbox. Permanent creeks and riverine habitat are also found in the area. Macrophytes expected to occupy such areas include alligator weed, long-leaf pondweed (*Potamogeton nodosus*), seedbox, arrowhead (*Sagittaria calycina* var. *calycina)*, and pickerel weed (*Pontederia cordata*).

Lakes are also present at the sequestration site and should contain macrophyte communities similar to those found in streams. Emergent species occurring in the littoral zone may include alligator weed, bulrush (*Scirpus validus*), and arrowhead. White water lilies (*Nymphaea* spp.) and American lotus (*Nelumbo hutea)* would be expected to occur in deeper waters away from the shore. This profundal zone (depths greater than 33 feet [10.1 meters]) would support elodea, pondweed, and coontail (*Ceratophyllum demersum*). Backwater sloughs and marshes associated with the river and lakes should have similar species to those found along the margins of creeks.

Utility Corridors

Surface waters crossed by the proposed utility corridors are listed and described in Section 6.7. No aquatic habitat is evident along the water supply pipeline corridor; therefore, no aquatic plants would be expected to occur.

There are six segments in the proposed potential CO_2 pipeline corridors. Aquatic vegetation would be expected to occur within them as follows.

Segment A-C of the proposed CO_2 pipeline corridor lies entirely within Freestone County. This segment crosses 14 intermittent stream channels. Because all aquatic habitat along this corridor has intermittent hydrological regimes (wet periods), any emergent macrophytes found here would be fast-growing and likely arise from roots or rhizomes. Possible opportunistic taxa include alligator weed and seedbox.

Segment B-C lies within Freestone and Leon counties. This segment crosses nine intermittent stream channels. Any emergent aquatic plants occurring along these channels would have characteristics similar to those discussed for Segment A-C.

Segment C-D lies entirely within Freestone County. In addition to crossing 16 intermittent channels, this segment traverses three perennial streams. Limitations for macrophyte growth in intermittent streams would be similar to those discussed for Segment A-C. While emergent aquatic plants in perennial streams may not be seasonally restricted by water availability, their growth may be controlled by available sunlight. Aquatic macrophytes found within perrenial streams include elodea (*Anarchis* spp.), arrowhead, and pickerel weed. Spikerushes (*Eleocharis* spp.), rushes (*Juncus* spp.), and sedges (*Carex* spp.) may occur along stream margins.

Segment D-F lies entirely within Freestone County. This segment crosses four perennial and three intermittent streams. Aquatic macrophyte communities occurring in the intermittent and perennial streams would be similar to those discussed for Segments A-C and C-D, respectively.

Segment F-G lies entirely within Freestone County. This segment crosses two perennial creeks and four intermittent channels. Aquatic macrophyte communities occurring in the intermittent and perennial streams would be similar to those discussed for Segments A-C and C-D. Additionally, a small lake occurs along the corridor. Emergent aquatic plants growing in the limnetic zone could include arrowhead, pickerel weed, delta arrowhead (*Sagittaria platyphylla*), and bulrush. In deeper waters of small ponds where sunlight is not limited, white water lily and American lotus may occur. True floating plants such as duckweed (*Lemna* spp.) and water hyacinth (*Eichornia* spp.) could be found in open waters of the lake.

Segment F-H lies within Freestone and Anderson counties. This segment crosses four intermittent streams and traverses the Trinity River, the perennial Edwards Creek, and Cedar Lake Slough. Emergent aquatic plants in the intermittent streams would have characteristics similar to those discussed for Segment A-C. Aquatic plants growing along the margins of the Trinity River would be similar to those found in perennial streams. These may include elodea, arrowhead, pickerel weed, smartweed (*Polygonum* spp.) and long-leaf pondweed. Additionally, backwater sloughs may provide habitat for seedbox, rushes, or common cattail (*Typha latifolia*).

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

Power Plant Site

The proposed power plant site and its ROI are located in Limestone, Leon, and Freestone counties, and within the Post Oak Savannah Vegetational Area of Texas (FG Alliance, 2006c). The Post Oak Savannah Vegetational Area occurs on gently rolling to hilly terrain and receives an average of 35 to 45 inches (89 to 114 centimeters) of rain per year (FG Alliance, 2006c). Originally, the two dominant tree species, post oak (*Quercus stellata*) and blackjack oak (*Q. marilandica*), were scattered throughout tallgrass prairies. The suppression of natural fires and other anthropogenic disturbances, however, have contributed to the development of oak and hickory (*Carya* spp.) thickets, which are now dispersed among improved or native pastures. Although the region was extensively cropped until the 1940s, many areas have returned to native vegetation or been developed into managed pastures for livestock operations (FG Alliance, 2006c). Common groundcover species under the woodland canopy or in the interspersed grasslands include little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*), purpletop (*Tridens flavus*), silver bluestem (*Bothriochloa saccharoides*), Texas wintergrass (*Stipa leucotricha*), and *Chasmanthium* spp. (FG Alliance, 2006c).

The dominant vegetation types on the proposed power plant site include Post Oak Woods/Forest and Grassland Mosaic and Post Oak Woods/Forest (FG Alliance, 2006c). Characteristic species of these communities include post oak, blackjack oak, eastern red cedar (*Juniperus virginiana*), honey mesquite (*Prosopis glandulosa*), black hickory (*Carya texana*), live oak (*Quercus virginiana*), cedar elm (*Ulmus* *crassifolia*), hackberry (*Celtis laevigata*), yaupon (*Ilex vomitoria*), American beautyberry (*Callicarpa americana*), supplejack (*Berchemia scandens*), greenbriar (*Smilax* sp.), little bluestem, silver bluestem, sand lovegrass (*Eragrostis trichodes*), beaked panicum (*Panicum ancepts*), three-awn (*Aristida* sp.), green sprangletop (*Leptochloa dubia*), and tickclover (*Desmodium* sp.) (FG Alliance, 2006c).

Much of the ROI includes portions of the Jewett Mine, where mine owners have previously conducted detailed vegetation studies. Data collected from these studies indicate that the predominant vegetation type is Upland Hardwood Forest (47 percent), followed by Grasslands (44 percent), Bottomland/Riparian Forest (5 percent), Hydric Habitat (3 percent), and Aquatic Habitat (1 percent). Upland Woodland Forest includes post and blackjack oak, black hickory, winged elm (*Ulmus alata*), sassafras (*Sassafras albidum*) and eastern red cedar. Understory vegetation consists of yaupon, American beautyberry, greenbriar, and wild grapes (*Vitis* spp.) Prairie grasses common to the area are indiangrass, little bluestem, silver bluestem, Texas wintergrass, switchgrass (*Panicum virgatum*), purpletop, and beaked panicum (*Panicum anceps*). Forbs frequently found in climax prairies include crotons (*Croton* spp.), prairie clovers (*Petalostemon* sp.), lespedezas (*Lespedeza* spp.), western ragweed (*Ambrosia psilostachya*), and sneezeweeds (*Helenium* spp.). Much of the grassland community has been converted to improved pasture grasses for grazing or hay production. Typical species in the improved pastures include bermudagrass (*Cynodon dactylon*), dallisgrass (*Paspalum dilatatum*), St. Augustine (*Stenotaphrum secundatum*), and bahiagrass (*Paspalum notatum*). Water oak (*Quercus nigra*), cedar elm, American elm (*Ulmus americana*), black gum (*Nyssa sylvatica*), river birch (*Betula nigra*), box elder (*Acer negundo*), pecan (*Carya illinioensis*), and Carolina basswood (*Tilia caroliniana*) are the predominant tree species found in the riparian woodlands. Common understory and shrubs include deciduous holly (*Ilex decidua*), coralberry (*Symphiocarpus orbiculatus*), red mulberry (*Morus rubra*), flowering dogwood (*Cornus florida*), American holly (*Ilex americana*), and eastern redbud (*Cercis canadensis*). Groundcover is dominated by small-flowered creek oats (*Chasmanthium sessiliflorum*), poison ivy (*Toxicodendron radicans*), peppervine (*Ampleopsis arborea*), and Virginia creeper (*Parthenocissus quinquefolia*).

Sequestration Site

The predominant vegetation types found at the sequestration site are Post Oak Woods/Forest, Post Oak Woods/Forest and Grassland Mosaic, and Water Oak-Elm-Hackberry Forest.

Utility Corridors

The proposed water supply pipeline corridor lies within Freestone and Limestone counties. The predominant vegetation types within the proposed water supply pipeline corridor are Post Oak Woods/Forest and Post Oak Woods/Forest and Grassland Mosaic, which are described above.

Segment A-C of the proposed CO_2 pipeline corridor lies entirely within Freestone County. Segment B-C of the proposed CO_2 pipeline corridor lies within Freestone and Leon counties. Segment C-D of the proposed CO_2 pipeline corridor lies entirely within Freestone County. The predominant vegetation types within these corridors are the previously described Post Oak Woods/Forest and Post Oak Woods/Forest and Grassland Mosaic.

Segments D-F and F-G of the proposed CO_2 pipeline corridor lie entirely within Freestone County. Water Oak-Elm-Hackberry Forest and the previously described Post Oak Woods/Forest are the primary vegetation types within these corridors. The Water Oak-Elm-Hackberry Forest occurs primarily in the upper floodplains of the Sabine, Neches, Sulphur, and Trinity rivers and their tributaries. The dominant species in this mosaic are water oak, water elm (*Planera aquatica*), and hackberry. Commonly associated species include cedar elm, American elm, willow elm, willow oak (*Quercus phellos*), southern red oak

(*Q. falcate*), white oak (*Q. alba*), black oak (*Quercus* sp.), black willow (*Salix nigra*), cottonwood (*Populus deltoides*), red ash (*Fraxinus pensylvanica*), sycamore (*Platanus occidentalis*), pecan, bois d'arc (*Manclura pomifera*), flowering dogwood (*Cornus florida*), dewberry (*Rubus* sp.), coral-berry (*Symphoricarpos orbiculatus*), dallisgrass, switchgrass, rescuegrass (*Bromus unioloides*), bermudagrass, eastern gamagrass (*Tripsacum dactyloides*), Virginia wildrye (*Elymus virginicus*), johnsongrass (*Sorghum halepense*), giant ragweed (*Ambrosia trifida*), and yankeeweed (*Eupatorium compositifolium*).

Segment F-H of the proposed CO_2 pipeline corridor lies within Freestone and Anderson counties. The principal vegetation types occurring in the corridor are the previously described Post Oak Woods/Forest and Grassland Mosaic, and Water Oak-Elm-Hackberry Forest.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected terrestrial environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

6.9.2.2 Habitats

Aquatic

Power Plant Site

Aquatic invertebrates expected to be found in the streams and ponds of the proposed power plant site; proposed CO_2 pipeline segments C-D, D-F, F-G, and F-H; and the ROI include a variety of insects, crustaceans, mollusks, and segmented worms. Aquatic crustaceans common to streams in the Trinity and Brazos River Drainage Basins include crayfish, freshwater prawns, and planktonic forms such as water fleas (Cladocera). Gastropod mollusks frequently encountered in central Texas include the genera *Physella* (Physidae) and *Helisoma* (Planorbidae). Several bivalve taxa, including the invasive Asiatic clam (*Corbicula fluminea*) are also expected. Annelid or segmented worms, such as oligochaetes and leeches, are found in most freshwater systems along with the larval forms of many insects. No fish are expected to occur within the three streams because they are intermittent. Any fish species found within the man-made impoundments on the proposed power plant site would be the result of land-owner stocking. No formalized federal, state, or local jurisdiction management plans are present.

Scientists studying the Jewett Mine previously conducted invertebrate surveys for a much larger region than the proposed power plant site, encompassing a portion of the ROI. These invertebrate samples were collected during the fall of 1991 and 1994; and spring of 1992 and 1994 (FG Alliance, 2006c). Table 6.9-1 provides a combined list of invertebrate species collected during these field surveys. The three small intermittent creeks and man-made impoundments found on the proposed power plant site and the perennial streams crossed by the proposed CO_2 pipeline segments are likely to contain a smaller diversity of species than found on this list; however, the entire ROI area is likely to contain additional aquatic invertebrate species.

Table 6.9-1. Aquatic Invertebrates Collected from Creeks within the ROI

Family	Genus
Annelida	
Oligochaeta (aquatic earthworms)	
Lumbricidae[1]	
Tubificidae[1]	
Tubificidae	***Limnodrilus***
Hirudinea (leeches)	
Hirudinidae	***Macrobdella***
Mollusca	
Bivalvia (clams/mussels)	
Sphaeriidae	***Corbicula***
Unionidae[1]	
Gastropoda (snails)	
Planorbidae	***Biomphalaria***
Planorbidae	***Helisoma***
Planorbidae	***Gyraulus***
Physidae	***Physa***
Physidae	***Physella***
Ancylidae	
Arthropoda, Class Insecta	
Collembola (springtails)	
Entomobryidae	***Cyphoderus***
Ephemeroptera (mayflies)	
Baetidae	***Baetis***
Caenidae	***Caenis***
Ephemerelliidae	***Ephemerella***
Ephemeridae	***Hexagenia***
Heptageniidae[1]	
Tricorythidae	***Leptohpyhes***
Odonata (dragonflies/damselflies)	
Coenagrionidae	***Argia***
Coenagrionidae	***Amphiagrion***
Lestidae	***Lestes***
Calopterygidae	***Calopterx***
Corduliidae	***Macromia***
Gomphidae	***Dromogomphus***

Table 6.9-1. Aquatic Invertebrates Collected from Creeks within the ROI

Family	Genus
Gomphidae	***Erpetogomphus***
Gomphidae	***Gomphus***
Gomphidae	***Promogomphus***
Libellulidae	***Celithemis***
Libellulidae	***Dythemis***
Libellulidae	***Leucorrhinia***
Libellulidae	***Macrothemis***
Libellulidae	***Miathyria***
Corduliidae	***Neurocordulia***
Macromiidae	***Macromia***
Hemiptera (true bugs)	
Belostomatidae	***Abedus***
Belostomatidae	***Belostoma***
Corixidae	***Hesperocoriza***
Gerridae	***Metobates***
Mesoveliidae	***Mesovelia***
Nepidae	***Ranata***
Notonectidae	***Notonecta***
Vellidae	***Rhagovelia***
Trichoptera (caddisflies)	
Hydropsychidae	***Arctopsyche***
Hydroptilidae[1]	
Leptoceridae	***Oecetis***
Coleoptera (beetles)	
Dytiscidae	***Pachydrus***
Chrysomelidae[1]	
Elmidae	***Dubiraphia***
Elmidae	***Stenelmis***
Gerridae	***Dineutus***
Gyrinidae	***Gyrinus***
Noteridae	***Hydrocanthus***
Haliplidae	***Peltodytes***
Hydrophilidae	***Berosus***
Hydrophilidae	***Tropostemus***
Diptera (flies)	
Ceratopogonidae[1]	

Table 6.9-1. Aquatic Invertebrates Collected from Creeks within the ROI

Family	Genus
Chironomidae	***Tanyponida***
Chironomidae	***Chironomus***
Chironomidae	***Kiefferulus***
Chironomidae	***Microtendipes***
Chironomidae	***Pentaneura***
Culicidae[1]	
Tabanidae	***Chrysops***
Tanyderidae[1]	
Lepidoptera (moths/butterflies)	
Pyralidae	***Crambus***
Arthropoda, Subphylum Crustacea	
Decapoda (crayfish/shrimp/crabs)	
Cambaridae	***Procambarus***
Palaemonidae	***Machrobrachium***
Palaemonidae	***Palaemonetes***
Amphipoda (scuds)	
Taltridae	***Hyallela***
Mysidacea (opossum shrimps)	
Mysidae[1]	
Isopoda (aquatic sow bugs)	
Sphaeromatidae[1]	***Thermosphaeroma***

[1] These organisms were identified to the lowest practical taxonomic level.
Source: FG Alliance, 2006c

Sequestration Site

Surface water bodies are located on the sequestration site. Aquatic organisms that inhabit lentic or still waters are generally adapted for that habitat. Many are surface dwellers that do not require highly oxygenated waters. These include whirligig beetles (Gyrinidae), water striders (Gerridae) and other skating "bugs," and larval mosquitoes (Culicidae). Although there are some strong lentic swimmers (Coleoptera, Hemiptera, some Ephemeroptera), most forms are not nektonic (i.e., swimming through the water constantly); instead, the majority are tied to the limnetic zone and emergent plants found there. Although the occurrence of water in such channels is unpredictable, on occasion they provide aquatic habitat for invertebrates. Ephemeral bodies of water can form in low-lying areas of compacted soils during periods of heavy rain. Aquatic invertebrates often take advantage of such conditions to reproduce.

Winged adults with rapid life cycles lay eggs in temporary waters when available. These include flies (Diptera), mosquitoes (Culicidae), biting midges (Ceratopogonidae), and some beetles (Coleoptera). The eggs of many midges (Chironomidae) and mayflies (Ephemeroptera) "oversummer" in low-lying areas where water collects during the wet season. Similarly, immature microcrustaceans, Ostracoda, Cyclopoida, and Amphipoda are able to survive for months in the top layer of a dry stream bed (FG Alliance, 2006c).

In the northern portion of the sequestration site, the combination of habitats includes a major river (the Trinity), major creeks such as Edwards, Indian, Gaston Branch, and Spring creeks, and large impoundments or archaic channel lakes such as Indian Lake, Blue Lake, Cedar Creek Slough, Big Lake, and Spring Lake. Additionally, numerous small "lakes" (sloughs) and ponds occur throughout this portion of the land area. The larger creeks, the Trinity River, and many of the sloughs formed in archaic stream channels could contain a very high percentage of the fish identified in Table 6.9-2. Additionally, many mainstream river species and species attaining large size could be found in such habitats. Gar, drum, carp, catfish, buffalo, and suckers are all species typically attaining body sizes requiring larger, more permanent bodies of water to inhabit. Commercial fishing for many of these species could occur in these areas. Bass, catfish, and numerous sunfish species provide recreational fishing opportunities as well.

The southern portion of the sequestration site provides a small area of habitat for fish species described for the northern portion of the ROI and the proposed power plant site and includes the upstream extent of Brinkley Creek, Indian Creek, and Gaston Creek. However, the majority of the area is drained by Upper Keechi Creek and its major tributaries, including Jelly Slough, Holly Branch, Plum Creek, Dowdy Creek, and Negro Creek. All of these perennial streams provide intermediate-sized habitat for fish. Some smaller lakes and ponds such as Red Lake, Little Red Lake, and Burleson Lake are found in this reach. These are generally more isolated water bodies without mainstream connections, and thus would likely support a more farm pond type species complex perhaps consisting of bass, catfish, sunfish, and forage species. Overall, the species complex in the streams would more likely resemble the proposed power plant site and its immediately adjacent construction corridors in that local fish communities would be represented by several minnow species and sunfish species with a few bass and catfish individuals added. No recreational fishery or commercial fishery exists in this area of the ROI above the sequestration reservoir. No formalized federal, state, or local jurisdiction management plans are present.

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Petromyzontidae	Lampreys	
Ichthyomyzon gagei	southern brook lamprey	
Polyodontidae	Paddlefishes	
Polyodon spathula	Paddlefish	
Lepisosteidae	Gars	
Lepisosteus oculatus	spotted gar	X
Lepisosteus osseus	longnose gar	
Amiidae	Bowfin	
Amia calva	Bowfin	X
Anguillidae	Eels	
Anguilla rostrata	American eel	

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Clupeidae	Herrings	
Dorosoma petenenese	threadfin shad	X
Dorosoma cepedianum	gizzard shad	X
Esocidae	Pike	
Esox americanus vermiculatus	grass pickerel	X
Cyprinidae	Minnows	
Cyprinus carpio	common carp	X
Carassius auritus	Goldfish	
Notemigonus crysoleucas	golden shiner	X
Opsopoeodus emiliae	pugnose minnow	X
Macrohybopsis aestivalis	speckled chub	
Phenacobius mirabilis	suckermouth minnow	X
Lythrurus fumeus	ribbon shiner	X
Lythrurus umbratilis	redfin shiner	X
Cyprinella venusta	blacktail shiner	X
Cyprinella lutrensis	red shiner	X
Notropis atherinoides	emerald shiner	X
Notropis shumardi	silverband shiner	X
Notropis texanus	weed shiner	
Notropis amnis	pallid shiner	
Notropis atrocaudalis	blackspot shiner	X
Notropis volucellus	mimic shiner	
Notropis buchanani	ghost shiner	X
Hybognathus nuchalis	Mississippi silvery minnow	
Pimephales vigilax	bullhead minnow	X
Catostomidae	Suckers	
Cycleptus elongates	blue sucker	
Ictiobus bubalus	Smallmouth buffalo	X
Ictiobus niger	black buffalo	
Carpiodes carpio	river carpsucker	
Moxostomacongestum	gray redhorse	
Minytrema melanops	spotted sucker	X
Erimyzon sucetta	lake chubsucker	X

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Ictaluridae	Catfishes	
Ictalurus punctatus	channel catfish	X
Ictalurus furcatus	blue catfish	
Ameiurus melas	black bullhead	X
Ameiurus natalis	yellow bullhead	X
Pylodictis olivaris	flathead catfish	
Noturus gyrinus	tadpole madtom	X
Noturus nocturnes	freckled madtom	
Aphredoderidae	pirate perch	
Aphredoderus sayanus	pirate perch	X
Fundulidae	Topminnows	
Fundulus dispar	starhead topminnow	X
Fundulus notatus	Blackstripe topminnow	X
Fundulus olivaceus	blackspotted topminnow	X
Poeciliidae	Livebearers	
Gambusia affinis	western mosquitofish	X
Atherinopsidae	New World silversides	
Menidia beryllina	inland silverside	X
Moronidae	Temperate basses	
Morone chrysops	white bass	
Centrarchidae	Sunfish	
Micropterus punctulatus	spotted bass	
Micropterus salmoides	Largemouth bass	X
Lepomis gulosus	Warmouth	X
Lepomis cyanellus	green sunfish	X
Lepomis symmetricus	bantam sunfish	
Lepomis punctatus	spotted sunfish	X
Lepomis microlophus	redear sunfish	X
Lepomis macrochirus	Bluegill	X
Lepomis humilis	orangespotted sunfish	X
Lepomis auritus	redbreast sunfish	
Lepomis megalotis	longear sunfish	X
Lepomis marginatus	dollar sunfish	X
Pomoxis annularis	white crappie	X

Table 6.9-2. Fish Species Whose Geographic Distribution Includes the Proposed Power Plant Site

Family Scientific Name	Common Name	Collected from the Proposed Power Plant Site Area
Pomoxis nigromaculatus	black crappie	X
Elassoma zonatum	banded pygmy sunfish	X
Percidae	Perch	
Percina sciera	dusky darter	X
Percina macrolepida	bigscale logperch	X
Ammocrypta vivax	scaly sand darter	X
Etheostoma chlorosomum	bluntnose darter	X
Etheostoma gracile	slough darter	X
Etheostoma parvipinne	goldstripe darter	X
Sciaenidae	drums and croakers	
Apolodinotus grunniens	Freshwater drum	

Source: FG Alliance, 2006c.

Utility Corridors

Aquatic invertebrates expected in the streams and ponds of the proposed CO_2 pipeline segments C-D, D-F, F-G, and F-H include a variety of insects, crustaceans, mollusks, and segmented worms.

Proposed CO_2 pipeline segment F-H crosses the Trinity River and connects with the land above the sequestration reservoir. Although large rivers provide some habitat for aquatic insects, available microhabitat is not especially diverse and taxa richness is generally low (FG Alliance, 2006c). Insect taxa adapted to large rivers and their adjoining channels include burrowing mayflies (Ephemeroptera) and mayflies with operculate gills, predacious dragonflies (Odonata), which feed on associated fauna such as riffle beetles (Emidae) and net-spinning caddisflies (Hydropsychidae). Aside from the aquatic insects, other invertebrates such as crustaceans and mollusks are common in large riverine systems. Gastropod mollusks frequently encountered in central Texas include the genera *Physella* (Physidae) and *Helisoma* (Planorbidae). Several bivalve taxa, including the invasive Asiatic clam (*Corbicula fluminea*) are also expected. Crustaceans, such as the river shrimp (*Macrobranchium ohione*), crayfish (*Procambarus* sp.), and freshwater prawns would also be found in abundance. Additionally, annelids such as leeches and oligochaete worms are ubiquitous to aquatic ecosystems in temperate climates.

The proposed process water supply pipeline corridor contains no aquatic habitat and therefore no aquatic invertebrates.

Table 6.9-2 presents fish species likely found within the ROI, including within the proposed utility corridor segments A-C, B-C, C-D, and D-F south of Highway 84. No aquatic habitat is present along the proposed water supply pipeline corridor. At least 71 species have geographic ranges that include the ROI, with 49 species collected from the area. The aquatic habitats found on the proposed power plant site would likely include smaller fish species due to the small nature of the creeks.

The proposed CO_2 pipeline segments D-F north of Highway 84, F-G, and F-H are located either within or very near the floodplain of the Trinity River. Because of this, the perennial creeks in the area are generally larger than those described for the proposed power plant site or the corridor segments to the south of Highway 84. Habitat for the bulk of the species listed in Table 6.9-2 would occur in these areas, except for the speckled chub (*Macrohybopsis aestivalis*) and gray redhorse (*Moxostoma congestum*). The two species listed occur primarily in the Brazos River drainage in this area of Texas. The following additional species not listed in the table would also occur: alligator gar (*Lepisostens spatula*), creek chubsucker (*Erimyzon oblongus*), blacktail redhorse (*Moxostoma poecilurum*), brook silversides (*Labidesthes sicculus*), yellow bass (*Morene mississippiensis*), and flier (*Centrarchus macropterus*).

Intermittent and ephemeral stream channels occur throughout all of the proposed CO_2 pipeline corridors. A small lake occurs within proposed CO_2 pipeline segment F-G. For habitat descriptions, see the above discussion of aquatic habitats in the sequestration site.

No formalized federal, state, or local jurisdiction management plans are present for the proposed utility corridors.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

The proposed power plant site, sequestration site, utility corridors, and ROI lie within the Texan Biotic Province described by Blair (FG Alliance, 2006c). The Texan Biotic Province corresponds to open woodland and savannah vegetational types, as the landscape transitions from the wetter forests in the east toward the slightly drier grassland provinces in the west. The faunal composition of this ecotonal region intermixes species typical of both the Austroriparian forestlands and the grasslands of the Kansan Biotic Province in the Texas Panhandle. This province contains no vertebrate species endemic to this region. It is estimated that 49 species of mammals, 16 species of lizards, 41 species of snakes, two species of turtles, five species of salamanders, and 18 species of frogs and toads occur within the Texan Province (FG Alliance, 2006c).

Reptiles commonly encountered in woodland habitats include the three-toed box turtle (*Terrapene carolina triunguis*), northern fence lizard (*Sceloporus undulatus hyacinthinus*), green anole (*Anolis carolinensis*), five-lined skink (*Eumeces fasciatus*), and Texas rat snake (*Elaphe obsoleta lindheimerii*). Resident avian species found in the upland hardwood forest include the eastern screech owl (*Otus asio*), hairy woodpecker (*Picoides villosus*), pileated woodpecker (*Dryocopus pileatus*), blue jay (*Cyanocitta cristata*), American crow (*Corvus brachyrhynchos*), Carolina chickadee (*Poecile carolinensis*), Carolina wren (*Thryothorus ludovicianus*), and northern cardinal (*Cardinalis cardinalis*); as well as the migratory great-crested flycatcher (*Myiarchus crinitus*), ruby-crowned kinglet (*Regulus calendula*), cedar waxwing (*Bombycilla cedrorum*), and black-and-white warbler (*Mniotilta varia*). Mammals occurring in the upland hardwoods include the Virginia opossum (*Didelphis virginiana*), red bat (*Lasiurus borealis*), nine-banded armadillo (*Dasypus novemcinctus*), eastern fox squirrel (*Sciurus niger*), white-footed mouse (*Peromyscus leucopus*), eastern woodrat (*Neotoma floridana*), common raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*).

Common grassland species include the eastern narrowmouth toad (*Gastrophryne carolinensis)*, pickerel frog (*Rana palustris*), ornate box turtle (*Terrapene ornata ornata*), eastern earless lizard

(*Holbrookia maculata perspicua*), eastern yellowbelly racer (*Coluber constrictor flaviventris*), and Louisiana milk snake (*Lampropeltis triangulum amaura*). Year-round resident bird species include the northern bobwhite, killdeer (*Charadrius vociferous*), inca dove (*Columbina inca*), loggerhead shrike (*Lanius ludovicianus*), lark sparrow (*Passerina ciris*), and eastern meadowlark (*Sturnella magna*). The yellow-billed cuckoo (*Coccyzus americanus*), common nighthawk (*Chordeiles minor*), scissor-tailed flycatcher (*Tyrannus forficatus*), and indigo bunting (*Passerina cyanea*) are summer resident species likely to occur within these habitats. Common mammals include the black-tailed jack rabbit (*Lepus californicus*), fulvous harvest mouse (*Reithrodontomys fulvescens*), hispid cotton rat (*Sigmodon hispidus*), coyote (*Canis latrans*), eastern spotted skunk (*Spilogale putorius*), and white-tailed deer.

No formalized federal, state, or local jurisdiction management plans are present.

6.9.2.3 Federally Listed Threatened and Endangered Species

Based on review of threatened and endangered species databases generated by the Texas Parks and Wildlife Department (TPWD) and FWS, and confirmed by a field reconnaissance that Horizon Environmental Services conducted on behalf of the site proponent in April 2006, there are no protected aquatic species within the proposed power plant site or surrounding area. There are also no federally listed aquatic species located within the proposed water supply or CO_2 pipeline corridors, or the proposed land above the sequestration reservoir. The coordination letters are included in Appendix A.

Although there are no known occurrences of federally listed species within any of the proposed project construction areas, according to FWS, federally listed threatened or endangered terrestrial species which could occur within Anderson, Leon, Limestone, and Freestone counties include the endangered Houston toad (*Bufo houstonensis*), endangered interior least tern (*Sterna antillarum*), threatened bald eagle (*Haliaeetus leucocephalus*), endangered wood stork (*Mycteria americana*), endangered Navasota ladies'-tresses (*Spiranthes parksii*), endangered large-fruited sand verbena (*Abronia macrocarpa),* and threatened tinytim (*Geocarpon minimum*). No designated critical habitat occurs at any of the areas to be affected by construction of the proposed project.

The Houston toad inhabits very deep, friable sands within a variety of associated forest cover types, including loblolly pine and post oak. They breed in shallow bodies of water that persist long enough (30 to 60 days) for egg hatching and metamorphosis to occur. Surveys for the Houston toad within the Jewett Mine site have been conducted on numerous occasions with no observations of the toads. FWS has concurred that the Houston toad is unlikely to occur in the vicinity of the Jewett Mine; therefore, it is unlikely it would occur on the proposed power plant site, utility corridors, or within the ROI. Suitable habitat does exist on the land above the sequestration reservoir.

The interior least tern nests on sandbars, salt flats, and barren shores along wide, shallow rivers. Recently, interior least terns have been documented nesting on both disturbed and reclaimed mine lands at the Jewett Mine. Since 1994, interior least terns have nested on portions of the Jewett Mine (approximately 2 to 3 miles [3.2 to 4.8 kilometers] northeast of the proposed power plant site), except for 1998, when no nesting terns were recorded but a tern was sighted flying above the western portion of a reclaimed area (FG Alliance, 2006c). In addition, during the 2000 breeding season, six pairs (unknown number of fledglings) nested on another site in the same general area. Interior least terns have also nested in mine areas approximately 2 to 3 miles (3.2 to 4.8 kilometers) southwest of the proposed power plant site during 2001 and 2006, and 1.5 to 2.5 miles (2.4 to 4.0 kilometers) southeast of the site in 2001 through 2006 (FG Alliance, 2006c). Although no interior least tern nesting habitat is present on the proposed power plant site, potential habitat is present within the proposed utility corridors and the land above the sequestration reservoir.

No suitable bald eagle habitat is present on the proposed power plant site; however, it is possible that eagles could pass over the site during migration or daily foraging travels. The closest known bald eagle habitat is Lake Limestone, which is located at the edge of the ROI to the southeast and northeast of the proposed power plant site. Wintering bald eagles were observed along the Trinity River near the land above the sequestration reservoir during a November 2006 site visit.

The wood stork is federally listed as endangered and state-listed as threatened. The wood stork formerly bred in southeast Texas, but now only occurs during post-breeding dispersal. Potential habitat for this species includes shallow-water habitats such as pond fringes, marshes, and lake fringes. It could occur in the proposed utility corridors and land above the sequestration reservoir during migration.

Navasota ladies'-tresses are found in sandy loam soils within post oak woodland openings along intermittent tributaries of the Navasota and Brazos rivers. Surveys for the Navasota ladies'-tresses have been conducted since 1991 on the Jewett Mine. This species has been found at various sites within the mine, but none have been reported to occur on the proposed power plant site. Many of the known locations of this species are within the ROI (FG Alliance, 2006c). The closest known location is approximately 3 to 4 miles (4.8 to 6.4 kilometers) to the east of the proposed utility corridors in Leon County. Potential habitat also occurs along the proposed utility corridors and on the sequestration site.

The large-fruited sand verbena occurs in deep sand soils with dune-like characteristics. This habitat does not occur on the proposed power plant site. Surveys for the sand verbena on the Jewett Surface Mine have been negative (FG Alliance, 2006c). It is unlikely this species occurs on the proposed power plant site, the proposed utility corridors, the sequestration site, or within the ROI due to lack of appropriate habitat.

Tinytim is a federally listed threatened plant species that occurs in Anderson County. This inconspicuous member of the pink family (Caryophyllidae) occurs in shallow soils that are rich in sodium or magnesium. Potential habitat occurs on the land above the sequestration reservoir.

6.9.2.4 Other Protected Species

Aquatic Species

Although several rare species of mollusks have been reported in Freestone, Leon, and Limestone counties, none have been identified during surveys previously conducted by Jewett Mine within the ROI (FG Alliance, 2006c). The federal candidate fish species smalleye shiner (*Notropis buccula*), state-listed threatened blue sucker (*Cycleptus elongatus*), state-listed endangered paddlefish (*Polydon spathula*), and state-listed threatened creek chubsucker (*Erimyzon oblongus*) all have ranges that include the proposed power plant site and its ROI; however, no habitat that would support these species exists on the site because no perennial water is present. Additionally, several invertebrate species (13 mussel species, three caddisfly species, and one dragonfly species) designated as rare are found in the counties containing the proposed power plant site, utility corridors, and land above the sequestration reservoir, as listed in Table 6.9-3. Potential habitat only exists within the perennial streams along the proposed CO_2 pipeline corridors and on the land above the sequestration reservoir. Overall, there are no known occurrences of state-listed rare, threatened, or endangered aquatic species.

Terrestrial

State-listed plants and animals that have the potential to occur within Anderson, Freestone, Leon, and Limestone counties include the peregrine falcon (*Falco peregrinus*), Texas horned lizard (*Phrynosoma cornumtum*), timber rattlesnake (*Crotalis horridus*), alligator snapping turtle (*Macrochelys temminckii*), Bachman's sparrow (*Aimophila aestivalis*), and the white-faced ibis (*Plegadis chihi*). None of these species are likely to occur within the proposed power plant site because of lack of suitable habitat or the extirpation of the species in the project area. Habitats within the proposed utility corridors and the sequestration site have the potential to support Bachman's sparrow and the white-faced ibis, both state-listed threatened species. Bachman's sparrow occurs in open pine woods with a scattered brush understory and overgrown fields in Anderson and Freestone counties. The previously described Post Oak Woods/Forest and Grassland Mosaic vegetation type, common in these counties, could provide habitat for this species. The white-faced ibis is found in freshwater marshy habitat or sloughs in Anderson and Limestone counties. Potentially suitable habitat exists within Segments F-G and F-H of the proposed CO_2 pipeline corridor and on the sequestration site. The peregrine falcon and an associated sub-species, the Arctic peregrine falcon (*Falco peregrinus tundrius*), are statewide migrants and may be present for short periods during spring and fall migrations in the proposed utility corridors and the sequestration site (FG Alliance, 2006c). Although potential habitat is present, there are no known occurrences of any state-listed rare, threatened, or endangered species within any of the proposed project construction areas.

Table 6.9-3. Invertebrates Designated as "Rare" by TPWD in Freestone, Leon, Limestone, and Anderson Counties

Common Name	Scientific Name	Counties Listing it as Rare
Creeper (squawfoot)	***Strophitus undulates***	Freestone and Leon
Fawnsfoot	***Truncilla donaciformis***	Freestone and Leon
Little spectaclecase	***Villosa lienosa***	Freestone and Leon
Louisiana pigtoe	***Pleurobema riddellii***	Freestone and Leon
Pistolgrip	***Tritogonia verrucosa***	Freestone, Leon, and Limestone
Rock-pocketbook	***Arcidens confragosus***	Freestone, Leon, and Limestone
Sandbank pocketbook	***Lampsilis satura***	Freestone and Leon
Texas heelsplitter	***Potamilus amphichaenus***	Freestone and Leon
Texas pigtoe	***Fusconaia askewi***	Freestone and Leon
Wabash pigtoe	***Fusconaia flava***	Leon
Smooth pimpleback	***Quadrula houstonensis***	Leon and Limestone
False spike mussel	***Quincuncina mitchelli***	Limestone
Texas fawnsfoot	***Truncilla macrodon***	Limestone
Purse casemaker caddisfly	***Hydroptila ouachita***	Anderson
Holzenthal's philopotamid caddisfly	***Chimarra holzenthali***	Anderson
Morse's net-spinning caddisfly	***Cheumatopsyche morsei***	Anderson
Texas emerald dragonfly	***Somatochlora margarita***	Anderson
Creeper (squawfoot)	***Strophitus undulatus***	Anderson
Fawnsfoot	***Truncilla donaciformis***	Anderson
Little spectaclecase	***Villosa lienosa***	Anderson

Source: FG Alliance, 2006c.

6.9.3 IMPACTS

6.9.3.1 Construction Impacts

Power Plant Site

There are three small intermittent tributary streams and three man-made impoundments on the power plant site. Placement of fill during site construction could result in direct permanent impacts to these features. Previous modifications for most of the lengths of two of these streams have degraded habitats to low value. Although the third tributary has not been previously modified, it is ephemeral in nature and considered of moderate value. None of the on-site streams or impoundments are known to contain any habitat or species that are not plentiful in this area of Texas. The Alliance could likely avoid these features during the site layout and planning process. Standard stormwater management practices for construction activities (e.g., placement of silt fencing around disturbed areas) would prevent indirect impacts, such as sedimentation to off-site surface waters.

Project construction would require the removal of up to 200 acres (81 hectares) of terrestrial habitat to accommodate the power plant envelope (plant buildings and associated corridors). This would predominantly consist of post oak woods and grassland habitat, neither of which is rare in the greater project area. Wildlife species found within the construction site are common to the area. Some small, less mobile species, such as reptiles and small mammals, would be lost during project construction; however, this would not affect the overall populations of these species due to their commonality and plentiful alternative habitat. Larger, more mobile species would likely disperse from the project site due to noise, disturbance, and the habitat loss. Because of the adjacent suitable habitat is plentiful, this would not likely affect population health. Additionally, construction of the proposed power plant site is unlikely to cause a proliferation of noxious weeds because the disturbed area would become an industrial facility with little vegetation.

No known federally or state-listed rare, threatened, or endangered species, or designated critical habitat, are located at the proposed power plant site. However, the federally listed Navasota ladies'-tresses could potentially occur on the proposed power plant site. Should this species occur within the area of construction, it could sustain direct impacts in the absence of enforced protection measures. Protocol-level surveys for the Navasota ladies'-tresses before commencement of any ground-disturbing activities at the proposed power plant site would confirm its presence or absence. If the species is found in proximity to any construction or disturbance area, consultation between the site proponent, the TPWD, and the FWS to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Sequestration Site

The proposed sequestration site contains numerous perennial, intermittent, and ephemeral stream channels, as well as a larger lake. Placement of the three proposed injection wells would likely avoid these locations to minimize impacts. Construction of the injection wells would disturb up to 10 acres (4 hectares) of land. However, this disturbance should not affect the overall extent and availability of terrestrial resources dispersed throughout the site. After construction, disturbed areas not used for injection wells would be revegetated with native species, limiting the proliferation of noxious weeds. Temporary impacts to vegetation would result from truck access during the required seismic surveys of the sequestration site, before injection well construction.

No federally or state-listed rare, threatened, or endangered species are known to occur in the sequestration site. However, the federally listed interior least tern, tinytim, and Houston toad; the state-listed Bachman's sparrow and white-faced ibis; and the state rare invertebrates listed in Table 6.9-3 could potentially occur within the sequestration site. Should any of these species occur within areas of construction, they could sustain direct impacts in the absence of enforced protective measures. The sequestration site does not contain any designated critical habitat. Protocol-level surveys for the interior least tern, Houston toad, Bachman's sparrow, white-faced ibis, and rare invertebrates before commencement of any ground-disturbing activities would confirm the presence or absence of these species. If any of these species are found in proximity to any construction or disturbance area, consultation between the site proponent, the TPWD, and the FWS to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Utility Corridors

The proposed CO_2 pipeline corridors would be between 52 and 59 miles (83.7 and 95 kilometers) long, depending upon which configuration is ultimately built. There are several perennial, intermittent, and ephemeral streams, as well as a small lake along the proposed CO_2 pipeline segments. The perennial streams include the Trinity River. If these utilities are not directionally drilled beneath these features, temporary and minor impacts to aquatic habitat could include trenching of stream and pond beds during construction to accommodate the pipeline. Flow, if present during construction, would be temporarily diverted around the area of installation. Traditional pipeline construction methods, along with appropriate protection and mitigation measures such as time of year construction restrictions, silt fencing, hay bales, and other sediment and erosion control mechanisms, would minimize these effects. The proposed water supply pipeline corridor does not contain aquatic habitat.

Construction of many of the proposed pipelines in existing ROWs would minimize the amount of vegetation and habitat loss. The terrestrial habitat type is similar to that described for the proposed power plant site and does not contain designated critical habitat for federally or state-listed rare, threatened, or endangered species. Similar habitat is plentiful in the project vicinity. The TPWD states that the proposed CO_2 pipeline traverses through high-quality deer and turkey hunting ground, which could be temporarily impacted by pipeline installation. The proposed water supply pipeline corridor would likely be only 0.4 mile (0.6 kilometer) of new ROW. Land above the pipelines would be revegetated with native species following construction, maintaining wildlife habitat similar to current conditions and limiting the proliferation of noxious weeds. Although it is likely that a new transmission line would not need to be built, one option (Option 2) would require 2 miles (3.2 kilometers) of new ROW. Wildlife species found along the proposed utility corridors, like those at the proposed power plant site, are common species that could be temporarily displaced during construction.

No federally or state-listed rare, threatened, or endangered species are known to occur in the project area, and therefore would not be affected. Additionally, there is no designated critical habitat within the proposed utility line corridors. However, the federally listed Navasota ladies'-tresses could potentially occur along the proposed CO_2 pipeline corridors. Should this species occur within the area of construction, it could sustain direct impacts in the absence of enforced protection measures. Additionally, the federally listed interior least tern, the state-listed Bachman's sparrow and white-faced ibis, and the state rare invertebrates listed in Table 6.9-3 have the potential to occur within the proposed CO_2 pipeline corridors. If any of these species occur within the areas of construction they could be directly impacted by the proposed project if protective measures are not taken. Protocol-level surveys would confirm the presence or absence of these species before commencement of any ground-disturbing activities. If any of these species are found in proximity to any construction or disturbance area, consultation between the site proponent, the TPWD, and the FWS to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Transportation Corridors

No new transportation corridors are proposed outside of the proposed power plant site or sequestration site. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

6.9.3.2 Operational Impacts

Power Plant Site

Operating the proposed power plant would have minimal effect on biological resources. Noise during proposed project facility operations would be slightly elevated in the absence of mitigation (see Section 6.14); however, wildlife species that are found near the proposed power plant site would either adapt to the noise or disperse in the plentiful adjacent habitat. Air emissions due to routine operation would result in small increases in ground-level pollutant concentrations (see Section 6.2 for description) that should be below levels known to be harmful to wildlife and vegetation or affect ecosystems through bio-uptake and biomagnification in the food chain. Because there are no high-quality or sensitive aquatic or wildlife receptors near the proposed power plant site, air emissions would not impact biological communities.

Sequestration Site

A limited number of site characterization seismic surveys would be required during operation of the sequestration site, resulting in temporary impacts to vegetation due to truck access within the survey plots.

Microbes occurring approximately 0.9 mile (1.4 kilometers) under ground within the sequestration reservoir could be affected by sequestration. Microbes are likely to exist in almost every environment, including the proposed sequestration reservoirs, unless conditions prevent their presence. CO_2 sequestration has the potential to destroy these localized microbial communities by altering the pH of the underground environment. However, it is also possible that CO_2 sequestration would not harm microbial communities (IPCC, 2005). The potential loss of localized microbial populations within the sequestration reservoir would not constitute an appreciable difference to the world's total microbial population.

No additional impacts are anticipated during normal operations. Should released gas from the sequestration reservoir reach surface water, impacts to aquatic biota would be unlikely because the concentration of CO_2 in the surface water would be less than the 2 percent level at which effects to aquatic biota could occur (see Section 6.17). Plants are not predicted to be impacted by gradual CO_2 releases from the sequestration reservoir, although effects in the immediate vicinity of the injection wells could result from a rapid CO_2 release (see Section 6.17).

Utility Corridors

The proposed water supply and CO_2 pipeline corridors would be maintained without trees due to safety concerns. Corridor maintenance would likely use both mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in close proximity to streams and wetlands could be potentially damaging. Following approved herbicide usage instructions would eliminate this concern (DOE, 2007). If a leak or rupture in the CO_2 pipeline occurred, respiratory effects to biota due to atmospheric CO_2 concentrations would be limited to the immediate vicinity along the pipeline where the rupture or leak occurred. While heat generated from the supercritical fluid in the CO_2 pipeline could potentially affect surface vegetation, pipeline construction techniques that would contain the heat through insulation and installation depth would prevent this impact. Soil gas concentrations vary depending on soil type; therefore, effects on soil invertebrates or plant roots could occur close to the segment of pipeline that ruptured or leaked (see Section 6.17).

Transportation Corridors

Other than a potential minimal increase in road kill, there would be no impact to biological resources due to increased traffic on existing roads and the new transportation spurs located at the proposed power plant site.

4. MATTOON SITE

4.1 CHAPTER OVERVIEW

This chapter provides information regarding the affected environment and the potential for impacts on each resource area in relation to construction and operation of the FutureGen Project at the proposed Mattoon Site. To aid the reader and to properly address the complexity of the FutureGen Project, as well as the need to evaluate four sites (two in Illinois and two in Texas), this Environmental Impact Statement (EIS) was prepared as two separate volumes. Volume I of the EIS includes the purpose and need for the agency action, a description of the Proposed Action and Alternatives, and a summary of the potential environmental consequences. Volume II addresses the affected environment and potential impacts for each of the four proposed alternative sites. Presenting the affected environment immediately followed by the potential impacts on each resource area allows the reader to more easily understand the relationship between current site conditions and potential project impacts on a particular resource.

Volume II is organized by separate chapters for each proposed site: Chapter 4-Mattoon, Illinois; Chapter 5-Tuscola, Illinois; Chapter 6-Jewett, Texas; and Chapter 7-Odessa, Texas.

This chapter is organized by resource area as follows:

- 4.2 Air Quality
- 4.3 Climate and Meteorology
- 4.4 Geology
- 4.5 Physiography and Soils
- 4.6 Groundwater
- 4.7 Surface Water
- 4.8 Wetlands and Floodplains
- 4.9 Biological Resources
- 4.10 Cultural Resources
- 4.11 Land Use
- 4.12 Aesthetics
- 4.13 Transportation and Traffic
- 4.14 Noise and Vibration
- 4.15 Utility Systems
- 4.16 Materials and Waste Management
- 4.17 Human Health, Safety, and Accidents
- 4.18 Community Services
- 4.19 Socioeconomics
- 4.20 Environmental Justice

Each resource section provides an introduction, describes the region of influence (ROI) and the method of analysis, and discusses the affected environment and the environmental impacts from construction and operation of the FutureGen Project at the candidate site. The affected environment discussion describes the current conditions at the proposed power plant and sequestration site, and utility and transportation corridors. This is followed by a discussion of potential construction and operational impacts. A summary and comparison of impacts for all four candidate sites are provided in the EIS Summary and in Chapter 3. Unavoidable adverse impacts, mitigation measures, and best management practices (BMPs) for all four candidate sites are also provided in Chapter 3.

4.1.1 POWER PLANT FOOTPRINT

The specific configuration of the power plant, rail loop, and access roads within the candidate sites would be determined after site selection, during the site-specific design phase. For purposes of analysis, the impact assessment for the proposed power plant site assumed a representative configuration or layout depicted in Chapter 2, Figure 2-18. The proposed power plant site would involve up to 200 acres

(81 hectares) to house the power plant, coal and equipment storage, associated processing facilities, research facilities, railroad loop surrounding the power plant envelope, and a buffer zone; the site could ultimately be located anywhere within the larger power plant parcel. Therefore, impact discussions in this chapter identify environmentally sensitive areas to be avoided and address potential impacts to be evaluated, avoided, or mitigated within the entire power plant parcel.

4.1.2 NO-ACTION ALTERNATIVE

As discussed in Chapter 2, Proposed Action and Alternatives, the No-Action Alternative is treated in this EIS as the "No-Build" Alternative. That is, under the No-Action Alternative, the Alliance would not undertake a FutureGen-like project in the absence of Department of Energy (DOE) funding assistance. In the unlikely event that the Alliance did undertake a FutureGen-like project in the absence of DOE funding assistance, impacts might be similar to those predicted in this EIS. However, the Alliance would not be subject to the oversight or the mitigation requirements of DOE.

One goal of the FutureGen Project would be to test and prove a technological path toward minimization of greenhouse gas (GHG) emissions from coal-fueled electric power plants. Should the FutureGen Project prove successful and the concept of carbon dioxide (CO_2) capture and geologic sequestration receive widespread application across the U.S. and around the world, the current trend of increasing CO_2 emissions to the atmosphere from coal-fueled power plants could be reduced. In the absence of concept proof, industry and governments may be unwilling to initiate all of the technological changes that would help to significantly reduce current trends and consequential increase of CO_2 concentrations in the Earth's atmosphere.

Impacts associated with the No-Action Alternative are provided in Chapter 3.

4.1.3 MATTOON SITE

Proposed Mattoon Power Plant and Sequestration Site

The proposed Mattoon Site consists of approximately 444 acres (180 hectares) of farmland located approximately 1 mile (1.6 kilometers) northwest of the City of Mattoon, in Coles County, Illinois. Key features of the Mattoon Site are listed in Table 4.1-1. The proposed power plant and sequestration site would be located on the same parcel of land. The proposed site is bordered to the northeast by State Route (SR) 121 and a Canadian National Railroad. Potable water would be supplied by extending existing lines from Mattoon's public water supply system. Process water would be provided from the effluent of the municipal wastewater treatment plants (WWTPs) of the cities of Mattoon and possibly Charleston, Illinois. Sanitary wastewater service would be provided through an extension of Mattoon's public wastewater system. Natural gas would be delivered through a high-pressure line that is within 0.25 mile (0.4 kilometer) of the proposed site. The proposed power plant would connect to the power grid via existing or new high voltage transmission lines. Following Table 4.1-1, Figures 4.1-1 and 4.1-2 illustrate the Mattoon Site and utility corridors, respectively.

Table 4.1-1. Mattoon Site Features

Feature	Description
Power Plant Site	The proposed Mattoon Power Plant and Sequestration Site consists of approximately 444 acres (180 hectares) located in Mattoon Township, Coles County, Illinois. The proposed site consists of 93 percent farmland and 3 percent public rights-of-way (ROWs), with the remaining percentage being rural residential development and woodlands. The Site Proponent is a group consisting of the State of Illinois (through the Illinois Department of Commerce and Economic Opportunity), the City of Mattoon, Coles County, and Coles Together (an economic development organization). The proposed site is currently privately owned, but the Site Proponent has an option to purchase the site title, which would be conveyed to the Alliance. The northeast boundary of the proposed site is adjacent to SR 121. Rail access is immediately adjacent to the northeast site boundary. The proposed power plant site is located approximately 1 mile (1.6 kilometers) northwest of Mattoon and approximately 150 miles (241.4 kilometers) south of Chicago. This Coles County site is used as farmland, is flat, and is surrounded by a rural area of low-density population.
Sequestration Site Characteristics and Predicted Plume Radius	The sequestration site is located on the same parcel of land as the power plant site. CO_2 injection would occur within the Mt. Simon saline-bearing sandstone at a depth of 1.3 to 1.6 miles (2.1 to 2.6 kilometers). The Mt. Simon formation is overlain by a thick (500- to 700-foot [152- to 213-meter]) regional seal of low permeability siltstones and shales of the Eau Claire formation and is underlain by Precambrian granitic rock. The St. Peter sandstone is proposed as an optional target reservoir. It occurs at a depth of 0.9 mile (1.4 kilometers), which is about 0.4 mile (0.6 kilometer) above the Mt. Simon formation. The St. Peter sandstone is estimated to be over 200 feet (61 meters) thick with state-wide lateral continuity. Both the Mt. Simon and St. Peter reservoirs have been successfully used for natural gas storage in other parts of Illinois. To estimate the size of the plume of injected CO_2, the Alliance used numerical modeling to predict the plume radius from the injection well. This modeling estimated that the plume radius at Mattoon could be as large as 1.2 miles (1.9 kilometers) after injecting 1.1 million tons (1 MMT) of CO_2 annually for 50 years. The dispersal and movement of the injected CO_2 would be influenced by the geologic properties of the reservoir, and it is unlikely that the plume would radiate in all directions from the injection point in the form of a perfect circle. However, for reference purposes, this modeled radius corresponds to a circular area equal to 2,789 acres (1,129 hectares). Data from a recent two-dimensional (2D) seismic line across the proposed injection site indicated that the continuity of the seismic reflectors on this seismic line suggests that there is no significant faulting cutting the plane on the seismic line within 1.5 miles (2.4 kilometers) to the west and 1.5 miles (2.4 kilometers) to the east of the Mattoon Sequestration Site (Patrick Engineering, 2006).
Utility Corridors	
Potable Water	Potable water would be supplied to the plant site from the Mattoon public potable water system. A 1-mile (1.6-kilometer) pipeline extension would be constructed within the ROW of County Road (CR) 800N from the proposed power plant site to a 10-inch (25-centimeter) potable water pipeline on 43rd Street south of SR 121.

Table 4.1-1. Mattoon Site Features

Feature	Description
Process Water	The proposed Mattoon Site would obtain process water from the effluent of the municipal WWTPs of Mattoon and possibly Charleston. For the Mattoon WWTP effluent, a 6.2-mile (10.0-kilometer) pipeline would be constructed, with all but 2 miles (3.2 kilometers) within an existing public ROW located within the city boundary. The Site Proponent has option contracts to buy the necessary easements for these 2 miles (3.2 kilometers) of pipeline. The possible addition of a new 8.1-mile (13.0-kilometer) pipeline from the Charleston WWTP would be within an existing ROW owned by Mattoon and Charleston. The jointly-owned ROW follows the Lincoln Prairie Grass Bike Trail, and existing 138-kilovolt (kV) overhead electric lines run the entire length. An on-site reservoir (on the power plant property) could be constructed to store up to 25 million gallons (94.6 million liters) of process water to satisfy water requirements. A small reservoir of 7 acres (2.8 hectares) would be adequate. If a larger reservoir were constructed (approximately 40 acres [16.2 hectares] in size) with a capacity of 200 million gallons (757 million liters), the Mattoon WWTP effluent would be sufficient by itself to supply the proposed plant's process water.
Sanitary Wastewater	Sanitary wastewater service would be provided to the proposed plant site through an extension of Mattoon's existing public wastewater system. A sanitary sewer lift station would be constructed at the proposed site. A 1.25-mile (2.0-kilometer) wastewater force main would then be constructed in the ROW of SR 121 to an existing sanitary lift station at the intersection of SR 121 and 43rd Street.
Electric Transmission Lines	Option 1: The proposed power plant would connect with an existing 138-kV transmission line located 0.5 mile (0.8 kilometer) from the proposed site. This line runs north-south and is owned by Ameren Corporation. A corridor easement to connect the proposed site to the existing 138-kV line has already been acquired by Mattoon. There are three scenarios to tie into this line under Option 1. Option 1a: Tie directly into the existing 138-kV line with transfer switching. Option 1b: Install a substation at the interconnection of the new easement with the existing ROW. Option 1c: Run a new transmission line south next to the existing 138-kV line and connect with the existing substation less than 2 miles (3.2 kilometers) away near Route 16. The existing substation would need to be upgraded. Option 2: Under this option, the proposed site would be connected to the nearest 345-kV line at the Neoga South Substation located 16 miles (25.7 kilometers) south of the proposed site. This option would require 16 miles (25.7 kilometers) of new line and ROW to connect the proposed plant with this substation.
Natural Gas	A natural gas mainline is located approximately 0.25 mile (0.4 kilometer) east of the proposed power plant site. This is a high-pressure line, and a new tap and delivery station would be required. The Site Proponent has obtained an option for additional land for the pipeline ROW that would give flexibility in the route to connect to this line.
CO_2 Pipeline	The CO_2 injection well for the FutureGen Project at Mattoon would be located at the proposed power plant site. Therefore, no off-site CO_2 pipeline or corridor would be necessary.

Table 4.1-1. Mattoon Site Features

Feature	Description
Transportation Corridors	The site is located 7 miles (11.3 kilometers) west of Interstate (I) Highway 57 (I-57), along SR 121. The Canadian National-Peoria Subdivision rail line is immediately adjacent to the northeast site boundary. The Canadian National/Illinois Central mainline connects to the Peoria Subdivision rail line approximately 3.5 miles (5.6 kilometers) from the proposed site. Illinois is located within the East North Central Demand Region for coal, which also includes Ohio, Indiana, Wisconsin, and Michigan. According to the Energy Information Administration (EIA, 2000), the East North Central Demand Region is ideally situated for access to coal, which it receives from each of the major U.S. supply regions. In 1997, the average distance that a coal shipment traveled to reach a destination in this region was about 830 miles (1,336 kilometers) (EIA, 2000). In terms of a straight-line distance, Mattoon is approximately 300 miles (483 kilometers) from the Pittsburgh Coalbed (near south-central Ohio in the northern Appalachian Basin), 900 miles (1,448 kilometers) from the Powder River Basin (PRB) (eastern Wyoming), and 50 miles (80.5 kilometers) from the nearest active coal mine within the Illinois Basin (Vermillion County, Illinois).

Source: FG Alliance, 2006a (unless otherwise noted).

4.10 CULTURAL RESOURCES

4.10.1 INTRODUCTION

Section 106 of the National Historic Preservation Act of 1966 (NHPA) and its implementing regulations at 36 CFR Part 800 (incorporating amendments effective August 5, 2004) require federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings.

Historic properties are a specific category of cultural resources. Cultural resources are any resources of a cultural nature (King, 1998). As defined at 36 CFR 800.16[l][1], a historic property is a cultural resource that is any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior. Historic properties include artifacts, records, and remains related to and located within such properties, as well as properties of traditional religious and cultural importance to Native American tribes or Native Hawaiian organizations, and properties that meet National Register criteria for evaluation (36 CFR 60.4).

The **National Historic Preservation Act** of 1966 (16 USC 470), establishes a program for the preservation of historic properties throughout the Nation.

The **National Register** criteria for evaluation states that:

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

36 CFR Part 800 outlines procedures to comply with NHPA Section 106. At 36 CFR Part 800(a), federal agencies are encouraged to coordinate Section 106 compliance with any steps taken to meet NEPA requirements. Federal agencies are to also coordinate their public participation, review, and analysis to meet the purposes and requirements of both the NEPA and the NHPA in a timely and efficient manner. The Section 106 process has been initiated for this undertaking with the intent of coordinating that process with DOE's obligations under NEPA regarding cultural resources.

For purposes of this document, cultural resources are:

- Archaeological resources, including prehistoric and historic archaeological sites;
- Historic resources, including extant standing structures;
- Native American resources, including Traditional Cultural Properties (TCPs) important to Native American tribes; or
- Other cultural resources, including extant cemeteries and paleontological resources.

Participants in the Section 106 process include an agency official with jurisdiction over the FutureGen Project, the ACHP, consulting parties, and the public. Consulting parties include the State Historic Preservation Officer; Native American tribes and Native Hawaiian organizations; representatives of local government; and applicants for federal assistance, permits, licenses, and other approvals. Additional consulting parties include individuals and organizations with a demonstrated interest in the proposed FutureGen Project due to their legal or economic relation to the undertaking or affected properties, or their concern with the effects of the undertakings on historic properties. In Illinois, the State Historic Preservation Officer is the Director of Historic Preservation within the Illinois Historic Preservation Agency (IHPA).

The NHPA Section 106 process is paralleled by the Illinois Section 707 process. The Section 707 process is embodied in the Illinois State Agency Historic Resources Preservation Act (20 ILCS 3420) governing projects under the direct or indirect jurisdiction of a state agency, or licensed or assisted by a state agency. The Archaeological and Paleontological Resources Protection Act (20 ILCS 3435) applies to all Illinois public lands and contains criminal sanctions for those who disturb burial mounds, human remains, shipwrecks, and other archaeological resources or fossils on public lands. Human burials are afforded additional protection under the Human Skeletal Remains Protection Act (20 ILCS 3440), forbidding disturbance of human skeletal remains and grave markers in unregistered cemeteries, including isolated graves and burial mounds, that are at least 100 years old. Younger graves and registered cemeteries are protected under the Cemetery Protection Act (765 ILCS 835).

The IHPA (20 ILCS 3410) establishes and maintains the Illinois Register of Historic Places that parallels the NRHP. Under the IHPA, a Comprehensive Statewide Historic Preservation Plan prepared in 1995 and updated in 2005 broadly outlines historic preservation in the state.

4.10.1.1 Region of Influence

The ROI for cultural resources includes (1) the proposed power plant and sequestration site and area within 1 mile (1.6 kilometers) of the proposed power plant site boundaries; (2) all related areas of new construction and those within 1 mile (1.6 kilometers) of said areas; and (3) the land area above the proposed sequestration reservoir(s). NHPA Section 106 states the correlate of the ROI is the Area of Potential Effects (APE).

> The **Area of Potential Effects** is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if such properties exist (36 CFR 800.16[d]).

Adverse effects to archaeological, paleontological, and cemetery resources are generally the result of direct impacts from ground disturbing activities. Therefore, the APE for such resources coincides with those areas where direct impacts from the construction and operation of the proposed facility would occur. Adverse effects to historic resources (i.e., standing structures) may occur through direct impacts that could change the character of a property's use or physical features within a property's setting that contribute to its historic significance. Adverse effects may also occur through indirect impacts that could introduce visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features. For historic resources, the APE encompasses the ROI as defined. TCPs may be subject to both direct and indirect impacts.

4.10.1.2 Method of Analysis

DOE reviewed the results of research and studies performed by the Alliance to determine the potential for impacts based on the following criteria:

- Archaeological Resources – Cause the potential for loss, isolation, or alteration of an archaeological resource eligible for NRHP listing.
- Historic Resources – Cause the potential for loss, isolation, or alteration of the character of a historic site or structure eligible for NRHP listing. Introduce visual, audible, or atmospheric elements that would adversely affect a historic resource eligible for NRHP listing.

- Native American Resources – Cause the potential for loss, isolation, or alteration of Native American resources, including graves, remains, and funerary objects. Introduce visual, audible, or atmospheric elements that would adversely affect the resource's use.
- Other Cultural Resources
  - Paleontological Resources – Cause the potential for loss, isolation, or alteration of a paleontological resource eligible for listing as a National Natural Landmark (NNL).
  - Cemeteries – Cause the potential for loss, isolation, or alteration of a cemetery.

The Alliance conducted archival research to determine whether archaeological and historic resources are known to exist or may exist within the APE/ROI. This research included review of the Illinois Archaeological Survey site files and the IHPA Historic Architectural and Archaeology Resources Geographic Information System (HAARGIS). The Alliance also consulted with personnel at IHPA (FG Alliance, 2006a). A Phase I archaeological survey of the ROI that included supplemental archival research, a pedestrian survey, and shovel testing in areas of the ROI with poor surface visibility was also conducted (Finney, 2006).

To identify Native American tribes that potentially have TCPs within the ROI, the Alliance used the National Park Service (NPS) Native American Consultation Database (FG Alliance, 2006a).

The Alliance used FAUNMAP to determine the potential for paleontological resources in the proposed project area. FAUNMAP is a database of the late Quaternary distribution of mammal species in the U.S., as well as the histories of Coles and Cumberland counties. Though paleontological resources are generally geological in nature rather than cultural, several environmental regulations have been interpreted to include fossils as cultural resources. The Antiquities Act of 1906 refers to historic or prehistoric ruins or any objects of antiquity situated on lands owned or controlled by the U.S. Government, but the term "objects of antiquity" has been interpreted by the NPS, Bureau of Land Management (BLM), U.S. Forest Service (USFS), and other federal agencies to include fossils. An area rich in important fossil specimens can be a NNL as defined in the NPS National Registry of Natural Landmarks (NRNL) (36 CFR 62.2). Paleontological resources are not analyzed under NHPA Section 106 unless they are recovered within culturally related contexts (e.g., fossils included within human burial contexts, a mammoth kill site).

4.10.2 AFFECTED ENVIRONMENT

4.10.2.1 Archaeological Resources

Review of the Illinois Archaeological Survey site files identified 13 previously recorded archaeological sites in the Mattoon/Charleston area (FG Alliance, 2006a), six of which are within the FutureGen Project's ROI. Table 4.10-1 lists the six sites within the project ROI, their cultural or temporal affiliation, and specific ROI within which they are located.

An archaeological survey was conducted of areas that would be subject to direct impact from construction, including the proposed power plant and sequestration site, electrical transmission line corridor south from the plant site to Highway 16, and process water corridor extending from the plant site along the north and east sides of Mattoon (Finney, 2006). The electrical transmission line corridor south of Highway 16 and the process water corridor east to Charleston did not require a survey as the transmission corridor is an existing transmission line that would be upgraded, and the process water corridor is in an existing, disturbed public ROW.

Table 4.10-1. Previously Recorded Archaeological Sites Within ROI

Site Number	Site Type	ROI
RIP-Co-1H	Historic, late 19th – early 20th century	Electrical transmission line corridor
11Co9	Prehistoric, indeterminate age	Process water corridor
11Co122	Historic, late 19th – early 20th century	Process water corridor
11Co129	Prehistoric, Early Archaic	Process water corridor
11Co130	Prehistoric, Early Archaic	Process water corridor
11Co139	Prehistoric Late Archaic and historic late 19th – early 20th century	Process water corridor

Source: FG Alliance, 2006a.

Background research before the survey indicated no previously recorded archaeological sites or isolated finds within the survey area, but three archaeological sites (11Co9, 11Co129, and 11Co130) are within 1 mile (1.6 kilometers) of the survey area (Finney, 2006). The remaining three archaeological sites within the ROI are within the utility corridor ROIs that were not surveyed (FG Alliance, 2006a).

Five isolated finds were identified during the survey, all within the proposed power plant and sequestration site area. The isolated finds include two prehistoric chert flakes and three historic ceramic whiteware fragments (Finney, 2006). No prehistoric or historic archaeological sites were identified by the survey and it was recommended that the project area be cleared from an archaeological perspective (FG Alliance, 2006a). IHPA concurrence has been received and no further investigations are needed (see Appendix A).

4.10.2.2 Historic Resources

The HAARGIS database shows seven historic properties in Mattoon and 10 historic properties in Charleston listed in the NRHP (FG Alliance, 2006a). Three of those 17 properties are within the project ROI. The Briggs and Alexander House located in downtown Charleston is within the ROI for the process water corridor. In Mattoon, the U.S. Post Office and a nine-block section of Brick Street that follows Oklahoma Avenue and 15th Street are within the ROI for the process water corridor.

4.10.2.3 Native American Resources

No publicly documented TCPs are known to exist within the ROI for the proposed power plant site, related areas of new construction, or in the land above the sequestration reservoir. DOE initiated consultation with federally recognized Native American tribes that may have an interest in the project area on December 6, 2006 (see Appendix A). The following tribes received consultation letters:

- Kickapoo Tribe of Kansas
- Kickapoo Tribe of Oklahoma
- Miami Tribe of Oklahoma
- Prairie Band of the Potawatomi Nation
- Peoria Tribe of Indians of Oklahoma

Regional Directors for the Bureau of Indian Affairs in the Southern Plains and Eastern Oklahoma Regions also received copies of the consultation letter. The Bureau of Indian Affairs South Plains and Eastern Oklahoma Regional offices both responded that they do not have jurisdiction over the alternative sites in Illinois (see Appendix A). The Eastern Oklahoma Regional Office has provided notice of the FutureGen Project to the Bureau of Indian Affairs Eastern Region Office, which does have jurisdiction. A response has not yet been received. To date, no Native American tribes have responded.

4.10.2.4 Other Cultural Resources

There are no registered cemeteries and no known paleontological resources within the project ROI.

4.10.3 IMPACTS

4.10.3.1 Construction Impacts

Construction impacts to cultural resources would primarily be direct and result in earth-moving activities that could destroy some or all of a resource. There are no known cultural resources in areas where earth moving would take place. Therefore, no direct or indirect impacts would occur on known cultural resources. The potential for the discovery or disturbance of an unknown cultural resource exists, particularly in areas where there has been no prior land disturbance. Although consultation with Native American tribes has not revealed the presence of TCPs in areas where disturbance could take place, this consultation is ongoing (see Appendix A) and the presence of these resources remains somewhat uncertain. However, before construction, previously unsurveyed areas with a potential for the cultural resources would be surveyed. Potential impacts to cultural resources discovered during construction would be mitigated through avoidance or through other measures, including those identified through consultation with the IHPA or the respective Native American tribes.

Power Plant Site

There are no known cultural resources in areas that would be disturbed by construction at the proposed power plant site. Therefore, no direct or indirect impacts would occur on known cultural resources. On January 30, 2007, IHPA concurrence was received stating that no significant historic, architectural, and archaeological resources are located in the proposed project area (see Appendix A).

Sequestration Site

Because the proposed sequestration site is co-located on the proposed power plant site, potential impacts would be the same as described for the power plant site.

Utility Corridors

There are no known cultural resources within the electrical transmission line corridor south from the proposed power plant site to Highway 16 and the process water corridor along the north and east sides of Mattoon. Therefore, no direct or indirect impacts would occur on known cultural resources. Corridor construction in new or previously undisturbed ROW would have a higher potential for impacting undocumented cultural resources. IHPA concurrence stated no further investigations are needed (see Appendix A).

Transportation Corridors

Because improvements to CH 13 have not yet been designed, potential impacts to cultural resources are unknown. However, if improvements take place within previously disturbed ROW, there would be no anticipated direct or indirect impacts to cultural resources. There would be a potential for affecting cultural resources if construction takes place outside of previously disturbed ROW. The IHPA would need to be consulted regarding the need for cultural resource investigations before improvements construction.

Because the rail spur is co-located on the proposed power plant site, potential impacts would be the same as described for the power plant site.

4.10.3.2 Operational Impacts

The potential for impacts to cultural resources related to the proposed FutureGen Project operations would be limited to indirect impacts that could alter the historic character of a resource or its setting. There is minimal potential for direct impacts (e.g., a historic façade becoming coated with dust or ash) as a result of operations. Because there are no known cultural resources in areas where the proposed FutureGen Project operations would take place, no direct or indirect impacts are anticipated. The U.S. Post Office and Brick Street in Mattoon, as well as the Briggs and Alexander House in Charleston, are outside of the ROI for the power plant and no indirect impacts would be expected to those historic resources.

4.11 LAND USE

4.11.1 INTRODUCTION

This section identifies land uses that may be affected by the construction and operation of the proposed FutureGen Project at the Mattoon Power Plant and Sequestration Site, and related corridors. It addresses the existing land use environment as well as potential effects on land uses and land ownership, relevant local and regional land use plans and zoning, airspace, public access and recreation sites, identified contaminated sites, and prime farmland. It also addresses potential effects related to subsurface rights for the land area above the proposed Mattoon Sequestration Reservoir.

4.11.1.1 Region of Influence

The ROI for land use includes the area within 1 mile (1.6 kilometers) of the boundary of the proposed Mattoon Power Plant and Sequestration Site and of all related areas of new construction (i.e., utility and transportation corridors). The CO_2 injection wells would be located within the power plant site boundary, although the plume footprint would extend beyond the site boundary.

4.11.1.2 Method of Analysis

DOE reviewed information provided in the Mattoon EIV (FG Alliance, 2006a) and relevant land use data, including the Coles County Comprehensive Plan (Coles County, 2006), City of Mattoon Zoning Ordinance (Ordinance No. 96-4835), Federal Aviation Administration (FAA) regulations, and various databases related to contaminated sites. DOE also reviewed aerial photographs and made site visits to note site-specific land use characteristics.

DOE assessed the potential impacts based on whether the proposed FutureGen Project would:

- Introduce structures and uses that are incompatible with land uses on adjacent and nearby properties;
- Introduce structures or operations that require restrictions on current land uses on or adjacent to a proposed site;
- Conflict with a jurisdictional zoning ordinance; and
- Conflict with a local or regional land use plan or policy.

4.11.2 AFFECTED ENVIRONMENT

The proposed Mattoon Power Plant and Sequestration Site consists of a 444-acre (180-hectare) parcel of land located in Mattoon Township, Coles County, Illinois. It is situated 1 mile (1.6 kilometers) west and outside of the Mattoon city limits. It is located 180 miles (290 kilometers) south of Chicago; 115 miles (185 kilometers) west of Indianapolis, Indiana; and 130 miles (209 kilometers) northwest of St. Louis, Missouri. The proposed plant site and area within 1 mile (1.6 kilometers) are relatively flat and consist of primarily farm crops and a small percentage of public rights-of-way (ROWs), rural residential development, and woodlands. The proposed plant site and lands within 1 mile (1.6 kilometers) are privately owned, excluding areas of public ROWs. The entire site is currently used for agricultural row crops.

According to the 2000 U.S. Census, Coles County had a population of 53,196 in 2000, and the City of Mattoon had a population of 18,291 (Coles County, 2006). Coles County includes 325,760 acres (131,830.4 hectares) of land, of which 93 percent is designated as farm land (Coles County, 2006).

4.11.2.1 Local and Regional Land Use Plans

The City of Mattoon does not have a current comprehensive plan, but does have current land use mapping available with its City of Mattoon Zoning Ordinance (see Section 4.11.2.2).

The Coles County Regional Planning and Development Commission has an approved Comprehensive Plan and land use map dated November 14, 2006. This plan includes County development recommendations with respect to issues such as farmland preservation, transportation, and utilities. The proposed Mattoon Power Plant Site falls within the Coles County Enterprise Zone, which was established to identify and prepare suitable sites for potential economic development (Coles County, 2006). Figure 4.11-1 depicts the Coles County Future Land Use Map (Coles County, 2006).

The City of Charleston, located approximately 5 miles (8 kilometers) east of Mattoon, has a Comprehensive Plan that was adopted December 7, 1999. This plan was developed to serve as a decision-making tool for long-range planning, setting recommended guidelines, and improving communications. This plan enables the city to explore and provide guidance for issues currently facing Charleston, such as economic development, planning/land use issues, housing, historic preservation issues, transportation (circulation and access), infrastructure and facilities, parks and recreation, and aesthetics and beautification (City of Charleston, 1999).

Part of the proposed process water pipeline would originate at the Charleston WWTP, which is located just within the city limits in a designated industrial district. However, once the process water pipeline corridor leaves the City of Charleston property at the Charleston WWTP, it crosses out of the Charleston city limits.

The southern 6.5 miles (10.5 kilometers) of one of the electrical transmission line options extends into Cumberland and Shelby counties. Those counties do not have comprehensive plans.

4.11.2.2 Zoning

The City of Mattoon Zoning Ordinance is intended to ensure orderly growth in the developed and underdeveloped areas of Mattoon, including residential, business, commercial, industrial, agricultural, and complementary developments. The City of Mattoon's zoning jurisdiction includes a 1.5-mile (2.4-kilometer) "extra-territorial" area past the city limits (Ordinance No. 96-4835). The city has the discretion to enforce its zoning ordinances within the extra-territorial area (see Figure 4.11-1). Because the proposed Mattoon Power Plant Site lies 1 mile (1.6 kilometers) west of the Mattoon city limits, it lies within the extra-territorial area where the City of Mattoon Zoning Ordinance may be applied, but the area is currently not zoned.

Most of the proposed utility corridors are located within Coles County and the City of Mattoon. A portion of the proposed process water supply would come from the Charleston WWTP, and a pipeline would be located on City of Charleston property from the Charleston WWTP to the ROW of the Lincoln Prairie Grass Bike Trail (see Section 4.11.2.4). The City of Charleston has a Unified Development Code that contains its zoning ordinance. As mentioned above, the area around the Charleston WWTP is zoned as an industrial district and once the process water pipeline corridor leaves the City of Charleston property at the Charleston WWTP, it continues beyond the Charleston city limits.

4.11.2.3 Airspace

The Coles County Memorial Airport is approximately 8 miles (13 kilometers) east of the proposed plant site and approximately 0.3 mile (1.1 kilometers) south of the process water pipeline corridor, the closest proposed project feature. Because the proposed project would include a 250-foot (76-meter) heat recovery steam generator stack and 250-foot (76-meter) flare stack, DOE reviewed FAA regulations to determine their applicability to the project. In administering 14 CFR Part 77—Objects Affecting Navigable Airspace—the prime objectives of FAA are to promote air safety and the efficient use of the navigable airspace. Pursuant to 14 CFR Part 77, the FAA must be notified if any of the following construction or alteration is being examined:

(1) Any construction or alteration of more than 200 feet (61 meters) in height above the ground level at its site.
(2) Any construction or alteration of greater height than an imaginary surface extending outward and upward at one of the following slopes:
    (i) 100 to 1 for a horizontal distance of 20,000 feet (6,096 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with at least one runway more than 3,200 feet (975 meters) in actual length, excluding heliports.
    (ii) 50 to 1 for a horizontal distance of 10,000 feet (3,048 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with its longest runway no more than 3,200 feet (975 meters) in actual length, excluding heliports (14 CFR 77).

4.11.2.4 Public Access Areas and Recreation

Wolf Creek State Park is the closest public access area to the proposed Mattoon Power Plant Site, at a distance of approximately 11.7 miles (18.8 kilometers). Lake Shelbyville, operated by the USACE as a flood control project on the Kaskaskia River, is located approximately 8 miles (12.9 kilometers) west of the proposed site. The lake provides camping, hiking trails, boating access, and picnicking facilities.

Lake Mattoon is located approximately 6 miles (10 kilometers) south of the City of Mattoon and approximately 7 miles (11 kilometers) south of the proposed Mattoon Power Plant Site. Owned by the City of Mattoon, Lake Mattoon is located in Coles, Shelby, and Cumberland counties. Its primary use is supplying water to the City of Mattoon. The lake has a maximum depth of 35 feet (11 meters), an average depth of 10.5 feet (3.2 meters), and a surface area of 1,050 acres (425 hectares). The City of Mattoon owns approximately 53 percent of the 55.5-mile (89.3-kilometer) shoreline, along with 348.5 acres (141.0 hectares) of surrounding property. Lake Mattoon is fed by the Little Wabash River and is a popular recreation spot for boating, fishing, and camping. Approximately 1,042 boat permits are issued every year (City of Mattoon, 2006).

Lake Paradise is located approximately 3 miles (5 kilometers) south of the City of Mattoon and approximately 4 miles (6 kilometers) south of the proposed Mattoon Power Plant Site. Owned by the City of Mattoon, Lake Paradise is the City of Mattoon's primary source of drinking water, and in an average year the City pumps 800 million gallons (3,028 million liters) of water out of Lake Paradise into the water system. Lake Paradise is zoned as a no wake and no swimming area. There is no limit on motor size, and the lake has been known for its bass and crappie fishing (City of Mattoon, 2006).

The Charleston WWTP portion of the proposed process water line for the project would parallel a ROW for the Lincoln Prairie Grass Bike Trail, which is located on a former railway ROW. The paved bike trail, owned by the cities of Charleston and Mattoon, is 12.6 miles (20.3 kilometers) long. The ROW is 100 feet (30 meters) wide, and the bike trail surface is 10 feet (3 meters) wide (FG Alliance, 2006a).

4.11.2.5 Contaminated Sites

DOE's review of the IEPA databases (IEPA, 2006) for the proposed Mattoon Power Plant Site indicates that it is not associated with cleanup under regulations related to voluntary site remediation program units, leaking underground storage tanks, the Resource Conservation and Recovery Act, permitted activities, or solid waste landfills.

DOE's review of the CERCLIS Database for Coles County, Illinois, revealed one site, The Young Radiator Company (U.S. Environmental Protection Agency (EPA) ID ILD005078571) located in the City of Mattoon approximately 3.5 miles (5.6 kilometers) east of the proposed site. The site is not on the National Priorities List (EPA, 2006).

> The Comprehensive Environmental Response, Compensation and Liability Information System (**CERCLIS**) Database contains general information on sites across the nation and U.S. territories, including location, contaminants, and cleanup actions taken (CERCLIS, 2006).

4.11.2.6 Land Ownership and Uses

Power Plant and Sequestration Site

The proposed Mattoon Power Plant Site includes several parcels of land that are currently under purchase options (FG Alliance, 2006a). The site is predominantly in agricultural use. The land uses surrounding the proposed Mattoon Power Plant Site within 1 mile (1.6 kilometers) include primarily agricultural use, two residences adjacent to the site on the north and east sides, two additional residences within 0.25-mile (0.4-kilometer), about 20 additional residences between 0.25-mile (0.4-kilometer) and 1 mile (1.6 kilometers) from the site, and one small commercial entity (antiques dealer) (see Figure 4.11-2).

The City of Mattoon and Coles County have both agreed to provide access to all municipally and county-owned property and ROWs needed for the proposed plant. Mineral rights for the site are intact and would be conveyed with the property (see Section 4.4 for more discussion concerning mineral rights). The proposed Mattoon Power Plant Site is adjacent to the Mattoon city limits, which allows for annexation and timely extension of municipal utilities under municipal authority included in the Illinois Compiled Statutes. Police and fire protection, as well as a full range of other emergency services, also would be provided upon annexation by the City of Mattoon (FG Alliance, 2006a).

Agriculture is the predominant use of land within 1 mile (1.6 kilometers) of the proposed Mattoon Power Plant Site. Approximately 3,735 acres (1,512 hectares) (in excess of 93 percent of the land) are used for farming or farm-related activities (farm outbuildings or pastures). As noted above, there are approximately 24 single-family residences in the 1-mile (1.6-kilometer) radius. The closest residential development to the proposed Mattoon Power Plant Site is located off Western Avenue approximately 1 mile (1.6 kilometers) southeast of the site. There are no hospitals, schools, or nursing residences within 1 mile (1.6 kilometers) of the proposed Mattoon Power Plant and Sequestration Site, although Riddle Elementary School is just beyond the 1-mile (1.6-kilometer) radius.

Mineral rights of the 444-acre (180 hectares) Mattoon Site are intact and would be conveyed if chosen as the host site (FG Site Proposal [Mattoon, Illinois, 2006]).

Utility Corridors

Potable water from the City of Mattoon public potable water system would serve the proposed Mattoon Power Plant Site. The proposed 1-mile (1.6-kilometer) pipeline would be placed on the public ROW of CR 800N.

The City of Mattoon proposes to supply sanitary sewer service through an extension of the City's existing public wastewater system. A 1.25-mile (2.0-kilometer) wastewater force main would be constructed in the ROW of SR 121 from the proposed Mattoon Power Plant Site to an existing sanitary lift station in the northeast quadrant of SR 121 and 43rd Street (County Road 300E). SR 121 has an existing ROW width of 100 feet (30 meters). IDOT has control of the ROW and has committed to allowing the wastewater force main to be placed on the ROW (FG Alliance, 2006a). The Riddle Elementary School on Western Avenue is just over 1 mile (1.6 kilometers) southeast of the proposed power plant site and about 0.5 mile (0.8 kilometer) from the point where proposed potable water and sanitary sewer lines would tie into existing corridors.

The proposed corridors for the process water supply lines would run from the Charleston and Mattoon WWTPs to the proposed Mattoon Power Plant Site and the corridors would total 14.3 miles (23.0 kilometers). The proposed 8.1-mile (13.0-kilometer) line from Charleston to Mattoon would parallel the ROW for the Lincoln Prairie Grass Bike Trail, which follows a former railway ROW. The process water line would continue on the bike trail ROW into Mattoon. The bike trail ROW is 100 feet (30 meters) wide, while the bike trail surface is 10 feet (3 meters) wide. The bike trail ROW has existing 138-kV overhead electric lines running its entire length. Buried fiber optic cable is also in the ROW. On the east side of I-57, the proposed Charleston corridor is within 1 mile (1.6 kilometers) of the Charleston Country Club, and Sarah Bush Health Center. West of I-57, the corridor is within 1 mile (1.6 kilometers) of Peterson Park (FG Alliance, 2006a).

The 6.2-mile-long (10-kilometer-long) process water pipeline from the Mattoon WWTP would be on existing public ROW for all but 2 miles (3.2 kilometers). The existing public ROW varies in width. As the line heads north out of the Mattoon WWTP, the corridor is an existing utility easement that is at least 30 feet (9 meters) wide. The corridor then follows the Mattoon Street ROW through the town to the northern edge of Mattoon. The street ROW is a minimum of 70 feet (20 meters) wide. North of the Mattoon city limits, the corridor lies on private property for 2 miles (3.2 kilometers). Three property owners own the 2 miles (3.2 kilometers) of ROW, which would require new easements in an area that appears to be primarily farm land. Option contracts have been secured to purchase the three necessary easements. For the last 3.5 miles (5.6 kilometers) of the corridor, the pipeline would be placed on the public ROW of CR 900N. The road ROW is 60 feet (18 meters) wide, with the roadway surface averaging 20 feet (6 meters) wide. The proposed Mattoon process water corridor is within 1 mile (1.6 kilometers) of two nursing residences and three schools near the Mattoon WWTP (FG Alliance, 2006a).

There is access to a natural gas pipeline owned by Trunkline Gas Company less than 0.25 mile (0.4 kilometer) from the proposed Mattoon Power Plant Site. The Trunkline Gas mainline is located approximately 1,325 feet (403 meters) east of the site, between the site and the City of Mattoon. An option has been secured for additional land adjacent to the proposed pipeline ROW, which is currently primarily farmland (FG Alliance, 2006a). Construction of the proposed natural gas pipeline would include horizontal directional drilling to run the natural gas pipeline under CR 13.

An existing 138-kV transmission line lies 0.5 mile (0.8 kilometer) east of the proposed site. If this existing line is used, the corridor would run from the proposed Mattoon Power Plant Site over the additional optioned farmland to the existing 138-kV line corridor.

The optional corridor for a 345-kV transmission line, if required, runs 16 miles (26 kilometers) south from the proposed Mattoon Power Plant Site to the Neoga substation. The corridor is parallel to an existing 138-kV transmission line through a primarily agricultural area. The proposed transmission line would cross Lake Mattoon and the Little Wabash River. The southern 6.5 miles (10.5 kilometers) of the proposed electric utility corridor's ROI is in Cumberland and Shelby counties. Those counties do not have current land use mapping available, although the land use characteristics are substantially similar to Coles County land uses.

4.11.2.7 Prime Farmland

> The U.S. Department of Agriculture (**USDA**) Natural Resource Conservation Service's (**NRCS**) website defines prime farmland as land that has the best combination of physical characteristics for producing food, feed, forage, and oilseed crops and is available for these uses (NRCS, 2000).

Illinois had 20,894,000 acres (8,455,502 hectares) of soils classified as prime farmland in 1997. About 18,679,800 (7,559,447 hectares) (89.4 percent) of this land area was used as cropland. The remaining amount was used for pastureland, forestland, Conservation Reserve Program (CRP) land, and other rural land. Between 1982 and 1997, 409,500 acres (165,719 hectares) of prime farmland were lost (approximately 27,060 acres [10,951 hectares] per year) (NRCS, 2000).

The Farmland Protection Policy Act (FPPA) of 1981 directs all federal agencies to evaluate their programs and projects, and to modify their actions so as to produce the least impact on farmland. The FPPA also seeks to ensure that federal programs are administered in a manner that, to the extent practicable, will be compatible with state and local government goals, as well as private programs and policies, to protect farmland. The Illinois Department of Agriculture (ILDOA) reviews programs, projects, and activities of federal agencies for compliance with the Farmland Preservation Act (state law) and the FPPA. The review is a systematic procedure to assist in determining which proposed governmental action would incur the least harm to the agricultural environment. ILDOA established the Land Evaluation and Site Assessment (LESA) system as a tool to use in making such evaluations. The NRCS also uses the LESA system to evaluate the viability of farmland proposed for non-agricultural use by a federally-sponsored project (ILDOA, 2001).

On the 444-acre (180-hectare) proposed Mattoon Power Plant and Sequestration Site, 427 acres (172 hectares) have been identified as prime farmland and unique farmland that is currently producing major crops of corn, soybean, wheat, and hay. According to the LESA scale, the total relative value of the site's farmland was assigned 98 points out of 100 possible points. The total site assessment was assigned 157 points out of a possible 200 points, totaling 255 LESA points out of a possible 300 (FG Alliance, 2006a). Within the proposed utility corridors, several of the soil types have been identified as prime farmland or would be prime farmland if drained. DOE did not conduct a formal farmland conversion impact rating for utility corridors because they are on existing utility ROWs or because they would not result in conversion of significant areas of soil to non-agricultural uses. Since the pipelines would be buried and the electrical transmission lines would be elevated, agricultural use of the land could continue following construction on any new ROWs.

4.11.3 IMPACTS

4.11.3.1 Construction Impacts

Power Plant Site

The 444-acre (180-hectare) proposed Mattoon Power Plant Site and area within 1 mile (1.6 kilometers) consists of 93 percent farm crops and 3 percent public ROW, with the remaining percentage being rural residential. The proposed project would require a laydown area for construction equipment and materials and would require construction of a power plant, rail loop, parking area, coal storage site, visitor center, process pond, research and development center, and injection well for carbon sequestration. Project construction would have a major, long-term impact on the current mainly agricultural land use of the 444-acre (180-hectare) parcel. Up to 200 acres (81 hectares) would be disturbed during construction. More than half of the parcel (that is, the remaining 244 acres [99 hectares] could be available for continued farming under a lease agreement. Project construction would have a direct impact to two small residential properties located adjacent to the north and east borders of the proposed power plant site on CR 900N and CR 200E, because of the proximity of the residential property to an industrial construction site.

The Coles County Illinois Comprehensive Plan and future land use map designates the area of the proposed Mattoon Power Plant Site as an Enterprise Zone best suited for industrial development. Therefore, construction of the proposed Mattoon Power Plant would fall within the parameters drafted by Coles County for land use and would be compatible with the land use plan.

The proposed Mattoon Power Plant Site lies at the edge of the City of Mattoon's 1.5-mile (2.4-kilometer) extra-territorial area where the City of Mattoon has the discretion of enforcing the City's zoning ordinance. However, the proposed Mattoon Power Plant Site is adjacent to the Mattoon city limits, which allows for annexation. Annexation of the proposed site into the Mattoon city limits would place the land within the area in which City of Mattoon Zoning Ordinance would apply. If the land is annexed, the land would be zoned and shown in the Zone Map for the City of Mattoon. Once land is zoned, the uses would need to be appropriate. For this proposed project to be compatible with the zoning ordinance, the land would need to be zoned as an Industrial District.

The proposed Mattoon Power Plant Site is well outside the 20,000-foot (6,096-meter) radius within which FAA Part 77 Airspace Obstruction Analysis would be required, and there is no military restricted use airspace in the vicinity of the proposed site (FG Alliance, 2006a). Project construction would therefore have no notable effect on the use of airspace, although signal lights would be required atop the heat recovery steam generator and flare stacks. FAA regulations (14 CFR 77) require such lighting for any structure more than 200 feet (61 meters) high.

As noted above, construction of the proposed facilities would convert up to 200 acres (81 hectares) of prime farmland to industrial use. This would represent 0.7 percent of the approximate 27,060 acres (10,951 hectares) of prime farmland the NRCS reports as lost annually in the State of Illinois. The proposed Mattoon Power Plant Site's LESA score of 255 points exceeds the 225-point threshold for lands that, under the Illinois LESA System, should be reevaluated so that the site could be retained for agricultural use. However, such conversions are not prohibited, and as noted in Section 4.11.2.1, the Coles County Comprehensive Plan identifies the site as suitable for potential economic (that is, non-agricultural) development.

Sequestration Site

The injection wells would be placed within the Mattoon Power Plant. The impacts on land use are included in the above discussion of impacts at the power plant site.

Utility Corridors

Construction in the proposed pipeline corridors would have temporary, minor effects on land use (bike path, agriculture, roads, etc.) during the actual construction period due to trenching, equipment movement, and material laydown. After construction is complete, the areas would be regraded, revegetated, or otherwise treated in accordance with conditions of applicable permits, and all original land uses such as farming, road and utility ROWs, and bike paths would continue.

Construction of the proposed new 0.5-mile (0.8-kilometer) long transmission line between the proposed Mattoon Power Plant Site and the existing 138-kV transmission line corridor would have temporary, minor effects on the primarily agricultural land use during the actual construction period due to the installation of new poles, equipment movement, and material laydown. If a 345-kV transmission line is required, construction along the proposed 16-mile (25.7-kilometer) corridor would temporarily interrupt the existing land uses along the corridor, including agricultural use. Once the construction is completed, all of the disturbed areas would be regraded and vegetated in accordance with conditions of the applicable permits, and a majority of the original land uses would continue. There would be some long-term minor impacts on land use within the transmission line corridor due to routine vegetative maintenance.

Transportation Corridors

IDOT has committed to improve CH 13 to a Class II truck route from CH 18 to the entrance of the proposed Mattoon Power Plant Site, including the intersection with SR 121, if the site is selected for the FutureGen Project. This new construction would consist of 1.25 miles (2.0 kilometers) of roadway widening and resurfacing with new shoulders and ditches. The intersection of SR 121 and CH 13 would be rebuilt so that CH 13 approaches SR 121 at right angles. In addition, a turn lane would be built on SR 121 (FG Alliance, 2006a). The upgrading of CH 13 and the intersection of SR 121 and CH 13 near the proposed Mattoon Power Plant Site is a direct project effect for this proposal. This construction, if confined to the existing ROW, would have very little effect on nearby land uses, simply expanding the footprint of the existing transportation infrastructure.

The existing Canadian National – Peoria Subdivision rail line immediately adjacent to the northeast boundary of the proposed Mattoon Power Plant Site connects with the Canadian National/Illinois Central mainline 3.5 miles (5.6 kilometers) from the site. The proposed rail for the site would not require any additional ROW other than the proposed site itself, and therefore would have no effect on surrounding land uses.

4.11.3.2 Operational Impacts

Power Plant Site

As noted in Section 4.11.3.1, construction of the proposed Mattoon Power Plant would permanently remove at least 200 acres (81 hectares) of the site from its current agricultural use. The remainder of the site (244 acres [99 hectares]) could be leased for continued crop production, although it could also be developed at some future date. Such development is a reasonably foreseeable event in terms of defining potential cumulative impacts, but is not proposed as part of the FutureGen Project. The introduction of industrial operations adjacent to residential property would permanently alter the land use mix of the area, particularly with respect to the two residences adjacent to the site (one across CR 900N and one across CR 200E), two additional residences within 0.25 mile (0.4 kilometer) of the site, and 20 additional residences located within 1 mile (1.6 kilometers) of the site.

The option contracts include all mineral rights for approximately 444 acres (180 hectares). Obtaining mineral rights from any additional landowners over the expected 30-year sequestration time frame (there may be additional landowners if subsurface rights are needed to the 0.25-mile [0.4-kilometer] buffer) may be required, and in Coles County this historically has not been difficult or uncommon. In addition, there are no economic mineral deposits known to exist in the Mt. Simon sandstone and surrounding formations; therefore, mining would most likely not occur over this formation (FG Site Proposal [Mattoon, Illinois], 2006).

Sequestration Site

The operational impacts of the sequestration site would occur within the Mattoon Power Plant Site. The impacts on land use are included in those described above for the power plant site. Mineral rights would need to be obtained from landowners over the expected 30-year sequestration plume. There are no economic mineral deposits known to exist in the Mt. Simon sandstone and surrounding formations; therefore, mining would most likely not occur over this formation.

Utility Corridors

Once the utility pipelines were in place, the lands would be returned to their pre-existing land use, such as roadways, cropland, or utility corridor. There would be no permanent change in the existing land use, although the presence of underground utilities would preclude future development of the ROWs for incompatible uses.

Over the long term, the presence of the electrical transmission line would permanently eliminate the locations of towers as land for agricultural production or other uses, but the remainder of the ROW could continue in its current, primarily agricultural, use. There could be some long-term minor impacts on land use within the transmission line corridor due to routine vegetative maintenance in areas where crops are not grown. The transmission line ROW would permanently preclude future development of incompatible uses, such as residential construction, within the ROW.

Transportation Corridors

Assuming the existing road ROWs are of sufficient size to accommodate any new construction, there would be no change to the land use of the transportation corridors.

4.12 AESTHETICS

4.12.1 INTRODUCTION

This section identifies viewsheds and scenic resources that may be affected by the construction and operation of the proposed FutureGen Project at the Mattoon Power Plant and Sequestration Site and related corridors. It addresses the appearance of project features from points where those features would be visible to the general public, and takes into account project characteristics such as light and glare. The distance from which the proposed power plant and associated facilities would be visible depends upon the height of the structures associated with the facilities, including buildings, towers, and electrical transmission lines, as well as upon the presence of existing intervening structures and local topography. Effects on visual resources can result from alterations to the landscape, especially near sensitive viewpoints, or an increase in light pollution.

4.12.1.1 Region of Influence

The ROIs for aesthetic resources include areas from which the proposed Mattoon Power Plant and Sequestration Site and all related areas of new construction would be visible. The ROIs are defined as 10 miles (16.1 kilometers) surrounding the proposed power plant and sequestration site, 1 mile (1.6 kilometers) on either side of the proposed electrical transmission line corridor, and immediately adjacent to the proposed underground utility corridors.

4.12.1.2 Method of Analysis

DOE identified land uses and potential sensitive receptors in the ROIs of the proposed power plant and sequestration site and utility corridors based on site visits, information in the Mattoon EIV (FG Alliance, 2006a), and a review of aerial photography. DOE used two approaches to assess the potential impacts of the proposed FutureGen Project on aesthetic resources. First, DOE applied Geographic Information Systems (GIS)-based terrain modeling, combined with height information associated with the proposed project facilities (i.e., the 250-foot [76-meter] HRSG stack and 250-foot [76-meter] flare stack), to determine the distance from which the facilities could be seen if there were no intervening structures or vegetation to screen the view. Secondly, DOE considered two artistic concepts of the proposed FutureGen Power Plant to depict a range of aesthetic approaches to the project. One concept is of a typical power plant with minimal screening and architectural design, while the second concept includes extensive screening and architectural design. DOE compared and contrasted the two concepts to assess the relative level of visual intrusiveness for each concept.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect a national, state, or local park or recreation area;
- Degrade or diminish a federal, state, or local scenic resource;
- Create visual intrusions or visual contrasts affecting the quality of a landscape; and
- Cause a change in a BLM Visual Resource Management classification.

4.12.2 AFFECTED ENVIRONMENT

4.12.2.1 Landscape Character

Natural and human-created features that give the landscape its character include topographic features, vegetation, and existing structures. The landscape of the proposed Mattoon Power Plant and

Sequestration Site, shown in Figure 4.12-1, is typical of farmland throughout the area, which is primarily used for row crop production of corn and soybeans. The topography of the site is relatively flat; however, slight natural and human-made drainages exist along the western and northern sections of the site. The drainages on the site collect at a drainage structure located approximately 0.25 mile (0.4 kilometer) south of the intersection of CRs 900N and 130E. There is a gradual elevation change of approximately 30 feet (9.1 meters) from the highest point of the site to the lowest point, located at the drainage structure. This change in elevation occurs over a distance of approximately 0.25 mile (0.4 kilometer; average approximated slope of 0.02 percent) (FG Alliance, 2006a).

The areas surrounding the proposed Mattoon Power Plant and Sequestration Site consist of CR 900N, a railroad, SR 121, and farmland to the north beyond SR 121; CR 130E, farmland, and a wooded fencerow to the west; farmland and CR 800N to the south; and CR 200E and farmland to the east. There are two residences across the street from the site on the north and east sides, two additional residences within 0.25 mile (0.4 kilometer), and about 20 additional residences within 1 mile (1.6 kilometers) of the site, for a total of about 24 residences in the ROI, including a group of residences on Western Avenue near the perimeter of the 1-mile (1.6-kilometer) ROI.

There are no known archaeological or historic resources within 1 mile (1.6 kilometers) of the proposed Mattoon Power Plant and Sequestration Site, although two historic properties, the U.S. Post Office in Mattoon and a nine-block section of brick street in Mattoon, are within approximately 3 miles (4.8 kilometers) of the site (see Section 4.10).

Source: FG Alliance, 2006a

Figure 4.12-1. Proposed Mattoon Power Plant and Sequestration Site

The landscape of the proposed underground utility corridors includes industrial lands, typical farmland used for row crop production, a bike path, city streets, and some adjacent residences. Figures 4.12-2 and 4.12-3 show two examples of the proposed process water pipeline corridor. Figure 4.12-2 is along the Prairie Grass Bike Trail, and Figure 4.12-3 is along 1st Street. The majority of the proposed process water pipeline corridor would run through flat terrain except near the Charleston WWTP, where the terrain changes to rolling woodlands. An unknown number of residences are adjacent to the proposed process water pipeline corridor, most in the vicinity of 1st and 2nd Streets and Lafayette Avenue, where the line would follow the city streets.

One option for the proposed electrical transmission line corridor follows an existing 138-kV transmission line that crosses farmland areas and periodically runs through slightly rolling small woodlots. Another option would require a new 16-mile (25.7-kilometer) ROW that crosses primarily farmland areas, as shown in Figure 4.12-4. Both options would be within 0.25 mile (0.4 kilometer) of just a few residences because most of the area is farmland.

As noted in Section 4.10, there are six archaeological sites within the ROIs of the utility corridors (one near the transmission line corridor and five near the process water pipeline corridor), and one historic site, the Briggs and Alexander House, near the process water pipeline corridor.

There are no BLM visual resource management classifications or designated scenic vistas within the ROIs of the proposed power plant and sequestration site or corridors (BLM, 2004).

4.12.2.2 Light Pollution Regulations

The ROIs for the proposed power plant and sequestration site and utility corridor are not regulated by any state or local light pollution abatement plans or goals (FG Alliance, 2006a).

Source: FG Alliance, 2006a

Figure 4.12-2. Proposed Mattoon Process Water Pipeline Corridor Along Prairie Grass Bike Trail

Source: FG Alliance, 2006a

Figure 4.12-3. Proposed Mattoon Process Water Pipeline Corridor Along 1st Street

Figure 4.12-4. Proposed Mattoon Electrical Transmission Line Corridor

4.12.3 IMPACTS

4.12.3.1 Construction Impacts

Power Plant Site

During construction at the proposed Mattoon Power Plant and Sequestration Site, the nearest neighbors, especially the two residences across the road from the site and the other (about 22) residences within a 1-mile (1.6-kilometer) radius, would have a nearly unobstructed view of the construction site and equipment moving on and off the site during the 44-month construction period, which would be a direct short-term impact.

As noted in Section 4.10, construction at the power plant site is not anticipated to have any direct or indirect effect on cultural resources in the ROI (see IHPA concurrence letter in Appendix A).

Sequestration Site

Because the proposed Mattoon Sequestration Site is on the proposed power plant site, there would be no additional impacts associated with construction at the sequestration site.

Utility Corridors

During construction along the proposed pipeline corridors, equipment used for trenching, pipe laying, and other construction activities would be visible only to viewers immediately adjacent to the pipeline corridors and construction laydown areas. This would constitute a direct short-term adverse impact on those nearest the corridors during the construction period, which is estimated at 4 to 6 months for the process water pipeline and 1 month each for the natural gas, potable water, and wastewater pipelines (FG Alliance, 2006a). Affected persons would include those using the Prairie Grass Bike Trail, which would share ROW with the proposed process water pipeline, and those in the vicinity of 1st and 2nd Streets and Lafayette Avenue, where the line would briefly follow the city streets.

Potential effects on cultural resources within the ROI are discussed in Section 4.10.

Construction along the electrical transmission line corridor would be visible within the 1-mile (1.6-kilometer) ROI. The length of the construction period would depend upon the results of transmission studies that would determine the transmission line option that should be pursued. Visual impacts would be greater if the optional 17-mile (27-kilometer) long new ROW were selected, although there are very few residences within the ROI in this rural area.

Transportation Corridors

If the Mattoon Power Plant and Sequestration Site is selected for the FutureGen Project, IDOT has committed to upgrading CH 13 to a Class II truck route from CH 18 to the entrance of the plant, including the intersection with IL 121. Construction along this route would be visible only to those immediately adjacent to the construction sites (e.g., motorists along the roadways) (FG Alliance, 2006a).

4.12.3.2 Operational Impacts

Power Plant Site

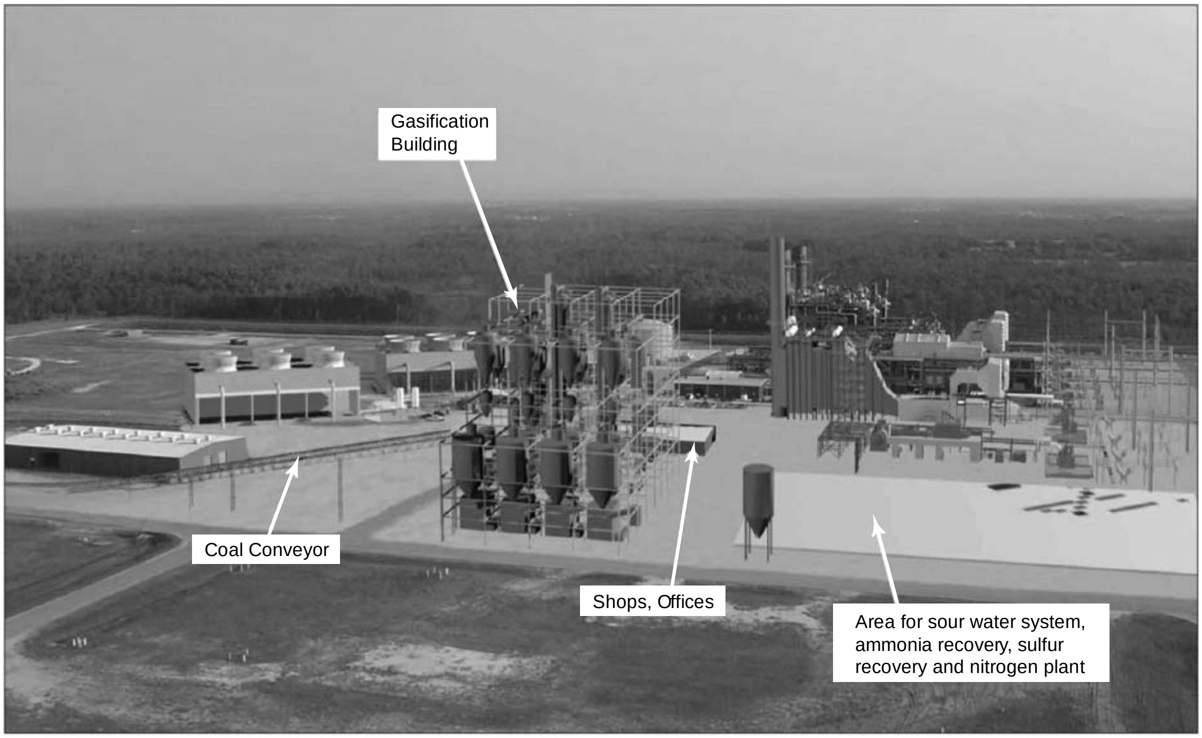
Major equipment for the power plant would include the gasifier and turbines, a 250-foot (76-meter) tall HRSG stack, a 250-foot (76-meter) tall flare stack, synthesis gas cleanup facilities, coal conveyance and storage systems, and particulate filtration systems. Additionally, the project would include on-site infrastructure, such as a rail loop for coal delivery, plant roads and parking areas, administration buildings, ash handling and storage facilities, water and wastewater treatment systems, and electrical transmission lines, towers, and a substation.

Once construction is complete, the tallest structures associated with the proposed Mattoon Power Plant Site would include the main building, stacks, and communication towers. The maximum proposed height of the facility is 250 feet (76 meters). The nearby residences noted in Section 4.12.2 (two adjacent to the site and fewer than 24 total residences within a 1-mile [1.6-kilometer] radius) would have a nearly unobstructed view of the Mattoon Power Plant. People at additional scattered residences located farther from the site, as well as people at public recreational sites such as Lake Mattoon and Lake Paradise, would also be able to see the plant because of the relatively flat topography and lack of structures, woodlands, or tree lines in the area. DOE's terrain analysis indicates that the facility would be visible for a distance of 7 to 8 miles (11.3 to 12.9 kilometers).

With respect to the site layout, the visual impact at nearby residences would be reduced if the facility were laid out so that the less intrusive features, such as administrative offices and similar buildings and parking areas, were located nearest the residences and the more industrial features and coal storage piles were located farthest from the residences.

For those viewing the proposed power plant from the adjacent roads or nearby residences or from a greater distance, the appearance of the facilities would depend upon the degree of architectural development and visual mitigation included in the design. Figures 4.12-5 and 4.12-6 show two points on a range of conceptual IGCC plant designs. Figure 4.12-5 is an artist's rendering of an IGCC facility proposed for Orlando, Florida (DOE, 2006a). This rendering shows a plant with minimal screening or enclosure of the facility components. Figure 4.12-6 is the artist's conceptual design of the proposed FutureGen Power Plant that was used during the scoping process for this EIS (DOE, 2006b). This rendering shows a plant with a high degree of architectural design, including enclosure of most of the plant features.

The proposed facility is still in the design stage, and decisions have not yet been made about the final configuration or appearance of the power plant. A plant design similar to Figure 4.12-5 would create a more industrial appearance. Although still very large in scale, a plant design similar to Figure 4.12-6 would have less of an industrial appearance, and would be visually less intrusive than the plant design shown in Figure 4.12-5. As noted above, the visual impact at nearby residences would be reduced if the facility were laid out so that the less intrusive features, such as administrative offices and similar buildings and parking areas, were located nearest the residences and the more industrial features and coal storage piles were located farthest from the residences.



Source: DOE, 2006a

Figure 4.12-5. Artist's Rendering of an IGCC Plant with Minimal Screening and Architectural Design Elements

Source: DOE, 2006b

Figure 4.12-6. Artist's Rendering of an IGCC Plant with Extensive Screening and Architectural Design Elements

Regardless of the final appearance of the proposed power plant, plant lighting and the flare would be highly visible at night, especially from nearby residences. Due to the relatively flat topography and lack of structures, woodlands, or tree lines in the area, it is likely that the plant, including the vapor plumes, would be visible both during the day and at night from scattered residences and other buildings as far as 7 to 8 miles (11.3 to 12.9 kilometers) away. Intervening buildings, vegetation, and topography would reduce the visibility of the plant from some vantage points.

Because there are no BLM visual resource management classifications or designated scenic vistas in the power plant and sequestration site or transmission line ROIs, the project would not have any effect on those classifications. Additionally, because there are no applicable light pollution standards in the area, the plant would create no conflict with such standards. Nonetheless, the choice of appropriate outdoor lighting and the use of various design mitigation measures (e.g., luminaries with controlled candela distributions, well-shielded or hooded lighting, directional lighting) could reduce the amount of nighttime glare associated with plant lighting. The plant is not anticipated to be visible from the two historic sites in Mattoon (see Section 4.10).

Sequestration Site

Because the proposed Mattoon Sequestration Site is on the proposed power plant site, no additional impacts on aesthetic resources would be associated with operating the CO_2 injection wells at the site.

Utility Corridors

Once construction is complete, the pipeline corridors would be returned to their pre-construction condition and would have essentially the same appearance as before construction. However, pump stations or compressor stations associated with proposed pipelines would be noticeable to those nearby, including those at nearby residences and those traveling on adjacent roadways.

On the proposed transmission line corridor, the visibility of the line would depend on which transmission line option is selected. This will not be known until certain transmission studies are completed. Any new line would be at least as visible as the existing 138-kV line that is proposed for interconnection, although there are very few residences in the rural area surrounding the proposed transmission line corridors. Any new substation would be very visible to those nearby.

Transportation Corridors

Once construction is complete and the power plant is in operation, the visual impacts would be similar to those for the power plant and sequestration site and utility corridors.

4.13 TRANSPORTATION AND TRAFFIC

4.13.1 INTRODUCTION

This section discusses the roadway and railroad networks that may be affected by the construction and operation of the proposed FutureGen Project at the Mattoon Power Plant and Sequestration Site.

4.13.1.1 Region of Influence

The ROI for the proposed Mattoon Power Plant and Sequestration Site includes a 50-mile (80.5-kilometer) radius around the site, as shown in Figure 4.13-1. The Mattoon Power Plant and Sequestration Site is located on SR 121 approximately 5 miles (8.0 kilometers) from the center of Mattoon and 8 road miles (12.9 kilometers) from the interchange of I-57 and SR 16. Because most vehicle trips to the site would be via SR 121 and SR 16 from the I-57 interchange, this analysis focuses on the 8-mile (12.9-kilometer) corridor from I-57, which passes through Mattoon. This analysis includes possible alternative routes using county roads, city streets, and US 45, thereby including Mattoon's city street network and the area north to (CH 18).

4.13.1.2 Method of Analysis

DOE reviewed information provided in the Mattoon EIV (FG Alliance, 2006a), which characterizes elements in the roadway hierarchy within the ROI based on function (e.g., city street and rural arterial), traffic levels, and observed physical condition. The EIV also contains traffic data obtained from the IDOT. The number of vehicle trips generated during construction and operations was based on data provided in the Mattoon EIV (FG Alliance, 2006a). DOE observed traffic conditions during site visits from October 11 to 12, 2006.

Traffic impacts were assessed using the planning methods outlined in: the Transportation Research Board's "2000 Highway Capacity Manual" (2000 HCM) (TRB, 2000), which assigns a level of service (LOS) to a traffic facility based on operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000); and The American Association of State Highway and Transportation Officials' (AASHTO) "A Policy on the Design of Highways and Streets" (the Green Book) (AASHTO, 2004), which describes LOS in more qualitative terms. The Green Book defers to the 2000 HCM to define LOS by facility type. The measures of effectiveness to assign LOS vary depending on the traffic facility. Highway Capacity Software Plus (HCS+) was used to perform capacity analysis.

> **LOS** is a qualitative measure that describes operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000).

For two-lane highways, the measure of effectiveness in assessing operations is the percent of time spent following another vehicle. LOS A through LOS F are assigned to a facility based on this measure of effectiveness. The LOS depends on the Highway Class (I or II), lane and shoulder widths, access-point density, grade and terrain, percent of heavy vehicles, and percent of no-passing zones within the analysis segment. Class I highways, according to the 2000 HCM, are highways where a motorist expects to travel at relatively high speeds. They are typically primary links in a state or national highway network and serve long-distance trips. A Class II highway typically operates at lower speeds and most often serves shorter trips. Class II also includes scenic or recreational routes. Table 4.13-1 defines each LOS category for Class I and II two-lane highways.

Table 4.13-1. Level of Service Criteria, Two-Lane Highways

LOS	Class I Two-Lane Highway		Class II Two-Lane Highway
	Percent Time Spent Following Another Vehicle	Average Travel Speed (mph [kmph])	Percent Time Spent Following Another Vehicle
A	< 35	>55 (88.5)	< 40
B	> 35 - 50	> 50 - 55 (80.5 – 88.5)	> 40 - 55
C	> 50 - 65	> 45 - 50 (72.4 – 80.5)	> 55 - 70
D	> 65 - 80	> 40 - 45 (64.4 – 72.4)	> 70 - 85
E	> 80	≤ 40 (64.4)	> 85

LOS F applies whenever the flow rate exceeds the capacity of the highway segment.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For multi-lane highways, the primary measure of effectiveness is density, measured in passenger cars per mile per lane. The traffic density is based on the free-flow speed, ranging from 45 to 60 mph (72.4 to 96.6 kmph). The LOS is dependent on the lane width, lateral clearance, median type, number of access points, free-flow speed, and percent of heavy vehicles. Table 4.13-2 defines the LOS criteria for each free-flow speed on a multi-lane highway.

Table 4.13-2. Level of Service Criteria, Multi-Lane Highways

Free-Flow Speed (mph [kmph])	Criterion	LOS				
		A	B	C	D	E
60 (96.6)	Maximum density (pc/mi/ln)	11	18	26	35	40
55 (88.5)		11	18	26	35	41
50 (80.5)		11	18	26	35	43
45 (72.4)		11	18	26	35	45

LOS F is not included in the table; vehicle density is difficult to predict due to highly unstable and variable traffic flow.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For basic freeway segments, the measure of effectiveness is density, measured in passenger cars per mile per lane. The LOS is dependent on the lane width, lateral clearance, number of lanes, interchange density, free-flow speed, and percent of heavy vehicles. Table 4.13-3 defines the LOS criteria for each free-flow speed.

The Green Book describes LOS in qualitative terms as follows: LOS A represents free flow, LOS B represents reasonably free flow, LOS C represents stable flow, LOS D represents conditions approaching unstable flow, LOS E represents unstable flow, and LOS F represents forced or breakdown flow (AASHTO, 2004).

Table 4.13-3. Level of Service Criteria, Basic Freeway Segments

LOS	Passenger Cars Per Mile Per Lane
A	0 – 11
B	>11 – 18
C	>18 – 26
D	>26 – 35
E	>35 – 45
F	>45

LOS = Level of Service.
Source: TRB, 2000.

No information is available for turning movements at specific intersections within the ROI. Therefore, intersection LOS has not been estimated for this analysis. However, DOE identified key intersections and evaluated the LOS qualitatively based on relative traffic volumes on intersecting roadways.

Though there are accident reduction factors that can be used to estimate a reduction in crashes based on a specific type of highway improvement, there are no methods available for estimating the increase in crashes due to increased roadway volume. In addition, specific recent accident data for the roadways around the proposed power plant and sequestration site are not available (IDOT, 2005a). DOE reviewed IDOT's Comprehensive Highway Safety Plan (IDOT, 2005b), which provides generic statistics and information about crashes at at-grade highway-railroad crossings and at intersections on a national and statewide basis. DOE qualitatively assessed potential safety impacts in this analysis.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Increase traffic volumes as to degrade LOS conditions on roadways;
- Alter traffic patterns or circulation movements;
- Alter road and intersection infrastructure;
- Conflict with local or regional transportation plans;
- Increase rail traffic compared to existing conditions on railways in the ROI; and
- Conflict with regional railway plans.

4.13.2 AFFECTED ENVIRONMENT

4.13.2.1 Roads and Highways

Figure 4.13-2 shows the local highway network in relationship to the regional network. Access to the proposed Mattoon Power Plant and Sequestration Site is primarily via I-57, approximately 3 miles (4.8 kilometers) east of the center of Mattoon and 8 road miles (12.9 kilometers) from the proposed Mattoon Power Plant and Sequestration Site. I-57 connects with I-70 approximately 25 miles (40.2 kilometers) to the south, and via I-70 to Indianapolis and St. Louis. US 45, a four-lane north-south highway, passes through the center of Mattoon and runs parallel with I-57. US 45 connects Mattoon with Effingham located approximately 25 miles (40.2 kilometers) to the south, and with Tuscola approximately 22 miles (35.4 kilometers) to the north.

IDOT Highways

Marked and unmarked routes under the jurisdiction and maintenance of the IDOT are typically one of four types of pavement: full depth bituminous, bituminous pavement overlay on a rigid base, concrete pavement, or a combination of concrete and bituminous. These pavements would be “high quality” pavements and surface types. According to IDOT (as cited in FG Alliance, 2006a), there are no “sharp or hazardous curves” on any of the state-maintained roads.

Mattoon and all of East Central Illinois are served by a fully developed roadway system. Mattoon is located on I-57, which runs from I-55 in Missouri to I-94 in Chicago, Illinois. Mattoon is served by two existing interchanges on I-57 and a new interchange is currently under construction at CH 18. I-57 provides two lanes in each direction. Each lane is approximately 12 feet (3.7 meters) wide, and 10-foot (3.0-meter) shoulders are provided on the right side of each direction of travel. A median separates the northbound and southbound directions of travel. Within 50 miles (80.5 kilometers) of Mattoon, I-57 connects to I-70, I-72, and I-74. All three system interchanges are 25 to 45 miles (40.2 to 72.4 kilometers) from the proposed Mattoon Power Plant and Sequestration Site. In Illinois, all interstates are designated as Class I truck routes.

A **Class I truck route** is defined as a limited access, divided highway that can handle 5-axle tractor semi-trailers of any length, up to 8.5 feet (2.6 meters) wide and up to 13.5 feet (4.1 meters) high, and have a gross weight of up to 80,000 pounds (36,287 kilograms).

US 45 runs north-south through Mattoon and connects to I-57 south of Mattoon. US 45 provides two lanes in each direction plus a two-way turn lane (TWTL). The pavement is in good condition.

SR 16 runs east-west through Mattoon. SR 16 provides two lanes in each direction plus a TWTL. SR 16 connects to I-57 east of Mattoon. SR 16 also connects to US 45 at a signalized intersection. The roadway pavement is in good condition.

SR 121, which directly abuts the proposed power plant site, passes through Mattoon and continues northwest past the site to Decatur, Illinois. SR 121 is a four-lane highway that runs east-west six blocks north of SR 16. US 45 connects SR 16 and SR 121. SR 121 provides a direct route to the proposed site, at which point SR 121 becomes a two-lane roadway.

A **Class II truck route** is defined as a roadway that allows 80,000-pound (36,287-kilogram) vehicles up to 60 feet (18.3 meters) long with a width of 8.5 feet (2.6 meters).

US 45, SR 16, and SR 121 are all highways designated as Class II truck routes. The characteristics of each roadway class are shown in Table 4.13-4.

Table 4.13-4. Roadway Class Characteristics

Type of Highway or Street	Width (feet [meters])	Height (feet [meters])	Length (feet [meters])	Maximum Weight (pounds [kilograms])
Class I	8.5 (2.6)	13.5 (4.1)	any	80,000 (36,287)
Class II	8.5 (2.6)	13.5 (4.1)	60 (18.3)	80,000 (36,287)
Class III	8 (2.4)	13.5 (4.1)	55 (16.8)	80,000 (36,287)

Source: IDOT, 2005c.

County Roads

CH 18 (also called CR 1000N) is a Class II roadway from US 45 to CH 13 (also called CR 200E). CH 18 provides one lane in each direction. The remaining portion of CH 18 from CH 13 to SR 121 west of the proposed power plant site is to be upgraded to a Class II truck route by Coles County in fiscal year 2008 (beginning July 1, 2007). CH 18 is also to be extended east to I-57 and west to SR 121 by 2008. The continuation of CH 18 is not related to the proposed FutureGen Project, as the extension will be constructed regardless of whether the proposed FutureGen Project takes place at the proposed power plant site.

CH 13 is a Class III truck route that connects CH 18 to SR 121 near the site. CH 13 provides one lane in each direction. CH 13 is paved with oil and chip.

Local Roads

Mattoon's street pattern is a grid of major and minor streets, as shown in Figure 4.13-3. Because SR 121 is six blocks north of SR 16, traffic from I-57 currently uses the city grid to reach SR 121 on its way to the vicinity of the proposed power plant site.

There are five key intersections in the vicinity of the proposed plant site. Turning movements for these intersections are not available; therefore, DOE used the LOS of adjacent road segments to estimate potential effects of the proposed FutureGen Project on these intersections:

- CH 18 and I-57 ramps
- SR 16 and US 45
- SR 16 and SR 121
- SR 121 and US 45
- SR 121 and CH 13

Programmed Transportation Improvements

IDOT has a Proposed Highway Improvement Program (HIP) for Fiscal Years 2007 to 2012 for each of its seven districts. The area within the ROI is covered in two district plans. Coles County and the southern half of the ROI are contained in District 7. The northern half of the ROI is part of District 5. Within the ROI, an interchange is currently under construction at I-57 and CH 18. The design includes a bridge over US 45 with connecting ramps. Other programmed improvements in the HIP within the ROI and the approximate distance from the proposed Mattoon Power Plant and Sequestration Site include:

- I-57 resurfacing, SR 16 to Douglas County Line (7 miles [11.3 kilometers]);
- US 45 over Canadian National Railroad, Mattoon, bridge beam replacement and re-decking (4 miles [6.4 kilometers]); and
- CH 18 resurfacing from SR 121 to 2 miles (3.2 kilometers) east of SR 121.

4.13.2.2 Railroads

There are four Class I railroads located within the ROI: CSX Transportation, Union Pacific, Canadian National, and Norfolk Southern. The Canadian National–Peoria spur borders the proposed power plant site at the north. This information is based on data provided by the Alliance (FG Alliance, 2006a). The railroads near the proposed Mattoon Power Plant and Sequestration Site are shown in Figure 4.13-3.

The Surface Transportation Board categorizes rail carriers into three classes based upon annual earnings. The earnings limits for each class were set in 1991 and are adjusted annually for inflation.

Class I – Gross annual operating revenues of $277.7 million or more

Class II – Non-Class I railroad operating 350 or more miles and with gross annual operating revenues between $40 million and $277.7 million

Class III – Gross annual operating revenues of less than $40 million

CSX Transportation operates 1,044 miles (1,680 kilometers) of track in Illinois, provides service to 270 industries in Illinois, and employs 1,000 Illinois residents. CSX invested $7.5 million to maintain and upgrade its Illinois track in 2004. There are two CSX lines running east and west within approximately 30 miles (48.3 kilometers) of Mattoon. One line is north of Mattoon and the other is south.

Union Pacific operates the largest railroad in Illinois, having 2,247 miles (3,616 kilometers) of track and 4,000 employees in Illinois. Union Pacific's main line track connecting Chicago and St. Louis runs northeast to southwest approximately 20 miles (32.2 kilometers) from Mattoon. Daily freight train counts on this Union Pacific main line average 22 trains per 24-hour period. This Union Pacific main line has 286,000-pound (129,727-kilogram) weight capacity as coal trains currently use this line. In addition to providing access to the St. Louis gateway, this line goes south at Findlay, Illinois, and serves southern Illinois points. Lines from Mt. Vernon to Chester and Benton to Gorham have recently had substantial track work and provide additional links to Union Pacific's main line to Texas and the Gulf ports. This line has direct access to the St. Louis and Chicago gateways.

Canadian National operates the second largest railroad in Illinois, with 1,519 miles (2,445 kilometers) of track. Through the Chicago gateway, Canadian National tracks move traffic between Canada and the Mississippi Valley, the Gulf Coast, and Mexico. Two Canadian National lines run through Mattoon: the main line and the Peoria spur. The Canadian National main line between Effingham and Champaign, Illinois, passes through Mattoon and parallels US 45. The main line runs 12 freight trains service six days per week through Mattoon. There are also four Amtrak passenger trains classified at 79 mph (127.1 kmph) through Mattoon each day. The Canadian National–Peoria spur, which borders the northeast corner of the proposed Mattoon Power Plant Site, comes off the main line in Mattoon and parallels SR 121. The Canadian National runs two trains per day on the Peoria spur. The track is at grade and is classified as Federal Railroad Administration Class III, with a maximum freight speed of 40 mph (64.4 kmph) with service as needed.

Norfolk Southern operates 1,260 miles (2,028 kilometers) of track in Illinois. The Norfolk Southern main line between Decatur and Danville, Illinois, is the closest Norfolk Southern track to Mattoon. This section of track is a main line, with approximately 36 through trains per day. The track along that line can support car loadings up to 286,000 pounds (129,727 kilograms).

4.13.2.3 Local and Regional Traffic Levels and Patterns

Regional Traffic

According to IDOT (FG Alliance, 2006a), I-57 carried approximately 16,600 vehicles per day (vpd, also referred to as average daily traffic [ADT]) south of SR 16, and approximately 18,300 vpd north of SR 16 in 2005. US 45 carried approximately 3,350 vpd near CH 18 and 11,800 vpd near SR 16. SR 121 carried approximately 4,450 vpd in the vicinity the proposed Mattoon Power Plant and Sequestration Site, and SR 16 carried 6,200 vpd in the vicinity of US 45. Typically, morning and afternoon peak hour volumes range from 8 to 12 percent of the ADT, assuming that each peak represents 10 percent of the ADT (Table 4.13-5). Peak hour truck percentages are typically slightly lower than the daily truck percentage because trucks travel in off-peak hours. However, to be conservative, the existing daily truck percentages were maintained for this analysis.

Table 4.13-5. 2005 Average Daily and Peak Hour Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[1] (vpd)	Weekday Peak Hour Volume[2] (vph)	Weekday Peak Hour Truck Volume[2] (vph)	LOS[3]
SR 121 near the site	4,450	350	445	35	C
CH 13 between SR 121 and CH 18	350	0[4]	35	0*	A
CH 18 near US 45	1,700	170[5]	170	17[5]	A
CH 18 near CH 13	1,200	120[5]	120	12[5]	A
US 45 near CH 18	4,350	475	435	48	A
US 45 near SR 16	11,900	675	1,190	48	A
SR 16 near US 45	6,200	425	620	43	A
I-57 south of SR 16	16,600	5,750	1,660	625	A
I-57 north of SR 16	18,300	6,250	1,830	575	A

[1] Source: FG Alliance, 2006a.
[2] DOE estimate of peak hour volume and LOS assumed peak hour equals 10 percent of ADT.
[3] DOE used HCS+ to perform capacity analysis.
[4] CH 13 is not currently rated for trucks.
[5] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

A new interchange on I-57 at CH 18, currently under construction, would provide the main access route for all traffic from the north and east to the proposed Mattoon Power Plant and Sequestration Site, but vehicles coming from the south could take a shorter route from I-57 through Mattoon via US 45 and SR 121. The US 45/SR 121 route provides four lanes plus a two-way left turn lane. All traffic from the west would use SR 121 to access the site.

During a site visit from October 11 to 12, 2006, DOE noted traffic flows below highway capacities (LOS C or better) on the likely routes to the proposed Mattoon Power Plant and Sequestration Site. Table 4.13-5 summarizes the capacity analysis of the existing roadway network. Based on the existing roadway LOS reported in Table 4.13-5, DOE concluded that the key intersections near the proposed Mattoon Power Plant Site are likely to be operating within their capacity as well.

Truck Traffic

Information provided by IDOT indicates that in 2005 there were approximately 5,750 trucks per day using I-57 south of SR 16, and there were approximately 6,250 trucks per day using I-57 north of SR 16 (FG Alliance, 2006a). These volumes represent 35 percent and 34 percent of the ADT volumes using I-57, respectively. US 45 carried approximately 475 trucks per day in the vicinity of CH 18, which represents 11 percent of the ADT. In the vicinity of SR 16, US 45 carried 675 trucks in 2005, representing around 6 percent of the total daily traffic. SR 121 carried approximately 350 trucks per day in the vicinity of the proposed power plant site, which represents about 9 percent of the ADT. SR 16 carried 425 trucks per day, or 7 percent of the ADT, in the vicinity of US 45.

There are several truck routes in the vicinity of the proposed Mattoon Power Plant and Sequestration Site that use state and county roads. These truck routes include I-57 (Class I); and SR 16, SR 121, and US 45 (Class II). A new I-57 interchange with CH 18, currently under construction (FG Alliance, 2006a), would create a new route for all truck traffic from the north and east to the proposed Mattoon Power Plant Site.

Rail Traffic

The proposed Mattoon Power Plant and Sequestration Site would be served by the Canadian National Railroad main line and the Peoria spur, which borders the site to the north. The main rail line through the center of Mattoon is depressed beneath town roads, and rail traffic does not create a conflict with the roads. No new at-grade crossings are proposed to access the proposed Mattoon Power Plant and Sequestration Site.

4.13.3 IMPACTS

4.13.3.1 Construction Impacts

Power Plant Site

Based on the necessary permitting and design requirements, DOE expects that the earliest year that construction would begin on the proposed power plant and related infrastructure is 2009 (FG Alliance, 2006a). Table 4.13-6 shows 2009 No-Build traffic volumes, which DOE projected to the construction year by applying a background growth rate of 1 percent per year to 2005 volumes. DOE determined this growth rate by reviewing other IDOT project EISs and study documentation (IDOT, 2005c).

Table 4.13-6. 2009 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[1] (vpd)	Weekday Peak Hour Volume[1] (vph)	Weekday Peak Hour Truck Volume[1] (vph)	LOS[2]
SR 121 near the site	4,631	364	463	36	C
CH 13 between SR 121 and CH 18	364	36[3]	36	4	A
CH 18 near US 45	1,769	177[4]	177	18	A
CH 18 near CH 13	1,249	125[4]	125	13	A
US 45 near CH 18	4,527	498	453	50	A
US 45 near SR 16	12,383	743	1,238	74	A
SR 16 near US 45	6,452	452	645	45	A
I-57 south of SR 16	17,274	6,045	1,727	605	A
I-57 north of SR 16	19,043	6,474	1,904	647	A

[1] DOE estimate based on 1 percent growth per year from 2005.
[2] DOE used HCS+ to perform capacity analysis.
[3] CH 13 is not currently rated for trucks. Assumed 10 percent trucks under future improved conditions.
[4] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Based on the 2009 No-Build volumes, DOE estimated each roadway's capacity (Table 4.13-6). Because there is no predicted change in the roadway LOS between the 2005 existing conditions and 2009 No-Build conditions, DOE concluded that there would be no change in LOS at key intersections near the proposed power plant and sequestration site. All intersections are expected to continue to operate at LOS C or better under the No-Build conditions.

Over a 44-month construction period, the construction work force for the proposed power plant site is estimated to average 350 workers on a single shift, with 700 workers during the construction's peak (FG Alliance, 2006e). DOE assumed that 100 percent of the construction workforce would arrive at the construction site in single-occupant vehicles. For the analysis of construction conditions, DOE used the peak period of construction to estimate the highest level of potential impact during construction.

Trips would be largely from Mattoon and the new I-57/CH 18 interchange north of Mattoon currently under construction. The balance of trips would come to the site via US 45 from the north and south, and from SR 16 and SR 121 from the southeast and northwest, respectively. The trip distribution is summarized in Figure 4.13-2. It is assumed that access to the proposed site would be provided via CR 800N or via CH 13.

DOE assumed that the construction workforce would work a 10-hour work day, 5 days per week. Construction workforce trips would generally occur prior to the morning peak hours (7:00 to 9:00 am) and coincide with the afternoon peak hours (4:00 to 6:00 pm). It is unlikely that many, if any, trips would occur during mid-day, as construction workers typically do not leave a job site during the half-hour lunch period.

Based on these construction workforce estimates, DOE estimated the percent change in ADT and peak-hour traffic volumes from 2009 No-Build conditions for the likely routes to the site during the expected 44-month construction period (2009-2012) (Table 4.13-7). The largest construction traffic impact would occur on CH 13, scheduled to be improved by IDOT should the proposed Mattoon Power Plant Site be selected. CH 13 would see a 325 percent increase in daily traffic during construction of the proposed power plant, including both workforce and construction-related truck traffic.

Table 4.13-7. 2009 Average Daily and Peak Hour Construction Traffic Volumes

Roadway	ADT[1,2] (vpd)	Change in ADT[1,2] (percent)	Peak Hour Volume[1,3] (vph)	Change in Peak Hour Volume[1,3] (percent)	LOS[4]
SR 121 near the site	6,273	36	1,185	156	D
CH 13 between SR 121 and CH 18	1,548	325[5]	628	1,626	C
CH 18 near US 45	2,953	67[6]	769	335	A
CH 18 near CH 13	2,433	95[6]	717	474	A
US 45 near CH 18	4,556	1	467	3	A
US 45 near SR 16	12,528	1	1,311	6	A
SR 16 near US 45	6,611	3	652	1	A
I-57 south of SR 16	17,418	1	1,800	4	A
I-57 north of SR 16	20,198	6	2,482	30	A

[1] DOE estimate based on peak workforce of 700 workers arriving at site in single-occupancy vehicles, plus 40 truck trips per day (20 entering and 20 exiting the site).
[2] Trip distribution on area roadways is shown in Figure 4.13-2.
[3] DOE derived peak hour volumes assuming half of all passenger car trips occur in peak hour and truck trips are evenly distributed over a 10-hour construction work day.
[4] DOE used HCS+ to perform capacity analysis.
[5] CH 13 is not currently rated for trucks. Assumed 10 percent trucks under future improved conditions.
[6] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

A new I-57 interchange with CH 18, currently under construction, would provide the main access route for all construction traffic from the north via I-57 and US 45 to the proposed Mattoon Power Plant Site, while construction traffic from the west would use SR 121 directly to the site entrance. Traffic from the east would use SR 16. This would not cause a large traffic impact on these roads due to the available capacity, as shown in Table 4.13-7. It appears that construction-related traffic could take a shorter route from the south, via I-57 to US 45 and SR 121. Unless a designated truck route was indicated for the project, this route would create more truck traffic and congestion in the downtown area. This could have a direct impact on intersection LOS in Mattoon.

As shown in Table 4.13-7, the number of passenger vehicle trips by construction workers would be relatively small in terms of available roadway capacity, and direct traffic impacts due to construction would be minor. The roadway that would experience the most direct impact during construction would be SR 121 because all construction-related trips would use this roadway en route to and from the proposed Mattoon Power Plant Site. SR 121 would operate at LOS D during construction compared to LOS C under 2009 No-Build conditions. This would result in a change to the roadway's conditions from one of stable flow (LOS C) to one approaching unstable flow (LOS D), which would be inconvenient for travelers on the highway, particularly during peak traffic hours, but is acceptable for a temporary condition during construction (Bureau of Local Roads and Streets, 2006). The analysis of CH 13 includes the planned upgrade of the roadway, which is described in Section 4.13.3. CH 13 would operate at LOS C (stable flow) during construction, compared to LOS A (free flow) under 2009 No-Build conditions. All other roadways would operate at LOS A, just as they would under 2009 No-Build conditions. Given that the roadways would be operating at LOS D or better, there is no reason to conclude there would be any notable increase in traffic accidents. The capacity analysis summary for the 2009 construction conditions of the proposed project area roadways is shown in Table 4.13-7.

Based on the volumes and LOS on these roadways during construction, the key intersections around the proposed site should be able to accommodate these daily and peak hour traffic volumes. The ramp termini intersections at I-57 and CH 18, as well as the intersections of CH 13 with CH 18 and with SH 121, could see a temporary change in LOS due to the volumes generated during construction. Changes to traffic signal timings may be required at the CH 18/I-57 ramp intersections to accommodate changes in the turning volumes. The planned improvements at CH 13 and SH 121 should adequately accommodate the construction traffic.

In addition to worker traffic, materials and heavy equipment would be transported to the proposed site on trucks from I-57 and via the adjacent rail line. Heavy equipment would remain at the proposed site for the duration of its use. Material deliveries and return trips by empty trucks would likely occur throughout the workday. Mattoon is served by several large construction material supply firms, offering both concrete and asphalt, within 20 miles (32.2 kilometers) of the proposed Mattoon Power Plant Site (Figure 4.13-4). In its estimates of construction-related traffic, DOE did not estimate a specific number of trips by truck from any supply location. However, DOE included 40 truck trips per day (20 entering and 20 exiting the proposed site) in the analysis. Based on the available roadway capacities and the fact that estimated 2009 No-Build LOS are C or better, DOE concluded that 40 truck trips per day would not have a significant direct impact on traffic operations on roadways surrounding the proposed site. Moreover, DOE also concluded that even if the number of trips did occasionally exceed 40 per day, it is highly unlikely that it would result in a significant direct impact on roadways surrounding the proposed site.

Sequestration Site

Because the proposed Mattoon Sequestration Site is the same as the proposed Mattoon Power Plant Site, there would be no additional direct or indirect impacts of construction beyond those described for the proposed power plant site.

Utility Corridors

All underground utilities (potable water, process water, wastewater, natural gas, and CO_2) are proposed to be constructed using boring and directional drilling under roads and railroads (FG Alliance, 2006a); therefore, no open trenches across roadways or railroads are expected. Although there would be a need for staging areas for this construction, DOE assumes that typical construction techniques would be employed and all roadways would be maintained during construction. Construction of several of the proposed utility lines (potable water, wastewater, natural gas) is expected to last for approximately 1 month. Construction of the process water pipeline is expected to last 4 to 6 months (FG Alliance, 2006a).

Construction of the utility lines would require approximately 35 persons for all construction to occur concurrently (FG Alliance, 2006a). In the most conservative case, all construction workers would travel in single-occupant vehicles. Therefore, there would be approximately 70 additional daily trips on the roadway network during construction of the utilities. Assuming that construction operations typically start earlier than the morning peak period of traffic, 35 trips would take place before the morning peak hour. The 35 afternoon trips made by construction workers leaving job sites would likely coincide with the afternoon peak period. Given the proposed locations of the utility corridors, these trips would be spread out on various roadways in the ROI and are not expected to have any appreciable direct impact on traffic operations.

Transportation Corridors

IDOT has committed to upgrade CH 13 to a Class II roadway if the proposed Mattoon Power Plant Site is chosen (FG Alliance, 2006a). This new construction would consist of 1.25 miles (2.0 kilometers) of roadway widening and resurfacing with new shoulders and ditches. The intersection of SR 121 and CH 13 would be rebuilt so that CH 13 would approach SR 121 at right angles. A turn lane would be built on SR 121. This would provide Class II truck route access from I-57 to the plant entrance. The roadway improvement project would require approximately 3 months and 15 workers to construct. The workers would add 30 trips per day to the roadway network (15 trips before the morning peak period and 15 trips coinciding with the afternoon peak period). The small number of trips would not have an appreciable direct impact on the LOS on CH 13, SR 121, or other adjacent roadways.

IDOT would require a Traffic Management Plan during roadway construction. The Traffic Management Plan could include detours while construction occurs on CH 13. However, more typically, at least one lane of travel would be maintained as part of the Traffic Management Plan during construction. While there could be some congestion in the local area surrounding the construction site, it should not have a significant direct impact on the traveling public, given the low existing daily traffic volumes on CH 13, which currently operates at LOS A (see Table 4.13-5). Reconstruction of CH 13 is assumed to occur before the construction of the proposed Mattoon Power Plant and Sequestration Site and associated utility corridors, to ensure that the necessary transportation infrastructure is in place to support the construction traffic volumes.

A private sidetrack from the Canadian National–Peoria spur would be constructed on the proposed Mattoon Power Plant and Sequestration Site and would require approximately 9 to 11 months to complete that could be spread over more than one construction season. It is estimated that up to 18 construction workers would be traveling to and from the proposed site, resulting in an additional 36 trips per day on the roadway network. Eighteen of those trips would take place before the morning peak period, assuming that construction activities typically begin earlier than the regular work day. The other 18 trips would occur during the afternoon peak period, assuming a 10-hour work day. Given that all roadways would be operating at LOS D or better during construction (see Table 4.13-7), these trips would not be expected to appreciably change traffic operations on the roadway network.

During connection of the new rail loop to the existing Canadian National–Peoria spur, railroad safety flaggers would be required. The construction could have some temporary impacts on Canadian National railroad operations while the connection between the private sidetrack and the Peoria spur is completed. This temporary impact could be avoided by completing the connection during hours when the Peoria spur has the least traffic.

4.13.3.2 Operational Impacts

The proposed FutureGen Project is expected to begin operating in 2012 (FG Alliance, 2006a). Table 4.13-8 shows 2012 No-Build traffic volumes, which DOE projected by applying a background growth rate of 1 percent per year to 2005 volumes. This growth rate was determined through review of other IDOT project EISs and study documentation by IDOT (IDOT, 2005c). Based on the 2012 No-Build volumes, DOE estimated the capacity of each roadway. The analysis of CH 13 includes the planned upgrade of the roadway (Table 4.13-8).

Table 4.13-8. 2012 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	2012 No-Build ADT[1] (vpd)	2012 No-Build Truck ADT[1] (vpd)	2012 No-Build Peak Hour Volume[1] (vph)	2012 No-Build Peak Hour Truck Volume[1] (vph)	LOS[2]
SR 121 near the site	4,771	375	477	38	C
CH 13 between SR 121 and CH 18	375	38[3]	38	4	A
CH 18 near US 45	1,823	182[4]	182	18	A
CH 18 near CH 13	1,287	129[4]	129	13	A
US 45 near CH 18	4,664	509	466	51	A
US 45 near SR 16	12,758	724	1,276	72	A
SR 16 near US 45	6,647	456	665	46	A
I-57 south of SR 16	17,797	6,701	1,780	670	A
I-57 north of SR 16	19,620	6,165	1,962	616	A

[1] DOE estimate based on 1 percent growth per year from 2005.
[2] DOE used HCS+ to perform capacity analysis.
[3] CH 13 is not currently rated for trucks. Assumed 10 percent trucks under future improved conditions.
[4] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Power Plant Site

The operating workforce for the proposed plant would be approximately 200 employees, of which 80 administrative personnel would work a regular office day (9:00 am to 5:30 pm), and 40 shift workers would work a daytime shift (7:00 am to 3:30 pm) and each of the two nighttime shifts (FG Alliance, 2006e). The workforce would result in 160 new peak hour trips in both the morning and afternoon. For this analysis, DOE assumed that these employees would arrive at the plant in single-occupant vehicles and that the trip distribution would be the same as for the construction worker trips, with the majority coming from Mattoon or from I-57 and reaching the plant site via SR 121. A portion of the workforce would come from Decatur and other communities to the northwest via SR 121. Depending on how the proposed plant is oriented, a single access gate could be located on either CR 800N or CH 13 (FG Alliance, 2006a).

There would be a small number of delivery truck trips to the proposed plant to support personnel and administrative functions, and deliver spare parts. Coal would be delivered primarily by rail. Other bulk materials used by the plant and byproducts are expected to be delivered or removed from the proposed Mattoon Power Plant Site by truck. DOE estimates that 13 trucks per week would be required for delivery of materials, while 98 trucks per week would be required for removal of byproducts, including slag, sulfur, and ash. The estimate of trucks required is based on the estimated annual amount of materials/byproducts (FG Alliance, 2006e). Based on these estimates and assuming an even distribution of trucks over each day of the week, materials delivery would result in 4 truck trips per day, 2 entering and 2 exiting, and byproduct removal would result in an additional 28 trips per day, 14 entering and 14 exiting. These trips are included in the 2012 Build ADT and peak hour traffic volumes shown in Table 4.13-9. The change in ADT and peak hour volumes between 2012 No-Build and 2012 Build conditions is also shown in Table 4.13-9.

Table 4.13-9. 2012 Average Daily and Peak Hour Build Traffic Volumes

Roadway	2012 Build ADT[1] (vpd)	Change in ADT[1] (percent)	2012 Build Peak Hour Volume[2] (vph)	Change in Peak Hour Volume[2] (percent)	LOS[3]
SR 121 near the site	5,203	9	641	34	C
CH 13 between SR 121 and CH 18	729	94	172	358	B
CH 18 near US 45	2,177	19	317	74	A
CH 18 near CH 13	1,641	27	263	105	A
US 45 near CH 18	4,672	<1	470	1	A
US 45 near SR 16	12,802	<1	1,292	1	A
SR 16 near US 45	6,695	1	666	<1	A
I-57 south of SR 16	17,841	<1	1,796	1	A
I-57 north of SR 16	19,966	2	2,093	7	A

[1] DOE derived ADT using the maximum operating workforce (200 people; 400 vpd) passenger car trips (FG Alliance, 2006a) and assuming 32 operations-related truck trips daily (16 arriving and 16 exiting the site).
[2] DOE derived peak hour volumes assuming that administration and one-third of shift workers arrive in peak hour, and that four truck trips occur in each peak hour.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Based on the predicted 2012 Build conditions capacity analysis summary given in Table 4.13-9, the peak hour traffic would result in no major direct impact on the roadways surrounding the proposed Mattoon Power Plant Site. CH 13 would operate at LOS B (reasonably free flow) under the 2012 Build conditions compared to LOS A (free flow) under 2012 No-Build conditions. All other roadways would experience no change in LOS as a result of operating the proposed Mattoon Power Plant. Given that the roadways would be operating at LOS B or better, there is no reason to conclude that there would be any notable increase in traffic accidents.

Based on the volumes and LOS on these roadways during construction, DOE concluded that the key intersections around the proposed site should be able to accommodate these daily and peak hour traffic volumes. Changes to traffic signal timings may be required at the CH 18/I-57 ramp intersections to accommodate changes in the turning volumes. The planned improvements at CH 13 and SR 121 should adequately accommodate the traffic at this location.

The primary component of materials transport would be the delivery of coal to the plant by rail, using a spur track constructed for the purpose. It is anticipated that coal deliveries would require five 100-unit trains per week, or 10 entering or exiting train trips per week (FG Alliance, 2006e). This would represent a 10 percent increase in the number of trains on the main line through Mattoon, which currently accommodates 100 trains per week (12 freight trains 6 days per week and four passenger trains 7 days per week). Ten train trips per week would represent a 71 percent increase in the number of trains on the Peoria spur, which currently accommodates approximately 14 trains per week (an average of two per day).

The Peoria spur joins the north-south Canadian National main line in Mattoon, and some of the trains would use this line to and from the south. The north-south main line runs parallel to South 21st Street and has no grade crossings in the city street grid, so additional rail traffic would not affect street traffic in the city. There are two grade crossings between Mattoon and the proposed Mattoon Power Plant and Sequestration Site. The crossings are currently protected by actuated signals and gates, so additional crossing protection would not be required. The additional 10 train trips per week would create additional delays for some road users, would slightly increase the risk of a vehicle-train accident, and could have an impact on emergency vehicle response time at these crossings. A unit train car ranges from 48 to 53 feet (14.6 to 16.2 meters) long; therefore, a 100-unit train is approximately 1 mile (1.6 kilometers) long. Train speed through at-grade crossings varies from 10 to 40 mph (16 to 64 kmph) (FRA, 2006). DOE assumed that trains would pass through the at-grade crossings at approximately 10 mph (16 kmph). A 100-unit train traveling at 10 mph (16 kmph) would take approximately 6 to 7 minutes to clear each at-grade crossing. DOE did not estimate the number of other trains trips needed to deliver or remove other materials, such as ammonia or sulfur; however, these occasional trains would not appreciably alter the results of this analysis.

Sequestration Site

There would be no additional direct or indirect impacts beyond those indicated for the proposed power plant operations because the proposed sequestration site would be located on the Mattoon Power Plant Site.

Utility Corridors

The proposed utility corridors would have little or no impact on traffic operations and roadway LOS once the proposed FutureGen Project is operational. There would be no direct impact to traffic unless there is a problem with a utility line that requires open trenching to repair. It is expected that this would be an infrequent occurrence, thus having very little long-term potential to affect traffic.

Transportation Corridors

IDOT has committed to roadway improvements on CH 13 to allow trucks to use this route to/from the proposed Mattoon Power Plant Site via I-57. These improvements would have a positive direct impact on the existing roadway traffic. The improvements at SR 121 and CH 13 would also have a positive direct impact on traffic operations around the proposed site. As noted earlier, DOE assumes that these improvements would be completed before beginning construction on the proposed Mattoon Power Plant and Sequestration Site, so the improvements would be in place during the construction period. Operations using the proposed rail spur on the proposed Mattoon Power Plant Site would have little to no direct or indirect impact on the rail operations on the Peoria spur or Canadian National main lines.

4.14 NOISE AND VIBRATION

4.14.1 INTRODUCTION

Noise is defined as any sound that is undesired or interferes with a person's ability to hear something. The basic measure of sound is the sound pressure level (SPL), commonly expressed as a logarithm in units called decibels (dB). Vibration, on the other hand, consists of rapidly fluctuating motions having a net average motion of zero that can be described in terms of displacement, velocity, or acceleration. This section provides the results of the analysis completed for both noise and vibration. Specific details of the noise and vibration analyses are provided in sequence under each subsection, with results of the noise analysis presented first, followed by those of the ground-borne vibration analysis.

4.14.1.1 Region of Influence

The ROI for noise and vibration includes the area within 1 mile (1.6 kilometers) of the proposed Mattoon Power Plant and Sequestration Site boundary and within 1 mile (1.6 kilometers) of the boundaries of all related areas of new construction, including the utility and transportation corridors.

4.14.1.2 Method of Analysis

This section provides the methods DOE used to assess the potential noise and vibration impacts of construction and operational activities related to the proposed Mattoon Power Plant and Sequestration Site and related corridors. In preparing the noise and vibration analyses, DOE evaluated information presented in the Mattoon EIV (FG Alliance, 2006a), estimated increases in ambient noise and ground-borne vibration levels, and evaluated potential impacts on sensitive receptors.

DOE assessed the potential for impacts based on the following criteria:

- Conflicts with a jurisdictional noise ordinance;
- Permanent increases in ambient noise levels at sensitive receptors during operations;
- Temporary increases in ambient noise levels at sensitive receptors during construction;
- Airblast noise levels in excess of 133 dB;
- Blasting peak particle velocity (PPV) greater than 0.5 inches per second (in/sec) (12.7 millimeters per second [mm/sec]) at off-site structures; and
- Exceeding the Federal Transit Administration's (FTA) distance screening and human annoyance thresholds for ground-borne vibrations of 200 feet (61 meters) and 80 velocity decibels (VdB).[1]

Noise Methods

Generally, ambient conditions encountered in the environment consist of an assortment of sounds at varying frequencies (FTA, 2006). To account for human hearing sensitivities that are most perceptible at frequencies ranging from 200 to 10,000 Hertz (Hz) or cycles per second, sound level measurements are often adjusted or weighted and the resulting value is called an "A-weighted" sound level.

> The **A-weighted** scale is the most common weighting method used to conduct environmental noise assessments and is expressed as a dBA.

A-weighted sound measurements (dBA) are standardized at a reference value of zero decibels (0 dBA), which corresponds to the threshold of hearing, or SPL, at which people with healthy hearing

[1] FTA threshold standards are not applicable to this project, but were used as a basis for comparing effects.

mechanisms can just begin to hear a sound. Because the scale is logarithmic, a relative increase of 10 decibels represents an SPL that is nearly 10 times greater. However, humans do not perceive a 10-dBA increase as 10 times louder; rather, they perceive it as twice as loud (FTA, 2006). Figure 4.14-1 lists measured SPL values of common noise sources to provide some context.

The following generally accepted relationships (Bolt et al., 1973) are useful in evaluating human response to relative changes in noise level:

- A 2- to 3-dBA change is the threshold of change detectable by the human ear in the ambient conditions;
- A 5-dBA change is readily noticeable; and
- A 10-dBA change is perceived as a doubling or halving of the noise level.

The SPL that humans experience typically varies from moment to moment. Therefore, a variety of descriptors are used to evaluate noise levels over time. Some typical noise descriptors are defined below:

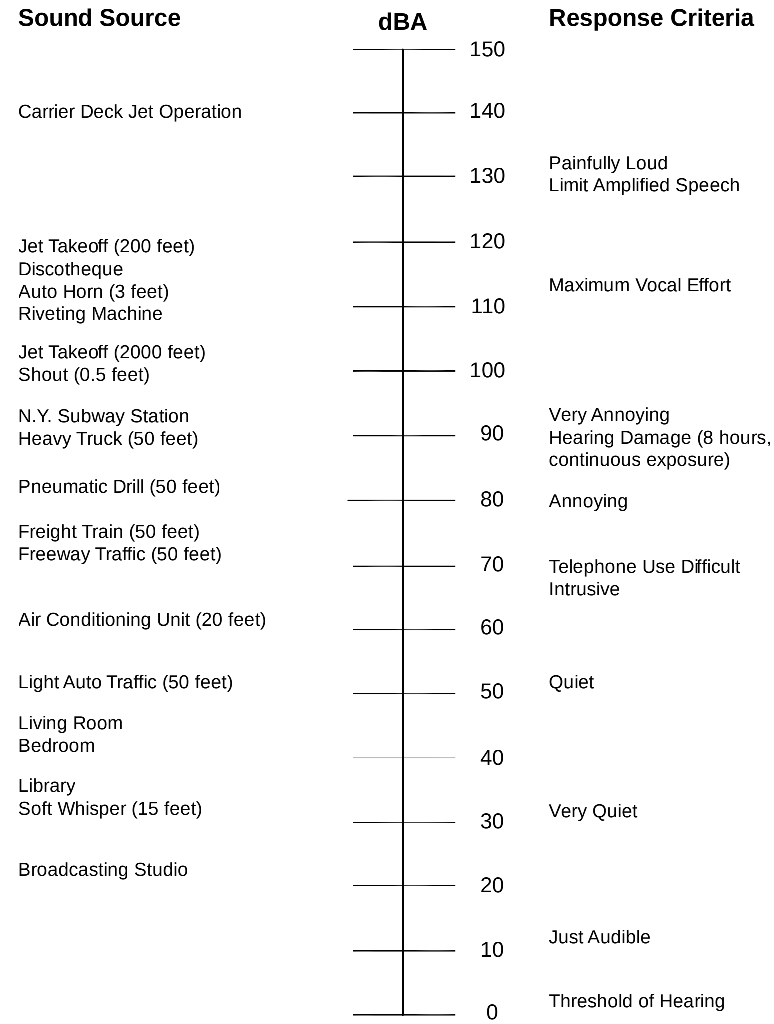
- L_{eq} is the continuous equivalent sound level. The sound energy from fluctuating SPLs is averaged over time to create a single number to describe the mean energy or intensity level. Because L_{eq} values are logarithmic expressions, they cannot be added, subtracted, or compared as a ratio unless that value is converted to its root arithmetic form.
- L_{max} is the highest, while L_{min} is the lowest SPL measured during a given period of time. These values are useful in evaluating L_{eq} for periods that have an especially wide range of noise levels.

For this analysis, DOE evaluated noise levels generated by stationary (e.g., fixed location) sources such as construction-related and power plant operating equipment, and mobile (e.g., moving) sources such as construction-related vehicle trips and operational deliveries by rail, car, and truck. DOE predicted stationary source noise levels during construction and normal plant operations at sensitive receptor locations in direct line-of-sight of proposed project facilities by summing anticipated equipment noise contributions and applying fundamental noise attenuation principles. DOE used the following logarithmic equation (Cowan, 1994) to predict noise levels at the sensitive receptor locations selected for the stationary source analysis:

$SPL_1 = SPL_2 - 20 \text{ Log } (D_1/D_2) - A_e$, where:

- SPL_1 is the noise level at a sensitive receptor due to a single piece of equipment operating throughout the day;
- SPL_2 is the equipment noise level at a reference distance D_2;
- D_1 is the relative distance between the equipment noise source and a sensitive receptor;
- D_2 is the reference distance at which the equipment level is known; and
- A_e is a noise level reduction factor applied due to other attenuation effects.

DOE compared the calculated results to the existing ambient noise levels and the City of Mattoon noise ordinance. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment are not available. In lieu of project-specific data, DOE used comparable noise data predicted for the proposed Orlando IGCC power plant facility (DOE, 2006) to estimate the increase in the noise level at sensitive receptors in the vicinity of the proposed Mattoon Power Plant Site. Residences and any schools, hospitals, nursing homes, houses of worship, and parks within the 1-mile (1.6-kilometer) ROI were considered sensitive receptors in this analysis.



Source: Barksdale, 1991

Figure 4.14-1. SPL Values of Common Noise Sources

For mobile sources, DOE estimated noise levels using traffic noise screening techniques to compare the vehicle traffic mix data for the future Build and No-Build traffic conditions on each roadway studied. DOE calculated the ratio of the future Build and future No-Build traffic volumes using the following equation (FHWA, 1992):

Predicted Change in Noise Level (dBA) = 10 Log (Future Build PCE/Future No-Build PCE), where one heavy truck = 28 passenger car equivalents (PCEs)

In applying this equation, a doubling of traffic means future Build conditions are predicted to be twice future No-Build condition. A doubling in the vehicle traffic volume would result in a 3-dBA increase in noise level (10 Log [2/1] = 3 dBA). A ten-fold increase in traffic would result in a +10 dBA change (10 Log [10/1] = 10 dBA).

For this analysis, DOE used a predicted a 3-dBA increase in the ambient noise level at sensitive receptors located adjacent to the project-related transportation routes as a threshold indicating that further detailed noise analysis (e.g., modeling) would be needed during evaluation of the final design to determine if the impacts would be potentially significant. Otherwise, DOE concluded that the anticipated increase in noise levels resulting from project-related activities would not be noticeable and would require no further analysis.

Vibration Methods

> **Vibration** is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration.

The concept of vibration can be understood in terms of displacement as it relates to the distance a fixed object (e.g., floor) moves from its static position. Common measurements of velocity are not well understood by the average person. For example, the preferred vibration descriptors used to assess human annoyance/interference and building damage impacts are the root-mean-square (RMS) vibration velocity level and the PPV, respectively. The RMS vibration level is expressed in units of VdB. The PPV, expressed in in/sec or mm/sec, represents the maximum instantaneous speed at which a point on the floor moved from its static position (FTA, 2006).

Generally, the background vibration velocity level encountered in residential areas is 50 VdB or lower (FTA, 2006). The threshold of perception for humans to experience vibrations is 65 VdB. Typical sources of vibration include the operation of mechanical equipment indoors, slamming of doors, movement of trains on rails, and ground-breaking construction activities such as blasting and pile driving. The effects on vibration-sensitive receptors from these activities can range from feeling the window and the building floor shake, to rumbling sounds, to causing minor building damage (e.g., cracks in plaster walls) in rare cases. The criterion for minor structural damage is 100 VdB, or 0.12 in/sec (3.05 mm/sec) in terms of PPV for fragile buildings (FTA, 2006).

DOE performed the vibration analysis using progressive levels of review. Initially, DOE prepared a vibration screening analysis to evaluate the potential effects that ground-borne vibrations generated by project-related construction and operational activity would have on adjacent sensitive receptors, including humans, buildings, and vibration-sensitive equipment. If the results of this preliminary analysis showed that screening thresholds would be exceeded, DOE applied further vibration study methods to determine if the impacts would be potentially significant.

4.14.2 AFFECTED ENVIRONMENT

4.14.2.1 Power Plant Site

The proposed Mattoon Power Plant Site and the majority of the land area within 1 mile (1.6 kilometers) of the site boundary are currently in agricultural use. There are about two dozen farmsteads (e.g., farm houses, outbuildings, silos, and pastures) and single-family residences within the 1-mile (1.6-kilometer) region surrounding the site, including about a dozen residences along Western Avenue, situated along the eastern edge of the 1-mile (1.6-kilometer) region. Riddle Elementary School is located just outside the 1-mile (1.6-kilometer) boundary along the southeastern edge.

Several existing noise sources contribute to the ambient noise levels in the vicinity of the proposed Mattoon Power Plant Site. These sources include a Canadian National rail line; traffic on SR 121, CR 800N, CR 900N, and CR 130E; and farmsteads. The Mattoon EIV describes ambient noise levels based on daytime and nighttime measurements collected on August 29, 2006, at various locations along and within 1 mile (1.6 kilometers) of the proposed site boundary, as shown in Figure 4.14-2 (FG Alliance, 2006a). Table 4.14-1 describes geographic information and identifiers used for each noise measurement location.[2]

[2] SL-2 is inside the proposed Mattoon Power Plant Site boundary and is not discussed further in this EIS. Instead, the EIS focuses on ambient noise levels and potential impacts at residences and other receptors beyond the site boundary.

Table 4.14-1. Noise Measurement Locations Near Proposed Mattoon Power Plant Site

Site ID	Location	Proximity to Proposed Mattoon Power Plant Site
SL-1	Along CR 900N between CR 130E and SR 121	Along northern boundary of proposed site near existing farmstead
SL-2	Along Dole Road, approximately 0.25 mile (0.40 kilometer) south of SR 121	Along eastern boundary of proposed site
SL-3	Intersection of Dole Road and CR 800N	Southeast corner of proposed site boundary near existing farmstead
SL-4	Intersection of CR 800N and CR 130E	Southwest corner of proposed site boundary
SL-5	Near intersection of CR 800N, 43rd Street and SR 121	Approximately 1 mile (1.6 kilometers) east of proposed site boundary near existing residence
SL-6	Along CH 13, north of CR 900N	Approximately 0.4 mile (0.6 kilometer) north of proposed site boundary near existing farmstead
SL-7	Intersection of Western Avenue and 43rd Street	More than 1 mile (1.6 kilometers) southeast of proposed site boundary near existing residences and Riddle Elementary School

Source: FG Alliance, 2006a.

Daytime noise measurements were collected at all locations shown on Figure 4.14-2, and nighttime measurements were collected at only three locations: SL-3, SL-5, and SL-7. These locations were chosen because they represent ambient noise levels along the property boundary and at sensitive receptors (residences and one school) that are closest to the proposed Mattoon Power Plant Site. Under Title 35 of the Illinois Administrative Code, Part 900 - "*General Provisions*," daytime hours are the hours between 7:00 AM and 10:00 PM, and nighttime hours are defined between 10:00 PM and 7:00 AM. As reported in the Mattoon EIV (FG Alliance, 2006a), existing noise levels were collected using a Reed Model 322 digital sound level meter with a data logging function in accordance with noise measurements procedures outlined in Title 35 of the Illinois Administrative Code, Part 910. Broadband noise levels were collected and recorded in dBA at each receptor location over 10-minute sampling periods. No octave band measurements were taken (FG Alliance, 2006a). The ambient noise environment in this area ranged from 48 to 59 dBA, which is generally typical of a quiet, rural setting (see Figure 4.14-1). Intermittent increases in the ambient noise due to road and rail traffic fluctuations were observed, which is indicated by the recorded peak maximum levels of 84.7 dBA (at SL-2) and 67.1 dBA (at SL-3) during the day and nighttime measurement periods, respectively. Table 4.14-2 lists the recorded L_{eq} noise levels as well as the maximum and minimum SPL values.

4.14.2.2 Sequestration Site

The proposed sequestration site is the same as the proposed Mattoon Power Plant Site. Therefore, information presented for the proposed power plant site is also applicable to this sequestration site.

4.14.2.3 Utility Corridors

Noise was not measured along the transmission line corridor options because any project-related impacts would be limited to a brief construction period. All of the options traverse mostly agricultural farmland. As such, the ambient noise environment along the corridors is likely to be similar to the proposed Mattoon Power Plant Site.

Table 4.14-2. Measured Ambient Noise Levels and Maximum and Minimum Sound Pressure Level Values

Location	Daytime Noise Levels in dBA			Nighttime Noise Levels in dBA			Time Collected	
	L_{max}	L_{min}	L_{eq}	L_{max}	L_{min}	L_{eq}	Day	Night
SL-1	51.7	44.2	47.9	-	-	-	8:50 AM	-
SL-2	84.7	57.0	59.2	-	-	-	7.53 AM	-
SL-3	61.0	49.9	52.2	67.1	55.5	57.5	8:10 AM	6:34 AM
SL-4	54.8	50.9	52.3	-	-	-	8:31 AM	-
SL-5	63.0	49.7	55.2	64.4	54.1	57.1	9:10 AM	5:49 AM
SL-6	70.9	49.1	51.5	-	-	-	7:32 AM	-
SL-7	76.9	48.3	52.5	64.2	50.9	54.3	9:26 AM	6:09 AM

dBA = A-weighted decibels; L_{max} = highest sound pressure level; L_{min} = lowest sound pressure level; L_{eq} = continuous equivalent sound level.
Source: FG Alliance, 2006a.

The project-related pipeline corridors (e.g., potable water, sanitary wastewater, process water, and natural gas pipelines) would traverse a variety of land uses. No noise measurements were taken along the proposed pipeline corridors because any project-related impacts would be limited to a brief construction period. Near the proposed Mattoon Power Plant Site, the ambient noise environment of the proposed pipeline corridors is generally similar to that described for the proposed power plant site. The ROIs for the pipeline corridors are predominantly agricultural farmland but also include some residences, woodlands, and water bodies. In particular, the proposed process water pipeline corridor includes some residential streets in Mattoon. Additionally, there are two municipal wastewater treatment plants and seven public schools in the ROIs. As such, the ambient noise levels in these areas are likely to be higher than the ambient noise levels near the proposed power plant site.

4.14.2.4 Transportation Corridors

A few residences are located along the transportation routes (e.g., CH 13 and CH 18) leading to the proposed Mattoon Power Plant Site. The existing ambient noise level measured in this area (SL-6) is 51.5 dBA (FG Alliance, 2006a).

4.14.2.5 Regulatory Setting

There are no federal, state, or local government noise standards applicable to proposed construction activities, although the City of Mattoon requires that noise control measures be applied to minimize objectionable noise from equipment. For plant operation, the State of Illinois and City of Mattoon have established maximum noise level threshold standards. Additionally, the FTA establishes guidelines and threshold standards for noise and vibration related to project affecting transit facilities (FTA, 2006). In Coles, Cumberland, and Shelby Counties, there are no noise ordinances or codes that would apply to activities proposed for this project.

State of Illinois Noise Code

Operational activities at the proposed Mattoon Power Plant Site and its related constructed corridors, including the electrical transmission line, CO_2, process water, wastewater, and potable water corridors, would be governed by noise regulations outlined in Title 35 of the Illinois Administrative Code, Part 901 – *Sound Emission Standards and Limitations for Property Line–Noise–Sources.* These regulations define property use by three distinct land classes: Class A properties are considered the most sensitive receptors (i.e., residences), Class B properties are considered businesses and services, and Class C properties are considered utilities, manufacturing, and industrial (i.e., railroads, industrial plants, agricultural). The proposed site is currently a Class C property (agricultural). Properties within the vicinity of the proposed site and its corridors are currently Class A (residences), Class B (businesses), and Class C (roads, industrial, agricultural, railroads).

Part 901 establishes maximum allowable octave band noise levels emitted from any property-line-noise-source located on any Class A, B, or C land to any receiving Class A property. Tables 4.14-3 and 4.14-4 provide threshold values that should not be exceeded to conform to noise spectrum levels at the octave band center frequencies for daytime and nighttime hours, respectively. The noise spectrum limitations do not apply to sound emitted from equipment being used for construction or to impulsive sound produced by blasting activities.

Table 4.14-3. Daytime Maximum Allowable Octave Band Noise Level Emitted to Receiving Class A Property in dB

Octave Band Center Frequency (Hertz)	Class C Property	Class B Property	Class A Property
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

dB = decibels.
Source: Illinois Administrative Code Title 35, Part 901 (35 IAC 901) – ***Sound Emission Standards and Limitations for Property Line-Noise-Sources During Daytime Hours***.

City of Mattoon Noise Ordinance

The City of Mattoon Noise Ordinance establishes a maximum noise level of 70 dB at the property line of any industrial site. Furthermore, it stipulates that noise must be muffled so as not to become objectionable due to intermittence, beat frequency, or shrillness. Noise generated by industrial operations may not exceed current noise levels encountered during the daytime from roadway traffic noise. As such, the City of Mattoon noise ordinance is more restrictive than the state standard; therefore, DOE used the city’s standard for assessing potential impacts.

Table 4.14-4. Nighttime Maximum Allowable Octave Band Noise Levels Emitted to Receiving Class A Property in dB

Octave Band Center Frequency (Hertz)	Class C Property	Class B Property	Class A Property
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

dB = decibels.
Source: 35 IAC 901 - ***Sound Emission Standards and Limitations for Property Line-Noise-Sources During Nighttime Hours.***

FTA Noise and Vibration Impact Assessment Criteria

FTA established guidelines and methods to perform noise and vibration impact assessments for proposed projects involving transit facilities (FTA, 2006). To assess noise impacts, FTA recommends applying the same methods described in Section 4.14.1.2 to identify receptors that the project could potentially affect and to estimate noise contributions from project-related mobile and stationary sources. To determine if a proposed transit project would significantly increase ambient conditions at a particular sensitive receptor, FTA established incremental change and absolute daytime/nighttime limits. For vibration, FTA recommends progressive levels of analysis depending on the type and scale of the project, the stage of project development, and the environmental setting. Such analysis typically begins with a screening process that evaluates relative distance information between the source of ground-borne vibrations and the vibration-sensitive receptors that have been identified. If the relative distance from the source of ground-borne vibrations to a residential receptor is greater than 200 feet (61 meters), FTA guidelines indicate that it is reasonable to conclude that no further evaluation of potential vibration impacts is needed (FTA, 2006). Otherwise, FTA provides criteria to assess the impacts of human annoyance, as well as building and vibration-sensitive equipment damage, using detailed quantitative analyses to predict VdB and PPV values generated by the proposed project.

4.14.3 IMPACTS

4.14.3.1 Construction Impacts

Construction of the proposed Mattoon Power Plant is expected to be typical of other power plants in terms of schedule, equipment used, and other related activities. Noise and vibration would be generated by a mix of mobile and stationary equipment noise sources, including bulldozers, dump trucks, backhoe excavators, graders, jackhammers, cranes, pumps, air compressors, and pneumatic tools during construction of the proposed power plant and the related utilities. For the purposes of this analysis, DOE evaluated the proposed project site an area-wide stationary source with construction equipment operating within its boundary. The results of DOE's noise and vibration analyses show that, in the absence of mitigation, the proposed project would increase ambient noise levels for the sensitive receptors located within the 1-mile (1.6-kilometer) ROI, and possibly beyond. However, impacts from ground-borne vibrations would not be expected.

Power Plant Site

Noise levels generated during construction at the proposed Mattoon Power Plant Site would vary, depending upon the phase of construction. Typical power plant construction activity entails the following phases:

- Site preparation and excavation;
- Foundation and concrete pouring;
- Erection of building components; and
- Finishing and cleanup.

DOE anticipates that construction noise contributions would be greatest at the site during the initial site preparation and excavation phase due to the almost constant loud engine and earth breaking noises generated by the use of heavy equipment such as a backhoe excavator, earth grader, compressor, and dump truck. In addition, noise level increases are anticipated along the off-site routes leading to the site because of entry/exit truck movements, especially during the foundation and concrete pouring construction phase. The other phases would generate less audible noise because the equipment used for these activities (e.g., cranes) generally would be transient in nature or would not generate much noise. Table 4.14-5 provides standard noise levels for construction equipment measured at a reference distance of 50 feet (15.2 meters).

Due to the proximity of the receptors located directly opposite the perimeter of the proposed site (SL-1 and SL-3), mitigation would be necessary to reduce impacts resulting from construction of the power plant. To evaluate the potential maximum effects of the anticipated noise level increases on the sensitive receptors located to north, east, and south/southeast of the site boundary, DOE predicted equipment source noise levels using the logarithmic equation described in Section 4.14.1.2. First, the combined noise level expected from the three noisiest pieces of equipment (e.g., excavators, graders, and dump trucks) used during the initial phase of construction was attenuated over relative distances from the site boundary to the following five directional noise-sensitive receptors:

- SL-1: Along northern boundary of proposed site near existing farmstead
- SL-3: Southeast corner of proposed site boundary near existing farmstead
- SL-5: East of proposed site boundary near existing residence
- SL-6: North of proposed site boundary near existing farmstead
- SL-7: Southeast of proposed site boundary near existing residences and Riddle Elementary School

Table 4.14-5. Common Equipment Sources and Measured Noise Levels at a 50-foot (15-meter) Reference Distance

Equipment	Noise Level in dBA
Backhoe Excavator	85
Bulldozer	80
Grader	85
Dump Truck	91
Concrete Mixer	85

Table 4.14-5. Common Equipment Sources and Measured Noise Levels at a 50-foot (15-meter) Reference Distance

Equipment	Noise Level in dBA
Crane	83
Pump	76
Compressor	81
Jackhammer	88
Pile Driver	101

dBA = A-weighted decibels.
Source: Bolt et al., 1971.

The existing and distance-attenuated noise levels were then logarithmically summed to predict an estimated noise level at each receptor location identified above, as shown in Table 4.14-6. This represents a maximum noise prediction estimate because sound waves generated by the noisiest pieces of equipment are assumed to start at the site boundary and continuously propagate in open air. In addition, the result does not account for any decibel-reducing factors due to atmospheric and ground attenuation effects.

Table 4.14-6. Estimated Noise Levels at Selected Residential Receptor Locations

Sensitive Receptor	Relative Distance in feet (meters)	Existing Ambient Noise Level (dBA)	Combined Equipment Noise Level (dBA)[1]	Equipment Noise Level Attenuated by Distance (dBA)	Estimated Noise Level (dBA)	Change in dBA
SL-1	30 (9.1)	47.9	93	89.1	89.1	+41.2
SL-3	30 (9.1)	52.2	93	89.1	89.1	+36.9
SL-5	5,280 (1,609)	55.2	93	52.5	57.1	+1.9
SL-6	2,000 (610)	51.5	93	61.0	61.5	+10.0
SL-7	5,500 (1,676)	52.5	93	52.2	55.4	+2.9

[1] Combined equipment noise level at 50 feet (15.2 meters) from source.
dBA = A-weighted decibels.

A comparison of the predicted noise levels with the measured daytime ambient noise levels at SL-1, SL-3, and SL-6 shows that, during the hours when construction equipment would be operating as described above (that is, with the noisiest equipment operating), construction of the proposed Mattoon Power Plant would be very noticeable to these receptors because the incremental change from the existing condition would be much greater than 3 dBA. Specifically, the increases would be 41.2, 36.9, and 10 dBA, respectively. Noise level changes of 41.2 and 36.9 would be very significant, as expected with heavy equipment operating right across the street from these two residences. The noise level change of 10 dBA at SL-6 would be perceived as an approximate doubling of the noise level. At SL-5 and SL-7, about 1 mile (1.6 kilometers) from the site, construction of the proposed plant, even with the noisiest equipment operating, would not be noticeable because the incremental change in the noise levels would be less than 3 dBA, the threshold of change detectable by the human ear, at both sensitive receptor locations. Noise mitigation measures, including the use of mufflers to control noise as mandated by the City of Mattoon, would reduce the predicted change in the noise environment.

To evaluate the potential maximum impacts at sites where ambient noise measurements were not taken, DOE estimated the change in noise level that would occur if the entire area in the vicinity of the power plant had a background noise level of 47 dBA. A noise level of 47 dBA was chosen because it was the lowest actual ambient noise level measurement taken for the receptors located adjacent to the plant site (see Table 4.14-6), and allows for the most conservative analysis. Based on an assumed 47 dBA background level, Figure 4.14-3 depicts the change in noise level at various distances from the power plant site. Under this assumption, the threshold 3 dBA increase detectable to the human ear would occur about 1.9 miles (3.1 kilometers) from the boundary of the power plant site, an area that would encompass several dozen residences and Riddle Elementary School. However, at any point where the background noise level was actually higher than 47 dBA, such as along roadways (for example, SR 121, CH 13, Western Avenue, or 43rd Street) or the Canadian National Railroad, Figure 4.14-3 overstates the increase in noise level at those locations.

During power plant startup, steam blowdown would be required toward the end of the construction phase. The blowdown activity would consist of several blows to test the IGCC system, including the gasifier steam lines, HRSG, and steam turbine. DOE anticipates that very loud noises as high as 102 dBA would be generated during all steam blows. The blowdown noise is assumed to originate at the center of the property and would attenuate to approximately 70 dBA at the property boundary, which would affect the two closest residential receptors (SL-1 and SL-3). Noise levels at these two receptors would increase by as much as 21 dBA, compared to the measured background levels shown in Table 4.14-2. At residential receptors located beyond the perimeter of the site (SL-5, SL-6, and SL-7), the ambient noise generated by the steam blows could range from 59 to 64 dBA, which is up to 13 dBA higher than the existing ambient conditions in the vicinity of the proposed power plant, resulting in short-term adverse impacts. Precautionary measures that could be taken to mitigate this impact include limiting steam blows to the daytime hours, providing advance notice to citizens residing near the power plant, and establishing a community outreach program to inform the community at large before beginning plant blowdown activity. Blowdown activities generally would last no more than 2 weeks.

DOE anticipates little or no vibration impact to sensitive receptors during construction because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment, are not located within the 200-foot (61-meter) distance screening and human annoyance threshold for ground-borne vibrations defined by FTA guidance (FTA, 2006).

Sequestration Site

The sequestration site is within the same footprint as the power plant site. Therefore, the impacts on sensitive receptors are included in those as described for the proposed power plant site.

Utility Corridors

Transmission Corridors

Construction of the proposed transmission line in any of the corridor options would occur mostly across agricultural farmland. No major noise and vibration impacts are anticipated; however, a temporary increase in noise due to construction could occur. No major noise and vibration impacts are anticipated at the few residences identified along the transmission line routes because of the nature of transmission line construction techniques and the fact that the duration of construction would be limited to less than 6 months for the 16-mile (25.7-kilometer) line. Temporary construction activities would include activities such as installing concrete footings and erecting towers or poles using an excavator, crane, and handheld tools at discrete intervals along the proposed transmission line corridor.

Pipeline Corridors

Trench excavations or horizontal directional drilling techniques used to install utility pipelines would take less than 6 months to complete and would result in a temporary increase in noise during construction. Elevated noise levels would be experienced by sensitive receptors located in the vicinity of the proposed construction activity. However, due to the temporary and linear nature of the pipeline construction, DOE expects minimal impacts at adjacent noise- and vibration-sensitive receptors. The primary equipment used for these types of short-term linear and limited ground disturbance construction activities includes excavatorg and dump trucks. At roadway and rail crossings, boring machines would be used to complete excavation under the roadway or rail line.

Transportation Corridors

The truck routes connecting I-57 to the proposed Mattoon Power Plant Site are CH 18, CH 13, and SR 121. The existing vehicle traffic count data along the primary transportation routes leading into the proposed site are provided in Table 4.14-7.

Additional construction-related truck trips entering or leaving the proposed site would cause the ambient noise levels to increase. To determine the extent of the anticipated traffic-caused noise level increases, DOE evaluated the existing and projected Build and No-Build traffic data for each roadway and applied a factor to account for the greater noise energy contribution from the movement of trucks compared to passenger cars when traveling along roadways near sensitive receptors. Traffic noise screening results listed in Table 4.14-7 show that, in the absence of mitigation, construction-related vehicles (e.g., passenger cars and trucks) traveling on CH 13 and CH 18 to and from the proposed power plant would appreciably increase the noise level (that is, the change would be greater than 3 dBA) at nearby noise-sensitive receptors. Conversely, the impacts on receptors adjacent to SR 121 would not be noticeable. Mitigation measures that would reduce noise impacts on CH 13 and CH 18 could include adjusting construction worker shifts to lower the total vehicle trips during the morning and evening peak hours.

Table 4.14-7. Projected Noise Level Increase During Construction

Roadway Segment	Existing Peak Hour Volume	Future No-Build Peak Hour Volume	Project New Total/Truck Trips	Future Build Peak Hour Volume	Projected Noise Level Increase
CH 13, south of CH 18	35/0[1]	36/4	592/4	628/8	+7.7 dBA
CH 18, east of CH 13	120/12	125/13	592/4	717/17	+3.9 dBA
SR 121, near site	445/35	463/36	722/5	1,185/41	+2.0 dBA

[1] CH 13 is not currently rated for trucks. Future conditions assume 10 percent trucks based on surrounding roadways.
Peak hour traffic data are provided as total/truck volumes.
Build/No-Build Year: 2009.
Percentage of trucks traveling along CH 18 is assumed to be 10 percent.
Hour volumes are the same.
Project New Total/Truck Trips were obtained from Table 4.13-9.

During construction of the rail spur loop, the noise and vibration impacts would be the same as described for the proposed power plant site.

4.14.3.2 Operational Impacts

Projected noise levels calculated using the noise screening and analysis methods described in Section 4.14.1.2 show that there would be significant permanent ambient noise level increases resulting from operation of the proposed power plant facility at receptors located directly opposite the perimeter of the proposed power plant site. Mitigation would be necessary to reduce impacts resulting from plant operations. Results from the mobile source analysis show that project-induced traffic noise would not be noticeable to noise-sensitive receptors identified near assigned transportation routes, except for those on CH 13. DOE expects no operational impacts at the constructed pipeline corridors because the pipelines would be buried underground. The transmission line may generate some additional noise; however, the results of the impacts analysis show that any noise impacts would be minimal.

Power Plant Site

The principal equipment noise sources during plant operation include the gas combustion turbine/generator, steam turbine/generator, heat recovery systems, turbine air inlets, exhaust stack, six-cell mechanical-draft cooling tower, coal crusher, coal mill, pumps (e.g., feed, circulating), fans, and compressors, as well as noise from piping flow and flared gas. For the most part, these noise sources would be enclosed inside of a building. In addition, noise sources within the building would be fitted with acoustical enclosures or other noise dampening devices to attenuate sound. Conversely, noise generated by equipment installed without full enclosures and exposed to the outside environment (e.g., flare) could potentially increase the ambient noise levels in the surrounding community.

To determine the impacts of normal plant operations, DOE used a noise prediction algorithm to estimate projected equipment noise contributions at the closest sensitive receptor location. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment are not available. DOE used comparable noise data estimated for the proposed Orlando IGCC power plant facility (DOE, 2006) to determine the potential effects of operational noise on sensitive receptors in the vicinity of the proposed Mattoon Power Plant Site. Using the predicted noise level of 53 dBA at 0.6 mile (1 kilometer) obtained in the model run completed for the Orlando gasification project (DOE, 2006), DOE used the logarithmic distance attenuation formula to derive an estimated source noise level of 89 dBA for the proposed Mattoon Power Plant.

DOE applied the source noise level to the proposed 444-acre (180-hectare) site to compute the attenuated noise level at the property boundary, assuming the noise sources would be at the center of the property. Based on a relative distance of 0.4 mile (0.6 kilometer) from the center of the property to the site's perimeter, DOE predicted a noise level of 57 dBA at the property boundary. A comparison of this predicted noise level value with the City of Mattoon maximum noise limits of 70 dBA shows that the proposed facility would be in conformance with local government regulations. The incremental change in the ambient noise level for SL-1 and SL-3 would be 9.1 and 5.6 dBAs, respectively, where a 10 dBA increase is perceived as a doubling in the noise level. The predicted noise level at SL-6 (approximately 4,100 feet [1,250 meters] from center of the proposed site) would be 51 dBA. Based on this analysis, DOE anticipates no noticeable impact at this sensitive receptor because noise contributions from the proposed power plant added to the existing ambient noise level at SL-6 (e.g., 51.5 dBA) would result in an incremental change of less than 3 dBA. Similarly, SL-5 and SL-7 located greater than 4,100 feet (1,250 meters) from the center of the proposed site would not be affected because noise contributions from operations of the proposed power plant would result in an incremental change of less than 3 dBA.

To evaluate the potential maximum impacts at sites where ambient noise measurements were not taken, DOE estimated the change in noise level that would occur if the entire area had a background noise level of 47 dBA. A noise level of 47 dBA was chosen because it was the lowest actual ambient noise level measurement taken for the receptors located adjacent to the plant site (see Table 4.14-6), and allows for the most conservative analysis. Based on an assumed 47 dBA background level, Figure 4.14-4 depicts the change in noise level at various distances from the power plant and sequestration site. Under this assumption, the threshold 3 dBA increase detectable to the human ear would occur about 1.2 miles (1.9 kilometers) from the center of the power plant site (not the boundary, which was used for the assessment of construction-related noise impacts), an area that would encompass about a dozen residences. However, as noted previously, at any point where the background noise level was actually higher than 47 dBA, such as along roadways (for example, SR 121, CH 13, Western Avenue, or 43rd Street) or the Canadian National Railroad, the figure overstates the increase in noise level that would actually occur at those sites.

During coal deliveries, noise would be generated by unloading/loading activities such as the movement of containers, placement of coal feedstock on conveyor systems, and surficial contact of rail containers with other metallic equipment. Based on the estimated number of coal deliveries anticipated for the proposed power plant site, DOE estimated an hourly L_{eq} of 69 dBA from unloading/loading activities at the rail yard using the noise prediction equations listed in Table 5-6 of FTA's guidance document (FTA, 2006). To determine the maximum effects on nearby receptors, DOE assumed that the rail yard noise would occur along the site boundary closest to the receptor. Adding the predicted values for plant operational noise at the boundary (59 dBA) to that of rail yard noise, a combined noise level of 69 dBA was estimated to be generated at the boundary of the plant site during unloading/loading activity. This would increase noise levels at the closest residence (SL-1) by as much as 17 dBA. DOE anticipates little or no increase in the noise level at SL-3 because the coal delivery area would likely be located near the northeastern boundary of the site near the existing railroad, which is more than 1,500 feet (457.2 meters) from SL-3. The foregoing analysis does not include additional intermittent noise and vibrations that may be generated by rail car shakers if they are used to loosen coal material from the walls of the rail cars during unloading. Typically, the shakers are mounted on a hoist assembly and are used intermittently for a 10-second period to induce material movement in the rail car (Bolt, Beranek, & Newman, 1984). Pneumatic or electric rail car shakers could generate noise levels up to 118 dBA (VIBCO, Undated-a; VIBCO, Undated-b; Western Safety Products, 2007). If the shaker is used on every rail car, it is estimated that the shaker would be used 253 to 428 times per week. Final design of the coal handling equipment should consider the noise and vibration contributions from the rail car shakers. Limiting unloading/loading activities to an enclosed or screened area or siting these types of activities farthest away from noise-sensitive receptors would help reduce the potential impact.

During unplanned or unscheduled restarts of the power plant, combustible gases would be diverted to the flare for open burning, which would increase the noise level at sensitive receptor locations. Potential noise sources from flare operation that could affect nearby receptors include steam-turbulent induced noise in piping flow and noise generated by pulsating or fluttering flames from the incomplete combustion of the gases. These noise sources could temporarily increase the ambient noise levels in the vicinity of the flare to a range of 96 to 105 dBAs. Positioning the flare unit at a location farthest from a receptor and implementing measures to control the flow of flare gas or steam through piping connected to the flare unit and the incomplete combustion of gases would reduce the impacts. Measures to minimize these short-term impacts would be addressed during the final conceptual design of the IGCC power plant.

Upon completion of final design plans for the proposed Mattoon Power Plant, octave band field measurements would be taken and compared to the State of Illinois noise spectrum limitations. Mitigation measures would be implemented if measured octave band noise levels exceeded the State of Illinois noise spectrum limitations.

Sequestration Site

Because the proposed CO_2 injection site is within the confines of the proposed Mattoon Power Plant Site, the potential effects of noise associated with that facility are included in the effects discussed for the proposed power plant. During borehole micro-seismic testing and surface seismic surveys performed at the sequestration injection site, ground-borne vibrations may be experienced by nearby receptors.

Utility Corridors

Transmission Corridors

No notable impacts would be anticipated from operation of the electrical transmission lines. However, under wet weather conditions, the transmission lines may generate audible or low frequency noises, commonly referred to as a “humming noise.” The audible noise emitted from transmission lines is caused by the discharge of energy (corona discharge) that occurs when the electrical field strength on the conductor surface is greater than the “breakdown strength” (the field intensity necessary to start a flow of electric current) of the air surrounding the conductor. The intensity of the corona discharge and the resulting audible noise are influenced by atmospheric conditions. Aging or weathering of the conductor surface generally reduces the significance of these factors.

Corona noise would not be noticeable because humans are generally insensitive to low frequency noise. However, in some cases, corona noise could be annoying to receptors that are located very near the transmission lines. To mitigate this occurrence, transmission lines are now designed, constructed, and maintained to operate below the corona-inception voltage.

Corona noise is caused by partial discharge on insulators and in air surrounding electrical conductors of overhead power lines.

Pipeline Corridors

No noise or vibration impacts would be anticipated at the proposed pipeline corridors during plant operation.

Transportation Corridors

Additional traffic resulting from operational truck trips entering or leaving the proposed site would be expected to increase the ambient noise levels at receptors adjacent to the assigned truck transportation routes. To determine the extent of the anticipated noise level increases, the existing traffic and the proposed Build and No-Build traffic data were evaluated for each roadway as described in Section 4.14.1.2. Results show that vehicle trips on roadways leading to the proposed Mattoon Power Plant Site would have no adverse effect on noise-sensitive receptors near CH 18 and SR 121 during normal plant operations because the predicted change in the ambient noise level would be 1.6 and 0.7 dBA, respectively, which is below the 3 dBA change detectable to the human ear. However, in the absence of mitigation, sensitive receptors near CH 13 would experience ambient noise level increases of up to 3.9 dBA. Table 4.14-8 details the projected noise level increase during plant operation.

During the early phase of plant operation, short-term traffic noise impacts are anticipated along the transportation routes related to an increased level of trucks entering/leaving the proposed power plant and sequestration site. Adhering to the recommended truck routes and limiting trips to the daytime hours would help reduce noise impacts at residences along transportation routes.

Table 4.14-8. Projected Noise Level Increase During Plant Operation

Roadway Segment	Existing Peak Hour Volume	Future No-Build Peak Hour Volume	Project New Total/Truck Trips	Future Build Peak Hour Volume	Projected Noise Level Increase
CH 13, south of CH 18	35/0[1]	38/4	134/3	172/7	3.9 dBA
CH 18, east of Ch 13	120/12	129/13	134/3	263/16	1.6 dBA
SR 121, near site	445/35	477/38	164/4	641/42	0.7 dBA

[1] CH 13 is not currently rated for trucks. Future conditions assume 10 percent trucks based on surrounding roadways.
Peak hour traffic data are provided as total/truck volumes.
Build/No-Build Year: 2012.
Percentage of trucks traveling along CH 18 is assumed to be 10 percent.
Hour volumes are the same.
Project New Total/Truck Trips were obtained from Table 4.13-13.
dBA = A-weighted decibels.

No noise and vibration-sensitive land use impacts would be anticipated along access routes leading to the pipeline corridors.

Five 100-unit trains per week for coal deliveries would use the Canadian National–Peoria spur rail line. Based on the estimated noise levels listed in FTA's guidance document (FTA, 2006), L_{max} values ranging from 76 to 88 dBA are anticipated from the locomotive, rail cars, whistles/horns, and track switches/crossovers as the freight trains pass by. The L_{max} values are based on an operating speed of 30 mph (48.3 kmph), as measured approximately 50 feet (15.2 meters) from the track's centerline. Comparing the number of additional rail trips projected for coal deliveries during plant operations with the existing two daily rail trips on the Canadian National–Peoria spur rail and the 12 freight trains running daily on the Canadian National main line, DOE estimates that trains using the spur would increase about 71 percent (five trains coming and going [10 trips] added to 14 trains per week) on the Peoria spur and 10 percent on the Canadian National main line (five trains coming and going [10 trips] added to 84 trains per week). Given that the change would amount to about one additional train per day coming or going from the site, the incremental change in the noise environment would be minimal.

Findings from the vibration screening analysis showed that there would be one residential receptor within FTA's distance threshold of 200 feet (61 meters) in one of the potential configurations for the rail spur loop track. As such, DOE applied further vibration study methods to determine if the impacts would be potentially significant to one of the receptors located directly opposite the perimeter of the site (e.g., SL-3). Using the FTA impact criteria for general vibration assessments, DOE compared the established 80 VdB-threshold limit for infrequent rail events to vibration levels that have been predicted in the generalized ground surface vibration curves. An "infrequent event" is defined as fewer than 30 vibration causing events (e.g., rail trips) of the same kind per day (FTA, 2006).

Results from the generalized vibration curves (FTA, 2006) show that freight trains traveling on the rail spur loop at speeds greater than 20 miles per hour (32 kilometers per hour) would cause an exceedance of the FTA's 80 VdB impact threshold limit, and thus vibration impacts are considered probable at any residential receptor located within 40 feet (12 meters) of the track's centerline. However, at lower train speeds or distances greater than 40 feet (12 meters) from the residential receptor, appreciable vibration impacts are not anticipated. A detailed analysis would be needed during final design to help determine appropriate vibration control measures, if deemed necessary to reduce anticipated vibration at sensitive receptors closest to the site (SL-1 and SL-3). The FTA's generalized curves represent the upper range of historical measurement data from well-maintained systems. Other factors, including track surface and rail car suspension characteristics, wheel type and condition, and foundation of the potentially affected building, as well as the placement of the rail spur loop on the site, would need to be evaluated to determine whether vibration from the rail spur loop would affect nearby residences (FTA, 2006).

In some cases geologic conditions, such as stiff clayey soils or shallow bedrock occurring at depths less than 30 feet (9.1 meters) below the surface can result in ground-borne vibrations propagating through the subsurface soils at greater than expected distances from the track (FTA, 2006). Based on the nature of the subsurface soils (e.g., silty clay and loam) and a depth to bedrock of 175 feet (53.3 meters) at the proposed Mattoon Power Plant Site, ground-borne vibrations are not expected to propagate over extended distances (FG Alliance, 2006e).

4.15 UTILITY SYSTEMS

4.15.1 INTRODUCTION

This section identifies utility systems that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Mattoon Power Plant and Sequestration Site and related corridors. It addresses the ability of the existing utility infrastructure to meet the needs of the proposed FutureGen Project while continuing to meet the needs of other users, and also addresses the question of whether construction of the proposed FutureGen Project could physically disrupt existing utility system features (pipelines, cables, etc.) encountered during construction.

4.15.1.1 Region of Influence

The ROI for utility systems includes two components: (1) the existing infrastructure that provides process and potable water, sanitary wastewater treatment, electricity, and natural gas to nearby existing users and that would also provide service to the proposed project; and (2) pipelines, transmission lines, and other utility lines that lie within or cross the proposed power plant and sequestration site or utility corridors.

4.15.1.2 Method of Analysis

Based on data provided in the Mattoon EIV (FG Alliance, 2006a), DOE performed a comparative assessment of the FutureGen Project utility needs versus the existing infrastructure to determine if the proposed project would strain any of the existing systems. Additionally, DOE used data provided in the EIV (FG Alliance, 2006a) to identify the presence of utility infrastructure that could be affected by project construction.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect the capacity of public water utilities directly or indirectly;
- Require extension of water mains involving off-site construction for connection with a public water source;
- Require water supply for fire suppression that would exceed water supply capacity;
- Affect the capacity of public wastewater utilities;
- Require extension of sewer mains involving off-site construction for connection with a public wastewater system; and
- Affect the capacity and distribution of local and regional energy and fuel suppliers.

4.15.2 AFFECTED ENVIRONMENT

4.15.2.1 Potable Water Supply

The City of Mattoon draws its potable water supply from Lake Paradise and Lake Mattoon in the Little Wabash River Basin. Currently, Mattoon’s daily average potable water use of 2.0 MGD (7.6 MLD) is taken from the Little Wabash River Basin and deposited in the Embarras River Basin as effluent from the wastewater treatment plant (WWTP).

Potable water would be supplied to the Mattoon Power Plant from the city’s public potable water system. A 1-mile (1.6-kilometer) extension would be constructed from the proposed Mattoon Power

Plant Site to a 10-inch (25.4-centimeter) potable water pipeline on 43rd Street (CR 300E) south of SR 121. On August 22, 2006, a hydrant flow test was conducted on the fire hydrant nearest the connection point south of the intersection of 43rd Street and SR 121. The hydrant had a flow of 3,438 gallons (13,014 liters) with a residual head of 20 psi (0.14 megapascals) (FG Alliance, 2006a).

Mattoon's potable water treatment plant was built near Lake Paradise in 1999. It is located 5.5 miles (8.9 kilometers) south of the proposed Mattoon Power Plant Site. Lake Paradise is Mattoon's primary potable water source, with the larger Lake Mattoon serving as a secondary source. The plant has a capacity to treat 7.1 MGD (26.9 MLD). From 2001 through 2005, the plant treated an average of 2.26 MGD (8.6 MLD).

4.15.2.2 Process Water Supply

The combined effluent from the municipal WWTPs of Mattoon and possibly Charleston, Illinois, would provide process water for the proposed power plant. Process water would be supplied through a new 6.2-mile (10.0-kilometer) pipeline from the Mattoon WWTP to the power plant site, with the addition of a new 8.1-mile (13-kilometer) pipeline from the Charleston WWTP if necessary. Analysis of daily effluent data from 2004 and 2005 from these two plants indicates that, during these 2 years, there were 179 non-consecutive days where the combined daily effluent amount was below 4.3 MGD (16.3 MLD) (FG Alliance, 2006a). The daily average of the combined effluent over that 2-year period was 7.1 MGD (26.9 MLD). The process water source would also be used for fire suppression. An on-site reservoir could be constructed to store up to 25 million gallons (94.6 million liters) of process water to satisfy water requirements. A small reservoir (7 acres [2.8 hectares]) would be adequate. If a larger reservoir were constructed (approximately 40 acres [16.2 hectares] in size) with a capacity of 200 million gallons (757 million liters), the Mattoon WWTP effluent would be sufficient by itself to supply the proposed plant's process water.

4.15.2.3 Sanitary Wastewater System

The City of Mattoon proposes to supply sanitary sewer service through a 1.25-mile (2-kilometer) extension of the city's existing public wastewater system (FG Alliance, 2006a). In 2004, Mattoon completed a $10 million upgrade to its WWTP. The plant now has the capacity to process 14.0 MGD (53.0 MLD) as a daily maximum and has a design average flow of 5.3 MGD (20 MLD). The current annual average daily flow for this sewer system is 4.4 MGD (16.7 MLD). The force main that would serve the power plant would empty into a lift station that has a maximum capacity of 158,000 gallons (598,095 liters) per day. Currently, during wet flows, it reaches 33,500 gallons (126,811 liters) per day, so the lift station is operating at less than 25 percent of its maximum capacity.

4.15.2.4 Electricity Grid, Voltage, and Demand

The proposed Mattoon Power Plant and Sequestration Site is located in the Southeastern Electric Reliability Corporation (SERC) region. The SERC region includes portions of 16 states in the southeastern and central U.S., and covers an area of approximately 560,000 square miles (1,450,400 square kilometers). SERC is the regional reliability organization for this part of the country, charged with operating and ensuring reliability of the electrical transmission grid.

> Annual average sales of electrical energy in the U.S. are expected to grow from 3,567,000 GWh in 2004 to 5,341,000 GWh by 2030—an increase of about 50 percent (EIA, 2006). The FutureGen Project is scheduled to go on line in 2012 and may contribute toward meeting this need; however, its primary purpose is to serve as a research and development project.

Peak demand in the SERC region occurs during the summer months. As of 2006, the total demand was

188,763 megawatts (MW), and this is forecast to increase to 226,921 MW by 2015 (North American Electric Reliability Council [NERC], 2006), representing a growth rate of 2.1 percent per year. Annual electric energy usage in the region was 962,054 gigawatt-hours (GWh) in 2005 and was forecast to be 973,215 GWh in 2006. Energy usage is forecast to grow at 1.7 percent per year over 10 years, which would result in a potential energy demand of 1,132,654 GWh by 2015 (NERC, 2006).

Current resources in the SERC region equal nearly 250,000 MW (NERC, 2006). This supply, combined with new energy resources of 36,759 MW projected to come on line between 2006 and 2015 (NERC, 2006), would lead to regional supplies exceeding demand by about 60,000 MW in 2015. Thus, the SERC region will likely have significantly more generation capability than needed to meet reliability and adequacy concerns in 2015.

As described in Chapter 2, there are several options for delivering power from the proposed Mattoon Power Plant Site to the regional transmission grid. The nearest high-voltage power line is the 138-kV transmission line running north-south and located less than 0.5 mile (0.8 kilometer) east of the site. A new substation would be required for this connection. The Mattoon West 138-kV substation is located 1.5 miles (2.4 kilometers) southeast and could also be a connection point for the 138-kVsystem. Another option is to connect to the 345-kV system at the Neoga South Substation with a new 16-mile (25.7-kilometer) line south. A preliminary interconnection study (FG Alliance, 2006a) estimates the capacities of the existing transmission network to deliver power from the proposed facility (Table 4.15-1).

Table 4.15-1. Capacities of Existing Transmission Network

Scenario	ATC (Thermal Capacity)		PV (Voltage Capacity)	
	Summer	Winter	Summer	Winter
138-kV	327 MW	531 MW	475 MW	500 MW
345-kV	529 MW	1,025 MW	1,150 MW	1,213 MW

kV = kilovolts; MW = megawatts.
Source: PowerWorld Corporation, 2006.

4.15.2.5 Natural Gas

Illinois produces minimal quantities of natural gas and consumes roughly five times what it produces. The state receives substantial natural gas supplies from traditional U.S. source regions along the Gulf Coast and in the mid-continent, as well as from Canada. Illinois ranks first in the nation in per capita annual residential natural gas demand, second in total residential consumption, and third in total commercial consumption of natural gas among the states. Illinois is an important natural gas distribution and storage state, ranking fifth in the nation in natural gas storage capacity, primarily through underground storage of gas used to meet peak winter heating demand in the Midwest and Northeast.

The proposed Mattoon Power Plant and Sequestration Site would have access to a natural gas pipeline owned by Trunkline Gas Company located within approximately 0.25 mile (0.4 kilometer), as shown in Figure 4.15-1. The gas pipeline is a looped high-pressure system. A new tap and delivery station would be required to serve the FutureGen Project.

4.15.2.6 CO_2 Pipeline

No CO_2 pipelines exist in the vicinity of the proposed power plant site.

4.15.3 IMPACTS

4.15.3.1 Construction Impacts

During construction, construction equipment, particularly trenching equipment, could accidentally sever or damage existing underground lines. Additionally, construction equipment could damage power or telephone poles and lines if the equipment were to come into contact with them. However, all of the proposed ROWs have sufficient width to allow for the safe addition of project-related lines without interfering with the existing utilities if standard construction practices are followed. Construction requirements for new utility infrastructure are presented in Table 4.15-2.

Table 4.15-2. Utility System Construction Requirements

Infrastructure Element	Equipment	Duration	Manpower
Potable water pipeline 1 mile (1.6 kilometers) to access nearest pipeline	Backhoe and other small equipment, boring machine for road and rail crossings	1 month	5 workers
Process water pipeline From Mattoon WWTP (6.2 miles [10 kilometers]) and possibly Charleston WWTP (8.1 miles [13.0 kilometers]), wet well, and pumping station	Track hoe, backhoe, other small equipment, boring machine for road and rail crossings	4-6 months each for Mattoon and Charleston portions (could be concurrent)	5-10 workers each for Mattoon and Charleston portions
Sanitary wastewater pipeline 1.25 miles (2.0 kilometers)	Backhoe and other small equipment, boring machine for road and rail crossings	1 month	5 workers
Electric transmission line Option 1: 138-kV line, 2.5 miles (4 kilometers) Option 2: 345-kV line, 16 miles (25.7 kilometers)	Crane for setting poles, bulldozer for earth moving and path leveling, and several bucket trucks	Not estimated	Not estimated
Natural gas pipeline 0.25 mile (0.4 kilometer) to access nearest pipe	Gas pipeline equipment, horizontal directional drilling equipment, other small equipment	1 month	5 workers
CO_2 pipeline	Sequestration site is same as plant site, so connecting pipeline is on plant site	Not estimated	Not estimated

WWTP = wastewater treatment plant.
Source: FG Alliance, 2006a.

Power Plant Site

The proposed Mattoon Power Plant Site does not have any utility lines crossing the site and thus construction at the site would not cause any utility disturbances.

Sequestration Site

The proposed Mattoon Sequestration Site is the same as the proposed power plant site and does not contain utility lines. Consequently, construction activities at the site would not cause any utility disturbances. Utility needs at the sequestration site would be limited to the provision of an electric service line to operate pumps and other equipment.

Utility Corridors

The proposed utility corridors are shown in Figure 4.15-1.

Potable Water Supply

The City of Mattoon proposes to supply potable water for the FutureGen Project from its public potable water system via a 1-mile (1.6-kilometer) extension of the potable water system in the ROW of CR 800N from the proposed Mattoon Power Plant Site to a 10-inch (25.4-centimeter) potable water pipeline on 43rd Street (CR 300E) south of SR 121. Mattoon Township has control of the proposed potable water pipeline ROW and has committed to allow the potable water pipeline to be placed on the ROW.

There are other utilities in the CR 800N ROW. There is a buried telephone cable running the entire length on the north ROW line. Moultrie County Rural Public Water District has a potable water line running between the telephone cable and the roadway on the north side. This line runs 0.5 mile (0.8 kilometer) east of the site to its terminus. An electric transmission line runs in the ROW on the south side of the road beginning 0.5 mile (0.8 kilometer) east of the site and continuing to 43rd Street. A 138-kV transmission line and a set of three high-capacity gas lines cross the proposed ROW perpendicularly 0.5 mile (0.8 kilometer) east of the proposed site.

Process Water Supply

The effluent from the municipal WWTPs of Mattoon and possibly Charleston, Illinois, would provide process water for the proposed power plant. The Mattoon WWTP is located 6.2 miles (10 kilometers) from the proposed Mattoon Power Plant Site. The process water pipeline would be on existing public ROW for all but 2 miles (3.2 kilometers). The existing public ROW varies in width.

North of the Mattoon WWTP, the process water supply corridor is an existing utility easement that is at least 30 feet (9.1 meters) wide. This portion of the corridor contains an existing gravity-flow sanitary sewer. The corridor then follows the Mattoon street ROW through town to the northern edge of Mattoon. The street ROW is a minimum of 70 feet (21.3 meters) wide. At different points, the street ROW contains water lines, sewer lines, underground telephone lines, and overhead electric lines. North of the Mattoon city limits, the corridor lies on private property for 2 miles (3.2 kilometers), which would require new easements. There are no existing utilities in the proposed easements, although there would be transverse crossings in existing public ROW. For the last 3.5 miles (5.6 kilometers) of the corridor, the pipeline would be placed on the public ROW of CR 900N. The road ROW is 60 feet (18.3 meters) wide, with the roadway surface averaging 20 feet (6.1 meters) wide. There is an existing underground telephone line and overhead electric lines in this ROW.

An on-site reservoir could be constructed to store up to 25 million gallons (94.6 million liters) of cooling water. The reservoir could be as small as 7 acres (2.8 hectares) or up to 40 acres (16.2 hectares) with a capacity of 200 gallons (757 million liters). If the larger on-site reservoir were developed, the corridor to the Mattoon WWTP would be sufficient to supply process water to the proposed FutureGen

Project. If the larger reservoir were not developed, 8.1 miles (13.0 kilometers) of new pipeline would be required to connect the Charleston WWTP to the proposed Mattoon Power Plant Site piping system. The plant's effluent would be captured in a wet well to be built at the existing outflow structure. From there, a water line would run on City of Charleston property from the WWTP to the ROW of the Lincoln Prairie Grass Bike Trail. The water line would continue on the bike trail into Mattoon. The bike trail is owned by the cities of Charleston and Mattoon. The bike trail ROW is 100 feet (30.5 meters) wide, while the bike trail surface is 10 feet (3.0 meters) wide. The bike trail ROW has existing 138-kV overhead electric lines running its entire length, and also contains buried fiber optic cable.

Fire protection water for the proposed Mattoon Power Plant Site would be supplied by the on-site reservoir.

Sanitary Wastewater System

The City of Mattoon proposes to supply sanitary sewer service through an extension of the city's existing public wastewater system. A sanitary sewer lift station would be constructed at the site. A 1.25-mile (2.0-kilometer) wastewater force main would be constructed in the ROW of SR 121 from the proposed Mattoon Power Plant Site to an existing sanitary lift station in the northeast quadrant of SR 121 and 43rd Street (CR 300E). For the proposed sanitary wastewater pipeline along SR 121, the IDOT maintains the ROW and has committed to allow the wastewater force main to be placed on the ROW (FG Alliance, 2006a).

There are other utilities in the SR 121 ROW. A buried telephone cable runs the entire length of the north ROW line. An electric transmission line on the north side of the ROW runs 0.3 mile (0.5 kilometer) to the east from the eastern edge of the site.

Transmission Line System

Two options for connecting the power plant site to existing transmission lines are being considered. Option 1 would connect with an existing 138-kV transmission line by one of three scenarios. One scenario would construct a transmission line from the proposed Mattoon Power Plant Site and tie into the Ameren 138-kV system 0.5 mile (0.8 kilometer) east of the site with transfer switching. The second scenario would tie directly into the existing 138-kV line with a new substation. The third scenario would run a new transmission line south next to the existing 138-kV line and connect with the existing 138-kV Mattoon West substation 2.5 miles (4.0 kilometers) southeast of the site adjacent to SR 16. The existing substation would need to be upgraded. Option 2 would connect to the 345-kV system at the Neoga South Substation with a new 16-mile (25.7-kilometer) line running south.

Ameren Corporation indicates that the standard width of a new easement for a transmission line is 150 feet (45.7 meters) (FG Alliance, 2006a). This width can be reduced, although narrower ROWs require closer tower spacing to avoid excess line sag. If a new power line is constructed next to an existing line, then an additional 100-foot (30.5-meter) easement would be necessary. It would be possible to add additional conductors on the existing 138-kV utility poles near the site and change the existing single-circuit line to a double circuit. The City of Mattoon has purchased a corridor easement to connect the site to the existing 138-kV electric transmission line.

Natural Gas Pipeline

The Trunkline Gas high-pressure mainline is located approximately 0.25 mile (0.4 kilometer) east of the proposed Mattoon Power Plant Site. The most direct route from the site to the existing gas line is along the CR 800N ROW. Figure 4.15-1 illustrates the location of the gas main relative to the site and the closest point of approach from the gas main to the site, which would be along CR 800N. However, the pipeline ROW could be located on other property adjacent to the proposed Mattoon Power Plant Site, as shown in Figure 4.15-1. This would allow for optimization of the final corridor from the gas main onto the site, depending on plant design and configuration.

CO_2 Pipeline

The proposed CO_2 injection well would be located within the power plant site. Therefore, no CO_2 corridor would be necessary.

4.15.3.2 Operational Impacts

As described below, all of the proposed operational requirements for potable and process water needs, sanitary wastewater needs, and natural gas are well within the capacities of currently existing systems. A report from MISO, scheduled for completion in 2007, is expected to provide a feasibility analysis of operational impacts on the existing transmission system.

Power Plant Requirements

Potable Water Supply

The daily potable water demand from the proposed Mattoon Power Plant Site would be limited to the sanitary needs of a workforce of 200 employees (FG Alliance, 2006a). For 200 employees using 30 gallons (114 liters) of potable water per day, the potable water consumption rate would average 4.2 gallons (15.9 liters) per minute, which would be negligible compared to the water supply capacity of the pipeline that would be connected to the plant (i.e., 3,438 gallons per minute [13,014 liters per minute]). Therefore, the operational needs of the FutureGen Project would have no adverse effect on the ability of the potable water supply system to meet any foreseeable demands.

Process Water Supply

As previously mentioned, an analysis of daily effluent data from 2004 and 2005 from the Mattoon and Charleston WWTPs indicates that during these 2 years, there were 179 non-consecutive days where the combined daily effluent amount was below 4.3 MGD (16.3 MLD) (Patrick Engineering, 2006a). The daily average of the combined effluent over that 2-year period was 7.1 MGD (26.7 MLD). Compared to the 4.3 MGD (16.3 MLD) average process water requirement for the FutureGen Project, the maximum combined cumulative shortfall for the two effluent streams would be 13.8 million gallons (52.3 million liters). The 13.8 million gallons (52.3 million liters) represents the deficit calculated to occur during the longest uninterrupted deficit period observed during two consecutive dry years. To provide sufficient process water at the Mattoon Power Plant Site, this shortfall would be made up by constructing a reservoir on the site. The WWTP effluent would be pumped into the reservoir when flows were above the required 4.3 MGD (16.3 MLD), and would then be available to the plant during shortfall periods. To supplement the WWTP effluent, the site's stormwater runoff could be stored in the reservoir as well.

A large percentage of the Mattoon sewer system that feeds the WWTP is combined sewer (i.e., contains both sanitary flow and storm flow). On an annual average, the stormwater flow accounts for 2.4 MGD (9.1 MLD) of the WWTP's 4.4 MGD (16.7 MLD) total. Because a large portion of the WWTP effluent that would provide process water to the proposed Mattoon Power Plant comes from storm runoff, the supply could be affected by drought. In 2005, Mattoon received 22.97 inches (58.34 centimeters) of rainfall. This was the lowest annual total of the last 5 years by 5.88 inches

(14.9 centimeters), or 25 percent. The 2005 annual rainfall was 42 percent below the area's average annual rainfall of 39.00 inches (99.1 centimeters) (Table 4.15-3).

Table 4.15-3. Annual Rainfall Totals for Mattoon Memorial Airport

Year	Total Annual Rainfall (inches [centimeters])
2001	35.77 (90.9)
2002	42.55 (108.1)
2003	28.85 (73.3)
2004	38.88 (98.8)
2005	22.97 (58.3)
Historic Average	**39.00 (99.1)**

Source: FG Alliance, 2006a.

An on-site reservoir is being considered for use for the combined flow from the Charleston and Mattoon reservoirs to ensure water is available to the power plant during drought. Conditions show that a 25-million-gallon (94.6-million-liter) reservoir would be more than adequate to store water during the lowest 2005 low precipitation period (FG Alliance, 2006a). This reservoir could be as small as 7 acres (2.8 hectares). Alternatively, a larger reservoir could be built that could hold 200 million gallons (757 million liters), which would eliminate the need for the Charleston WWTP to supplement the effluent from the Mattoon WWTP. The size of this reservoir could be up to 40 acres (16.2 hectares).

In summary, in 2005, a year that was well below average for rainfall, the Mattoon and Charleston WWTP effluent supply was sufficient to supply current needs plus expected future needs, including the needs of the FutureGen Project with the on-site reservoir available to cover for shortfall periods. Therefore, the project would have no adverse effect on the capacity of the process water supply system, including the availability of water for fire protection.

Sanitary Wastewater System

Because the FutureGen Project would use a ZLD system, there would be no process-related wastewater disposal associated with the project. The daily sanitary wastewater effluent from the power plant would be limited to the sanitary needs of a workforce of 200 employees. Assuming 30 gallons (114 liters) of sanitary wastewater per employee per day (FG Alliance, 2006e), the wastewater needs would equal 6,000 gallons (22, 712 liters) per day. As noted above, the sanitary wastewater force main would empty into a lift station that is operating at less than 25 percent of its maximum capacity, and would therefore be capable of handling project-related sanitary wastewater. The water treatment plant has a capacity to treat 14 million gallons (53.0 million liters) of water each day, but averaged just 4.4 million gallons (16.7 million liters) per day, 31 percent of capacity, from 2001 through 2005. Therefore, the operational requirements of the project would have no adverse effect on the wastewater treatment plant's ability to meet current and future sanitary wastewater treatment needs.

Transmission Line System

The proposed power plant would provide a nominal 275 MW of capacity. The project is proposed to operate at an 85 percent plant factor over the long term after reaching steady-state conditions, which would result in an average output of 2,047,650 megawatt-hours (MWh) of energy per year.

The electrical system interconnection was evaluated with both 138-kV and 345-kV connection options (PowerWorld Corporation, 2006). Based on the conclusions of PowerWorld's report, both the 138-kV and 345-kV interconnections are generally capable of supporting the rated output of the proposed FutureGen facility. The simulations reveal that the system could support each of the proposed interconnections at the rated output of the proposed facility, under the specific summer and winter conditions tested. Thus, it appears at this time that the existing electrical transmission system would be adequate to handle the electrical output of the proposed FutureGen Project, and the project would have minimal effects on the system.

PowerWorld's modeling indicates that the 345-kV interconnection is generally more robust than the 138-kV interconnection with respect to both thermal and voltage constraints. It is likely that the 138-kV interconnection may require more reactive power capability or supplemental voltage support than the 345-kV interconnection to satisfy operating criteria and stability margins. It is possible that either of the proposed interconnections could be subject to curtailment under specific loading conditions and contingencies not modeled in PowerWorld's study. Curtailment occurs when the system controller from the Independent System Operator (in this case, MISO) observes a thermal or voltage limit overload for an operating situation or, upon performing a contingency analysis, predicts a thermal or voltage limit overload for a planned project. If this occurs, MISO would notify the participant or power source that new transmission facilities must be completed to avoid this problem. If the facility is predicted to cause an overload, it would have to operate in a curtailed mode. If the power source is already operating and an overload is apparent, MISO would issue a directive to curtail the production of energy from a particular facility or more than one facility on a pro-rata basis if several facilities are involved in causing the overload. A MISO study has been requested, which would clarify the ultimate line requirements to transmit power from the FutureGen Project.

Natural Gas Pipeline

The capacity of a high pressure transmission pipeline consisting of a 26-inch (66.0-centimeter) diameter mainline and 30-inch (76.2-centimeter) diameter and 36-inch (91.4-centimeter) diameter loop lines would typically be significantly more than 1 billion cubic feet (28.3 million cubic meters) per day, or 42 million cubic feet (1.3 million cubic meters) per hour. This is more than sufficient to supply the demands of the proposed FutureGen Project, which could be up to 1.8 million cubic feet (50,970 cubic meters) per hour. Therefore, the operational needs of the project would not have an adverse effect on the ability of the system to supply existing and other future demands for natural gas.

CO_2 Pipeline

The CO_2 pipeline would be constructed on the same site as the power plant and would have sufficient capacity to accommodate the CO_2 expected from the proposed Mattoon Power Plant.

Utility Corridors

Once construction was completed, the operation of project-related utilities would have no impact on the operation of other utilities sharing the corridors.

4.16 MATERIALS AND WASTE MANAGEMENT

4.16.1 INTRODUCTION

Construction and operation of the FutureGen Project would require a source of coal, access to markets for sulfur products, a means to reuse by-products such as slag, and the ability to capture and sequester CO_2, and dispose of any waste that is generated. This section discusses the capabilities of the proposed Mattoon Site to meet each of these requirements. It describes the potential impact of the demands posed by the FutureGen Project on the supply of construction and operational materials in the region. It also discusses the impacts to regional waste management resources.

4.16.1.1 Region of Influence

The ROI includes waste management facilities; industries that could use the FutureGen byproducts; and the suppliers of construction materials, coal, and process chemicals used in the construction and operation of the proposed FutureGen Project (power plant and sequestration site, CO_2 distribution system, and associated utilities and transportation infrastructure). The extent of the ROI varies by material and waste type. For example, the ROI for construction material suppliers and solid waste disposal facilities is small (within about 50 miles [80 kilometers]) of the proposed Mattoon Site) because these types of resources are widely available and the large volumes of materials that would be needed or waste that would be generated are costly to transport over large distances. Treatment and disposal facilities for hazardous waste are less common and the associated ROI includes a multi-state (Illinois, Indiana, Ohio, Michigan) area extending 100 to 400 miles (160 to 644 kilometers) from the site. The ROI for coal and process chemicals, as well as the sulfur product, includes the State of Illinois and could extend farther if the cost or value of the commodity makes it economical to transport over a greater distance.

4.16.1.2 Method of Analysis

DOE evaluated impacts by comparing the demands posed by construction and operation of the FutureGen power plant, sequestration site, utility corridors, and transportation infrastructure to the capacities of materials suppliers and waste management facilities within the ROI. The analysis also evaluated regional demand and access to markets for sulfur products. DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause new sources of construction materials and operational supplies to be built, such as new mining areas, processing plants, or fabrication plants;
- Affect the capacity of existing material suppliers and industries in the region;
- Create waste for which there are no commercially available disposal or treatment technologies;
- Create hazardous waste in quantities that would require a treatment, storage, or disposal (TSD) permit;
- Affect the capacity of hazardous waste collection services and landfills;
- Create reasonably foreseeable conditions that would increase the risk of a hazardous waste release; and
- Create reasonably foreseeable conditions that would increase the risk of a hazardous material release.

DOE reviewed information provided in the Mattoon Site EIV (FG Alliance, 2006a) and proposal (FG Site Proposal [Mattoon, Illinois], 2006). Letters of interest, bid prices, and other prospective material supplier information were identified for use in the EIS. DOE then consulted waste management and

material supplier information compiled by state agencies and trade organizations to confirm availability of these resources in the ROI. Uncertainty regarding the specific technologies that would be employed in the FutureGen facility and variability in the potential coal feeds made it difficult to quantify operational materials requirements and waste generation. The maximum value for each item was used in the analysis to bound the potential impacts of the technologies that could be selected. Limited information is available regarding materials requirements or waste generation for construction. DOE used NEPA documentation and design information for facilities of similar scope and size to augment the FutureGen-specific information.

4.16.2 AFFECTED ENVIRONMENT

The Mattoon Power Plant and Sequestration Site is 444 acres (180 hectares) and is primarily (93 percent) farm crops with public ROW (3 percent) and rural residential development and woodlands (4 percent). The proposed Mattoon Power Plant and Sequestration Site is typical of farmland throughout the area, which is used for row crop production (primarily corn and soybeans).

A review of various IEPA databases indicates that the proposed site is not associated with voluntary cleanup, leaking underground storage tanks, Resource Conservation and Recovery Act (RCRA) permitted activities, or solid waste landfills. There are no known existing site hazards (FG Alliance, 2006a).

4.16.2.1 Construction Materials

Concrete, asphalt, and aggregate producers within a 50-mile (80-kilometer) radius of the Mattoon Site were asked to identify their capacity to provide materials to support construction of the FutureGen facility. Inquiries were also made regarding the availability and amount of fill material.

Concrete

There are five concrete batch plants within 20 miles (32 kilometers) of the Mattoon Site with a total hourly plant capacity of 500 cubic yards (382 cubic meters) per hour (FG Alliance, 2006a). These plants are:

- Mid-Illinois Concrete, Inc., with a plant in Mattoon capable of batching 140 cubic yards (107 cubic meters) per hour, and a plant in Charleston capable of 120 cubic yards (90 cubic meters) per hour.
- A.J. Walker Construction Company, with a plant in Mattoon rated to produce 90 cubic yards (69 cubic meters) per hour.
- Charleston Stone Company, with the Charleston Farrier concrete plant rated to produce 100 cubic yards (76 cubic meters) of concrete per hour.
- Moultrie County Redi-Mix of Sullivan, with a plant able to produce 50 cubic yards (38 cubic meters) per hour.

Asphalt

There are two companies with three stationary asphalt plants within 20 miles (32.2 kilometers) of the Mattoon Site with a total hourly capacity of over 750 tons (680 metric tons) per hour (FG Alliance, 2006a).

- Howell Companies, headquartered in Mattoon, is a large construction company that specializes in asphalt construction. The company's plant in Mattoon has the capacity to produce 260 tons (236 metric tons) of asphalt per hour. Its Charleston plant is rated at 360 tons (327 metric tons) per hour. Additionally, Howell owns a portable plant capable of producing 300 tons (272 metric tons) per hour.

- Ne-Co Asphalt of Charleston has a plant rated at 130 tons (118 metric tons) per hour.

Aggregate and Fill Material

Charleston Stone Company owns two quarries with an annual production totaling 900,000 tons (816,466 metric tons) per year of aggregate. In addition, the proposed Mattoon Site would require some excavation; therefore, some fill would be available at the site.

4.16.2.2 Process-Related Materials

Coal Supply Environment

Illinois coal-fueled electric generating facilities use mainly sub-bituminous PRB coal from Wyoming or bituminous Illinois Basin coal from Illinois, Indiana or Kentucky. Small amounts of coal from Colorado and Utah also are used in Illinois (FG Alliance, 2006a). Because Pittsburgh coal is not generally utilized by Illinois power plants, delivered pricing is not available.

The best-price quotes shown in Tables 4.16-1 and 4.16-2 indicate coal and transportation bids for the Mattoon Site. Illinois Basin coal could be transported via truck or rail. There would be no truck-delivered option for PRB coal to the Mattoon Site due to distance. The quotes reflect 2006 costs.

Table 4.16-1. Illinois Basin Bituminous Coal

	Rail Dollars per ton (Dollars per metric ton)	Truck Dollars per ton (Dollars per metric ton)
Coal price	30 (33)	28 (30.80)
Transportation cost	5 (5.50)	17 (18.70)
Delivered price	35 (38.50)	45 (49.50)

Source: FG Site Proposal (Mattoon, Illinois), 2006.

Table 4.16-2. Western-PRB Sub-Bituminous Coal

	Rail Dollars per ton (Dollars per metric ton)
Coal price	14.15 (15.56)
Transportation cost	16 (17.60)
Delivered price	30.15 (33.16)

Source: FG Site Proposal (Mattoon, Illinois), 2006.

Figure 4.16-1 shows the locations of coal mines and probable locations of coal deposits in relation to the proposed Mattoon Site. Although coal is present throughout the Illinois Basin, relatively small areas of Springfield and Herrin coal are available for mining in the local area. “Available” coal means coal that is not known to have geological, technological, or land-use restrictions that would negatively affect the economics or safety of mining. The resources are not necessarily economically mineable at the present time, but they are expected to have mining conditions comparable with those currently being mined in the

Illinois state. The Springfield, Herrin, and Danville coals, where available for mining, average approximately 3.5 to 5.5 feet (1.1 to 1.7 meters) thick in this area.

Overall, the thickness of the coals is quite variable in this area, and the coals are thin (less than 2.5 feet [0.8 meters] thick) or are eroded outside the areas classified as available for mining. The Herrin and Springfield coals average 1,000 to 1,100 feet (305 to 335 meters) deep near the Mattoon Site, and the Danville coal averages 900 to 1,000 feet (274 to 305 meters) deep (FG Alliance, 2006a).

The nearest active coal mining area is approximately 50 miles (80 kilometers) to the northeast, in Vermilion County, Illinois, where the Black Beauty Coal Company operates the Riola and Vermilion Grove Mines. These mines are in the Herrin coal, at an average depth of 250 feet (76 meters) and seam thickness of 5 to 6 feet (1.5 to 1.8 meters). Production for each mine was approximately 1 million tons (907,185 metric tons) in 2004 (FG Alliance, 2006a).

Process Chemical Supply Markets

The process chemicals required by the proposed project are common water treatment and conditioning chemicals that are widely used in industry with broad regional and national availability. Large suppliers in the area of water and waste treatment chemicals include Ciba, Kemira, Nalco, Stockhausen, and the SNF Group.

4.16.2.3 Sulfur Markets

The technologies that would be available for sulfur removal at the proposed power plant are similar to the technologies employed in the petroleum refining industry. These treatment technologies result in the production of elemental sulfur, which is marketable. Sulfur is used in the manufacturing of numerous chemical, pharmaceutical, and fertilizer products. U.S. production of sulfur was 13.6 million tons (12.3 MMT) in 2002 (TIG, 2002).

The worldwide supply of sulfur is expected to exceed demand by 5.4 and 5.9 million tons (4.9 and 5.4 MMT) in 2006 and 2011, respectively. The surplus could increase up to 12.1 million tons (11 MMT) in 2011 if clean fuel regulations continue to be implemented worldwide. However, the Sulphur Institute, an international non-profit organization founded by the world's sulfur producers to promote and develop uses for sulfur, sees market potential in developing plant nutrient sulfur products and sulfur construction materials, especially sulfur asphalt. The estimate for the plant nutrient sulfur market is 10.5 million tons (9.5 MMT) annually by 2011. The Sulphur Institute estimates that the potential consumption of sulfur in the asphalt industry in North America could reach 0.45 million tons (0.41 MMT) by 2011 (assuming sulfur captures 5 percent of the 30-million-ton [27-million-metric-ton] asphalt market and an average of 30 percent by weight of asphalt replaced by sulfur). Tests on asphalt made with sulfur show it to have a greater resistance to wheel rutting and cracking than conventional asphalt (Morris, 2003).

4.16.2.4 Recycling Facilities

The bottom slag and ash produced by the gasifier would have local and regional markets for reuse. The American Coal Ash Association (ACAA), a non-profit organization that promotes the beneficial use of coal combustion products, reported that 96.6 percent of the bottom slag and up to 42.9 percent of the ash generated by power plants in 2005 was beneficially used rather than disposed of. Primary uses of slag are as blasting grit and as roofing granules, with lesser amounts in structural and asphalt mineral fills. Ash is primarily used in concrete products, structural fills, and road base construction. The ACAA expects the demand for coal combustion products to increase in the next few years. Some of the increase would be due to federal and state transportation departments promoting the use of coal combustion products for road construction (ACAA, 2006).

4.16.2.5 Sanitary Waste Landfills

The Illinois Solid Waste Management and Landfill Capacity Report (IEPA, 2005) provides the general location and life expectancies of the landfills in the region. Table 4.16-3 lists the sanitary waste landfills in the region and their remaining disposal capacity. Regional landfill availability in the Mattoon area would be up to 116 years (based on closure of the Illinois Landfill in 2122). Space on the 444-acre (180-hectare) proposed Mattoon Power Plant Site would be available for a landfill if needed. Figure 4.16-2 shows the location of these facilities in relation to the Mattoon Site.

Table 4.16-3. Nearby Sanitary Waste Landfills

Landfill	City	State	Remaining Disposal Capacity in Place[1] (yd^3 [m^3])	Expected Closure Date	Approximate Distance from Site (miles [km])
ERC Coles County Landfill	Charleston	IL	799,000 (610,897)	2008[2]	16 (26)
Landfill 33 Ltd.	Effingham	IL	3,280,000 (2,507,739)	2017	38 (61)
Onyx Valley View Landfill	Decatur	IL	3,831,000 (2,929,000)	2010	45 (72)
Clinton Landfill #2	Clinton	IL	3,518,000 (2,689,704)	2030	57 (92)
Brickyard Disposal and Recycling, Inc.	Danville	IL	18,837,000 (14,401,920)	2022	90 (145)
Illinois Landfill	Hoopeston	IL	21,503,000 (16,440,223)	2122	100 (161)

[1] Capacity as of January 2005.
[2] A transfer station is being developed at the landfill site with an average capacity of 750 tons (680 metric tons) per day. After closure, waste will be transferred to the Onyx Valley View Landfill.
yd^3 = cubic yards; m^3 = cubic meters; km = kilometers.
Source: IEPA, 2005 and FG Alliance, 2006a.

IEPA concluded that the East Central Illinois region (a 19-county region that includes the Mattoon Site) had 15 years of remaining solid waste landfill capacity at the 2004 rate of disposal (IEPA, 2005). New disposal capacity was permitted in 2004, increasing disposal capacity in the region by more than 170 percent (IEPA, 2005). Capacity at hazardous waste landfills is also substantial. The closest hazardous waste landfill alone has remaining capacity of over 14 million cubic yards (11 million cubic meters).

4.16.2.6 Hazardous Waste Treatment, Storage, or Disposal Facilities

Table 4.16-4 provides the location of hazardous waste landfills closest to the Mattoon Site that have historically received hazardous waste from Illinois sources.

Special waste includes hazardous waste, potentially infectious medical waste, pollution control waste, and industrial process waste.

In Illinois, pollution control waste is a special waste, which must be managed in accordance with State of Illinois regulations (Title 35 of the Illinois Administrative Code [IAC] Part 808). Numerous Illinois municipal landfills are approved to accept special waste. A special waste can also be certified as non-special, which allows it to be disposed in a municipal landfill. In addition, coal combustion waste is often reclaimed for beneficial uses, depending on their composition. The bottom slag produced from the coal gasification process is expected to be highly marketable.

Table 4.16-4. Hazardous Waste Landfills

Hazardous Waste Landfill	City	State	Remaining Disposal Capacity in Place[1] (yd^3 [m^3])	Approximate Distance from Site (miles [km])
Heritage Environmental	Roachdale	IN	14,665,907 (11,212,890)	112 (180)
PDC	Peoria	IL	660,944 (505,327)	140 (225)
CID Recycling & Disposal Facility #4	Calumet City	IL	88,269 (67,486)	175 (282)
Envirosafe of Ohio, Inc.	Oregon	OH	822,000 (628,464)	400 (644)
Wayne Disposal	Belleville	MI	2,134,101 (1,631,637)	410 (660)

[1]Capacity as of January 2004.
yd^3 = cubic yards; m^3 = cubic meters; km = kilometers.
Source: FG Alliance, 2006a.

A non-hazardous special waste certification is required to make a determination that industrial process or pollution control waste is a “non-special waste.” This certification must be made in writing and must be provided when requested by IEPA, the waste transporter, the disposal site, and any other entity involved in managing the waste. If the process that generates the waste changes or the raw materials change, a new certification is required (FG Alliance, 2006a). The information contained in this certification must include (as applicable):

- A description of the process that generated the waste;
- The method for determining that the waste is not hazardous;
- The method for determining that the waste is not a liquid, does not contain polychlorinated biphenyls (PCBs) or asbestos, is not formerly hazardous waste rendered non-hazardous, and is not shredded recyclable metals;
- Any analytical results, or relevant Material Safety Data Sheet; and
- An explanation as to why any analysis was not performed or required.

4.16.3 IMPACTS

4.16.3.1 Construction Impacts

Power Plant Site

Power plant construction materials would consist primarily of structural steel beams and steel piping, tanks, and valves. Locally obtained materials would include crushed stone, sand, and lumber for the proposed facilities and temporary structures (e.g., enclosures, forms, and scaffolding). Components of the facilities would also include concrete, ductwork, insulation, electrical cable, lighting fixtures, and transformers.

Waste from construction of the proposed facilities would include excess materials; metal scraps; and pallets, crates, and other packing materials. Excess supplies of new materials would be returned to vendors or be retained for future use. Surplus paint and other consumables, partial spools of electrical cable, and similar leftover materials would also be retained for possible future use in maintenance, repairs, and modifications. Scrap metal that could not be reused on site would be sold to scrap dealers. Other scrap materials could also be recycled through commercial vendors. Packaging material (e.g., wooden pallets and crates), support cradles used for shipping large vessels and heavy components, and cardboard and plastic packaging would be collected in dumpsters and periodically transported off site for recycling or disposal.

Construction equipment would include cranes, forklifts, air compressors, welding machines, trucks, and trailers. Operation of heavy equipment would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and would be appropriately managed by the construction contractor.

Petroleum products are sometimes spilled at construction sites as a result of equipment failure (split hydraulic lines, broken fittings) or human error (overfilled tanks). To mitigate the impacts of spills, use of petroleum products, solvents, and other hazardous materials would be restricted to designated areas equipped with spill containment measures appropriate to the hazard and volume of material being stored on the construction site. Refueling, lubrication, and degreasing of vehicles and heavy equipment would take place in restricted areas. A Spill Prevention, Control, and Countermeasure (SPCC) Plan would be prepared in accordance with 40 CFR 112.7. Personnel would be trained to respond to petroleum and chemical spills, and the necessary spill control equipment would be available on site in immediately accessible locations.

A reservoir would be constructed at the power plant site to store the water from the Charleston and Mattoon municipal WWTPs that would serve as the process water supply. The reservoir would be sized to ensure adequate water supply during periods of drought. The size of the reservoir would range from 25 to 200 million gallons (95 to 757 million liters), covering an area of 7 to 40 acres (2.8 to 16.2 hectares), depending on whether one or both WWTP effluents were used. Construction of the reservoir would require use of heavy equipment. Depending on the size and design of the reservoir, fill material may be required for the construction of berms, or spoils may be generated as a result of excavation.

The proposed Mattoon Power Plant Site would require up to 200 acres (81 hectares) to allow for the power plant, coal and equipment storage, associated processing facilities, research facilities, the railroad loop surrounding the power plant envelope, and a buffer zone. Debris would be generated as a result of clearing and grading. Only about 60 acres (24 hectares) of the site would be required for the facilities comprising the power plant footprint (see Figure 2-18). Any excavated material could be used as fill on the site when feasible. Debris would be disposed of at an on-site landfill or transported to an off-site landfill for disposal. In Illinois, on-site non-hazardous landfills do not require a permit but are regulated under Illinois Administrative Code Title 35, Subtitle G – Waste Disposal, Part 815, Procedural Requirements for All Landfills Exempt from Permits.

The Mattoon Site would have adequate acreage for placement of an on-site landfill, if one should be required at the site.

The large amount of solid waste disposal capacity in the region is detailed in Table 4.16-3. Because the quantity of waste from construction of the FutureGen facility would be small in comparison with the landfill capacity and waste quantities routinely handled, the impact to waste collection and disposal services would be negligible.

Sequestration Site

The proposed sequestration site is co-located with the power plant site on the same parcel of land. The component dedicated to CO_2 sequestration would be the injection well(s), associated piping from the plant to the well, and the compression units. The materials needed would include piping and concrete for seaming. Sources for these construction materials are well established nationally, and none of the quantities of materials required would create demand or supply impacts.

The materials would be ordered in the correct sizes and quantities, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill that accepts construction debris. Heavy equipment would be used that requires fuel, oils, lubricants, and coolants. Should any of these hazardous materials require disposal, they would be special waste or hazardous waste and would be appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Tables 4.16-3 and 4.16-4. There would be no impact to waste collection services or disposal capacity.

Utility Corridors

The following utility corridors and pipelines would be constructed to support the proposed FutureGen facility:

- 0.5-mile (0.8-kilometer) long transmission line in existing ROW and new substation (options to connect to an existing substation less than 2 miles (3.2 kilometers) from the site or to connect a substation about 1.6 miles (2.6 kilometers) from the site are also being evaluated). A second option would be a 16-mile (25.7-kilometer) transmission line that would connect to an existing 345-kV line.
- 6.2-mile (10.0-kilometer) long process water pipeline on existing ROW for all but 2 miles (3.2 kilometers).
- 8.1-mile (13.0-kilometer) long process water pipeline on existing ROW (this second corridor may not be required if the larger process water reservoir option is selected).
- 0.25-mile (0.4-kilometer) long natural gas pipeline connecting to the existing mainline, a new tap, and delivery station using an existing ROW.
- 1-mile (1.6-kilometer) long potable water pipeline in existing ROW.
- 1.25-mile (2.0-kilometer) long sanitary wastewater force main from the sanitary sewer lift station at the power plant site to an existing lift station using existing ROW.

The sequestration site would be located at the power plant site; therefore, no CO_2 pipeline corridor would be needed (FG Alliance, 2006a).

Where utilities would be placed along existing utility corridors minimal clearing of vegetation and grading, creating land clearing debris may require removal and disposal. The 2 miles (3.2 kilometers) of new ROW for the process water pipeline may require more extensive land clearing and grading. However, adequate construction debris disposal capacity is available at area landfills.

The construction of pipelines, transmission lines, transmission substation, and sanitary sewage lift stations would require metal and PVC pipe, as well as joining and welding materials including compressed gasses, steel cable and structures, and insulated wiring for transmission lines. Sources for these construction materials are well established nationally, and the quantities of materials required to construct the pipelines and transmission lines would not create demand or supply impacts.

Construction materials would be ordered in the correct sizes and quantities, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris. Heavy equipment would be used that requires fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste, and would be appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Tables 4.16-3 and 4.16-4. There would be no impact to waste collection services or disposal capacity.

Transportation Corridors

Roads

The Mattoon Site is served by a well-developed road system. Approximately 1.25 miles (2.0 kilometers) of county road leading to the site boundary would require upgrading (i.e., widening and resurfacing) by the Illinois Department of Transportation (FG Alliance, 2006a). The FutureGen contractor would be responsible for constructing on-site roads.

The materials needed for on-site road construction include concrete, aggregate, and asphalt. Road construction would result in minimal waste due to recycling and reuse of these materials. Excavated soil would be used for fill elsewhere along the route and asphalt would be recycled. Road construction would require heavy equipment that would need fuel, oils, lubricants, and coolants. Should any of these hazardous materials require disposal, they would be special waste or hazardous waste, and would be appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Tables 4.16-3 and 4.16-4. There would be no impact to waste collection services or disposal capacity.

Rail

The materials needed for construction of an industrial rail siding and loop track (approximately 2.0 miles [3.2 kilometers] of track [FG Alliance, 2006a]) would be steel rails, pre-cast concrete railbed ties, and rock for ballast. The sources for rails and railbed ties are well established nationally, and none of the quantities of materials required for constructing a rail spur would create demand or supply impacts. Furthermore, these materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and extremely small amounts of waste to be disposed in a permitted landfill that accepts construction debris.

In addition to the materials to be installed, construction of the rail spur would require fuel, oils, lubricants, and coolants for heavy machinery, and compressed gasses for welding. Should any of these hazardous materials require disposal, they would be special waste or hazardous waste, and would be shipped to a permitted hazardous waste treatment and disposal facility or other disposal facility permitted to accept the waste. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Tables 4.16-3 and 4.16-4. There would be no impact to waste collection services or disposal capacity.

4.16.3.2 Operational Impacts

Power Plant Site

The FutureGen power plant would be capable of using various coals. For purpose of analysis, the following coals are evaluated:

- Northern Appalachian Pittsburgh seam;
- Illinois Basin from the states of Illinois, Indiana, and Kentucky; and
- PRB from Wyoming.

Coal consumption would vary depending on the gasification technology and type of coal. Table 4.16-5 provides the range of values based on the conceptual design for the FutureGen Project. The Case 3B option is a smaller, side-stream power train that would enable more research and development activities than the main train of the power plant. To estimate the operating parameters for analysis of impacts in this EIS, DOE assumed this smaller system could be paired with any of the other designs under consideration. The Illinois Basin and PRB are the main sources of coal used by Illinois electric generating facilities and are the most viable options for the Mattoon Site. For those fuel types, the maximum coal consumption rate would be approximately 254 tons (230 metric tons) per hour (FG Alliance, 2007) or up to 1.89 million tons (1.72 MMT) per year based on 85 percent availability (FG Alliance, 2006e). This represents 3.5 percent of the 53.8 million tons (48.9 MMT) of coal of all types consumed by electric utilities within the State of Illinois in 2005 (EIA, 2006). Coal would be delivered to the power plant site by rail and would be stored in two coal piles, each providing storage capacity for approximately 15 days of operation (FG Alliance, 2006e). If required, runoff from the coal storage areas would be collected and treated in the plant's zero liquid discharge (ZLD) wastewater treatment system.

Table 4.16-5. Coal Consumption

Coal Gasification Technology	Type of Coal (pounds [kilograms] per hour)		
	Pittsburgh	Illinois Basin	Powder River Basin
Case 1	224,745 (101,943)	248,370 (112,659)	281,167 (127,535)
Case 2	213,287 (96,745)	244,153(110,746)	353,809 (160,485)
Case 3A	208,425 (94,540)	238,577 (108,217)	342,790 (155,487)
Case 3B (optional)[1]	97,625 (44,282)	111,791 (50,708)	154,349 (70,012)

[1]Case 3B is an optional add-on to any of the other technology cases (1, 2, 3A), but is considered unlikely to be implemented.
Source: FG Alliance, 2007.

The estimated consumption of process chemicals by the proposed power plant is presented in Table 4.16-6. The table also provides the estimated on-site storage requirements assuming a 30-day chemical supply would be maintained at the power plant site. Potential impacts from storage of the chemicals are discussed in Section 4.17. These chemicals are commonly used in industrial facilities and are widely available from national suppliers. The materials needed in the largest quantities would be sulfuric acid, sodium hypochlorite, and lime. The polymer and antiscalants and stabilizers needed for the cooling tower, makeup water, and wastewater systems are not specified at this time and a variety of products are available from national suppliers including the Illinois-based Nalco and the largest producer of water treatment specialty chemicals, Ciba (Nalco, 2006 and Ciba, 2006).

Table 4.16-6. Process Chemicals Consumption and Storage

Chemical	Annual Consumption (tons [metric tons])	Estimated Storage On Site (gallons [liters])
Selective Catalytic Reduction (NO_x emission control)		
Aqueous Ammonia (19 percent)	1,333 (1,209)	28,700 (108,641)
Cooling Tower		
Sulfuric Acid (98 percent)	8,685 (7,879)	94,200 (356,586)
Antiscalant	0.47 (0.42)	8 (30)
Sodium Hypochlorite	1,684 (1,527)	32,900 (124,540)
Make-up Water and Wastewater Treatment Demineralizers		
Sodium Bisulfite	12 (10.9)	155 (587)
Sulfuric Acid	106 (95.8)	1,150 (4,353)
Liquid Antiscalant and Stabilizer	27 (24.5)	443 (1,677)
Clarifier Water Treatment		
Lime	1,237 (1,122)	7,380 (27,936)
Polymer	295 (268)	5,020 (19,003)
Acid Gas Removal		
Physical Solvent	11,300 gallons (42,775 liters)	940 (3,558)

Source: FG Alliance, 2007.

The coal gasification process would annually consume approximately 8,700 tons (7,893 metric tons) of sulfuric acid, 1,680 tons (1,524 metric tons) of sodium hypochlorite, and 1,240 tons (1,120 metric tons) of lime. As discussed in Section 4.16.2.3, the sulfur market is expected to have a surplus for the next few years as production increases, so additional demand would not adversely impact the sulfur market. Sodium hypochlorite has producers located across the U.S. including Illinois, Indiana, Michigan, and Missouri. The U.S. sodium hypochlorite production capacity is vastly underused. Industrial sodium hypochlorite production capacity is estimated at 1.55 billion gallons (5.87 billion liters) per year (TIG, 2003). The current (2006) demand is projected to be 292 million gallons (1.1 billion liters), less than 20 percent of the production capacity (TIG, 2003). Worldwide production of lime was 141 million tons (128 MMT) in 2005, with the U.S. producing 22 million tons (20 MMT) (USGS, 2006a). Charmeuse, one of the 10 largest lime producers in the U.S., operates plants in South Chicago, Illinois and in Buffington, Indiana (USGS, 2006b). Given that the chemicals required to operate the proposed FutureGen facility are common industrial chemicals that are widely available and produced in large quantities in the U.S., the chemical consumption impact would be minimal.

The byproducts generated by the proposed power plant would be sulfur, bottom slag, and ash. As previously discussed, there are established markets and demand for these materials.

Sulfur production would depend on the gasification technology and the type of coal used. The maximum amount of sulfur generated would be 133 tons (121 metric tons) per day (FG Alliance, 2007) for an annual maximum of 41,232 tons (37,406 metric tons) based on 85 percent availability. The U.S. production of sulfur in 2002 was 13.6 million tons (12.3 MMT). The maximum potential FutureGen sulfur production represents 0.30 percent of the total U.S. production. Supply of sulfur exceeds demand; however, new uses of sulfur are being promoted by sulfur producers that should help balance future supply and demand of sulfur. The worldwide supply is estimated to exceed demand by up to 12.1 million tons (11 MMT) in 2011 without the development of new markets. The FutureGen Project maximum production would increase this surplus by less than 0.34 percent.

As previously noted, operation of the FutureGen Project would require a source of sulfuric acid. Assuming a complete conversion to sulfuric acid, the facility would generate about 126,000 tons (115,000 metric tons) per year of sulfuric acid. This would be sufficient to meet the demand for sulfuric acid at the power plant site.

The FutureGen facility would generate an estimated 96,865 tons (87,875 metric tons) of bottom slag or ash annually based on the three primary technology cases (1, 2, and 3A) (FG Alliance, 2007). If Case 3B were implemented, the amount of slag or ash would increase by approximately 49 percent over the base case. Nearly all of the bottom slag (96.6 percent) produced in the U.S. enters the market and is beneficially used, and the availability of bottom slag is expected to decrease (ACAA, 2006). Based on the 2006 statistics from ACAA for beneficial use of slag, 3.4 percent of the bottom slag that would be generated annually would be disposed as waste (see Table 4.16-7). Further characterization would be necessary to determine whether the quality of the slag produced by the proposed power plant would support this level of reuse. Based on the average of the ACAA (2006) statistics for bottom ash and fly ash, 58.1 percent of the ash that would be generated annually would be disposed as waste (see Table 4.16-7). The recycled bottom slag and ash produced by the proposed power plant would not be expected to have an adverse impact on the market, as future supply is expected to be equal to or less than the demand.

Table 4.16-7. Waste Generation

Waste	Annual Quantity (tons [metric tons])	Classification
Unrecycled bottom slag (Cases 1, 2, 3B)	3,290 (2,985)[1]	Special waste (Coal combustion byproduct)
Unrecycled ash (if non-slagging gasifiers are used)	56,280, (51,056)[2]	Special waste (Coal combustion byproduct)
ZLD (wastewater system) clarifier sludge	1,545 (1,402)	Special waste
ZLD filter cake	5,558 (5,042)	Special waste
Sanitary solid waste (office and break room waste)[3]	336 (305)	Municipal solid waste

[1] Based on ACAA (2006) statistics, DOE assumed that all but 3.4 percent of total slag production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[2] Based on ACAA (2006) statistics, DOE assumed that 41.9 percent of total ash production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[3] Quantity estimated for 200 employees using an industrial waste generation rate of 9.2 pounds (4.2 kilograms) per day per employee (CIWMB, 2006).
Source: FG Alliance, 2007, except as noted.

The estimated waste generated for the Mattoon Power Plant is presented in Table 4.16-7. In addition to the waste listed in the table, the facility may generate small amounts of hazardous waste such as solvents and paints from maintenance activities. Hazardous waste would be managed in accordance with federal and state hazardous waste regulations, including providing secondary containment where necessary. The special waste category would require disposal in a hazardous waste facility if the waste is hazardous, or in a sanitary waste landfill that is also permitted to dispose of special waste that is non-hazardous. As discussed in Section 4.16.2.6, special waste meeting certain criteria can also be certified as non-hazardous and can be disposed of as sanitary waste.

Chemical waste would be generated by periodic cleaning of the heat recovery steam generator and turbines. This waste would consist of alkaline and acidic cleaning solutions and wash water, which are likely to contain high concentrations of heavy metals. Chemical cleaning would be performed by outside contractors who would be responsible for the removal of associated waste products from the site. Precautions would be taken to prevent releases by providing spill containment for tankers used to store cleaning solutions and waste.

Other waste would include solids generated by water and wastewater treatment systems, such as activated carbon used in sour water treatment. Sulfur-impregnated activated carbon would be used to remove mercury from the synthesis gas. This mercury sorbent would be replaced periodically and the spent carbon would likely be hazardous waste. The spent carbon would be regenerated and reused at the site. It could also be returned to the manufacturer for treatment and recycling, or be transferred to an off-site hazardous waste treatment facility. Used oils and used oil filters would be collected and transported off site by a contractor for recycling or disposal.

Effluents from the Charleston and Mattoon municipal WWTPs would serve as the process water supply for the FutureGen facility. The as-received quality of these wastewater treatment plant effluents may not meet the FutureGen process water requirements. The water would be treated to decrease the concentrations of dissolved solids and constituents such as sodium and potassium to levels consistent with the process water design parameters. Waste generated by the water treatment facility would include sludge and spent filter media that would be transported off site for disposal in a municipal landfill approved for disposal of special waste.

The FutureGen facility would have the option of disposing of some of its waste in an on-site landfill, if one was developed. In addition, the operator could apply to certify its special waste as non-hazardous and dispose of those waste streams in a municipal landfill permitted to dispose of non-hazardous special waste. Given the sanitary and hazardous waste disposal capacities available in the region, the impact of disposal of FutureGen-generated waste would be minimal. Given the small amount of hazardous waste (e.g., paints and solvents) that would be generated and the availability of commercial treatment and disposal facilities, the on-site waste management activities are not expected to require a RCRA permit.

Sequestration Site

During normal operations, the sequestration site components would generate minimal waste due to routine maintenance and presence of workers. The waste could be special/hazardous (e.g., lubricants and oils) and sanitary waste (e.g., packaging and food waste). The expected minimal waste quantities would not impact disposal capacities of area landfills and waste collection services.

Several pre-injection hydrologic tests would be performed during site characterization to establish the hydrologic storage characteristics and identify the general permeability characteristics at the sequestration site. The following water-soluble tracers may be used:

- Potassium bromide (as much as 220 lb [100 kg])
- Fluorescein (as much as 132 lb [60 kg])
- 2,2-dimethyl-3-pentanol (as much as 4.4 lb [2.0 kg])
- Pentafluorobenzoic acid (as much as 8.8 lb [4.0 kg])

A suite of gas-phase tracers would be co-injected with the CO_2 to improve detection limits for monitoring. The tracers expected to be used include:

- Perfluoromethylcyclopentane (as much as 330 lb [150 kg])
- Perfluoromethylcyclohexane (as much as 2,646 lb [1,200 kg])
- Perfluorodimethylcyclohexane (as much as 330 lb [150 kg])
- Perfluorotrimethylcyclohexane (as much as 2,646 lb [1,200 kg])
- Sulfur hexafluoride (SF_6) (as much as 66 lb [30 kg])
- Helium-3(^{3}He) (as much as 0.033 lb [15 g])
- Krypton-78 (^{78}Kr) (as much as 0.44 lb [200 g])
- Xenon- 124 (^{124}Xe) (as much as 0.088 lb [40 g])

The last three are stable, non-radioactive, isotope noble gas tracers. Tracers are a key aspect of the planned monitoring activities for the FutureGen sequestration site. The tracers would 1) contact the CO_2, water and minerals, 2) limit the problem of interference from naturally occurring CO_2 background concentrations, and 3) provide a statistically superior monitoring and characterization method because of the redundancy built in by using multiple tracers. Tracers would be purchased in the required amounts and would be consumed (injected into the subsurface) as a result of the site characterization and monitoring activities.

Utility Corridors

During normal operations, the utility corridors and pipelines would not require additional materials and would not generate waste other than cleared vegetation, if necessary, that could be disposed of at a non-hazardous waste landfill.

Transportation Corridors

Roads

On-site roads would require periodic re-surfacing at a frequency dependent on the level of use and weathering. Asphalt removed from the road surface would be recycled. Road re-surfacing would involve heavy equipment that would require oils, lubricants, and coolants. Should any of these materials require disposal, they would be special waste or hazardous waste and would be appropriately managed by the construction contractor.

Rail

Maintenance of the rail spur would consist of replacing the rails and equipment at a frequency dependent on the level of use and weathering. Replacement materials would be obtained in the correct sizes and quantities from established suppliers, and the small amount of waste remaining after materials are reused or recycled would be disposed of in a permitted facility. Any special or hazardous waste (e.g., oils and coolants) generated during rail replacement would be properly managed by the contractor.

4.17 HUMAN HEALTH, SAFETY, AND ACCIDENTS

4.17.1 INTRODUCTION

This section describes the potential human health and safety impacts associated with the construction and operation of the proposed project. The health and safety impacts are evaluated in terms of the potential risk to both workers and the general public. The level of risk is estimated based on the current conceptual design of the proposed project, applicable health and safety and spill prevention regulations, and expected operating procedures.

Federal, state, and local health and safety regulations would govern work activities during construction and operation of the proposed project. Additionally, industrial codes and standards also apply to the health and safety of workers and the general public.

4.17.1.1 Region of Influence

The ROI for human health, safety, and accidents is the area within 10 miles (16.1 kilometers) of the boundaries of the proposed power plant and sequestration site, and CO_2 pipeline. At the proposed Mattoon Power Plant and Sequestration Site, modeling of the deep saline formation with an injection rate of 1.1 million tons (1 MMT) per year for 50 years produced a CO_2 plume radius of 1.2 miles (1.9 kilometers) (FG Alliance, 2006a). Because this is a first of its kind research project, 10 miles (16.1 kilometers) was chosen as a conservative distance in terms of the ROI for the proposed sequestration site.

4.17.1.2 Method of Analysis

DOE performed analyses to evaluate the potential effects of the proposed power plant and sequestration activities on human health, safety, and accidents. The potential for occupational or public health impacts was based on the following criteria:

- Occupational health risk due to accidents, injuries, or illnesses during construction and normal operating conditions;
- Health risks (hazard quotient or cancer risk) due to air emissions from the proposed power plant under normal operating conditions;
- Health risks due to unintentional releases associated with carbon sequestration activities; and
- Health risks due to terrorist attack or sabotage at the power plant or carbon sequestration site.

Potential occupational safety impacts were estimated based on national workplace injury, illness, and fatality rates. These rates were obtained from the U.S. Bureau of Labor Statistics (USBLS) and are based on similar industry sectors. The rates were applied to the anticipated numbers of employees for each phase of the proposed project. From these data, the projected numbers of Total Recordable Cases (TRCs), Lost Work Day Cases (LWDs), and fatalities were calculated. These analyses are presented in Section 4.17.2.

The calculated cancer risks and hazard quotients for air emissions under normal operating conditions are summarized in Section 4.17.3.1. Potential hazards from the accidental release of toxic/flammable gas for different plant components were evaluated by Quest (2006). This study addressed failure modes within the proposed plant boundary and was performed to identify any systems or individual process unit components that would produce a significantly larger potential for on-site or off-site impact based on different plant configurations. The results are summarized in Section 4.17.3.2.

Potential health effects were evaluated for workers and the general public who may be exposed to releases of captured gases (CO_2 and H_2S) during pre- and post-sequestration conditions. Gas releases were evaluated at the proposed plant, during transport via pipeline, at the sequestration site, and during subsurface storage (Tetra Tech, 2007). The results of these risk analyses are summarized in Section 4.17.4.

The potential impacts from a terrorism or sabotage event were determined by examining the results of the accident analysis of major and minor system failures or accidents at the proposed plant site and gas releases along the CO_2 pipeline(s) and at injection wells. The results of this analysis are provided in Section 4.17.5.

4.17.2 OCCUPATIONAL HEALTH AND SAFETY

4.17.2.1 Typical Power Plant Health and Safety Factors and Statistics

Power Plant Construction

Table 4.17-1 shows the injury/illness and fatality rates for utility related construction. These rates are expressed in terms of injury/illness per 100 worker-years (or 200,000 hours) for TRCs, LWDs, and fatalities.

Power Plant Operation

Because of the gasification and chemical conversion aspects of the proposed power plant, it would operate more like a petrochemical facility rather than a conventional power plant. As a result, occupational injury/illness rates for the petrochemical manufacturing sector were used in the analysis of the proposed power plant operation (Table 4.17-1). These rates are presented for TRCs, LWDs, and fatality rates.

Table 4.17-1. Occupational Injury/Illness and Fatality Data for Project Related Industries in 2005

Industry	2005 Average Annual Employment (thousands)[1]	Total Recordable Case Rate (per 100 workers)[1]	Lost Work Day Case Rate (per 100 workers)[1]	Fatality Rate (per 100 workers)[2]
Utility system construction	388.2	5.6	3.2	0.028
Petrochemical Manufacturing	29.2	0.9	0.4	0.001
Electric power transmission, control, and distribution	160.5	5.1	2.4	0.0062
Natural Gas Distribution	107.0	5.9	3.2	0.0025

[1] Source: USBLS, 2006a.
[2] Source: USBLS, 2006b.

Transmission Lines and Electro-Magnetic Fields

Magnetic fields are induced by the movement of electrons in a wire (current); and electric fields are created by voltage, the force that drives the electrical current. All electrical wiring, devices, and equipment, including transformers, switchyards, and transmission lines, produce electromagnetic fields (EMF). The strength of these fields diminishes rapidly with distance from the source. Building material, insulation, trees, and other obstructions can reduce electric fields, but do not significantly reduce magnetic fields. Electrical field strength is measured in kilovolts per meter, or kV/m. Magnetic field strength is expressed as a unit of magnetic induction (Gauss) and is normally expressed as a milligauss (mG), which is one thousandth of a Gauss. The average residential electric appliance typically has an electrical field of less than 0.003 kV/ft (0.01 kV/m). In most residences, when in a room away from electrical appliances, the magnetic field is typically less than 2 mG. However, very close to an appliance carrying a high current, the magnetic field can be thousands of milligauss.

Electric fields from power lines are relatively stable because line voltage does not vary much. However, magnetic fields on most lines fluctuate greatly as current changes in response to changing loads (consumption or demand).

Transmission lines contribute a relatively small portion of the electric and magnetic fields to which people are exposed. Nonetheless, over the past two decades, some members of the scientific community and the public have expressed concern regarding human health effects from EMFs during the transmission of electrical current from power plants. The scientific evidence suggesting that EMF exposures pose a health risk is weak. The strongest evidence for health effects comes from observations of human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults (NIEHS, 1999). The National Institute of Environmental Health Sciences report concluded that, “extremely low-frequency and magnetic field exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard” (NIEHS, 1999). While a fair amount of uncertainty still exists about the EMF health effects issue, the following determinations have been established from the information:

- Any exposure-related health risk to an individual would likely be small;
- The types of exposures that are most biologically significant have not been established;
- Most health concerns relate to magnetic fields; and
- Measures employed for EMF reduction can affect line safety, reliability, efficiency, and maintainability, depending on the type and extent of such measures.

CO_2 and Natural Gas Pipeline Safety

More than 1,500 miles (2,414 kilometers) of high-pressure long distance CO_2 pipelines exist in the U.S (Gale and Davison, 2004). In addition, numerous parallels exist between CO_2 and natural gas transport. Most rules and regulations written for natural gas transport by pipeline include CO_2. These regulations are administered and enforced by DOT’s Office of Pipeline Safety. States also may regulate pipelines under partnership agreements with Office of Pipeline Safety. The rules are designed to protect the public and the environment by ensuring safety in pipeline design, construction, testing, operation, and maintenance. Risks associated with pipeline activities are determined to be low (IOGCC, 2005). However, in pipelines that carry captured CO_2 for sequestration, other gases may be captured and transported as well, and could affect risks posed to human health and the environment. For the proposed FutureGen Project, the captured gases might contain up to 100 parts per million volume (ppmv) of H_2S in the pipeline on a routine basis, and should any of the captured gases escape to the environment, risks from exposure to H_2S would have to be estimated, as well as risks from CO_2 exposure.

Table 4.17-1 shows the occupational injury and fatality rates for 2005 for operation of natural gas distribution systems. These rates are expressed in terms of injury/illness rate per 100 workers (or 200,000 hours) for TRCs, LWDs, and fatality rates. These rates are used to indicate occupational injuries associated with pipelines, although the properties and types of hazards of natural gas are different from those of CO_2. Because natural gas is highly flammable, these rates are determined to be conservative in relation to CO_2 pipelines.

4.17.2.2 Impacts

This subsection describes potential occupational health and safety risks associated with construction and operation of the proposed project. Features inherent in the design of project facilities as well as compliance with mandatory regulations, plans, and policies to reduce these potential risks are summarized within each risk category.

Construction

Power Plant Site

Potential occupational health and safety risks during construction of the proposed power plant and facilities are expected to be typical of the risks for major industrial/commercial construction sites. Health and safety concerns include: the movement of heavy objects, including construction equipment; slips, trips, and falls; the risk of fire or explosion from general construction activities (e.g., welding); and spills and exposures related to the storage and handling of chemicals and disposal of hazardous waste.

Risk of Fire or Explosion from General Construction Activities

Contractors experienced with the construction of coal and gas-fired electricity generating plants and refineries would be used on the proposed project. Construction specifications would require that contractors prepare and implement construction health and safety programs that are intended to control worker activities as well as establish procedures to prevent and respond to possible fires or explosions. The probability of a significant fire or explosion during construction of the proposed project has been determined to be low. With implementation of BMPs and procedures described in the following paragraphs, health and safety risks to construction workers and the public would also be low.

During construction, small quantities of flammable liquids and compressed gases would be used and stored on site. Liquids would include construction equipment fuels, paints, and cleaning solvents. Compressed gases would include argon, acetylene, helium, nitrogen, and O_2 for welding. Potential risk hazards associated with the use of flammable liquids and compressed gases would be reduced by compliance with a construction health and safety program and proper storage of these materials when not in use, in accordance with all applicable federal, state, and local regulations. The construction health and safety program would include the following major elements:

- An injury and illness prevention program;
- A written safety program (including hazard communication);
- A personnel protection devices program; and
- On-site fire suppression and prevention plans.

Storage and Handling of Hazardous Materials, Fuels, and Oils

Hazardous materials used during construction would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of materials would be stored in a flammable storage locker, and drums and tanks would be stored in a secondary containment. Storage of the various types of chemicals would conform to Occupational Safety and Health Administration (OSHA) and applicable state guidelines. Construction personnel would be trained in handling chemicals, and would be alerted to the dangers associated with the storage of chemicals. An on-site Environmental Health and Safety Representative would be designated to implement the construction health and safety program and to contact emergency response personnel and the local hospital, if necessary. MSDSs for each chemical would be kept on site, and construction employees would be made aware of their location and content.

To limit exposure to uncontrolled releases of hazardous materials and ensure their safe handling, specific procedures would be implemented during construction, including:

- Lubrication oil used in construction equipment would be contained in labeled containers. The containers would be stored in a secondary containment area to collect any spillage.
- Vehicle refueling would occur at a designated area and would be closely supervised to avoid leaks or releases. To further reduce the possibility of spills, no topping-off of fuel tanks would be allowed.
- If fuel tanks are used during construction, the fuel tank(s) would be located within a secondary containment with an oil-proof liner sized to contain the single largest tank volume plus an adequate space allowance for rainwater. Other petroleum products would be stored in clearly labeled and sealed containers or tanks.
- Construction equipment would be monitored for leaks and undergo regular maintenance to ensure proper operation and reduce the chance of leaks. Maintenance of on-site vehicles would occur in a designated location.
- All paint containers would be sealed and properly stored to prevent leaks or spills. Unused paints would be disposed of in accordance with applicable state and local regulations.

Overall, BMPs would be employed that would include good housekeeping measures, inspections, containment maintenance, and worker education.

Spill Response and Release Reporting

Small quantities of fuel, oil, and grease may leak from construction equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations. If a large spill from a service or refueling truck were to occur, a licensed, qualified waste contractor would place contaminated soil in barrels or trucks for off-site disposal.

The general contractor's responsibility would include implementation of spill control measures and training of all construction personnel and subcontractors in spill avoidance. Training would also include appropriate response when spills occur, and containment, cleanup, and reporting procedures consistent with applicable regulations. The primary plan to be developed would describe spill response and cleanup procedures. In general, the construction contractor would be the generator of waste oil and miscellaneous hazardous waste generated during construction and would be responsible for compliance with applicable federal, state, and local laws, ordinances, regulations, and standards. This would include licensing, personnel training, accumulation limits, reporting requirements, and record keeping.

During construction, the potential exists for a major leak during the chemical cleaning of equipment or piping before it is placed into service. This method of cleaning could consist of an alkaline degreasing step (in which a surfactant, caustic, or NH_3 solution is used), an acid cleaning step, and a passivation step. Most of the solution would be contained in permanent facility piping and equipment. The components of the process that would be most likely to leak are the temporary chemical cleaning hoses, pipes, pump skids, and transport trailers. The cleaning would be within curbed areas, and spills would be manually cleaned up and contaminated materials disposed of in accordance with the applicable regulations.

Due to the limited quantities and types of hazardous materials used during construction, the likelihood of a spill reaching or affecting off-site residents would be low.

Medical Emergencies during Construction

Selected construction personnel would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid or stabilization of the victim(s) until professional medical attention could be attained. Any injury or illness that would require treatment beyond first aid would be referred to the local hospital.

Worker Protection Plan

The construction contractor would develop, implement, and maintain a Worker Protection Plan. This plan would implement OSHA requirements (1910 and 1926) and would define policies, procedures, and practices implemented during the construction process to ensure protection of the workforce, environment, and the public. The minimum requirements addressed by the Worker Protection Plan would include:

- Environment, Safety, and Health Compliance
- Working Surfaces
- Scaffolding
- Powered Platforms, Manlifts, and Vehicle-Mounted Platforms
- Fall Protection
- Cranes, Derricks, Hoists, Elevators, and Conveyors
- Hearing Conservation
- Flammable and Combustible Liquids
- Hazardous Waste Operations
- Personal Protective Equipment
- Respiratory Protection
- Confined Space Program
- Hazardous Energy Control
- Medical and First Aid
- Fire Protection
- Compressed Gas Cylinders
- Materials Handling and Storage
- Hand and Portable Powered Tools
- Welding, Cutting and Brazing
- Electrical Safety
- Toxic and Hazardous Substances
- Hazardous Communications
- Heat Stress

Industrial Safety Impacts

Based on data for the construction of similar projects, the construction workforce would average about 350 employees, with a peak of about 700 during the most active period of construction. Since the nature of the activities to be performed across all areas of the proposed project would be similar in scope, industrial safety impacts were calculated for the proposed project and not for each construction sector. Based on the employment numbers during the construction phase, the TRCs, LWDs, and fatalities presented in Table 4.17-2 would be expected. As shown in Table 4.17-2, based on the estimated number of workers during construction, no fatalities would be expected (calculated number of fatalities is less than one).

Table 4.17-2. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Construction

Construction Phase	Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
Average	350	20	11	0.098
Peak	700	39	22	0.196

Sequestration Site

Accidents are inherently possible with any field or industrial activities. Well drilling can lead to worker injuries due to: being struck with or pinned by flying or falling parts and equipment; trips and falls; cuts, bruises, and scrapes; exposure to high noise; and muscle strains due to overexertion. Catastrophic accidents could involve well blowouts, derrick collapse, exposure to hydrogen sulfide and other hazardous gases, fire, or explosion. Although catastrophic accidents frequently involve loss of life as well as major destruction of equipment, they represent only a small percentage of the total well drilling occupational injury incidence and severity rates. Most well drilling injuries (60 to 70 percent) were reported by workers with less than six months of experience (NIOSH, 1983). To avoid well drilling accidents, a worker protection plan and safety training (particularly for new workers) should be instituted, covering all facets of drilling safety.

Utility Corridors

Risks and hazards associated with construction of power lines, substations, and pipelines would be addressed through the Worker Protection Plan. Many of these types of construction activities may be undertaken by public utilities or companies specializing in this type of work and would be governed by their worker protection programs.

Transportation Infrastructure Corridors

Risks and hazards associated with construction activities for access roads, public road upgrades, and the rail loop would be addressed through the Worker Protection Plan. Construction activities on public roads may be undertaken by city or county public works departments and would be governed by their worker protection programs.

Operational Impacts

Two categories of accidents could occur that would pose an occupational health and safety risk to individuals at the proposed power plant and sequestration site, on the CO_2 pipeline corridor, or in the project vicinity: risk of fire or explosion either from general facility operations or specifically from a gas release (e.g., syngas, hydrogen, natural gas, H_2S, or CO_2); and risk of a hazardous chemical release or spill. Risk assessments evaluating accidents (e.g., explosions and releases) were performed to evaluate potential impacts for both workers and the public. The results of these assessments are summarized in Sections 4.17.3.2 and 4.17.4.

Power Plant Site

The operation of any industrial facility or power plant holds the potential for workplace hazards and accidents. To promote the safe and healthful operation of the proposed power plant, qualified personnel would be employed and written safety procedures would be implemented. These procedures would provide clear instructions for safely conducting activities involved in the initial startup, normal operations, temporary operations, normal shutdowns, emergency shutdowns, and subsequent restarts. The procedures for emergency shutdowns would include the conditions under which such shutdowns are required and the assignment of emergency responsibilities to qualified operators to ensure that procedures are completed in a safe and timely manner. Also covered in the procedures would be the consequences of operational deviations and the steps required to correct or avoid such deviations. Employees would be given a facility plan, including a health and safety plan, and would receive training regarding the operating procedures and other requirements for safe operation of the proposed power plant. In addition, employees would receive annual refresher training, which would include the testing of their understanding of the procedures. The operator would maintain training and testing records.

The proposed power plant would be designed to provide the safest working environment possible for all site personnel. Design provisions and health and safety policies would comply with OSHA standards and consist of, but not be limited to, the following:

- Safe egress from all confined areas;
- Adequate ventilation of all enclosed work areas;
- Fire protection;
- Pressure relief of all pressurized equipment to a safe location;
- Isolation of all hazardous substances to a confined and restricted location;
- Separation of fuel storage from oxidizer storage;
- Prohibition of smoking in the workplace; and
- Real-time monitoring for hazardous chemicals with local and control room annunciation and alarm.

Industrial Safety Impacts

The operational workforce is expected to average about 200 employees. As shown in Table 4.17-3, the number of calculated fatalities for operation of this facility would be less than one.

Table 4.17-3. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
200	2	1	0.002

Risk of Fire or Explosion

Operation of the proposed facility would involve the use of flammable and combustible materials that could pose a risk of fire or explosion. The potential for fire or explosion at the proposed power plant would be minimized through design and engineering controls, including fire protection systems. The risks of fire and explosion could be minimized also through good housekeeping practices and the proper storage of chemicals. Workers would consult MSDS information to ensure that only compatible chemicals are stored together. Impacts of a potential large or catastrophic explosion are discussed in Section 4.17.3.2.

Risk of Hazardous Chemical Release or Spill

Chemicals and hazardous substances would be delivered, used, and stored at the proposed project site during operation. Petroleum products used on site during operation would be stored following the same guidelines described for construction. During operation, the worst-case scenario would be a major leak during chemical cleaning of equipment and associated piping.

The presence of hazardous environments during normal operations is not anticipated. Plant equipment would be installed, maintained, and tested in a manner that reduces the potential for inadvertent releases. Scheduled and forced maintenance would be planned to incorporate engineering and administrative controls to provide worker protection as well as mitigate any possible chemical releases. Facility and spot ventilation would provide for the timely removal and treatment of volatile chemicals. Worker practices and facility maintenance procedures would provide for the containment and cleanup of non-volatile chemicals. Personnel and area monitoring will provide assurance that worker exposures are maintained well below regulatory limits.

Seven chemical compounds are identified that could produce harmful effects in exposed individuals. The severity of these effects is dependent on the level of exposure, the duration of the exposure, and individual sensitivities to the various chemical compounds. Table 4.17-4 describes chemical exposure limits, potential exposure routes, organs targeted by the compounds, and the range of symptoms associated with exposures to these chemicals. The occupational exposure limits are defined in Table 4.17-5. Potential public exposures to accidental releases of these chemicals are described in Section 4.17.3.2.

While some of the chemicals listed in Table 4.17-4 would be generated during proposed power plant operation, others are stored on site and the potential for personnel exposure as the result of minor spills or leaks, while low, exists.

Table 4.17-5. Definitions of Occupational Health Criteria

Hazard Endpoint	Description
NIOSH REL C	NIOSH REL. A ceiling value. Unless noted otherwise, the ceiling value should not be exceeded at any time.
NIOSH REL ST	NIOSH REL. Short-term exposure limit (STEL), a 15-minute TWA exposure that should not be exceeded at any time during a workday.
NIOSH REL TWA	NIOSH REL. TWA concentration for up to a 10-hour workday during a 40-hour work week.
OSHA PEL C	Permissible exposure limit (PEL). Ceiling concentration that must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure.
OSHA PEL TWA	PEL. TWA concentration that must not be exceeded during any 8-hour work shift of a 40-hour workweek.
IDLH	Airborne concentration from which a worker could escape without injury or irreversible health effects from an IDLH exposure in the event of the failure of respiratory protection equipment. The IDLH was evaluated at a maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection should be permitted. In determining IDLH values, NIOSH evaluated the ability of a worker to escape without loss of life or irreversible health effects along with certain transient effects, such as severe eye or respiratory irritation, disorientation, and incoordination, which could prevent escape. As a safety margin, IDLH values are based on effects that might occur as a consequence of a 30-minute exposure.

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.

The FutureGen Project would use aqueous NH_3 in a selective catalytic reduction process to remove NO_X and thousands of pounds could be stored on-site. Three scenarios for the accidental release of NH_3 were evaluated using the EPA's ALOHA model: a leak from a tank valve, a tanker truck spill, and a tank rupture. (See Appendix F for summary of how the model was used, a description of input data, and the results of sensitivity analyses.) Health effects from inhalation of NH_3 can range from skin, eye, throat, and lung irritation; coughing; burns; lung damage; and even death. Impacts of NH_3 releases on workers and the public depends on the location of the releases, the meteorological conditions (including atmospheric stability and wind speed and direction) and other factors. The criteria used to examine potential health effects, are defined in Table 4.17-6 and Table 4.17-7.

Table 4.17-6. Hazard Endpoints for Individuals Potentially Exposed to an Ammonia Spill

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
1 hour	NH_3	Adverse effects	30	AEGL 1
		Irreversible adverse effects	160	AEGL 2
		Life Threatening	1,100	AEGL 3

[1]See Table 4.17-7 for descriptions of the AEGL endpoints.
AEGL = Acute Exposure Guideline Level.

Table 4.17-7. Description of Hazard Endpoints for Ammonia Spill Receptors

Hazard Endpoint	Description
AEGL 1	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
AEGL 2	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.
AEGL 3	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

AEGL = Acute Exposure Guideline Level.
Source: EPA, 2007.

Leakage of 400 pounds (180 kilograms) of aqueous NH_3 solution (19 percent NH_3) from a tank, through a faulty valve was selected as a plausible upper-bound accidental spill. It was assumed that this release would create a one-centimeter deep pool, with a surface area of 211 square feet (19.6 square meters). The temperature of the solution was assumed to be 101°F (38.3°C), based on the maximum daily air temperature in Mattoon for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 2,805 feet (855 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 4.17-8). Individuals exposed within a distance of 1,266 ft (386 m) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur only within 531 feet (162 meters) of the spill. Thus, only workers (assumed to be within 250 meters of a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 5 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 250 meters.

Table 4.17-8. Effects of an Ammonia Spill at the Proposed Power Plant

Release Scenario	Gas	Effect[1]	Distance (feet [meters])
NH_3 leaky valve (400 pounds, 19 percent solution)	NH_3	Adverse Effects	2,805 (855)
		Irreversible adverse effects	1,266 (386)
		Life threatening effects	531 (162)
NH_3 tanker truck spill (46,200 pounds, 19 percent solution)	NH_3	Adverse Effects	14,763 (4500)
		Irreversible adverse effects	5,577 (1700)
		Life threatening effects	1,880 (573)
NH_3 tank rupture (104,355 pounds, 19 percent solution)	NH_3	Adverse Effects	8,202 (2500)
		Irreversible adverse effects	2,969 (905)
		Life threatening effects	1,023 (312)

Multiply distance in feet by 0.3048 to convert to meters.
[1] See Table 4.17-6 and 4.17-7 for an explanation of the effects.

For the tanker truck spill scenario, it was assumed that all 46,200 pounds (20,956 kilograms) of the 19 percent NH_3 solution in the truck may be spilled on the ground surface. It was assumed that this release would create a ten-centimeter deep pool, with a surface area of 2,454 square feet (228 square meters). The temperature of the solution was assumed to be 101°F (38.3°C), based on the maximum daily air temperature in Mattoon for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 14,763 feet (4,500 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 4.17-8). Individuals within a distance of 5,577 feet (1,700 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,880 feet (573 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters), but not inside a building.

For the tank rupture spill scenario, it was assumed that all 104,355 pounds (13,400 kilograms) of the 19 percent NH_3 solution in one of two on-site storage tanks may be released within the diked area around the tank. The tank discharge was assumed to create a 92-centimeter deep pool with a surface area of 601 square feet (55.8 square meters). Again the temperature of the solution was conservatively assumed to be 101°F (38.3 °C). The same atmospheric conditions as above, and EPA's ALOHA model with a source duration of 1 hour were used to calculate downwind atmospheric NH_3 concentrations. Concentrations within 8,202 feet (2,500 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 4.17-8). Individuals within a distance of 2,969 feet (905 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,023 feet (312 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters).

The meteorological conditions specified for these analyses (F stability class) result in conservative estimates of exposure. At Mattoon, this stability class occurs about 8 percent of the time. Simulations of the other six stability classes showed that the predicted distances to a given criteria were no more than 35 percent of the distance for the conservative stability class F. The stability class (D12), which gave the second highest results, occurs about 0.3 percent of the time. Since NH_3 produces a distinct, pungent odor at low concentrations (approximately 17 ppmv (AIHA, 1997), it is expected that most workers and the public in the vicinity of an accident would quickly evacuate under the scenarios discussed above. Depending on the size and location of the accident, the public would be alerted to the appropriate response such as shelter-in-place procedures or evacuation for the public living near the accident.

Sections 4.17.3.2 and 4.17.4 discuss scenarios involving equipment failure or rupture at the proposed power plant site, along utility corridors, and at the injection site.

Medical Emergencies

All permanent employees at the facility would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid treatment or stabilization of the victim(s) until professional medical attention is obtained. Any injury or illness that requires treatment beyond first aid would be referred to the plant's medical clinic or to a local medical facility.

Coal Storage

The National Fire Protection Association (NFPA) identifies hazards associated with storage and handling of coal, and gives recommendations for protection against these hazards. NFPA recommends that any storage structures be made of non-combustible materials, and that they be designed to minimize the surface area on which dust can settle, including the desirable installation of cladding underneath a building's structural elements.

Coal is susceptible to spontaneous combustion due to heating during natural oxidation of new coal surfaces. Also, coal dust is highly combustible and an explosion hazard. If a coal dust cloud is generated inside an enclosed space and an ignition source is present, an explosion can ensue. Dust clouds may be generated wherever loose coal dust accumulates, such as on structural ledges or if there is a nearby impact or vibration due to wind, earthquake, or even maintenance operations. Because of coal's propensity to heat spontaneously, ignition sources are almost impossible to eliminate in coal storage and handling, and any enclosed area where loose dust accumulates is at great risk. Further, even a small conflagration can result in a catastrophic "secondary" explosion if the small event releases a much larger dust cloud.

A Quonset hut-type building for on-site coal storage is being evaluated (FG Alliance, 2006e). This structure would protect the pile from rain and wind, which would otherwise foster spontaneous combustion in open-air piles and cause air and runoff pollution. Internal cladding would prevent dust accumulation on the structure. A breakaway panel may provide for accidental overloading and ventilation at the base, and exhaust fans or ventilation openings ensure against methane or smoke buildup. Dust suppression/control techniques would be employed. Fire detection and prevention systems may also be installed.

The surfaces of stored coal can be unstable, and workers can become entrapped and subsequently suffocate while working on stored coal piles (NIOSH, 1987). NIOSH recommendations for preventing entrapment and suffocation would be followed.

Sequestration Site

Industrial Safety Impacts

The operational workforce for the proposed sequestration site would be up to 20 employees. Since this proposed site would not be a permanently staffed facility, these personnel would be rotated from the permanent site pool. Based on these employment numbers, during operation of the proposed power plant, the TRCs, LWDs, and fatalities presented in Table 4.17-9 would be expected. As shown in Table 4.17-9, the number of calculated fatalities for operation of this facility would be less than one.

Table 4.17-9. Calculated Annual Occupational Injury and Fatality Cases for Sequestration Site Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Utility Corridors

Risk of Fire or Explosion

The proposed transmission line connector would be located high above ground (typically between 50 to 100 feet [15.2 to 30.5 meters] high). Only qualified personnel would perform maintenance on the proposed transmission lines. Sufficient clearance would be provided for all types of vehicles traveling under the proposed transmission lines. The operator of the line would establish and maintain safe clearance between the tops of trees and the proposed transmission lines to prevent fires. Ground and counterpoise wires would be installed on the proposed transmission system, providing lightning strike protection and thereby reducing the risk of explosion. However, a brush fire could occur in the rare event that a conductor parted and one end of the energized wire fell to the ground, or perhaps in the event of lightning strikes. Under these rare circumstances, the local fire department would be called upon.

Releases or Potential Releases of Hazardous Materials to the Environment

Hazardous materials used during maintenance of the proposed transmission facilities would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of fuel, oil, and grease may leak from maintenance equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations.

Industrial Safety Impacts

The operational workforce for the proposed utility corridors would be less than 20 employees. As with the proposed sequestration site, the majority of these workers would not be on permanent assignment and would be drawn from the plant pool. Based on these employment numbers, during operation and maintenance of utility corridors, the TRCs, LWDs, and fatalities presented in Table 4.17-10 would be expected. As shown in Table 4.17-10, the number of calculated fatalities for operation of this facility would be less than one.

Table 4.17-10. Calculated Annual Occupational Injury and Fatality Cases for Utility Corridors Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Transportation Corridors

Facility personnel would not be involved in activities associated with these infrastructure operations. Rail and road transportation activities would be performed by non-facility employees and vendors. Hazards related to the proposed transportation corridor operation would not be different from those posed by the normal transportation risks associated with product delivery.

4.17.3 AIR EMISSIONS

4.17.3.1 Air Quality – Normal Operations

Air quality impacts on human health were evaluated for HAPs potentially released during normal operation of the proposed Mattoon Power Plant and Sequestration Site. HAP emissions from the FutureGen Project were estimated based on the Orlando Gasification Project. The methods used to analyze impacts are described in Section 4.2.3 with supporting materials in Appendix E. Assessment of the potential toxic air pollutant emissions demonstrated that all ambient air quality impacts for air toxics would be below the relevant EPA recommended exposure criteria. This section of the report provides a summary of the results of potential air quality impacts.

As described in Section 4.2.3 regarding the modeling approach, estimated emissions of HAPs were based on data taken from the Orlando Gasification Project (DOE, 2007). Although the Orlando project is an IGCC power plant, there are differences from the proposed project. Consequently, the Orlando project data were scaled, based on relative emission rates of VOCs and particulate matter, to produce more appropriate estimates of stack emissions from the proposed project.

Airborne HAP concentrations were determined by modeling the impact of 1 g/s emissions rate using AERMOD. Table 4.17-11 shows representative air quality impacts for several metallic and organic toxic air pollutants. Each of these airborne concentrations was evaluated using chronic exposure criteria (expressed as inhalation unit risk factors and reference concentrations) obtained from the EPA Integrated Risk Information System (IRIS) (EPA, 2006a). As appropriate, an inhalation unit risk factor was multiplied by the maximum annual average airborne concentration for each HAP to calculate a cancer risk. Hazard coefficients were calculated by dividing the maximum annual average airborne concentration for each HAP by the appropriate reference concentration taken from the EPA IRIS (EPA, 2006a). The cancer risks and hazard coefficients calculated for each HAP were then summed and compared to the EPA criteria for evaluating HAP exposures. The results of this analysis, as indicated in Table 4.17-11, show that predicted exposures are safely well below the EPA exposure criteria.

Normal Air Quality and Asthma

Asthma is a chronic respiratory disease characterized by attacks of difficulty breathing. It is a common chronic disease of childhood, affecting over 6.5 million children in the U.S. in 2005 and contributing to over 12.8 million missed school days annually (DHHS, 2006). In 2005, the prevalence of asthma among children in the U.S. was 8.9 percent. Asthma prevalence rates among children remain at historically high levels after a large increase from 1980 until the late 1990s.

Asthma-related hospitalizations followed a trend similar to those for asthma prevalence, rising from 1980 through the mid-1990s, remaining at historically high plateau levels. Asthma-related mortality rates in the U.S. have declined recently after a rising trend from 1980 through the mid-1990s (DHHS, 2006).

It remains unknown why some people get asthma and others do not (DHHS, 2006). Asthma symptoms are triggered by a variety of things such as allergens (e.g., pollen, dust mites, and animal dander), infections, exercise, changes in the weather, and exposure to airway irritants (e.g., tobacco smoke and outdoor pollutants). Although extensive evidence shows that ambient air pollution (based on measurements of NO_2, particulate matter, soot, and O_3) exacerbates existing asthma, a link with the development of asthma is less well established (Gilmour et al., 2006).

A 2006 workshop sponsored by the EPA and the National Institute of Environmental Health Sciences (Selgrade et al., 2006) found that there are a number of scientific questions that need to be answered in order to make appropriate regulatory decisions for ambient air, including which air pollutants are of greatest concern and at what concentrations. Nevertheless, IGCC power plants that are currently in operation have achieved the lowest levels of criteria air pollutant (SO_2, CO, O_3, NO_2, Pb, and respirable particulate matter) emissions of any coal-fueled power plant technologies (DOE, 2002). Tables 4.2-1 and 4.2-2 show that the IGCC technology under evaluation for the proposed project would exceed the performance of technologies used at more conventional types of coal-fueled power plants of comparable size. Furthermore, based on evaluations conducted for this proposed site (as described in Section 4.2), the maximum predicted concentrations of the criteria air pollutants would not exceed the National Ambient Air Quality Standards and would not significantly contribute to existing background levels. Based on these determinations, it is unlikely that the proposed project would be a factor in asthma-related health effects.

Table 4.17-11. Summary Analysis Results — Hazardous Air Pollutants

Chemical Compound	CT/HRSG Emissions[1]		Inhalation Unit Risk Factor[2] ($\mu g/m^3$)$^{-1}$	Reference Concentration[2] ($\mu g/m^3$)$^{-1}$	Cancer Risk[3]	Hazard Coefficient[4]
	(lb/hr)	(g/s)				
2-Methylnaphthalene	1.99E-04	2.51E-05	n/a	n/a	n/a	n/a
Acenaphthyalene	1.44E-05	1.81E-06	n/a	n/a	n/a	n/a
Acetaldehyde	9.99E-04	1.26E-04	2.20E-06	9.00E+00	2.77E-12	1.40E-07
Antimony	**5.59E-03**	**7.04E-04**	n/a	**2.00E-01**	n/a	**3.52E-05**
Arsenic	**2.94E-03**	**3.70E-04**	**4.30E-03**	**3.00E-02**	**1.59E-08**	**1.24E-04**
Benzaldehyde	1.61E-03	2.03E-04	n/a	n/a	n/a	n/a
Benzene	2.69E-03	3.39E-04	7.80E-06	3.00E+01	2.65E-11	1.13E-07
Benzo(a)anthracene	1.28E-06	1.61E-07	1.10E-04	n/a	1.77E-13	n/a
Benzo(e)pyrene	3.05E-06	3.84E-07	8.86E-04	n/a	3.40E-12	n/a
Benzo(g,h,i)perylene	5.26E-06	6.63E-07	n/a	n/a	n/a	n/a
Beryllium	**1.26E-04**	**1.59E-05**	**2.40E-03**	**2.00E-02**	**3.81E-10**	**7.93E-06**
Cadmium	**4.06E-03**	**5.12E-04**	**1.80E-03**	**2.00E-02**	**9.21E-09**	**2.56E-04**
Carbon Disulfide	2.49E-02	3.14E-03	n/a	7.00E+02	n/a	4.49E-08
Chromium[5]	**3.78E-03**	**4.76E-04**	**1.20E-02**	**1.00E-01**	**5.72E-08**	**4.76E-05**
Cobalt	**7.97E-04**	**1.00E-04**	n/a	**1.00E-01**	n/a	n/a
Formaldehyde	1.85E-02	2.33E-03	5.50E-09	9.80E+00	1.28E-13	n/a
Lead	**4.06E-03**	**5.12E-04**	n/a	**1.50E+00**	n/a	**3.41E-06**
Manganese	**4.34E-03**	**5.47E-04**	n/a	**5.00E-02**	n/a	**1.09E-04**
Mercury	**1.27E-03**	**1.60E-04**	n/a	**3.00E-01**	n/a	**5.34E-06**
Naphthalene	2.95E-04	3.72E-05	3.40E-05	3.00E+00	n/a	1.24E-07
Nickel	**5.45E-03**	**6.87E-04**	**2.40E-04**	**9.00E-02**	**1.65E-09**	**7.63E-05**
Selenium	**4.06E-03**	**5.12E-04**	n/a	**2.00E+01**	n/a	**2.56E-07**
Toluene	4.12E-04	5.19E-05	n/a	4.00E+02	n/a	1.30E-09
TOTAL					8.44E-08	6.65E-04
Risk Indicators					1.00E-06	1.00E+00
Percent of Indicator					8.4 percent	0.07 percent

[1] Emission rates scaled by the ratio of VOC or particulate emissions from Orlando EIS to FutureGen.
[2] Provided by EPA Integrated Risk Information System (IRIS).
[3] Unit risk factor multiplied by maximum annual average impact of 0.0100 $\mu g/m^3$ determined by AERMOD at a 1 g/s emission rate.
[4] Maximum AERMOD annual average impact divided by reference concentration.
CT/HRSG = combustion turbine/heat recovery steam generator; lb/hr = pounds per hour; g/s = grams per second; $\mu g/m^3$ = micrograms per cubic meter; n/a = not available.
[5] Conservatively assumed all chromium to be hexavalent.
Compounds that are considered to be particulate matter in **bold** text.

4.17.3.2 Hazard Analysis

The “Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations” (referred hereafter as the Quest Study) was conducted to define creditable upperbound impacts from potential accidental releases of toxic and flammable gas from the proposed systems (Quest, 2006). Risks associated with gas releases include asphyxiation, exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions.

A particular concern associated with the release of gas is exposure to a toxic component within the dispersing gas cloud. Many of the process streams of the proposed power plant could contain one or more toxic components. The Quest Study evaluated the extent of exposure to gas clouds containing NH_3, CO, Cl_2, HCl, H_2S, and SO_2. Additional analyses were performed to define the extent of potential asphyxiation hazard associated with exposure to high concentrations of CO_2.

The hazard of interest for flash fires was direct exposure to flames. Flash fire hazard zones were determined by calculating the maximum size of the flammable gas cloud before ignition. The lower flammable limit (LFL) of the released hydrocarbon mixture was used as a boundary. The hazard of interest for the torch fires (ignition of a high velocity release of a flammable fluid, such as a hydrogen deflagration) was exposure to thermal radiation from the flame (Quest, 2006). For vapor clouds explosions, the hazard of interest was the overpressure created by the blast wave. For toxic components, potential impacts were determined by calculating the maximum distance at which health effects could occur.

Plant System Configurations

For the purposes of the analysis, the facility was assumed to be located in an area of reasonably flat terrain with limited vertical obstructions. This provided the bounding conditions that allow for the most conservative hazard impact analysis (Quest, 2006).

For the base case evaluation, the main process components for each of the proposed plant configurations were laid out in a rectangular area approximately 75 acres (30 hectares) in size. This area was surrounded by the rail line used to deliver the coal. The total area required for the project would consist of a minimum of 200 acres (81 hectares) (Quest, 2006).

Three other cases were also evaluated. Assuming the proposed facility is placed in the middle of a 200-, 400-, or 600-acre (81-, 162-, or 243-hectare) site, it was determined whether any explosion would extend beyond the boundaries of each site configuration.

Summary of Results

A full evaluation of the hazards associated with the preliminary designs of the four proposed gasifier systems for use in the proposed project was performed. This analysis was composed of the following three primary tasks:

- Task 1: Determine the maximum credible potential releases for each process unit within each proposed system configuration for each candidate coal source.
- Task 2: For each release point identified in Task 1, determine the maximum downwind travel for harmful, but not fatal, consequences of the release under worst-case atmospheric conditions.
- Task 3: Using the results of Task 2 and the available general layout information for the proposed system configurations, develop a methodology to rank the potential impacts to the workers on site and the potential off-site public population.

Hazards Identification

In general, all four of the gasifier systems evaluated for the FutureGen Project are composed of similar equipment. All gas processing equipment downstream of the gasifier is in common use in the petroleum industry and does not provide any unique hazards (Quest, 2006).

Upperbound-Case Consequence Analysis

The Quest Study evaluated the largest releases to determine the extent of possible flammable and toxic impacts under maximum (upperbound) release conditions. The analysis included a combination of four gasifiers and three types of coal (12 gasifier/coal combinations). The impacts were defined as those that could cause injury to workers or members of the public.

None of the flammable hazards were found to have impacts that extended beyond the proposed plant property. The largest flash fire impact zones extended less than 200 feet (61 meters) from the point of release. Areas within the process units in each of the four project system designs would have the potential to be impacted by flammable releases. This result is not unexpected for a facility handling similar materials (Quest, 2006).

The upperbound for toxic impacts associated with the 12 gasifier/candidate coal combinations evaluated would have the potential to extend past the proposed project property line. The toxic impacts would be dominated by releases of H_2S and SO_2 from the Claus process unit. The resulting plumes could extend from 0.3 to 1.4 miles (0.5 to 2.3 kilometers) from the point of release. There are 22 family residences or farm home sites and one elementary school within the 1.4-mile (2.3-kilometer) plume release radius.

The longest downwind toxic impact distance associated with any of the four gasifiers is due to the CO in the syngas process stream. These streams can produce toxic CO impacts extending from 0.4 to 0.6 mile (0.6 to 1.0 kilometer) from the point of release (Quest, 2006). There are three family residences or farm homes within the 0.6-mile (1.0-kilometer) release footprint radius, with two farm home sites immediately adjacent to the release area perimeter.

The potential health risks to these receptors are discussed in more detail in Section 4.17.5.

Hazard Ranking

Using the results from Tasks 1 and 2, a framework for ranking the flammable and toxic impacts associated with the upperbound release was designed as a function of the location of a worker or member of the public relative to the facility process units. Four zones were developed: two for the workers inside the property line and two for the public outside of the property lines (Quest, 2006).

Since none of the flammable hazards were found to have impacts that extended past the property line, there would be no off-site or public impacts due to flammable releases within the facility process units (Quest, 2006).

The upperbound for toxic impacts associated with all 12 gasifier/coal candidate combinations would have the potential to extend past the project property line. In 11 of the 12 gasifier/candidate coal combinations, toxic impacts associated with the Claus unit would be greater than the impacts from any other process unit (Quest, 2006).

In general, all 12 gasifier/candidate coal systems would have the potential to produce toxic impacts that could extend into a public area outside of the property line for the 200-acre (81-hectare) base case layout. By this measure, all four gasifier systems, regardless of candidate coal, have the potential to produce similar worst-case impacts and, thus, are ranked equally. This conclusion is also true for a 400-acre (162-hectare) layout and is true for 11 of the 12 gasifier/candidate coal systems assuming a 600-acre (243-hectare) site (Quest, 2006).

Conclusions

The identification and evaluation of the largest potential releases associated with the four gasifier system designs for the proposed project results in the following findings:

- There are no flammable hazard impacts that extend off the project property.
- All four gasifier designs produce similar toxic hazards. No design demonstrates a clear advantage over others in this respect.

- The potential toxic impacts associated with the four gasifier system designs are dominated by releases of H_2S and SO_2 from the Claus unit that is included in each design.
- All three candidate coals, when used as feed to any of the four gasifier designs, have the potential to produce off-site toxic impacts. The Powder River Basin coal, used in any of the gasifiers, produces slightly smaller toxic impact distances strictly due to its lower sulfur content and thus, lower H_2S flow rates to the Claus unit (Quest, 2006).

4.17.4 RISK ASSESSMENT FOR CO_2 SEQUESTRATION

The “Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement” (Tetra Tech, 2007) describes the results of the human health risk assessment conducted to support the proposed project. The risk assessment addresses the potential releases of captured gases at the proposed power plant, during transport via pipeline to the proposed geologic storage site, and during subsurface storage.

The approach to risk analysis for CO_2 sequestration in geologic formations is still evolving. However, a substantial amount of information exists on the risks associated with deep injection of hazardous waste and the injection of either gaseous or supercritical CO_2 in hydrocarbon reservoirs for enhanced oil recovery. There are also numerous projects underway at active CO_2 injection sites that are good analogs to determine the long-term fate of CO_2. The FutureGen Project assessment relies heavily on the findings from these previous and ongoing projects.

4.17.4.1 CO_2 Sequestration Risk Assessment Process

The human health risk assessment is presented in five sections: conceptual site models (CSMs); toxicity data and benchmark concentration effect levels; pre-injection risk assessment; the post-injection risk assessment; and the risk screening and performance assessment. The results of the risk screening of CO_2 sequestration activities are presented in Section 4.17.4.2.

Conceptual Site Models

A central task in the risk assessment was the development of the CSMs. Potential pathways of gas release during capture, transport, and storage were identified for the pre- and post-injection periods. Site-specific elements of the proposed Mattoon Site were described in detail based on information from the EIVs provided by the FutureGen Alliance (FG Alliance, 2006a-d). These data provided the basis for the CSM parameters and the analysis of likely human health exposure routes.

Toxicity Data and Benchmark Concentration Effect Levels

The health effect levels were summarized for the identified exposure pathways. The toxicity assessment provides information on the likelihood of the chemicals of potential concern (COPCs) to cause adverse human-health effects. These data provided the basis for the comparison of estimated exposures and the assessment of potential risks.

Risk Screening and Performance Assessment

Pre-Injection Risk Assessment

This assessment evaluated the potential risks associated with the proposed plant and aboveground facilities for separating, compressing, and transporting CO_2 to the proposed injection site. The risk assessment for the pre-injection components was based on qualitative estimates of fugitive releases of captured gases and quantitative estimates of gas releases from aboveground sources under different failure scenarios. Failure scenarios of the system included pipeline rupture, pipeline leakage through a puncture (3-square-inch [19.4-square-centimeter] hole), and rupture of the wellhead injection equipment. The volumes of gas released for the pipeline scenarios were calculated using site-specific data for the four sites and the equations for gas emission rates from pipelines (Hanna and Drivas, 1987).

In general, the amount of gas released from a pipeline rupture or puncture was the amount contained between safety valves, assumed to be spaced at 5-mile (8.0-kilometer) intervals. The amount of gas released by a wellhead rupture was assumed to be the amount of gas contained within the well casing itself. The atmospheric transport of the released gas was simulated using the SLAB model (Ermak, 1990), with the gas initially in a supercritical[1] state (pressure ~2000 psi, temperature ~90°F [32.2°C]). The evaluation was conducted for the case with CO_2 at 95 percent and H_2S at 100 ppmv. The predicted concentrations in air were used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors.

Post-Injection Risk Assessment

The post-injection risk assessment describes the analysis of potential impacts from the release of CO_2 and H_2S after the injection into the subsurface CO_2 storage formation. A key aspect of the analysis was the compilation of an analog database that included the proposed site characteristics and results from studies performed at other CO_2 storage locations and from sites with natural CO_2 accumulations and releases. The analog database was used for characterizing the nature of potential risks associated with surface leakage due to caprock seal failures, faults, fractures, or wells. CO_2 leakage from the proposed project storage formation was estimated using a combination of relevant industry experience, natural analog studies, modeling, and expert judgment.

Qualitative risk screening of the proposed site was based upon a systems analysis of the site features and scenarios portrayed in the CSM. Risks were qualitatively weighted and prioritized using procedures identified in a health, safety, and environmental risk screening and ranking framework developed by Lawrence Berkeley National Laboratory for geologic CO_2 storage site selection (Oldenburg, 2005). In addition, further evaluation was conducted by estimating potential gas emission rates and durations using the analog database for a series of release scenarios. Three scenarios could potentially cause acute effects: upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells.

Six scenarios could potentially cause chronic effects: upward leakage through caprock and seals by gradual failure; release through existing faults due to effects of increased pressure; release through induced faults due to effects of increased pressure (local over-pressure); upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells. For the chronic-effects case for the latter three well scenarios, the gas emission rates were estimated to be at a lower rate for a longer duration. The predicted concentrations in air were then used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors. Other scenarios, including catastrophic failure of the caprock and seals above the sequestration reservoir and fugitive emissions, are discussed, but were not evaluated in a quantitative manner.

[1] A supercritical fluid occurs at temperatures and pressures where the liquid and gas phases are no longer distinct. The supercritical fluid has properties of both the gaseous and liquid states; normally its viscosity is considerably less than the liquid state, and its density is considerably greater than the gaseous state.

4.17.4.2 Consequence Analysis

Risk Screening Results for Pre-Sequestration Conditions (CO_2 Pipeline and Injection Wellheads)

As with all industrial operations, accidents can occur as part of the CO_2 transport and sequestration activities. Of particular concern is the release of CO_2 and H_2S. The CO_2 sequestration risk assessment (Tetra Tech, 2007) identified three types of accidents that could potentially release gases into the atmosphere before sequestration. Accidents included ruptures and punctures of the pipeline used to transport CO_2 to the injection sites and rupture of the wellhead equipment at these sites. The frequency of these types of accidents along the pipelines or at the wellheads is expected to be low. The amount of gas released depends on the severity and the location of the accident (i.e., pipeline or wellhead releases).

Accident Categories and Frequency Ranges

Likely: Accidents estimated to occur one or more times in 100 years of facility operations (frequency ≥ 1 x 10^{-2}/yr).

Unlikely: Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from 1 x 10^{-2}/yr to 1 x 10^{-4}/yr).

Extremely Unlikely: Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency from 1 x 10^{-4}/yr to 1 x 10^{-6}/yr).

Incredible: Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1 x 10^{-6}/yr).

Health effects from inhalation of high concentrations of CO_2 gas can range from headache, dizziness, sweating, and vague feelings of discomfort, to breathing difficulties, increased heart rate, convulsions, coma, and possibly death. Exposure to H_2S can cause health effects similar to those for CO_2, but at much lower concentrations. In addition H_2S can cause eye irritation, abnormal tolerance to light, weakness or exhaustion, poor attention span, poor memory, and poor motor function.

Impacts of CO_2 and H_2S gas releases on workers and the public depends on the location of the releases, the equipment involved, the meteorological conditions (including atmospheric stability and wind speed and direction), the directionality of any release from a puncture (e.g., upwards and to the side), and other factors. The effects to workers near a ruptured or punctured pipeline or wellhead are likely to be dominated by the physical forces from the accident itself, including the release of gases at high flow rates (3,000 kilograms per second) and at very high speeds (e.g., ~ 500 mph [804.7 kmph]). Thus, workers involved at the location of an accidental release would be impacted, possibly due to a combination of effects, such as physical trauma, asphyxiation (displacement of oxygen), toxic effects, or frostbite from the rapid expansion of CO_2 (2,200 psi to 15 psi). Workers near a release up to a distance of 79 feet (24 meters) could also be exposed to very high concentrations of CO_2 (e.g., 170,000 ppm) for short durations of 1 minute, which would be life-threatening.

For this evaluation, risks to workers were evaluated at two distances: workers at a distance of 66 feet (20 meters) of a release and other workers at a distance of 820 feet (249.9 meters). For all ruptures or punctures, these individuals may experience adverse effects up to and including irreversible effects when concentrations predicted using the SLAB model (Ermak, 1990) exceed health criteria. The criteria used for this determination were the RELs established as occupational criteria for exposures to CO_2 and H_2S, consisting, respectively, of a short-term exposure limit (averaged over 15 minutes) for CO_2 and a ceiling concentration for H_2S that should not be exceeded at any time during a workday (NIOSH, 2007). Each of these criteria was listed in Table 4.17-4. Table 4.17-12 summarizes locations where pipeline and wellhead accidents create gas concentrations exceeding allowable levels for facility workers. Workers would be expected to be affected by CO_2 concentrations equal to or greater than 30,000 ppm from a pipeline puncture out to a distance of 372 feet (113.4 meters), but not for a pipeline rupture or a wellhead rupture. H_2S concentrations would exceed worker criteria at least out to a distance of 66 feet (20 meters) from the failure, but not at the proposed plant boundary 820 feet (249.9 meters) for a pipeline puncture, a pipeline rupture or a wellhead rupture.

Table 4.17-12. Exceedance of Occupational Health Criteria[1] for Workers

Release Scenario	Frequency Category[2]	Exposure Time	Gas	Area of Exceedance
Pipeline Rupture	EU	Minutes	CO_2	None
			H_2S	Within plant boundaries[3]
Pipeline Puncture[4]	EU	Approximately 4 hours	CO_2	Near pipeline only[5]
			H_2S	Near pipeline only[5]
Wellhead Rupture	EU	Minutes	CO_2	None
			H_2S	Near wellhead only[5]

[1] Occupational health criteria used were the NIOSH REL ST and NIOSH REL C for CO_2 and H_2S, respectively. See Table 4.17-4.
[2] EU (extremely unlikely) = frequency of $1x10^{-4}$/yr to $1x 10^{-6}$/yr;.
[3] Within 820 feet (250 meters) of release.
[4] 3-inch by 1-inch rectangular opening in pipe wall.
[5] Distances for a pipeline puncture are: 372 feet (113.4 meters) for CO_2 and at least 548 feet (167 meters) for H_2S; for a pipeline rupture is at least 131 feet (40 meters) and a wellhead rupture at least 216.5 feet (66 meters).

There is also interest in whether ruptures or punctures may affect non-involved workers. Non-involved workers are those workers present within the proposed plant boundary distance, but employed in activities distant from the release point.

The effects for non-involved workers were evaluated at a distance of 820 feet (249.9 meters) from the release point. The same occupational health criteria were used to determine the potential effects to the non-involved workers. Potential effects were determined by comparing SLAB model calculated concentrations with health criteria at the distances of concern. As shown in Table 4.17-12, no effects were estimated for non-involved worker exposures to CO_2 from any of the evaluated accidental releases. H_2S would also not affect non-involved workers exposed to releases from a pipeline puncture, or pipeline or wellhead rupture.

Accidental releases from the pipeline or wellhead, although expected to be infrequent, could potentially have greater consequences and affect the general public in the vicinity of a release. To determine potential impacts to the public, the CO_2 sequestration risk assessment

Health Effects from Accidental Chemical Releases

The impacts from accidental chemical releases were estimated by determining the number of people who might experience adverse effects and irreversible adverse effects.

Adverse Effects*:* Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as headache or sweating (associated with lower chemical concentrations) to irreversible (permanent) effects, including death or impaired organ function (associated with higher concentrations).

Irreversible Adverse Effects: A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system damage), and other effects that impair everyday functions.

Life Threatening Effects: A subset of irreversible adverse effects where exposures to high concentrations may lead to death.

(Tetra Tech, 2007) evaluated potential effects to the public for accidental releases of gases from the pipelines and wellheads. The CO_2 pipeline failure frequency was calculated based on data contained in the on-line library of the Office of Pipeline Safety (OPS, 2007). Accident data from 1994-2006 indicated that 31 accidents occurred during this time period. DOE categorized the two accidents with the largest CO_2 releases (4,000 barrels and 7,408 barrels) as rupture type releases, and the next four highest releases (772 barrels to 3,600 barrels) as puncture type releases. For comparison, 5 miles (8.0 kilometers) of FutureGen pipeline contains about 6,500 barrels, depending on the pipeline diameter. Assuming the total length of pipeline involved was approximately 1,616 miles (2,600 kilometers) based on data in Gale and Davison (2004), the rupture and puncture failure frequencies were calculated to be 5.92×10^{-5}/(km-yr) and 1.18×10^{-4}/(km-yr), respectively. Puncture failure frequencies are reported in failure events per unit length and time based on data for a particular length of pipeline and period of time.

The pipeline failure frequencies are only one component of the exposure frequency. The total exposure frequency also considered the percent of time the wind was blowing in the direction of the receptor, the percent of time the wind stability was the greatest, and the section of the pipeline that would have to fail to possibly allow the release to reach the exposed population.

The failure frequencies for pipeline ruptures and punctures are calculated as the product of the pipeline length at the site and the failure frequencies presented above (ruptures: 5.92×10^{-5}/km-yr; punctures: 1.18×10^{-4}/km-yr) (Gale and Davison, 2004). The failure rate of wellhead equipment during operation is estimated as 2.02×10^{-5} per well per year based on natural gas injection-well experience from an IEA GHG Study (Papanikolau et al., 2006). These failure frequencies provide the basis for the frequency categories presented in Tables 4.17-12 and Table 4.17-15.

The predicted releases, whether by rupture or puncture, are classified as extremely unlikely: the frequencies for ruptures is 4.7×10^{-5}, and the frequency for punctures is 9.4×10^{-5}. The frequencies for a wellhead rupture are 1×10^{-6} to 2×10^{-5}/year. The criteria used to examine potential health effects, including mild and temporary as well as permanent effects, are defined in Tables 4.17-7 and 4.17-13. The CO_2 and H_2S exposure durations that could potentially occur for the three types of release scenarios are presented in Table 4.17-14.

Table 4.17-13. Description of Hazard Endpoints for Public Receptors

Hazard Endpoint	Description
RfC	An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
TEEL 1	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
TEEL 2	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
TEEL 3	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

RfC = Inhalation Reference Concentration.
TEEL = Temporary Emergency Exposure Limits.
Sources: EPA, 2006a,b; DOE, 2006.

Table 4.17-14. Hazard Endpoints for Public Receptors

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
Minutes (Pipelines)	CO_2	Adverse	30,000	TEEL 1
		Irreversible adverse	30,000	TEEL 2
		Life threatening	40,000	TEEL 3
	H_2S	Adverse	0.51	TEEL 1
		Irreversible adverse	27	TEEL 2
		Life threatening	50	TEEL 3
Minutes (Explosions[2])	H_2S	Irreversible adverse	41	AEGL 2 (10 minute)
		Life threatening	76	AEGL 3 (10 minute)
	SO_2	Irreversible adverse	0.75	AEGL 2 (10 minute)
		Life threatening	42	AEGL 3 (10 minute)[3]
Hours/Days	CO_2	Adverse	20,000	Headache, etc.[4,5]
		Life threatening	70,000	Headache, etc.[4,5,6]
	H_2S	Adverse	0.33	AEGL 1 (8 hour)
		Irreversible adverse	17	AEGL 2 (8 hour)
		Life threatening	31	AEGL 3 (8 hour)
Years	CO_2	Adverse	40,000	Headache, etc.[4,7]
		Life threatening	70,000	Headache, etc.[4,6,7]
	H_2S	Irreversible adverse	0.0014	RfC

[1] See Tables 4.17-7 and 4.17-13 for descriptions of the TEEL and AEGL endpoints.
[2] Used by Quest (2006) to evaluate releases from explosions.
[3] Quest, 2006.
[4] EPA, 2000.
[5] Headache and dyspnea with mild exertion.
[6] Unconsciousness and near unconsciousness.
[7] Headache, dizziness, increased blood pressure, and uncomfortable dyspnea.
TEEL = Temporary Emergency Exposure Limits
AEGL = Acute Exposure Guideline Level
RfC = Inhalation Reference Concentration.

Simulation models were used to estimate the emission of CO_2 for the aboveground release scenarios when the gas is in a supercritical state. The SLAB model developed by the Lawrence Livermore National Laboratory and approved by U.S. EPA was used to simulate denser-than-air gas releases for both horizontal jet and vertically elevated jet scenarios. The model simulations were conducted for the case with CO_2 at 95 percent and H_2S at 100 parts per million by volume (ppmv). The state of the contained captured gas prior to release is important with respect to temperature, pressure, and the presence of other constituents. Release of CO_2 under pressure would likely cause rapid expansion and then reduction in temperature and pressure, which can result in formation of solid-phase CO_2, as explained in Appendix C-III of the risk assessment (Tetra Tech, 2007). The estimated quantity of solid-phase formed was 26 percent of the volume released; therefore 74 percent of the volume released from a pipeline rupture or puncture was used as input to the SLAB model for computing atmospheric releases of CO_2 and H_2S. Carbon dioxide is heavier than air and subsequent atmospheric transport and dispersion can be substantially affected by the temperature and density state of the initially released CO_2. The

meteorological conditions at the time of the release would also affect the behavior and potential hazard of such a release.

The potential effects of CO_2 and H_2S releases from pipeline ruptures and punctures were evaluated using an automated "pipeline-walk" analysis. The methodology (described briefly in Appendix D and in detail in Section 4.4.2 and Appendix C-IV of the risk assessment) estimates the maximum expected number of individuals from the general public potentially affected by pipeline ruptures or punctures at each site. The analysis takes into account the effects of variable meteorological conditions and the location of pipeline ruptures or punctures. For wellhead ruptures the potential impact zones corresponding to health-effects criterion values for H_2S and CO_2 were determined using the SLAB model and assuming meteorological conditions that resulted in the highest potential chemical exposures (i.e., assuming wind speeds of 2 meters per second and stable atmospheric conditions). The number of individuals potentially affected within the impact zone was determined from population data obtained from the 2000 U.S. Census.

This modeling approach to assess potential chemical exposures is based on the assumption that the population size and locations near the proposed project would not change during the time period assessed for this proposed project (i.e., 50 years for releases during the operation phase and 5,000 years for releases of sequestered gases).

Among the three types of accidental releases at this site, none of the postulated accidents would result in adverse health effects (including mild and temporary as well as permanent effects) to off-site residents (see Table 4.17-15). Since the pipeline would be within the boundaries of the proposed power plant site property, workers are more likely to be affected than members of the public.

The postulated accident of a pipeline puncture would not cause irreversible health effects to the general public (e.g., poor memory or poor attention span). No fatalities were projected for the same group.

As shown in Table 4.17-15, no members of the general public would be affected by adverse effects from other types of accidents such as a pipeline rupture or wellhead rupture. No fatalities were projected for a pipeline puncture or wellhead rupture.

Although the potential for releases from pipelines or wellheads may be low, any releases from the pipeline or wellheads could be high consequence events. For this reason, there are well-established measures for preventing or reducing impacts of accidental releases. These include design recommendations (e.g., increasing pipeline wall thickness, armoring pipelines in specific locations such as water body and road crossings and near the plant); use of newer continuous pipeline monitors to detect corrosion and computer models to rapidly interpret changes in fluid densities, pressures, etc.; use of safety check valves that can quickly isolate damaged section of the pipeline, operational procedures (e.g., activating "bleed" valves to control location and direction of releases should a puncture occur); and emergency response procedures (e.g., notifying the public of events requiring evacuation). In some cases, it may be possible to further reduce the concentrations of effect-causing substances being transported (e.g., H_2S). These measures would be implemented, as appropriate.

Risk Screening Results for Post-sequestration Conditions

Under post-sequestration conditions, a slow continuous leak through a deep well was determined to be the only scenario that may cause adverse health effects to the general public (Tetra Tech, 2007). Since the deep wells within the vicinity of the proposed CO_2 injection wells would be properly sealed before initiation of CO_2 sequestration and, since the proposed CO_2 injection well(s) would also be properly sealed after their use, it is extremely unlikely that the proposed project would create a gas release of consequence from the subsurface (Table 4.17-16). However, if this type of release occurred at the proposed sequestration site, it is estimated that approximately one member of the public might experience

Table 4.17-15. Effects to the Public from Pre-Sequestration Releases

Release Scenario	Frequency Category[2]	Gas	Effect[3]	Distance ft (m)	Number Affected
Pipeline Rupture[1] (release duration = minutes)	EU	CO_2	Adverse	<3 (<0.9)	0
			Irreversible adverse	<3 (<0.9)	0
			Life threatening	<3 (<0.9)	0
		H_2S	Adverse	4,170 (1,271)	0
			Irreversible adverse	131 (40)	0
			Life threatening	13 (4)	0
Pipeline Puncture (release duration = approximately 4 hours)	EU	CO_2	Adverse	646 (197)	0
			Life threatening	125 (38)	0
		H_2S	Adverse	5,341 (1,628)	0
			Irreversible adverse effects	548 (167)	0
			Life threatening	377 (115)	0
Wellhead Equipment Rupture (release duration = minutes)	EU	CO_2	Adverse	16 (4.9)	0
			Irreversible adverse	16 (4.9)	0
			Life threatening	13 (4.0)	0
		H_2S	Adverse	2,257 (688)	0
			Irreversible adverse	138 (42.1)	0
			Life threatening	<66 (<20.1)	0

[1] Rupture assumed to occur on the proposed power plant property since the sequestration site is at the approximate center of the plant property.
[2] EU (extremely unlikely) = frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[3] See 4.17.4.2 for an explanation of the effects categories.

irreversible adverse effects from H_2S exposures (i.e., nasal lesions). This estimate is based on assuming that the future population would be the same as current conditions, with the sequestration plume footprint coinciding with the proposed power plant site and the surrounding area remaining as farmland. Also, this evaluation is based on the EPA RfC criterion for chronic (i.e., long-term and low level) exposures that incorporates a safety factor of 300 to be protective of sensitive individuals. The RfC criterion value for H_2S is an extremely low concentration: 0.0014 ppm.

Since CO_2 sequestration is a relatively new technology, a series of mitigation and monitoring measures have been developed for these activities. In addition to plugging and properly abandoning wells, monitoring plans include use of remote sensing methods, atmospheric monitoring techniques, methods for monitoring gas concentrations in the subsurface and surface environments, and processes for monitoring subsurface phenomena associated with the injection reservoir and the caprock (FG Alliance, 2006a-d). A specific schedule for different types of monitoring has been proposed for the proposed Mattoon Sequestration Site and surrounding areas that would occur before and during sequestration activities (FG Alliance, 2006a). Also, after the cessation of injection monitoring, activities would be used to identify any long-term, post-closure changes in land surface conformation, soil gas, and atmospheric fluxes of CO_2.

Table 4.17-16. Number of Individuals with Adverse Effects from Potential Exposure to Post-Sequestration H_2S Gas Releases

Release Scenario	Frequency Category[1]	Number Affected[2]
Upward slow leakage through CO_2 injection well	EU	1
Upward slow leakage through deep oil and gas wells	n/a	n/a
Upward slow leakage through other existing wells	EU[3]	1

[1] EU (extremely unlikely)=frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[2] Potentially irreversible adverse effects could occur within 745 feet of the release point; instances presented here are converted from meters, which were used in the risk assessment (see Appendix D). Also, assumed future population density would remain the same as current conditions, with the property surrounding the proposed power plant and sequestration plume footprint remaining as farmland.
[3] Assumes that the other wells potentially within the sequestration plume footprint have been properly sealed before sequestration begins.
n/a = not applicable.

4.17.5 TERRORISM/SABOTAGE IMPACT

As with any U.S. energy infrastructure, the proposed power plant could potentially be the target of terrorist attacks or sabotage. In light of two recent decisions by the U.S. Ninth District Court of Appeals (*San Luis Obispo Mothers v. NRC, Ninth District Court of Appeals, June 2, 2006; Tri Valley Cares v. DOE, No. 04-17232, D.C. No. CV-03-03926-SBA, October 16, 2006),* DOE has examined potential environmental impacts from acts of terrorism or sabotage against the facilities being proposed in this EIS.

Although risks of terrorism or sabotage cannot be quantified because the probability of an attack is not known, the potential environmental effects of an attack can be estimated. Such effects may include localized impacts from releases from the proposed power plant and associated facilities, assuming that such releases would be similar to what would occur under an accident or natural disaster (such as a tornado). To evaluate the potential impacts of terrorism/sabotage, failure scenarios are analyzed without specifically identifying the cause of failure mechanism. For example, a truck running over a wellhead at the proposed sequestration site would result in a wellhead failure, regardless of whether this was done intentionally or through mishap. Therefore, the accident analysis evaluates the outcome of catastrophic events without determining the motivation behind the incident. The accident analyses evaluated potential releases from pipelines, wellheads, and major and minor system failures/accidents at the proposed power plant site. These accidents could also be representative of the impacts from a sabotage or terrorism event.

Various release scenarios were evaluated including: pipeline rupture, pipeline puncture, and wellhead equipment rupture. Gaseous emissions were assumed to be 95 percent CO_2 and 0.01 percent H_2S. Table 4.17-15 provides effects levels for individuals who could potentially be exposed to releases. Of these release scenarios at the proposed Mattoon Site, a pipeline puncture would result in impacts to the public over the largest distance. For a release of the CO_2 gas from a pipeline puncture, no impacts from CO_2 would occur beyond 646 feet (147 meters) of the release, while irreversible adverse impacts from the H_2S in the gas stream could occur within 548 feet (167 meters) of the release, tapering to no impact at a distance of 5,341 feet (1,628 meters). Under upperbound conditions such a release would not cause any fatalities, but there could be adverse health effects to workers at the plant, but not the general public.

For short-term CO_2 and H_2S co-sequestration testing over a two-week period, the concentration of H_2S in the sequestered gas would be 2 percent (20,000 ppmv) or 200 times greater than the base case, which assumed the H_2S concentration would be 100 ppmv. Thus, impacts to the public (both mild and life-threatening effects) could extend to greater distances than shown for the base case in Table 4.17-15. Although short-term testing of co-sequestration (CO_2 with H_2S) would be examined for two weeks during the DOE-sponsored phase of the proposed project, no decision has been made yet to pursue co-sequestration over a longer period. However, co-sequestration cannot be ruled out as a possible operating scenario.

In general, ruptures or punctures of pipelines are rare events. Based on Office of Pipeline Safety nationwide statistics, 31 CO_2 pipeline accidents occurred between 1994 and 2006. None of these reported accidents were fatal or caused injuries (OPS, 2006). Should a CO_2 pipeline rupture occur, it would be immediately detected by the pipeline monitoring system, alerting the pipeline operator. Once the flow of gas has stopped, the gas would dissipate and chemical concentrations at the source of the release would decline to non-hazardous levels in a matter of minutes for a pipeline rupture and several hours for a pipeline puncture. However, the released gas then migrates downwind, as described in the preceding sections.

The potential health effects from "upperbound" explosion and release scenarios at the proposed power plant (Section 4.17.3.2) can be contrasted with those associated with the pipeline. Hazardous events evaluated for the proposed power plant included: gas releases and exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions. Evaluations of these results indicate:

- Toxic releases from the Claus unit that could extend from 0.2 to 1.4 miles (0.3 to 2.3 kilometers) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are 22 family residences or farm home sites within the 1.4-mile (2.3-kilometer) plume release radius where adverse health effects could potentially occur (see Section 4.17.4.2). Examination of population density estimates (see Section 4.17.4.2) suggests that such releases could potentially cause irreversible adverse effects in 19 individuals exposed to H_2S and 143 individuals exposed to SO_2, with 10 exposed to potentially life threatening concentrations of H_2S and 4 exposed to potentially life threatening concentrations of SO_2 (Table 4.17-17). The Riddle Elementary School is nearby; however, it is located outside of the 1.4 miles (2.3 kilometers) point of release boundary; therefore, the school population was not added to the potentially affected individuals.
- Toxic releases from the gasifier could extend from 0.2 to 0.6 mile (0.3 to 1.0 kilometer) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are three family residences or farm homes within the 0.6-mile (1.0-kilometer) release radius, with two farm home sites immediately adjacent to the release area perimeter. However, examination of the population density estimates suggests that such a release could potentially cause irreversible adverse effects in 26 individuals exposed to carbon monoxide, with four exposed to potentially life-threatening effects.
- Fire hazards at the plant site would not extend off site.
- Under all worst case scenarios, plant workers would be the most at-risk of injury or death.

As discussed, if an explosion occurred at the proposed plant site as the result of a terrorist attack, it is likely that hazardous gases would cause injury and death of workers within the proposed plant site and most likely the public located within 1.4 miles (2.3 kilometers) of the proposed plant site.

Table 4.17-17. Effects to the Public from Explosions at the FutureGen Plant

Release Scenario	Gas	Effect[1]	Distance[2] (miles [kilometers])	Number Affected
Claus unit failure (release duration = minutes)	H_2S	Irreversible adverse	0.5 (0.8)	19
		Life threatening	0.4 (0.6)	10
	SO_2	Irreversible adverse	1.4 (2.3)	143
		Life threatening	0.2 (0.3)	4
Gasifier release (release duration = minutes)	CO	Irreversible adverse	0.6 (1.0)	26
		Life threatening	0.2 (0.3)	4

[1]See Table 4.17-6 and Table 4.17-7 for an explanation of the effects.
[2]Distances taken from Quest, 2006.

4.18 COMMUNITY SERVICES

4.18.1 INTRODUCTION

This section identifies the community services most likely to be affected by the construction and operation of the proposed FutureGen Project at the Mattoon Power Plant and Sequestration Site in Coles County, Illinois. This section addresses law enforcement, fire protection, emergency response, health care services, and the school system. Additionally, the potential effects that construction and operation of the FutureGen Project could have on those services, as well as any proposed mitigation measures that could reduce any adverse effects, are discussed.

4.18.1.1 Region of Influence

The ROI for community services includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant and sequestration site. As shown in Figure 4.18-1, the proposed sequestration site is located on the same property as the proposed power plant site. The ROI for the proposed Mattoon Power Plant and Sequestration Site includes all land area within the counties of Coles, Clark, Cumberland, Douglas, Effingham, Moultrie and Shelby in Illinois; and some land area within the counties of Champaign, Christian, Clay, Crawford, DeWitt, Edgar, Fayette, Jasper, Macon, Marion, Montgomery, Piatt, Richland, Sangamon and Vermillion in Illinois, and Vigo in Indiana.

Community services data are reported county-wide because this format is most often used in public information. This includes counties that have only a relatively small portion of land lying within the 50-mile (80.5-kilometer) radius. Therefore, if only a minor portion of a county was touched by the 50-mile (80.5-kilometer) radius and two or fewer small communities fall within that minor portion of the county, then that county was excluded from the analysis as not materially affecting the aggregate community services in the ROI. Those counties with two or fewer small communities that were excluded from the ROI include Logan in Illinois, and Sullivan and Vermillion in Indiana. Excluding these counties from the ROI makes the remaining data more meaningful for determining project effects.

Although the analysis in this section addresses the entire ROI, the affected environment and environmental consequences focus on the proposed power plant site in Coles County.

4.18.1.2 Method of Analysis

DOE evaluated the impacts to community services based on anticipated changes in demand for law enforcement, fire protection, emergency response, health care services, and schools using research provided in the Mattoon EIV (FG Alliance, 2006a). In many cases, the change in demand is directly related to the increased population.

DOE assessed the potential impacts based on the following criteria:

- Affect on law enforcement;
- Conflict with local or regional management plans for law enforcement;
- Affect on fire protection;
- Conflict with local or regional management plans for fire protection;
- Affect on emergency response;
- Conflict with local or regional management plans for emergency response;
- Affect on health care services;

- Conflict with local or regional management plans for health care services;
- Affect on local schools; and
- Conflict with local or regional management plans for local schools.

4.18.2 AFFECTED ENVIRONMENT

4.18.2.1 Law Enforcement

Coles County is served by three municipal police departments located in Mattoon, Charleston, and Oakland, and all operate under a mutual aid agreement (UC, 2005a and FG Alliance, 2006a). Table 4.18-1 presents the staffing levels of these police departments. Seventy-four full-time and six part-time law enforcement officers work out of the three departments in Coles County (FG Alliance, 2006a and CD, 2002). Coles County is also served by the Coles County Sheriff's Office and District 10 of the Illinois State Police (UC, 2005a and ILSP, 2004).

Table 4.18-1. Staffing Levels of Police Departments in Coles County

Community	Full-Time Officers	Part-Time Officers
Mattoon	40	0
Charleston	33	6
Oakland	1	0
Total	**74**	**6**

Source: FG Alliance, 2006a and CD, 2002.

Clark, Cumberland, Douglas, Effingham, Moultrie, and Shelby counties in Illinois are served by a total of 25 municipal police departments and each county has its own Sheriff's Office (UC, 2005a). Clark, Cumberland, and Effingham counties are served by District 12 of the Illinois State Police and Douglas, Moultrie, and Shelby counties are served by District 10 of the Illinois State Police (ILSP, 2004). The other Illinois counties located in the ROI are served by a total of 73 municipal police departments, their own County Sheriff's Office, and the Illinois State Police (UC, 2005a and ILSP, 2004). Vigo County in Indiana is served by two municipal police departments, their own county Sheriff's Office, and District 32 of the Indiana State Police (UC, 2005b and INSP, 2006).

The U.S. has an average of 2.3 police officers per thousand residents (Quinlivan, 2003). In Coles County, the ratio is approximately 1.4 officers per thousand residents based on the 2005 projected population and the equivalent of 77 full-time law enforcement officers. Although the ratio of police officers is well below the national average, crime in Coles County is extremely low. Index offenses, which include criminal sexual assault, robbery, aggravated assault, burglary, theft, motor vehicle theft and arson, are a way of measuring and comparing crime statistics (ICJIA, 2004). The State of Illinois averaged 3,844 index offenses per 100,000 residents in 2003, whereas Coles County reported 376 per 100,000 residents for the same year (The Disaster Center, 2005).

4.18.2.2 Emergency and Disaster Response

The Coles County Sheriff's Office operates the county's 911 center and dispatches fire and rescue, ambulances, and emergency medical personnel. Coles County and the entire ROI are served by 48 ambulance services, one air ambulance service, and the Illinois State Police (FG Alliance, 2006a; ILSP, 2004; and YYP, 2006a). Through the established Mutual Aid Box Alarm System, up to 120 ambulances from throughout Illinois could be made available for local response within an hour of notification (FG Alliance, 2006a).

4.18.2.3 Fire Protection

Coles County has 10 fire departments with trained fire services personnel (ISFM, 2006). The ROI is served by a total of 194 fire departments in Illinois and at least 10 fire departments in Vigo County in Indiana (ISFM, 2006 and YYP, 2006b). All Illinois fire departments are members of the region's mutual aid association and would assist in an emergency if called upon.

The Decatur, Charleston, Mattoon, Oakland, Urbana and Champaign fire departments have the capability to provide a high angle, vertical or confined space rescue (FG Alliance, 2006a).

4.18.2.4 Hazardous Materials Emergency Response

The Illinois counties within the ROI would be entirely served by Illinois' 36 statewide Hazardous Materials (HazMat) teams (IHS, 2003). All 36 teams are members of the mutual aid association and would respond to a hazardous materials emergency if so directed (IHS, 2003). HazMat materials units respond and perform functions to handle and control actual or potential leaks or spills of hazardous substances (OSHA, 1994).

4.18.2.5 Health Care Service

A total of 26 hospitals and medical centers serve the ROI, with 22 in Illinois counties and 4 in Vigo County in Indiana (IHA, 2006 and IDOH, 2006a). Coles County is served by the Sara Bush Lincoln Health Center in Mattoon and by four other regional hospitals, including Decatur Memorial Hospital in Decatur, Paris Community Hospital in Paris, Kirby Hospital in Monticello, and Memorial Medical Center in Springfield. There are approximately 3,956 beds in the 26 hospitals and medical centers in the ROI (HD, 2006; IDOH, 2006a; and IDOH, 2006b). Based on the 2005 total projected population for the ROI, there are 3.6 beds per thousand people within the ROI.

4.18.2.6 Local School System

Coles County has seven elementary schools, two junior high schools, three high schools, one specialty school, and as many as three private schools (Swager, 2006 and CD, 2002). Table 4.18-2 shows the expenditure per pupil per school year and the student-teacher ratios for Coles County, the State of Illinois, and the U.S.

Table 4.18-2. School Statistics for Coles County, Illinois and the U.S. in 2005

	Expenditure per Pupil per School Year ($)	Pupils per Teacher (Elementary/Secondary)
Coles County	12,300	17.7/20.4
Illinois	14,000	18.9/18.4
Nationwide	8,287	15.4/15.4

Source: FG Alliance, 2006a; USCB, 2006; and NCES, 2005.

4.18.3 IMPACTS

4.18.3.1 Construction Impacts

As discussed in Section 4.19, the need for construction workers would be limited in duration, but would likely cause an influx of temporary residents. Construction workers could be drawn from a large labor pool within the ROI; however, some temporary construction workers with specialized training and workers employed by contractors from outside the ROI would also likely be employed to construct the facilities. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period.

Law Enforcement

The temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. The increased temporary population could affect the working capacities of individual local police departments, depending on where the workers chose to reside. The affected locations would depend on the degree to which the construction workers would be dispersed throughout the communities within the ROI. As discussed in Section 4.19, temporary construction workers would likely reside in short-term housing. Coles County does not have enough hotel rooms, when occupancy rates are taken into account, to accommodate all of the temporary workers (FG Alliance, 2006a). Therefore, it is anticipated that the availability of local lodging would effectively disperse workers throughout communities within the ROI and law enforcement would not be affected.

The population in the ROI is expected to grow on average by 3 percent, or approximately 27,479 people, by 2010 (FG Alliance, 2006a). Additional police and other law enforcement services would be required to accommodate the growing population. Although the current number of Coles County law enforcement officers is below the U.S. average, county crime rates are extremely low, which is an indication that law enforcement is appropriately staffed (FG Alliance, 2006a; CD, 2002; and Quinlivan, 2003). The exact number of construction workers and their families who would temporarily relocate to the area for the proposed project is unknown, but any additional population is not anticipated to create a permanent unsustainable increase in the demand for law enforcement.

Construction activities would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 4.17, construction of the proposed facility would involve the use of flammable and combustible materials that pose an overall increase in risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during construction of the proposed project is low. Incidents during construction of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Illinois fire departments would have the capacity to respond to a major fire emergency at the proposed power plant and sequestration site. Currently, 194 fire departments within the ROI are members of the State's mutual aid agreement. Any of these fire departments would be available to assist in a fire emergency if needed.

Emergency and Disaster Response

As discussed in Section 4.17, it is anticipated that construction of the proposed facilities would result in an average of 20 total recordable injury cases per year with a peak maximum of 39 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant and sequestration site would be adequately served in an emergency. Coles County and the entire ROI are served by 48 ambulance services and one air ambulance service, and a total of 120 ambulances from throughout Illinois could be made available for local response within an hour of notification. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond current available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

The 350 to 700 temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. Currently, the ROI has 3.6 hospital beds per thousand residents, whereas the U.S. average is 2.9 hospital beds per thousand residents. Even if all 700 temporary workers relocated within the ROI, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 3.6 and, therefore, no impacts are expected.

The **Hill-Burton Act of 1946** established the objective standard for the number of hospitals, beds, types of beds, and medical personnel needed for every 1,000 people, by county (Everett, 2004). It called for states to "afford the necessary physical facilities for furnishing adequate hospital, clinic, and similar services to all their people." The Hill-Burton standard is 4.5 beds per thousand residents (Everett, 2004). However, the U.S. average in 2001 was 2.9 beds per thousand residents, which is about 24 percent fewer beds per thousand residents than the current ratio within the ROI (Everett and Baker, 2004).

Local School System

Although some portion of the temporary construction workers may relocate to the ROI with their families, a large influx of school-aged children would not be anticipated. Because construction of the proposed facilities would create temporary work, it is unlikely that the construction workers would relocate with their families. It is more likely that temporary workers, who permanently reside outside of the ROI, would seek short-term housing for themselves during the work week. As a result, any influx of school-aged children would result in a minimal impact to local schools and their resources.

Project construction would not displace existing school facilities or conflict with school system plans.

4.18.3.2 Operational Impacts

As discussed in Section 4.19, the operational phase of the proposed facilities would require approximately 200 permanent staff. Although the exact number of permanent staff who would relocate to the ROI is unknown, the increase in population would be very small, even if all 200 positions were filled by staff relocating to the ROI. Based on the 2005 projected population and the average family size within the ROI, the relocation of 200 workers would result in a population increase of 500 people, representing a 0.05 percent increase in population within the ROI.

Law Enforcement

Law enforcement in the ROI would be sufficient to handle the 0.05 percent increase in population during facility operation. A 0.05 percent increase in population in the ROI would result in an imperceptibly small decrease, less than 0.02, in the ratio of law enforcement officers per thousand residents. In addition, the average crime rate in Coles County, which is consistent with crime rates in rural communities in Illinois, is well below the national average. This is an indication that law enforcement is appropriately staffed and would be sufficient to handle a minor increase in population.

Project operation would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 4.17, operation of the proposed power plant would involve the use of flammable and combustible materials that pose an overall increase to risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during operation of the proposed project is low. Incidents during the operational phase of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Illinois fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site. There are currently 194 fire departments within the ROI that are members of the state's mutual aid agreement. Any of these fire departments could assist in a fire emergency if needed.

Emergency and Disaster Response

As indicated in Section 4.17, it is anticipated that the operational phase of the proposed facilities would result in an average of 6.6 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant and sequestration site would be adequately served in an emergency. Coles County and the entire ROI are served by 48 ambulance services and one air ambulance service, and a total of 120 ambulances from throughout Illinois could be made available for local response within an hour of notification. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond current available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

It is anticipated that the 200 permanent jobs created by FutureGen Project operations could cause an influx of permanent residents to the communities within the ROI. This influx would result in an increase in population of 0.05 percent, representing approximately 500 new residents. Currently, health care capacity in the ROI is greater than the national average, with 3.6 hospital beds per thousand residents. The U.S. average is 2.9 hospital beds per thousand residents. Although the proposed project would increase the number of residents requiring medical care, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 3.6 and, therefore, no impacts are expected.

Local School System

While the actual number of the 200 permanent staff who would relocate to the ROI with their families to work at the facility is unknown, based on the average family size and the percent of school-aged children within the ROI, it can be estimated that a maximum of 119 new school-aged children could relocate to the ROI (FG Alliance, 2006a). The projected 2007 public school enrollment for the Illinois counties within the ROI is 141,622 for kindergarten through 12th grade (ISBE, 2005). An additional 119 new school-age children would represent a 0.08 percent increase in the number of students who would share the current schools' resources in the ROI.

Project operation would not displace existing school facilities or conflict with school system plans.

4.19 SOCIOECONOMICS

4.19.1 INTRODUCTION

This section addresses the region's socioeconomic resources most likely to be affected by the construction and operation of the proposed FutureGen Project. This section discusses the region's demographics, economy, sales and tax revenues, per capita and household incomes, sources of income, housing availability, and the potential effects that construction and operation of the proposed project could have on socioeconomics.

4.19.1.1 Region of Influence

The ROI for socioeconomics includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant and sequestration site and utility and transportation corridors. As shown in Figure 4.18-1, the ROI for the proposed FutureGen Project includes all land area in the following counties: Coles, Clark, Cumberland, Douglas, Effingham, Moultrie, and Shelby in Illinois. The ROI also includes some land area in the following counties: Champaign, Christian, Clay, Crawford, DeWitt, Edgar, Fayette, Jasper, Macon, Marion, Montgomery, Piatt, Richland, Sangamon, and Vermillion in Illinois and Vigo in Indiana. Therefore, this section focuses on the socioeconomic environment at the county level rather than by the proposed power plant and sequestration site and utility and transportation corridors.

A few counties have a relatively small portion of land within the ROI and were, therefore, excluded from the analysis as not materially affecting the aggregate socioeconomics of the ROI. Logan County in Illinois and Sullivan and Vermillion counties in Indiana contain no more than two small communities and were also excluded from the ROI. Although the analysis addresses the entire ROI, the affected environment and environmental consequences focus more on the proposed power plant and sequestration site in Coles County.

4.19.1.2 Method of Analysis

DOE reviewed U.S. Census data, the Alliance EIVs, and other information to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Displace existing population or demolish existing housing;
- Alter projected rates of population growth;
- Affect the housing market;
- Displace existing businesses;
- Affect local businesses and the economy;
- Displace existing jobs; and
- Affect local employment or the workforce.

4.19.2 AFFECTED ENVIRONMENT

4.19.2.1 Regional Demographics and Projected Growth

The regional demographics for the ROI are provided in Table 4.19-1. In 2000, the total population for the counties within the ROI was 1,089,578 (USCB, 2000a). The total population of the ROI is anticipated to increase by approximately 3 percent by 2010 to 1,117,057 (FG Alliance, 2006a).

The 2000 Illinois population was 12,419,293 and is anticipated to increase by approximately 4 percent by 2010 to 12,916,894 (USCB, 2005a). The 2000 U.S. population was 282,125,000 and is anticipated to increase by approximately 9.5 percent by 2010 to 308,936,000and approximately 19 percent by 2020 to 335,805,000 (USCB, 2000b). Thus, the ROI is anticipated to grow at a slower rate than the U.S. and Illinois (FG Alliance, 2006a). Coles County had a year 2000 total population of 53,196 (FG Alliance, 2006a)and has the sixth largest population within the ROI and a growth rate less than the ROI's average growth rate. The median age of residents in 2000 was 35.3 years for the U.S., 34.7 years for Illinois, and 30.8 years for Coles County (USCB, 2000c and USCB, 2000d).

Table 4.19-1. Population Distribution and Projected Change for Counties Containing Land Area Within the ROI

County	Year 2000					2010 Projected Total Population	Projected Change 2000 to 2010 (percent)
	Total	Under 18	18-64	65 and over	Average Family Size		
Counties Located Completely Within the ROI							
Coles	53,196	10,477	35,652	7,067	2.3	54,178	982 (2.0)
Clark	17,008	4,233	9,714	3,061	2.4	17,734	726 (4.0)
Cumberland	11,253	2,976	6,495	1,782	2.6	11,511	258 (2.0)
Douglas	19,922	5,388	11,354	3,180	2.6	21,032	1,110 (5.0)
Effingham	34,264	9,784	19,713	4,767	2.6	36,558	2,294 (7.0)
Moultrie	14,287	3,670	8,093	2,524	2.6	14,928	641 (4.0)
Shelby	22,893	5,728	13,088	4,077	2.5	23,087	194 (0.8)
Subtotal or Average	**172,823**	**42,256**	**104,109**	**26,458**	**2.5**	**179,028**	**6,205 (3.6)**
Counties Located Partially Within the ROI							
Champaign	179,669	37,819	124,380	17,470	2.3	186,883	7,214 (4.0)
Christian	35,372	8,521	20,757	6,094	2.4	37,212	1,840 (5.0)
Clay	14,560	3,483	8,285	2,792	2.4	14,703	143 (0.9)
Crawford	20,452	4,664	12,391	3,397	2.4	20,978	526 (3.0)
De Witt	16,798	4,126	10,006	2,666	2.4	19,084	2,286 (3.0)
Edgar	19,704	4,701	11,509	3,494	2.4	19,901	197 (0.1)
Fayette	21,802	5,188	13,150	3,464	2.5	21,860	58 (0.2)
Jasper	10,117	2,620	5,830	1,667	2.6	10,174	57 (0.5)
Macon	114,706	28,171	69,054	17,481	2.4	115,199	493 (0.4)
Marion	41,691	10,622	24,144	6,925	2.5	42,449	758 (2.0)
Montgomery	30,652	7,275	18,162	5,215	2.4	30,808	156 (0.5)
Piatt	16,365	4,115	9,721	2,529	2.5	16,815	450 (3.0)
Richland	16,149	3,964	9,343	2,842	2.4	16,330	181 (1.0)
Sangamon	188,951	47,147	116,280	25,524	2.4	190,721	1,770 (0.9)

Table 4.19-1. Population Distribution and Projected Change for Counties Containing Land Area Within the ROI

County	Year 2000					2010 Projected Total Population	Projected Change 2000 to 2010 (percent)
	Total	Under 18	18-64	65 and over	Average Family Size		
Vermilion	83,919	20,972	49,522	13,425	2.4	84,471	552 (3.0)
Vigo, IN	105,848	24,216	66,584	15,048	2.4	110,441	4,593 (4.0)
Subtotal or Average	**916,755**	**217,604**	**569,118**	**130,033**	**2.4**	**938,029**	**21,274 (2.3)**
Total	**1,089,578**	**259,860**	**673,227**	**156,491**	**2.5**	**1,117,057**	**27,479 (3.0)**
Illinois	**12,419,293**					**12,916,894**	**49,760 (3.9)**
U.S.	**282,125,000**					**308,936,000**	**2,681,100 (9.5)**

Source: FG Alliance, 2006a and USCB, 2000a.

4.19.2.2 Regional Economy

Income and Unemployment

Table 4.19-2 provides information about the workforce, and per capita and median household incomes for the counties located within the ROI. Based on regional data reported for Decatur, Illinois, the average unemployment rate for the ROI was 6.2 percent and approximately 34,880 were unemployed in July 2006 (USBLS, 2006a). The average unemployment rate in July 2006 was 4.8 percent in the U.S., and 4.7 percent in Illinois (USBLS, 2006a and 2006b). Thus, the unemployment rate within the ROI is higher than that for either Illinois or the U.S.

Table 4.19-2. Employment and Income and for Counties Within the ROI

County	Employment		Income	
	2004 Labor Force	July 2006 Unemployment Rate[1]	1999 Per Capita Income	1999 Median Household
Counties Located Completely Within the ROI				
Coles	27,110	n/a	$17,370	$32,286
Clark	8,840	n/a	$17,655	$35,967
Cumberland	5,685	n/a	$16,953	$36,149
Douglas	10,796	n/a	$18,414	$39,439
Effingham	18,182	n/a	$18,301	$39,379
Moultrie	8,218	n/a	$18,562	$40,084
Shelby	122,782	n/a	$17,313	$37,313
Subtotal or Average	**201,613**	**n/a**	**$17,795**	**$37,231**

Table 4.19-2. Employment and Income and for Counties Within the ROI

County	Employment		Income	
	2004 Labor Force	July 2006 Unemployment Rate[1]	1999 Per Capita Income	1999 Median Household
Counties Located Partially Within the ROI				
Champaign	102,196	n/a	$19,708	$37,780
Christian	17,334	n/a	$17,937	$36,561
Clay	6,972	n/a	$15,771	$30,599
Crawford	9,446	n/a	$16,869	$32,531
De Witt	49,909	n/a	$20,488	$41,256
Edgar	10,411	n/a	$17,857	$35,203
Fayette	10,399	n/a	$15,357	$31,873
Jasper	5,373	n/a	$16,649	$34,721
Macon	18,239	n/a	$20,067	$37,859
Marion	7,413	n/a	$17,235	$35,227
Montgomery	13,607	n/a	$16,272	$33,123
Piatt	9,161	n/a	$21,075	$45,752
Richland	7,454	n/a	$16,847	$31,185
Sangamon	4,466	n/a	$23,173	$42,957
Vermilion	38,406	n/a	$16,787	$34,071
Vigo, IN	50,176	n/a	$17,620	$33,184
Subtotal or Average	**360,962**	**n/a**	**$18,107**	**$35,868**
ROI Total or Average	**562,575**	**6.2 percent**	**$17,951**	**$36,550**
Illinois	**9,968,309**	**4.7 percent**	**$23,104**	**$46,590**
U.S.	**n/a**	**4.8 percent**	**$21,587**	**$41,994**

[1] Unemployment data were not available for Illinois counties for July 2006.
n/a = not available.
Source: FG Alliance, 2006a; USCB, 2000e; USCB, 2000f; USCB, 2000g; USCB, 2000h; USCB, 2000i; and USCB, 2000j.

In 1999, the average median household income for the ROI was $36,550 and the average per capita income in 1999 was $17,951 (FG Alliance, 2006a and USCB, 2000f). Respectively, the median household income for the U.S. was $41,994, and the per capita income was $21,587 (USCB, 2000e and USCB, 2000f). The State of Illinois had a median household income of $46,590 and a per capita income of $23,104 (USCB, 2000g). Coles County had a median household income of $32,286 and a per capita income of $17,370 (FG Alliance, 2006a). Based on 2000 Census data, both Coles County and the ROI have median household and per capita incomes less than Illinois and U.S. averages.

Coles County collected $45 million in property taxes in 2003 and $9.2 million in sales taxes in 2004 (FG Alliance, 2006a). The counties located within the ROI each collected an average of $38.9 million in sales taxes (FG Alliance, 2006a).

Table 4.19-3 provides minimum and maximum hourly wages for Coles County in November 2005 for trades that would be required for construction of the proposed project. Average wages for these trades were not available. Although actual wage costs would not be known until contractor selection, it is expected that wages for construction of the proposed FutureGen Project would be typical for construction trades in Coles County adjusted for inflation.

Table 4.19-3. Minimum and Maximum Hourly Wages by Trade in Coles County, Illinois, in November 2005

Trade	Minimum and Maximum Wages
Boilermaker	$27.75 - $30.25
Cement Mason	$25.83 - $27.08
Electric Power Equipment Operator	$28.84 - $34.10
Electric Power Groundman	$19.79 - $34.10
Electric Power Lineman	$32.04 - $34.10
Electrician	$29.48 - $32.42
Iron Worker	$24.45 - $25.75
Laborer	$22.92 - $23.92

Source: IDOL, 2006.

Housing

Table 4.19-4 provides total housing and vacant units by county within the ROI. As of 2006, there were 469,983 existing housing units within the ROI, with Coles County accounting for 22,768 of those (FG Alliance, 2006a). Of the existing housing units within the ROI, 7.2 percent, or 33,605, were vacant (FG Alliance, 2006a). Of the total vacant units within the ROI, there were 14,253 units for rent and 6,225 units for sale (FG Alliance, 2006a). In addition, there were at least 4,336 short-term hotel and motel rooms within the ROI (FG Alliance, 2006a).

In the City of Mattoon, there were 11 new developments with at least 178 building lots for sale (FG Alliance, 2006a). There are two residences located adjacent to, two residences located within 0.25 mile (0.5 kilometer) of, and 20 additional residences located within 1 mile (1.6 kilometer) of the 444-acre (180-hectare) proposed power plant and sequestration site.

4.19.2.3 Workforce Availability

Construction

In 2004, there were approximately 562,575 people within the ROI workforce (FG Alliance, 2006a). Because construction workers represented 6.3 percent of the workforce in Illinois, there were approximately 35,000 construction workers within the ROI (USCB, 2005b and FG Alliance, 2006a). This indicates that there could be a large local workforce from which some or all of the construction workers could be drawn.

Table 4.19-4. Total Housing Units Within the ROI in 2006

County	Total Housing Units	Vacant Units			
		For Rent	For Sale	Seasonal Use	Other Vacant
Counties Located Completely Within the ROI					
Coles	22,768	714	249	215	364
Clark	7,816	255	117	113	286
Cumberland	4,876	79	92	134	140
Douglas	8,005	115	87	32	137
Effingham	13,959	282	156	201	231
Moultrie	5,743	56	81	31	132
Shelby	10,060	1,004	132	170	166
Subtotal	**73,227**	**2,505**	**914**	**896**	**1,456**
Counties Located Partially Within the ROI					
Champaign	75,280	2,306	653	214	1,189
Christian	14,992	341	202	63	348
Clay	6,394	119	138	41	188
Crawford	8,785	362	214	56	243
De Witt	7,282	184	97	51	114
Edgar	8,611	175	140	57	314
Fayette	9,053	158	129	207	311
Jasper	4,294	87	53	30	143
Macon	50,241	1,628	554	139	981
Marion	18,022	312	202	100	601
Montgomery	12,525	203	211	93	367
Piatt	6,798	57	62	24	129
Richland	7,468	272	150	83	257
Sangamon	85,459	2,715	1,131	240	2,137
Vermilion	36,349	1,077	533	141	911
Vigo, IN	45,203	1,752	842	302	701
Subtotal	**396,756**	**11,748**	**5,311**	**1,841**	**8,934**
Total	**469,983**	**14,253**	**6,225**	**2,737**	**10,390**

Source: FG Alliance, 2006a.

Operations

Utility workers made up 0.7 percent of the workforce in Illinois in 2004, resulting in approximately 4,200 utility workers within the ROI (USCB, 2005b). Operations workers could be drawn from this workforce.

4.19.3 IMPACTS

4.19.3.1 Construction Impacts

Population

The need for construction workers would be limited to the estimated 44-month construction period, and a potential influx of temporary residents is not expected to cause an appreciable increase in the regional population. Monthly employment on the proposed power plant and sequestration site would average 350 workers during construction, with a peak of 700 workers (FG Alliance, 2006e). Approximately 35,000 general construction workers residing within the ROI would provide a local workforce. Temporary construction workers with specialized training and workers employed by contractors from outside the ROI could also construct the proposed power plant facilities. Some of these workers could be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period. Although it is not known how many workers would relocate, the required number of construction workers represents less than 0.1 percent of the population within the ROI. Therefore, impacts on population growth within the ROI would be small.

Employment, Income, and Economy

Construction of the proposed facilities could result in 350 to 700 new jobs in Coles County. These new jobs would represent a 0.06 to 0.1 percent increase in the number of workers employed in Coles County (FG Alliance, 2006a). These workers would be paid consistent with wages in the area for similar trades. Wages for trades associated with power plant construction for November 2005 are provided in Table 4.19-3, although it is likely that actual wages could be higher than those presented because of inflation. Therefore, a direct, but small, positive impact on employment rates and income could occur within the ROI during the construction period.

Illinois and Coles County could benefit from temporarily increased sales tax revenue resulting from project-related spending on payroll and construction materials. It is anticipated that construction workers would spend their wages on short-term housing, food, and other personal items within the ROI. Additional sales tax revenues would result from taxes that are embedded in the price of consumer items such as gasoline. Therefore, an indirect and positive impact could be expected for the local economy from increased spending and related sales tax revenue.

Illinois and Coles County could also benefit from increased property tax revenues associated with properties acquired for the proposed FutureGen Project. Property taxes are applied to construction sites on the basis of an evaluation of work completed to date in each year. The amount paid would depend not only on levy rates at the time the construction is under way, but also on the construction schedule relative to the evaluation's timing. The facility's property tax could be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue could be in the millions of dollars each year. This increase would have a direct and positive impact on the total property tax revenue for Coles County and Illinois. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance.

The proposed FutureGen Project could directly impact agriculture-related employment and income by converting up to 200 acres (81 hectares) of agricultural land for the proposed power plant and sequestration site. Similar impacts could also occur on the additional 244 acres (99 hectares) of the proposed site if these areas were removed from agricultural use. These impacts would be limited to those who till and harvest these properties. Indirect impacts related to incremental reduction in the supplies and equipment needed to farm the land, and in the amount of corn and soybeans being brought to market would also occur. These impacts would be minor when evaluated in the context of agricultural activities within the ROI.

Housing

A potential influx of construction workers may increase local housing demand, which would have a beneficial short-term impact on the regional housing market. The ROI has approximately 14,253 vacant housing units for rent with Coles County accounting for approximately 714 of these units. There are at least 4,336 hotel rooms within the ROI, with Coles County accounting for approximately 461 of these rooms. In 2005, Illinois had an average occupancy rate of 61.8 percent (IHI, 2006). Therefore, depending upon the percentage of construction jobs that could be filled by existing residents, the influx of workers from outside the region could increase the occupancy rate within the ROI by as much as 12.2 percent. This increase would result in a hotel occupancy rate of 74 percent and a positive, direct impact for the hotel industry within the ROI.

Power Plant Site

There are two residences located adjacent to, two residences located within 0.25 mile (0.4 kilometer) of, and 20 additional residences located within 1 mile (1.6 kilometer) of the 444-acre (180-hectare) proposed power plant site that may have an unobstructed view of the construction site. Although construction activities could adversely impact these properties (e.g., increased traffic), construction would not cause the displacement of residents or demolition of houses. Potential impacts to property values are discussed in Section 4.19.3.2.

Sequestration Site

The proposed sequestration site is located on the same property as the proposed power plant; therefore, the impacts would be the same.

4.19.3.2 Operational Impacts

Population

Operation of the proposed power plant could result in a very small increase in population growth. It is anticipated that power plant operation could require approximately 200 permanent workers. Based on the 2005 projected population and average family size within the ROI, the relocation of 200 workers could result in a population increase of 492 people. This would represent a 0.04 percent increase in population within the ROI and a 0.9 percent increase in Coles County.

Employment, Income, and Economy

The operational phase of the proposed FutureGen Project could have a direct and positive impact on employment by creating 200 permanent jobs in Coles County. These new jobs could represent a 0.04 percent increase in the total number of workers employed in the Coles County (FG Alliance, 2006a).

Each new operations job created by the proposed FutureGen Project could generate both indirect and induced jobs. An indirect job supplies goods and services directly to the plant site. An induced job results from the spending of additional income from indirect and direct employees. A job multiplier is used to determine the approximate number of indirect and induced jobs that would result. The Illinois Venture Capital Association reported a job multiplier of 2.2 for venture capital projects in Illinois (IVCA, 2006). A job multiplier of 2.2 means that, for every direct job, 1.2 indirect or induced jobs would result (IVCA, 2006). Based on this multiplier, the proposed FutureGen Project could have an indirect impact on employment by creating approximately 240 indirect or induced jobs in and around Coles County.

The proposed FutureGen Project would also have annual operation and maintenance needs that could benefit Coles County. Local contractors could be hired to complete specialized maintenance activities that could not be undertaken by permanent staff, and items such as repair materials, water, and chemicals could be purchased within the ROI. The 200 employees who would fill new jobs created by the proposed FutureGen Project could generate tax revenues from sales and use taxes on plant materials and maintenance. The property tax from the proposed power plant could be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue would be in the millions of dollars each year. This increase would have a direct and positive impact on the total property tax revenue for Coles County and Illinois. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance. Illinois would likely benefit from a public utility tax it would levy when power is produced by the proposed FutureGen Project.

Housing

During operation of the proposed power plant, employees relocating to the area would likely be distributed between owned and rental accommodations. Although it is not known how many of the permanent staff would relocate within the ROI, if all 200 permanent employees relocated, the increased demand for housing would be small. In Illinois, approximately 69.9 percent of housing units are owner-occupied (USCB, 2005c). Using this value, operation of the proposed facilities would result in a 2.2 percent decrease in residences for sale and a 0.4 percent decrease in residences for rent within the ROI.

Power Plant Site

There are two residences located adjacent to, two residences located within 0.25 mile (0.5 kilometer) and 20 additional residences located within 1 mile (1.6 kilometer) that may have an unobstructed view of the facility. Direct and adverse long-term impacts on property values in relation to comparable property values in Mattoon may occur for these properties. The degree to which property values could be affected is uncertain because there are many variables associated with real estate markets and public sentiment.

Sequestration Site

The proposed sequestration site is located on the same property as the proposed power plant site; therefore, the impacts would be the same.

4.2 AIR QUALITY

4.2.1 INTRODUCTION

This section describes existing local and regional air quality and the potential impacts that may occur from constructing and operating the FutureGen Project at the Mattoon Power Plant and Sequestration Site. The FutureGen Project would use integrated gasification combined-cycle (IGCC) technology and would capture and sequester carbon dioxide (CO_2) in deep underground formations. Chapter 2 provides a discussion of the advancements in IGCC technology associated with the FutureGen Project that would reduce emissions of air pollutants. Because of these technologies, emissions from the FutureGen Project would be lower than emissions from existing IGCC power plants and state-of-the-art (SOTA), conventional coal-fueled power plants.

4.2.1.1 Region of Influence

The ROI for air quality includes the area within 50 miles (80.5 kilometers) of the boundaries of the proposed Mattoon Power Plant and Sequestration Site. Sensitive receptors that have been identified within the ROI are discussed in Section 4.2.2.3.

4.2.1.2 Method of Analysis

DOE reviewed available public data and also studies performed by the Alliance to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Result in emissions of criteria pollutants and hazardous air pollutants (HAPs);
- Result in mercury (Hg) emissions and conflict with the Clean Air Mercury Rule (CAMR) as related to coal-fueled electric utilities;
- Cause a change in air quality related to the National Ambient Air Quality Standards (NAAQS);
- Result in consumption of Prevention of Significant Deterioration (PSD) increments as defined by the Clean Air Act (CAA), Title I, PSD rule;
- Affect visibility and cause regional haze in Class I areas;
- Result in nitrogen and sulfur deposition in Class I areas;
- Conflict with local or regional air quality management plans;
- Result in emissions of greenhouse gases (GHGs);
- Cause solar loss, fogging, icing, or salt deposition on nearby residences; and
- Discharge odors into the air.

Plant upset is a serious malfunction of any part of the IGCC process train and usually results in a sudden shutdown of the combined-cycle unit's gas turbine and other plant components.

Based on the above criteria, DOE assessed potential air quality impacts from construction and operational activities related to the FutureGen Project at the proposed Mattoon Power Plant and Sequestration Site. For impacts related to FutureGen Project operations, DOE conducted air dispersion modeling of criteria pollutants using EPA's refined air dispersion model, AERMOD (American Meteorological Society/EPA Regulatory Model). Details on the air modeling protocol are presented in Appendix E. To establish an upper bound for potential impacts, DOE used the FutureGen Project's estimate of maximum air emissions, which was developed by the Alliance and reviewed by DOE, for the air dispersion modeling, based on 85 percent plant availability and unplanned restarts as a result of plant upset (also called unplanned outages) (see Table 4.2-1). The estimate of maximum air emissions was developed using the highest pollutant emission rates for various technology options being considered for the FutureGen Project (see Section 2.5.1.1). Surrogate data from similar existing or permitted units (e.g., the Orlando Gasification Project [Orlando Project]) were used for instances where engineering details and emission data were not available due to the early design stage of the FutureGen Project (DOE, 2007).

Table 4.2-1 presents expected emissions of air pollutants from the FutureGen Project during the 4-year research and development period and beyond. Emissions from the first year of proposed power plant operation, which are expected to be highest, represent the upper bound for potential air emissions and were modeled for this EIS. Emissions would be expected to decrease each year, as learning and experience would reduce the frequency and types of unplanned restart events from an estimated 29 in the first year to 3 in the fifth year and beyond (see Appendix E). Consequently, annual emissions would be expected to decrease progressively from the first year of operation to the fourth year of operation and beyond. Because emissions of some criteria pollutants are projected to exceed 100 tons per year (tpy) (90.7 metric tons per year [mtpy]) (even with less than 3 restarts per year), the FutureGen Project would be classified as a major source under Clean Air Act regulations.

Table 4.2-1. Yearly Estimates of Maximum Air Emissions from the FutureGen Project[1] (tpy [mtpy])

Pollutant	Year 1	Year 2	Year 3	Year 4	Year 5 Onward[2]
Sulfur Oxides[3] (SO_X)	543 (492)	322 (292)	277 (251)	255 (231)	100 (90.7)
Nitrogen Oxides[4] (NO_X)	758 (687)	754 (684)	753 (683)	753 (683)	750 (680)
Particulate Matter[5] (PM_{10})	111 (100)	111 (100)	111 (100)	111 (100)	111 (100)
Carbon Monoxide[5] (CO)	611 (554)	611 (554)	611 (554)	611 (554)	611 (554)
Volatile Organic Compounds[5] (VOCs)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)
Mercury[5] (Hg)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)

[1] Because the FutureGen Project would be a research and development project, DOE assumes that the maximum facility annual availability would be 85 percent. Values are estimated based on maximum emissions rates for design Case 1, 2, or 3A, plus maximum emissions rates for design Case 3B and includes emissions from unplanned restarts (upset conditions).
[2] Year 1 to Year 4 calculated based on information provided by the Alliance. Year 5 estimated by DOE; not provided by the Alliance.
[3] SO_x emissions from coal combustion systems are predominantly in the form of sulfur dioxides (SO_2).
[4] NO_x emissions from coal combustion are primarily nitric oxide (NO); however, for the purpose of the air dispersion modeling, it was assumed that all NO_x emissions are nitrogen dioxides (NO_2). One of the technologies being considered for the FutureGen Project is post-combustion selective catalytic reduction (SCR), which would reduce the annual NO_X emissions to 252 tpy (228.6 mtpy).
[5] Values for PM_{10}, CO, VOCs, and Hg would remain constant between Year 1 through 5 because unplanned restarts would not affect these emissions. Conversely, SO_2 and NO_2 emissions would decrease each year due to expected decrease in restart events. See Appendix E, Tables E-2 and E-3.
tpy = tons per year; mtpy = metric tons per year.
Source: FG Alliance, 2007.

In addition to assessing impacts of criteria pollutant emissions, DOE assessed impacts of HAP emissions by estimating the annual quantities of HAPs that would be emitted from the proposed FutureGen Power Plant. These estimates were developed based on emissions predicted for the Orlando Project, which would burn a carbon-rich syngas (DOE, 2007). The estimated HAPs may be overstated since the FutureGen Project would include new technologies that would produce syngas that would contain lower levels of carbon. The estimated emissions are presented in Section 4.2.3.2.

DOE also assessed the potential for impacts to local visibility from the vapor plume using qualitative measures because engineering specifications needed to conduct quantitative modeling for vapor plume sources (e.g., cooling towers) were not available. Class-I-related modeling, including pollutant dispersion and air-quality-related values (AQRV), were reviewed for their applicability. Potential effects to soil, vegetation, animals, human health, and economic development were also reviewed.

4.2.2 AFFECTED ENVIRONMENT

4.2.2.1 Existing Air Quality

The Illinois Environmental Protection Agency (IEPA) Bureau of Air has monitoring sites throughout the state, which monitor ambient air quality and designate areas or regions that either comply with all of the NAAQS or fail to meet the NAAQS for one or more criteria pollutants. The NAAQS specify the maximum allowable concentrations of six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and inhalable particles, which are also known as respirable particulate matter (PM). The PM_{10} standard covers particles with diameters of 10 micrometers or less and the $PM_{2.5}$ standard covers particles with diameters of 2.5 micrometers or less. Areas that meet the NAAQS for a criteria pollutant are designated as being in “attainment” for that pollutant, and areas where a criteria pollutant concentration exceeds the NAAQS are designated as “non-attainment” areas. Where insufficient data exist to determine an area’s attainment status, the area is designated as unclassifiable. Maintenance areas are those non-attainment areas that have been redesignated as attainment areas and are under a 10-year monitoring plan to maintain their attainment status.

The proposed Mattoon Power Plant and Sequestration Site is located in Coles County, Illinois. Coles County is part of the East Central Illinois Intrastate Air Quality Control Region (AQCR). No ambient air monitoring data are recorded in Coles County (FG Alliance, 2006a); however, in the East Central Illinois Intrastate AQCR, monitors are located in Champaign County, which is within the proposed Mattoon Power Plant Site ROI, and McLean County, which is outside the ROI. These monitors measure O_3 and $PM_{2.5}$ concentrations. The East Central Illinois Intrastate AQCR has no history of non-attainment for the six criteria pollutants. The nearest SO_2 monitor within the ROI of the proposed site is in Macon County in the West Central Interstate AQCR. This monitor indicates attainment with the SO_2 NAAQS. Neither the East Central Illinois Intrastate AQCR nor other AQCRs within the ROI of the proposed Mattoon Power Plant and Sequestration Site has monitors for NO_X, PM_{10}, and CO concentrations. Concentrations of Pb have not been recorded in recent years due to a decrease in use of leaded gasoline in automobiles, which has lowered Pb concentrations in the ambient air to levels well below the NAAQS. Table 4.2-2 provides monitored background data of O_3, $PM_{2.5}$, and SO_2 for the proposed Mattoon Power Plant and Sequestration Site.

While the ROI for the proposed project is currently designated as in attainment or unclassified, air moving from nearby non-attainment areas could likely contribute to the air quality within the region of the proposed Mattoon Power Plant and Sequestration Site. The nearest non-attainment and maintenance areas are located in Indianapolis, Indiana (146 miles [235.0 kilometers] away) and Vigo County, Indiana (46 miles [74.0 kilometers] away). Site-specific monitoring to collect representative background data for all criteria pollutants could be required at the proposed project site as part of the PSD permit application process (EPA, 1990), although the IEPA has indicated that such monitoring would not be required. However, the Alliance may choose to conduct site-specific monitoring for criteria pollutants as appropriate for development of a detailed site characterization if the proposed Mattoon Site is selected.

Table 4.2-2. Monitoring Stations and Ambient Air Quality Data

Monitoring Site Location	Distance from Proposed Site (miles [kilometers])	Pollutant and Averaging Time	Monitored Data[1]	Primary/ Secondary Standard[1]
Decatur, Illinois Macon County West Central Illinois Interstate AQCR	45 (72.4)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour) SO_2 (Annual) SO_2 (24-hour) SO_2 (3-hour)	0.093 0.070 13.3 34.1 0.004 0.024 0.040	0.12 0.08 15 35 0.03 0.14 None
Champaign, Illinois Champaign County East Central Illinois Interstate AQCR	48 (77.2)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	0.082 0.079 12.5 31.9	0.12 0.08 15 35
Bondville, Illinois Champaign County East Central Illinois Interstate AQCR	52 (83.7)	$PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	12.6 31.8	15 35
Normal, Illinois McClean County East Central Illinois Interstate AQCR	100 (160)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	0.093 0.072 12.7 34.3	0.12 0.08 15 35

[1] Units for O_3 and SO_2 are in parts per million (ppm) and $PM_{2.5}$ is in micrograms per cubic meter (µg/m^3). To determine representative background data for both PM_{10} and $PM_{2.5}$, 24-hour and annual averaging period, the monitored data were averaged over a period of 3 years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values for each year for a period of 3 years (2003 to 2005) was used (see Appendix E).
Source: EPA, 2006a; FG Alliance, 2006a.

4.2.2.2 Existing Sources of Air Pollution

Emissions from the proposed FutureGen Project and potential environmental consequences must be considered in the context of both regional air quality and existing local sources of emissions. Existing sources of emissions outside and within the ROI are discussed. Additionally, local sources (i.e., within 1 mile [1.6 kilometers] of the proposed Mattoon Power Plant and Sequestration Site) are discussed.

Outside the Region of Influence

Traffic-related pollution and pollution from existing industrial sources, associated with nearby large cities, can contribute to air quality problems in rural areas. The proposed Mattoon Power Plant and Sequestration Site has the large Illinois cities of Champaign and Urbana to the north (approximately 52 miles [83.7 kilometers]); Springfield to the west (approximately 83 miles [133.6 kilometers]); Indianapolis, Indiana, to the east; and Terre Haute, Indiana, to the southeast. The greater metropolitan Chicago area is approximately 180 miles (289.7 kilometers) to the north of the proposed site and is in non-attainment for O_3 and $PM_{2.5}$. The St. Louis, Missouri, area, which is 90 miles (144.8 kilometers) southwest of Mattoon is also in non-attainment for O_3 and $PM_{2.5}$. However, because of the west-to-east trend of overall air patterns and closer proximity to the proposed site, the St. Louis area would probably have a greater influence on air quality in Mattoon than the greater metropolitan Chicago area. Additionally, the medium-sized city of Decatur is located about 45 miles (72.4 kilometers) northwest and is in a prevalent upwind direction from the proposed Mattoon Power Plant and Sequestration Site. For pollutants for which there were no monitored background data, background data from cities such as Briadwood and Peoria, which are attainment areas but outside the ROI, were used.

Inside the Region of Influence

A **major source** is a unit that emits any one criteria pollutant in amounts equal to or greater than thresholds of 100 tpy (90.7 mtpy) or one HAP in amounts greater than or equal to 10 tpy (9.1 mtpy) or a combination of HAPs in amounts greater than or equal to 25 tpy (22.7 mtpy). Additionally, an electric generating unit is one of the 28 categories defined by the PSD rule. For sources that are not in one of the 28 categories, the threshold is 250 tpy (226.8 mtpy) of criteria pollutants (40 Code of Federal Regulations [CFR] 52.21, 2006).

Small towns or cities within 10 miles (16.1 kilometers) of Mattoon include Windsor, Gays, Allenville, Lerne, Humboldt, and Charleston, and could contribute to background ambient air quality. The types and quantities of air pollutants emitted from existing sources located within 10 miles (16.1 kilometers) of the proposed power plant site may contribute to the background concentrations of pollutants within and surrounding the ROI. According to the EPA Envirofacts website (http://www.epa.gov/enviro), the major sources of criteria pollutants and HAPs within a 10-mile (16.1-kilometer) radius are RR Donnelley and Sons Company, Masterfoods USA, GE Lighting LLC, and AJ Walker Construction Company (EPA, 2006b). Other sources include the vehicle traffic in Mattoon and surrounding areas plus possible fugitive emissions of hydrocarbons from the Mattoon Oil and Gas Field, which extends along a north-south oriented trend through the western side of Mattoon as well as to the north and to the south of the city. These existing sources provide a context for understanding the potential emissions and associated air quality impacts from the proposed project.

Local

No major emissions sources are located within 1 mile (1.6 kilometers) of the proposed Mattoon Power Plant and Sequestration Site. With the exception of the western margin of Mattoon, the area within 1 mile (1.6 kilometers) of the proposed power plant and sequestration site supports mostly agricultural activities (row crops). The croplands are not highly susceptible to wind erosion and, most of the time, would not present a source of wind-blown particulates or dust. However, cultivation and tilling of the soil may cause some dust suspension or render the soil more susceptible to wind erosion for short periods of time.

4.2.2.3 Sensitive Receptors (Including Class I Areas)

There are two residences across the street from the proposed site on the north and east sides, and two additional residences within approximately 0.25 mile (0.4 kilometer). Approximately 20 additional residences are located within 1 mile (1.6 kilometers) of the site, including a group of residences on Western Avenue. There are no hospitals, schools, or nursing homes within 1 mile (1.6 kilometers) of the proposed site.

Within the 10-mile (16.1-kilometer) radius of the proposed Mattoon Power Plant Site, there are about 24 residences, 10 schools, one hospital, and five nursing homes (see Figure 4.2-1) (FG Alliance, 2006a).

Class I Areas

For areas that are already in compliance with the NAAQS, the PSD requirements provide maximum allowable increases in concentrations of pollutants, which are expressed as increments. Allowable PSD increments currently exist for three pollutants: SO_2, NO_2, and PM_{10}. They apply to the three types of areas classified under the PSD regulations: Classes I, II, and III, where the smallest allowable increments correspond to Class I areas (Table 4.2-3).

Table 4.2-3. Allowable PSD Increments (µg/m^3)

Pollutant, Averaging Period		Class I Area	Class II Area	Class III Area
SO_2	3-Hour	25	512	700
	24-Hour	5	91	182
	Annual	2	20	40
NO_2	Annual	2.5	25	50
PM_{10}	24-Hour	8	30	60
	Annual	4	17	34

µg/m^3 = micrograms per cubic meter.
Source: EPA, 2005.

Class I areas, which are those areas designated as pristine, require more rigorous safeguards to prevent deterioration of the air quality, and include many national parks and monuments, wilderness areas, and other areas as specified in 40 CFR 51.166(e). The closest Class I area is 190 miles (305.8 kilometers) from the proposed Mattoon Power Plant and Sequestration Site (see Table 4.2-4), which is well beyond the 62-mile (100-kilometer) distance required to consider impacts to Class I areas under the PSD regulations. All other clean air regions are designated Class II areas, with moderate pollution increases allowed (FWS, 2007). The proposed Mattoon Power Plant and Sequestration Site is located in a Class II area.

Table 4.2-4. Nearest Class I Areas to Proposed Mattoon Power Plant and Sequestration Site

Class I Area/Location	Distance (miles)	Distance (kilometers)	Direction
Mammoth Cave National Park, Kentucky	190	305.8	SE
Mingo National Wildlife Refuge, Missouri	198	318.7	SW

Source: FG Alliance, 2006a.

4.2.2.4 Air Quality Management Plans

The CAA requires states to develop federally approved regulatory programs, called State Implementation Plans (SIPs), for meeting the NAAQS throughout the state. These plans aim to limit emissions from sources as necessary to achieve and maintain compliance. In part, SIPs focus on new major stationary sources and modifications to existing major stationary sources. A state's New Source Review (NSR)/PSD review program is defined and codified in its SIP. The Illinois SIP is available from the IEPA.

The FutureGen Project would be required to undertake the NSR/PSD permit application process after a host site is selected. State and local governmental officials contacted during the development of this EIS and the supporting Environmental Information Volume (EIV) indicate that there are no local air quality management plans currently in existence for the ROI (FG Alliance, 2006a). Additionally, these officials have no knowledge of specific local needs or concerns for air quality management at the proposed Mattoon Power Plant and Sequestration Site.

4.2.3 IMPACTS

4.2.3.1 Construction Impacts

Construction at the proposed power plant and sequestration site, utility corridors, and transportation corridors would result in localized increases in ambient concentrations of SO_2, NO_X, CO, VOCs, and PM. These emissions would result from the use of construction equipment and vehicles, including trucks, bulldozers, excavators, backhoes, loaders, dump trucks, forklifts, pumps, and generators. In addition, fugitive dust emissions (i.e., PM emissions) would occur from various construction-related activities, including earth moving and grading, material handling and storage, and vehicles traveling over dirt and gravel areas.

Given the size of the proposed site and the short duration of the construction period, potential impacts would be localized and temporary in nature. Construction impacts would be minimized through the use of best management practices (BMPs), such as wetting the soil surfaces, covering trucks and stored materials with tarps to reduce windborne dust, and using properly maintained equipment (see Section 3.4).

Power Plant and Sequestration Site

DOE assumed that up to 200 acres (81 hectares) of the proposed 444-acre (180-hectare) site would be directly affected for the purposes of the air impact analysis. DOE estimates that construction of the proposed Mattoon Power Plant and Sequestration Site would take 44 months. The CO_2 injection wells would be located within the proposed power plant site and only a very small fraction of the land area would be disturbed by either exploratory investigations (e.g., geophysical surveys) or construction of the sequestration facilities (e.g., injection and monitoring wells).

PM concentrations would be localized because of the relatively rapid settling of larger dust particles and impacts to off-site receptors would be temporary. In addition, PM emissions would decrease with the total amount of land disturbed, as PM emissions were calculated on the basis of site acreage. Impacts of the SO_2, NO_X, CO, and VOC emissions from vehicular sources would be temporary in nature and could cause minor to moderate short-term degradation of local air quality. The air pollutant emissions would be minimized through the use of BMPs, such as limiting the amount of vehicle trips, wetting the soil surfaces, covering trucks, limiting vehicle idling, and properly maintaining equipment.

Utility Corridors

The proposed utility corridors could include a natural gas pipeline, process water pipeline, potable water pipeline, sanitary wastewater pipeline, and electric transmission line. Construction of the utility corridors would require less acreage, use less equipment, and take less time than the construction of the proposed power plant. The duration of utility corridor construction would range from 1 month for the process water pipeline to 6 months for the other pipelines. The emissions from construction would include SO_2, NO_X, PM, CO, and VOCs. Impacts from emissions of these pollutants would be localized and temporary in nature and could cause minor to moderate short-term degradation of air quality in the areas where construction is taking place.

Transportation Corridors

Access to the proposed Mattoon Power Plant and Sequestration Site would be primarily via SR 121 along the northeast boundary of the site. Additionally, the Canadian National Railroad – Peoria Spur also runs along the northeast border of the proposed power plant site. Delivery to and from the proposed site could be accomplished either by railway or roadway; therefore, construction of additional public roadways or railways would not be required, and no impact would be expected. However, if the Mattoon Power Plant and Sequestration Site is selected for the FutureGen Project, the Illinois Department of Transportation (IDOT) has committed to upgrading County Highway (CH) 13 to a Class II truck route from CH 18 to the entrance of the plant, including the intersection with SR 121 (FG Alliance, 2006a). Impacts associated with upgrading this roadway would be dependent on the extent of construction activities required.

4.2.3.2 Operational Impacts

Power Plant Site

Sources of Air Pollution

Primary sources of air emissions associated with the FutureGen Project would be the combustion turbine, flare, gasifier preheat, cooling towers, and sulfur recovery system (see Figure 2-18). DOE and the Alliance have estimated the maximum potential emissions that would be expected (see Table 4.2-1) using data from equipment typical of an IGCC power plant. However, because the FutureGen Project is in the early stages of design, specific engineering and technical information on the equipment that would ultimately be used is not available. Other sources of air emissions could include mobile sources such as plant vehicular traffic and personnel vehicles, which would be equipped with standard pollution-control devices to minimize emissions.

Local traffic within the proposed power plant site would be expected to emit small amounts of criteria pollutants. In addition, coal delivery trains (five trains per week) would emit a small amount of criteria pollutants from the train exhaust, and potentially PM during coal unloading and handling. However, coal handling emissions are not expected to appreciably change air quality because the emissions would be reduced by minimizing points of transfer of the material, enclosing conveyors and loading areas, and installing control devices such as baghouses and wetting systems.

Clean Air Act General Conformity Rule

Section 176(c)(1) of the Clean Air Act requires that federal actions conform to applicable SIPs for achieving and maintaining the NAAQS for the criteria air pollutants. In 1993, EPA promulgated a rule titled "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," codified at 40 CFR Parts 6, 51, and 93. The rule is intended to ensure that criteria air pollutant emissions and their precursors (e.g., VOCs and NO_X) are specifically identified and accounted for in the attainment or maintenance demonstration contained in a SIP. The conformity rule applies to proposed federal actions that would cause emissions of criteria air pollutants above certain levels in locations designated as non-attainment or maintenance areas for the emitted pollutants. Under the rule, an agency must engage in a conformity review process and, depending on the outcome of that review, conduct a conformity determination.

DOE conducted a conformity review to assess whether a conformity determination (40 CFR Part 93) is needed for the proposed FutureGen Project. As discussed in Section 4.2.2.1, Coles County is in attainment or unclassified with the NAAQS for all pollutants. Additionally, Coles County is not designated as a maintenance area. Consequently, no conformity determination is needed (see Section 4.2.2.4).

Criteria Pollutant Emissions

DOE conducted refined modeling using AERMOD. Table 4.2-5 presents the results of the AERMOD modeling for the operational phase of the proposed Mattoon Power Plant. Limited amounts of background air concentration data for the Mattoon area were available for use in this EIS. For SO_2 and $PM_{2.5}$, representative background data were available from monitors within the same AQCR as Coles County or within the ROI. For NO_2, PM_{10}, and CO, DOE used background data from monitors that were outside the ROI but within attainment areas to represent ambient concentrations for those pollutants. To determine representative background data for both PM_{10} and $PM_{2.5}$ 24-hour and annual averaging periods, DOE took the average of the second-highest monitored data over a period of 3 years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values of each year for a period of 3 years (2003 to 2005) was used (see Appendix E).

Table 4.2-5 shows that concentrations of pollutants during the operational phase combined with background concentrations would be below their respective NAAQS during normal plant operation and plant upset. Additionally, the proposed FutureGen Project would not exceed the Class II PSD allowable increments; however, short-term 3-hour and 24-hour SO_2 concentrations could approach Class II PSD increment limits during plant upset from emissions associated with unplanned restart events. These unplanned restart emissions of SO_2 would typically be higher than steady-state SO_2 emissions, because syngas would be directly flared without the benefit of the sulfur recovery unit (see Appendix E). The probability of the proposed power plant exceeding the 3-hour SO_2 Class II PSD increment at the proposed Mattoon Power Plant Site during periods of plant upset is 0.23 percent and zero percent during normal operating scenarios. The probability of the proposed power plant exceeding the 24-hour SO_2 Class II PSD increment at the proposed Mattoon Power Plant Site at any time is zero. Maximum concentrations of the pollutants at anytime would be limited to a radius of less than 1 mile (1.6 kilometers) from the center of the proposed Mattoon Power Plant Site. Currently, two residences are across the street from the site on the north and east sides, two additional residences are within 0.25 mile (0.4 kilometer), and about 20 additional residences are within 1 mile (1.6 kilometers). These residences would be impacted.

Table 4.2-5. Comparison of Maximum Concentration Increases with NAAQS and PSD Increments

Pollutant	Maximum Concentration FutureGen Project Alone[1] (μg/m³)	Maximum Concentration FutureGen Project + Background (μg/m³)	NAAQS (μg/m³)	Class II PSD Increments (μg/m³)	PSD Increment Consumed by FutureGen Project (percent)	Distance of Maximum Concentration (miles [kilometers])
SO_2 (normal operating scenario)[2]						
3-hour	0.72	123.75	1,300	512	0.14	0.61 (0.98)
24-hour	0.26	70.93	365	91	0.29	1.00 (1.6)
SO_2 (upset scenario)[3]						
3-hour	511.82	634.85	1,300	512	99.96	0.67 (1.1)
24-hour	88.00	158.67	365	91	96.70	0.67 (1.1)
SO_2 Annual[4]	0.18	10.65	80	20	0.92	0.63 (1.0)

Table 4.2-5. Comparison of Maximum Concentration Increases with NAAQS and PSD Increments

Pollutant	Maximum Concentration FutureGen Project Alone[1] (µg/m³)	Maximum Concentration FutureGen Project + Background (µg/m³)	NAAQS (µg/m³)	Class II PSD Increments (µg/m³)	PSD Increment Consumed by FutureGen Project (percent)	Distance of Maximum Concentration (miles [kilometers])
NO_2[4, 5]						
Annual	0.26	30.35	100	25	1.03	0.63 (1.0)
PM/PM_{10}[4, 6]						
24-hour	0.52	57.86	150	30	1.75	1.00 (1.6)
Annual	0.04	26.04	50	17	0.22	0.63 (1.0)
$PM/PM_{2.5}$[4, 6]						
24-hour	0.52	32.46	35	n/a	n/a	1.00 (1.6)
Annual	0.04	12.54	15	n/a	n/a	0.63 (1.0)
CO[7]						
1-hour	11.33	5,622.76	40,000	n/a	n/a	0.50 (0.8)
8-hour	5.01	3,462.94	10,000	n/a	n/a	0.63 (1.0)

[1] Value based on site-specific meteorological and terrain data. Except for the 3-hour SO_2 during the upset scenario, the highest maximum predicted concentrations are provided for all pollutants and corresponding averaging times, based on the worst-case emissions rates, meteorological data, and terrain data. For the 3-hour SO_2 averaging time during the upset scenario, the 85th highest maximum predicted concentration is provided. Although the highest maximum 3-hour SO_2 concentration could exceed the PSD increment during the upset scenario, the 3-hour increment would not be exceeded at least 99.77 percent of the time. The highest maximum predicted concentrations for the other pollutants and corresponding averaging times would not be expected to exceed the PSD Class II increment at any time.
[2] The normal operating scenario is based on steady-state emissions and is a period when the plant is operating without flaring, sudden restarts, or other upset conditions (see Appendix E).
[3] The upset scenario is based on unplanned restart emissions and is a period when a serious malfunction of any part of the IGCC process train usually results in a sudden shutdown of the combined-cycle units gas turbine and other plant components (see Appendix E).
[4] Annual impacts are based on maximum annual emissions (see Appendix E) over 7,446 hours per year.
[5] There are no short-term NAAQS for NO_2.
[6] There are no unplanned restart emissions of PM_{10} and $PM_{2.5}$ pollutants; therefore, short-term impacts (24-hour) are based on steady-state emissions.
[7] Although there are unplanned restart emissions of CO pollutants, the short-term impacts (1-hour and 8-hour) are based on steady-state emissions because steady-state CO emissions are larger than unplanned restart CO emissions.
n/a = not applicable; µg/m³ = micrograms per cubic meter.
Source: AERMOD modeling results (see Appendix E).

Hazardous Air Pollutants

HAP emissions from the FutureGen Project were estimated based on the Orlando Project, a recent IGCC power plant that was determined to provide the best available surrogate data (DOE, 2007). DOE scaled the Orlando Project data based on relative emission rates of VOCs and PM to produce more appropriate estimates of emission rates for the FutureGen Project. However, only emissions from the gas turbine were considered to account for differences between the Orlando design and the FutureGen Project. These differences include the FutureGen Project's use of oxygen (O_2) in the gasifier instead of air, the use of a catalytic shift reactor to convert CO to CO_2, and CO_2 capture and sequestration features.

Predicted HAP emissions are presented in Table 4.2-6. These data indicate that the FutureGen Project would not emit any individual HAP above the 10-tpy (9.1-mtpy) major source threshold. Additionally, at 0.32 tpy (0.3 mtpy) of combined HAPs, the proposed FutureGen Project would not be a major source of HAPs as defined under the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Health hazards and risks associated with these HAP emissions and other air toxins are discussed in Section 4.17.

Table 4.2-6. Annual Hazardous Air Pollutant Emissions[1]

Chemical Compound	Combustion Turbine Emissions	
	tpy	mtpy
2-Methylnaphthalene	7.41E-04	6.72E-04
Acenaphthyalene	5.36E-05	4.86E-05
Acetaldehyde	3.72E-03	3.37E-03
Antimony[2]	2.08E-02	1.89E-02
Arsenic[2]	1.09E-02	9.93E-03
Benzaldehyde	5.99E-03	5.44E-03
Benzene	1.00E-02	9.09E-03
Benzo(a)anthracene	4.77E-06	4.32E-06
Benzo(e)pyrene	1.14E-05	1.03E-05
Benzo(g,h,i)perylene	1.96E-05	1.78E-05
Beryllium[2]	4.69E-04	4.26E-04
Cadmium[2]	1.51E-02	1.37E-02
Carbon Disulfide	9.27E-02	8.41E-02
Chromium[2, 3]	1.41E-02	1.28E-02
Cobalt[2]	2.97E-03	2.69E-03
Formaldehyde	6.89E-02	6.25E-02
Lead[2]	1.51E-02	1.37E-02
Manganese[2]	1.62E-02	1.47E-02
Mercury[2]	4.73E-03	4.29E-03
Naphthalene	1.10E-03	9.96E-04
Nickel	2.03E-02	1.84E-02
Selenium	1.51E-02	1.37E-02
Toluene	1.53E-03	1.39E-03
TOTAL	3.21E-01	2.91E-01

[1] Emission rates scaled by the ratio of VOC or PM emissions from Orlando Gasification Project EIS to the FutureGen Project. The Orlando Project's VOC emissions were multiplied by a factor of 0.2727, based on 30 tpy (27.2 mtpy) VOC for the FutureGen Project divided by 110 tpy (99.8 mtpy) VOC for the Orlando Project. The Orlando Project's PM emissions were multiplied by a factor of 0.6894, based on 111 tpy (100.7 mtpy) PM for the FutureGen Project divided by 161 tpy (146.1 mtpy) PM for the Orlando Project.
[2] Compounds that are considered to be PM are in bold text.
[3] Conservatively assumed all chromium to be hexavalent.
tpy = tons per year; mtpy = metric tons per year.
Source: DOE, 2007.

Mercury

The CAMR establishes standards of performance, limiting Hg emissions from new and existing coal-fueled power plants that produce more than 25-MW equivalent output and that would sell at least a portion of the electricity. The CAMR also creates a cap-and-trade program. Under the CAMR, the Illinois Pollution Control Board requires controls that would reduce 90 percent of input Hg from various coal-fueled electrical generating units by mid-year 2009. The FutureGen Project would be subject to the CAMR because it is a unit that would generate approximately 275 megawatts-electrical (MWe) and would sell more than one-third of its potential electric output. The FutureGen Project would remove over 90 percent of Hg during the syngas cleanup process using activated carbon beds.

The maximum potential emissions of Hg from the FutureGen Project of 0.011 tpy (0.01 mtpy) would be well below the major source threshold for Hg of 10 tpy (9.1 mtpy) and significant emissions rate of 0.1 tpy (0.09 mtpy). The AERMOD analysis predicted that a negligible annual concentration of Hg (3.78×10^{-6} micrograms per cubic meter) would be deposited within 0.63 mile (1.0 kilometer) of the proposed power plant site.

Greenhouse Gases

GHGs include water vapor, CO_2, methane, NO_X, O_3, and several chlorofluorocarbons. Water vapor is a naturally occurring GHG and accounts for the largest percentage of the greenhouse effect. Next to water vapor, CO_2 is the second-most abundant GHG. Uncontrolled CO_2 emissions from power plants are a function of the energy output of the plants, the feedstock consumed, and the power plants' net efficiency at converting the energy in the feedstock into other forms of energy (e.g., electricity, useable heat, and hydrogen gas). Because CO_2 is relatively stable in the atmosphere and essentially uniformly mixed throughout the troposphere and stratosphere, the climatic impact of CO_2 emissions does not depend upon the CO_2 source location on the earth (DOE, 2006a). Although regulatory agencies are taking actions to address GHG effects, there are currently no Illinois or federal standards or regulations limiting CO_2 emissions and concentrations in the ambient air.

The proposed FutureGen Project would produce electricity and hydrogen fuel while emitting CO_2. DOE estimates that up to 0.28 million tons (0.25 million metric tons [MMT]) per year of CO_2 would be released into the atmosphere. A goal of the FutureGen Project is to capture and permanently sequester at least 90 percent of the CO_2 generated by the proposed power plant at a rate of 1.1 to 2.8 million tons (1.0 to 2.5 MMT) per year. By sequestering the CO_2 in geologic formations, the FutureGen Project aims to prove one technological option that could virtually eliminate future CO_2 emissions from similar coal-based power plants.

DOE's Energy Information Administration (EIA) report (DOE, 2006a) indicates that U.S. CO_2 emissions have grown by an average of 1.2 percent annually since 1990 and energy-related CO_2 emissions constitute as much as 83 percent of the total annual CO_2 emissions. DOE reviewed EPA's Emissions and Generation Resource Integrated Database (eGRID) to gain an understanding of the scale of the estimated CO_2 emissions from the proposed FutureGen Project compared to existing coal-fueled plants (EPA, 2006c). eGRID provides information on the air quality indicators for almost all of the electric power generated in the U.S.

The most recent data that can be accessed electronically are for the year 2000. A review of the database yielded the following information:

- In 2000, CO_2 emissions from all coal-fueled plants in Illinois equaled 94.7 million tons (85.9 MMT). The average emissions rate of these coal plants was 2,326 pounds (1,055 kilograms) per megawatt-hour.
- Based on the average CO_2 emissions rates of nine representative coal plants in the size range of 153 to 508 MW, a conventional 275-MW coal-fueled power plant would emit 2.17 million tons (2.0 MMT) per year at an 85 percent capacity factor. This is in the same range as the estimated amount of CO_2 (1.1 to 2.8 million tons [1.0 to 2.5 MMT] per year) that would be sequestered by the proposed FutureGen Project.

Carbon capture and sequestration, if employed widely throughout the U.S. in future power plants or retrofitted existing power plants, could help reduce and possibly reverse the growth in national annual CO_2 emissions.

Acid Rain Requirements

Acid rain or acid deposition can occur when acid precursors (such as SO_2 and NO_X) are released into the atmosphere, and they react with O_2 and water to form acids (EPA, 2007). Acid rain can cause soil degradation; increase acidity of surface water bodies; and reduce growth, injure, or even cause death of forests and aquatic habitats. The Acid Rain Program, established under Title IV of the CAA, requires electric generating units greater than 25 MW to obtain a Phase II Acid Rain Permit and meet the objectives of the program, which are achieved through a system of marketable allowances. The FutureGen Project would be required to obtain a Phase II Acid Rain Permit and would operate in a manner that is consistent with EPA's overall efforts to reduce emissions of acid precursors. Continuous emissions monitoring for SO_2, NO_X, and CO_2, as well as volumetric gas flow and opacity, is a part of the acid rain regulations, which include requirements for monitoring, recordkeeping, and reporting. Upon facility startup, the FutureGen Project would need to obtain SO_2 allowances each year in an amount equal to the actual SO_2 emissions from the facility.

Odors

Operation of the FutureGen Project may cause noticeable odors. The chemical components that could cause noticeable odors are hydrogen sulfide (H_2S) and ammonia (NH_3). H_2S is formed during the gasification of coal containing sulfur. The FutureGen Project would use an acid gas removal system that would potentially remove 99 percent of the sulfur in the syngas stream, thereby reducing the amount of H_2S emitted and reducing the impact from H_2S odors. For the FutureGen Project, the fuel stock would be blown into the gasifier using O_2; therefore, the NH_3 in the syngas would be formed from fuel bound nitrogen. Additionally, NH_3 would be used in a selective catalytic reduction (SCR) system, a potential component of the FutureGen Project that controls NO_X emissions. While the current FutureGen Project design configurations include an SCR system, current research activities sponsored under the DOE Fossil Energy Turbine Program are investigating technologies that can achieve the NO_X emissions goals through combustion modifications only, thereby eliminating the need for post-combustion SCR (DOE, 2006b). The Alliance estimates that approximately 1,333 tons (1,209 metric tons) of NH_3 per year would be consumed in the FutureGen SCR process (FG Alliance, 2006e).

Both gases would normally only be emitted as small quantities of fugitive emissions (e.g., through valve or pump packing); however, if an accidental large release were to occur, such as a pipe rupture in the Claus Unit (the sulfur recovery unit) or from on-site NH_3 storage, a substantial volume of odor would be noticeable beyond the plant boundary. Other odors could be emitted from activities such as equipment maintenance, coal storage, and coal handling; however, these potential odors should be limited to the immediate site area and should not affect off-site areas. Illinois regulates all odors detected in the ambient air (i.e., beyond the fence line) under the provisions of Title 35 Part 245. Depending on the wind direction, even small volumes of H_2S and NH_3 odors could be a nuisance for up to 20 residences within 1 mile (1.6 kilometers) of the proposed Mattoon Power Plant Site.

Local Plume Visibility, Shadowing, Fogging, and Water Deposition

The proposed Mattoon Power Plant would have two main sources of water vapor plumes: the gas turbine exhaust stack and the cooling towers. The height of the cooling tower is typically less than the height of the gas turbine exhaust stack, which for the FutureGen Project is estimated to be 250 feet (76.2 meters) (FG Alliance, 2006e). Because of a reduced height, the cooling tower presents a greater concern than the gas turbine exhaust stack for impacts such as ground-level fogging, water deposition, and solids deposition (including precipitates). Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Potential deposition of solids would occur because the Mattoon Site proposes to use process water from the Charleston and Mattoon WWTPs, which may contain total dissolved solids and other PM (FAO, 1992) (see Table 4.7-2). Effects from vapor plumes and deposition would be most pronounced within 300 feet (91.4 meters) of the vapor source and would decrease rapidly with distance from the source. Both cooling towers and the gas turbine exhaust plume may cause some concern for shadowing and aesthetics. Plume shadowing is generally a concern only when considering its effect on agriculture, which, due to the attenuation of sunlight by the plume's shadow, may reduce yield.

At the proposed Mattoon Power Plant and Sequestration Site, nearby residences or agriculture could be impacted by fogging, water deposition, icing, or solid deposition under rare meteorological events; however, the impacts would be minimal. The greatest concern would be for traffic hazards created on SR 121, which borders the northeast side of the proposed power plant property. Because the proposed Mattoon Site has 444 acres (180 hectares) and the FutureGen Project footprint requires 60 acres (24 hectares), it is unlikely that the boundary of the power plant would be located within 300 feet (91.4 meters) of the road. If the locations of the cooling tower and stack are more than 300 feet (91.4 meters) from the road, fog from the plant would dissipate and deposition of solids on the road should not occur. Overall, solar loss, fogging, icing, or salt deposition from the proposed Mattoon Power Plant would not interfere with quality of life in the area.

Effects of Economic Growth

Any air quality impacts due to residential growth would be in the form of automobile and residential (fuel combustion) emissions that would be dispersed over a large area. Commercial growth would be expected to occur at a gradual rate in the future, and any significant new source of emissions would be required to undergo permitting by the IEPA. Impacts of economic growth on ambient air quality and PSD increments are unknown at this time. As part of the PSD permitting process, a determination of existing background concentrations of pollutants and additional modeling work would be required to estimate the maximum air pollutant concentrations that would be associated with the proposed Mattoon Power Plant as a result of future economic growth. Section 4.19 provides detailed discussions of the impacts of economic growth from the FutureGen Project on the local resources.

Effects on Vegetation and Soils

Section 165 of the Clean Air Act requires preconstruction review of major emitting facilities to provide for the prevention of significant deterioration and charges federal managers with an affirmative responsibility to protect the AQRVs of Class I areas. Implementing regulations requires an analysis of the potential impairment to visibility, soils, and vegetation. Subsequently, EPA developed "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals," which specifies the air pollutant screening concentrations for which adverse effects may occur for various vegetation species and soils, depending on their sensitivity to pollutants (EPA, 1980). While the Mattoon Power Plant Site is more than 62 miles (100 kilometers) from a Class I area, it is surrounded by cropland that could be affected by the plant's air emissions. Therefore, DOE compared the power plant's predicted maximum air pollutant emissions with the EPA screening concentrations (Table 4.2-7). Based on this comparison, the power plant's emissions would be well below applicable screening concentrations. Emissions also would be well below the secondary NAAQS criteria, which are established to prevent unacceptable effects to crops and vegetation, buildings and property, and ecosystems.

Table 4.2-7. Screening Analysis for Effects on Vegetation and Soils

Pollutant	Averaging Period[1]	Maximum Total Concentration[2] (µg/m^3)	Screening Concentrations[3] (µg/m^3)	Secondary NAAQS (µg/m^3)
SO_2	3-hour	634.85	786	1,300
NO_2	Annual	30.35	94	100

[1] Maximum concentration for shortest averaging period available.
[2] Maximum concentration, including background data (see Table 4.2-5).
[3] The most conservative values were utilized, based on the highest vegetation sensitivity category.
µg/m^3 = micrograms per cubic meter.
Source: EPA, 1980.

Effects on Animals

The secondary NAAQS were established to set limits to protect public welfare, including protection against harm to animals. The maximum predicted concentrations from the FutureGen Project estimated from the upper-bound emissions of the FutureGen Project's estimates of maximum air emissions, in addition to the ambient background concentration, are below the secondary NAAQS for all pollutants.

Sequestration Site

The proposed CO_2 sequestration reservoir is within bedrock layers located several thousand feet beneath the ground surface, far below the soil zone, water table aquifer, and overlying unsaturated zone (see Section 4.5 and Chapter 2). Because co-sequestration of H_2S and CO_2 is being considered as part of research and development activities for the FutureGen Project, minor air emissions of H_2S and CO_2 would occur during routine operations over the lifetime of the proposed injection period, which DOE expects to be between 20 to 30 years, and possibly up to 50 years. Sources of emissions during sequestration site operations could include:

- Injection wells, monitoring wells, and other wells; and
- Aboveground valves, piping, and well heads that comprise the transmission system.

Injection Wells, Monitoring Wells, and Other Wells

Wells provide the greatest opportunity for the escape of sequestered fluids. The injection well would extend into a target injection zone, with steel pipe inserted its full length and cemented into the bore hole to prevent upward escape of sequestered fluid around the outside of the pipe. Within the steel casing, tubing is installed from the well head down to the top of the injection zone, with the annular space sealed against the casing with a packer. The annular space is filled with heavy liquid, such as brine, to help control any accidental leakage into the annular space. This tubing could be removed and replaced should it become corroded or damaged over time. The technology is standard for constructing a well of this type and no measurable fugitive emissions from the well would be expected. Monitoring wells would be constructed in a similar manner as the injection wells, so they would be secure and could also be monitored for leaks and repaired as needed. There should be no contact by CO_2 with the soils. The sequestration reservoir would be tested for assurance that no leak paths exist prior to project operations. Pre-existing oil wells that are not related to the FutureGen Project present a greater risk of leakage. If Mattoon is selected to host the FutureGen Project, DOE anticipates that some means of identifying the locations of pre-existing wells over the plume and monitoring these wells for leakage would be employed at levels commensurate with the risks posed by the pre-existing wells. Wells that provide leakage points would be repaired or plugged to prevent leakage and emissions. All exploratory wells would be properly plugged with concrete and abandoned before operation of the sequestration facility if they are not used as injection wells or monitoring wells, preventing potential fugitive emissions from the sequestered CO_2.

Aboveground Valves, Piping, and Well Heads

The supercritical CO_2 that would be piped from the plant to the injection wells would enter each well through a series of valves attached to the underground steel pipe to ensure proper direction and control of flow. These valves would be above ground and easily accessible to workers for controlling well operation and conducting well maintenance. There would typically be four valves with flanged fittings for each well. Fugitive emissions from each valve were estimated based on a California South Coast Air Quality Management District (SCAQMD, 2003) valve emission factor of 0.0013 pound (0.6 gram) per hour for non-methane organic compounds. In addition to the expected fugitive emissions typical of gate valves, periodic well inspections, testing, and maintenance would be another source of emissions. The well valves would be periodically manipulated to allow insertion of inspection or survey tools to test the integrity of the system or to repair or replace system components. During each of those instances, some amount of CO_2 gas would be vented to the atmosphere.

The annual emissions estimate is based on the two injection wells required, accounting for the tubing volume and the number of evacuations that would occur each time a valve is opened. DOE estimates annual emissions of approximately 66 tons (59.9 metric tons) of CO_2. A number of tracers would also be used to track the fate and transport of the injected CO_2. Descriptions of these compounds are provided in Section 4.16. Fugitive emissions from valves, piping, and well heads may also contain very minute amounts of these tracers.

Utility Corridors

There are no planned operational activities along the proposed utility corridors that would cause air emissions impacts. Routine maintenance along the corridors would not result in fugitive emissions. However, if repairs were required and an underground line had to be excavated, there would be localized and temporary soil dust releases during the excavation process, which would be minimized through BMPs.

Transportation Corridors

During operation of the power plant, transportation-related air emissions would be produced from train and truck shipments to and from the plant and also from employee automobiles. Major pollutants emitted from automobiles, trucks, and trains include hydrocarbons (HC), NO_X, CO, PM, and CO_2. Trucks emit more HC and CO than trains on a brake horsepower per hour basis although they emit less NO_x and PM on the same basis. The higher values for HC and CO are caused by the differences in driving cycle—the truck driving cycle is much more dynamic than that of a train, which has more constant speed operations (Taylor, 2001). The FutureGen Project would aim to utilize train shipments for materials and waste to the greatest extent possible to increase transportation efficiency and reduce shipping costs but to also minimize related air pollution.

4.20 ENVIRONMENTAL JUSTICE

The U.S. Department of Energy defines "**Environmental Justice**" as: The fair treatment and meaningful involvement of all people—regardless of race, ethnicity, and income or education level—in environmental decision-making. Environmental Justice programs promote the protection of human health and the environment, empowerment via public participation, and the dissemination of relevant information to inform and educate affected communities. DOE Environmental Justice programs are designed to build and sustain community capacity for meaningful participation for all stakeholders in DOE host communities (DOE, 2006).

Specific populations identified under Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 *Federal Register* 7629), are examined here along with the potential effects on these populations from construction and operation of the proposed FutureGen facility. In the context of this EIS, Environmental Justice refers specifically to the potential for minority and low-income populations to bear a disproportionate share of high and adverse environmental impacts from activities within the project area and the municipalities nearest to the proposed Mattoon Power Plant and Sequestration Site, and related corridors.

4.20.1 INTRODUCTION

Executive Order 12898 directs federal agencies to achieve Environmental Justice as part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations. Minorities are defined as individuals who are members of the following population groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. To classify as a minority population, an area must have a population of these groups that exceeds 50 percent of the total population, or the minority population percentage of the affected area should be meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis (59 *Federal Register* 7629).

The Council on Environmental Quality (CEQ) guidance recommends that low-income populations in an affected area be identified using data on income and poverty from the U.S. Census Bureau (CEQ, 1997). Low-income populations are groups with an annual income below the poverty threshold, which was $19,971 for a family of four for calendar year 2006.

4.20.1.1 Region of Influence

The ROI includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant and sequestration site, reservoir, and utility and transportation corridors. The proposed sequestration site and reservoir are located on the same property as the proposed plant site. The ROI includes the following counties in Illinois: Coles, Champaign, Christian, Clark, Clay, Crawford, Cumberland, DeWitt, Douglas, Edgar, Effingham, Fayette, Jasper, Macon, Marion, Montgomery, Moultrie, Piatt, Richland, Sangamon, Shelby and Vermilion. The ROI also includes Vigo County in Indiana. Section 4.19.1.1 describes the rationale for including these counties in the ROI.

4.20.1.2 Method of Analysis

DOE collected demographic information from the U.S. Census Bureau 2000 census to characterize low-income and minority populations within 50 miles (80.5 kilometers) of the proposed Mattoon Power Plant and Sequestration Site. Census data are compiled at various levels corresponding to geographic areas and include, in order of decreasing size, states, counties, census tracts, block groups, and blocks. In order to accurately characterize and locate minority and low-income populations, DOE followed CEQ Guidance (CEQ, 1997) to determine minority and low-income characteristics using U.S., State of Illinois, regional (defined by the 23-county ROI), and individual county data. The data presented in Table 4.20-1 show the overall composition and makeup of both minority and non-minority populations, and low-income populations within the ROI. Where available, DOE obtained U.S. Census data for local jurisdictions (i.e., towns and cities) to further identify the presence of minority or low-income populations. DOE used Census block group data (FG Alliance, 2006a) to examine the distribution of minority and low-income populations within the ROI.

DOE used potential environmental, socioeconomic, and health impacts identified in other sections of this EIS to assess potential impacts to Environmental Justice that could occur with the proposed construction and operation of the FutureGen Project.

DOE assessed the potential for impacts based on the following criteria:

- A significant and disproportionately high and adverse effect on a minority population; or
- A significant and disproportionately high and adverse effect on a low-income population.

Table 4.20-1. County, Regional and National Population and Low-Income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-Income (percent)
Counties Completely Located Within the ROI								
Coles	53,196	95.4	2.3	0.2	0.8	<0.1	1.4	17.5
Clark	17,008	98.8	0.2	0.2	0.1	<0.1	0.3	9.2
Cumberland	11,253	98.8	0.1	0.2	0.2	<0.1	0.6	9.5
Douglas	19,922	97.3	0.3	0.2	0.3	<0.1	3.5	6.4
Effingham	34,264	98.7	0.2	0.2	0.3	<0.1	0.7	8.1
Moultrie	14,287	98.9	0.2	0.2	0.1	<0.1	0.5	7.8
Shelby	22,893	98.9	0.2	0.1	0.2	<0.1	0.5	9.1
Counties Partially Located Within the ROI								
Champaign	179,669	78.8	11.2	0.2	6.5	<0.1	2.9	16.1
Christian	35,372	96.3	2.1	0.2	0.4	<0.1	1.0	9.5
Clay	14,560	98.5	0.1	0.2	0.5	<0.1	0.6	11.8
Crawford	20,452	93.6	4.5	0.3	0.3	<0.1	0.5	11.2
DeWitt	16,798	97.8	0.5	0.2	0.3	<0.1	1.3	8.2

Table 4.20-1. County, Regional and National Population and Low-Income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-Income (percent)
Edgar	19,704	97.1	1.8	0.2	0.2	<0.1	0.8	10.5
Fayette	21,802	94.0	4.9	0.1	0.2	<0.1	0.8	12.2
Jasper	10,117	99.1	0.1	0.1	0.2	<0.1	0.5	9.9
Macon	114,706	83.5	14.1	0.2	0.6	<0.1	1.0	12.9
Marion	41,691	94.0	3.8	0.2	0.6	<0.1	0.9	11.3
Montgomery	30,652	94.9	3.7	0.2	0.2	<0.1	1.1	13.4
Piatt	16,365	98.8	0.2	0.1	0.1	<0.1	0.6	5.0
Richland	16,149	98.2	0.3	0.1	0.6	<0.1	0.8	12.9
Sangamon	188,951	87.4	9.7	0.2	1.1	<0.1	1.1	9.3
Vermilion	83,919	85.8	10.6	0.2	0.6	<0.1	3.0	13.3
Vigo (IN)	105,848	90.7	6.0	0.3	1.2	<0.1	1.2	14.1
Regional and National Statistics								
23-County ROI	1,089,578	94.6	3.4	0.2	0.7	<0.1	1.1	10.8
Illinois	12,419,293	73.5	15.1	0.2	3.4	<0.1	12.3	10.7
U.S.	281,421,906	75.1	12.3	0.9	3.6	0.1	12.5	12.4

[1] Some of the minority population counted themselves as more than one ethnic background, thus the counts do not add up to 100 percent.
Source: USCB, 2006.

4.20.2 AFFECTED ENVIRONMENT

4.20.2.1 Minority Populations

Table 4.20-1 compares the minority percentage and low-income percentage of county populations within the ROI with those of Illinois and the U.S. The 2000 Census revealed a more diverse population in Illinois compared to the 1990 Census. In 2000, 26.5 percent of Illinois residents identified themselves as non-white, up from 21.6 percent in 1990 (USCB, 2006). The regional population within the ROI has non-minority populations (white) as the highest percentage (94.6 percent) compared to the state (73.5 percent) and U.S. (75.1 percent) percentages.

Areas of higher minority percentages are located within the ROI, with the highest percentages occurring within the communities of Decatur (22.4 percent non-white) and Urbana-Champaign (33 percent and 26.8 percent non-white, respectively) (USCB, 2006). Because the overall population in the ROI is far more homogeneous racially and ethnically (less than 5 percent non-white) than the general population of the state and country, a “minority population” as characterized by CEQ does not exist in the potentially affected area of the proposed project.

4.20.2.2 Low-Income Populations

The percentage of low-income populations for individuals, by county, is generally comparable to state (10.7 percent) and national (12.4 percent) percentages (Table 4.20-1). No areas of low-income population percentages approaching or exceeding 50 percent exist within the proposed Mattoon Power Plant and Sequestration Site, or associated utility and transportation corridors. The majority (89.2 percent) of households within the ROI is at or above poverty level (annual household income above $19,971) (USCB, 2006). Low-income populations exceeding the national percentages occur in Champaign (16.1 percent), Coles (17.5 percent), Macon (12.9 percent), Montgomery (13.4 percent), Richland (12.9 percent), Vermilion (13.3 percent), and Vigo (14.1 percent) counties.

4.20.3 IMPACTS

This section discusses the potential for disproportionately high and adverse impacts on minority and low-income populations associated with the proposed FutureGen Project. The CEQ's December 1997 Environmental Justice Guidance (CEQ, 1997) provides guidelines regarding whether human health effects on minority populations are disproportionately high and adverse. CEQ advised agencies to consider the following three factors to the extent practicable:

- Whether the health effects, which may be measured in risks and rates, are significant (as defined by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.
- Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as defined by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority population, low-income population, or Native American tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Based on the definitions in Section 4.20.1, the criteria outlined above, and the findings regarding environmental and socioeconomic impacts throughout this EIS, the analysis for Environmental Justice in this EIS was performed in the following sequence:

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a minority population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 4.20.1, was determined.

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a low-income population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 4.20.1, was determined.

Using the impacts analyzed in Section 4.17, the potential for adverse health risks in a wider radius from project sites and corridors was compared with the potential adverse health risks that could affect a minority population or low-income population at a disproportionately high and adverse rate.

Using the impacts analyzed in Section 4.17, the potential for health effects in a minority population or low-income population affected by cumulative or multiple adverse exposures to environmental hazards was determined.

4.20.3.1 Construction Impacts

As discussed in Section 4.20.2.1, no areas of minority populations, as defined by EO 12898, are located within the ROI. Therefore, no disproportionately high and adverse impacts to minority populations are anticipated.

The power plant would be located in Coles County, which has a higher percentage of low-income population when compared to the regional (6.7 percent higher), state (6.8 percent higher) and national (5.1 percent higher) percentages; however, the percentage is far below the 50 percent threshold as defined in EO 12898. Due to some of the minority population counting themselves as belonging to more than one ethnic background, DOE calculated the percentages by subtracting the White population Census number from 100 percent (e.g., 100 percent – 95.4 percent = 4.6 percent for Coles County). No disproportionately high and adverse impacts are anticipated to the low-income population. Construction activities may cause temporary air quality, water quality, transportation and noise impacts to the general population (see Sections 4.2, 4.7, 4.13, and 4.14). Short-term beneficial impacts may include an increase in employment opportunities and potentially higher wages or supplemental income through jobs created during facility construction.

4.20.3.2 Operational Impacts

No areas of minority populations are located within the ROI for the proposed power plant and sequestration site, and associated utility and transportation corridors. Therefore, no disproportionately high and adverse impacts to minority populations are anticipated.

Aesthetics, transportation, noise and socioeconomic impacts (see Sections 4.12, 4.13, 4.14, and 4.19) resulting from operations were determined not to have a disproportionately high and adverse effect on the low-income population. A potential risk to health was determined to be from a slow, upward leakage of H_2S from an injection or existing well, which is extremely unlikely. Potential risk could also occur from a catastrophic accident, terrorism, or sabotage, however, this risk cannot be predicted (see Section 4.17). This potential would be uniform to the general population and, therefore, no disproportionately high and adverse impacts are anticipated.

Long-term beneficial impacts would be anticipated due to an increase in employment opportunities and potentially higher wage jobs associated with facility operation.

INTENTIONALLY LEFT BLANK

4.21 REFERENCES

4.1 Chapter Overview

Energy Information Administration (EIA). 2000. ***Energy Policy Act Transportation Rate Study: Final Report on Coal Transportation.*** Accessed January 1, 2007 at ftp://ftp.eia.doe.gov/pub/pdf/coal.nuclear/059700.pdf

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

Patrick Engineering, Inc. 2006. "2D Seismic Survey of Proposed FutureGen Sites (Final Report)." IL.

4.2 Air Quality

40 CFR 6. "Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 51.166. "Requirements for Preparation, Adoption and Submittal of Implementation Plans: Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 52.21. "Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 93. "Determining Conformity of Federal Actions to State or Federal Implementation Plans." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

Food and Agriculture Organization of the United Nations (FAO). 1992. *Wastewater Treatment and Use in Agriculture – FAO Irrigation and Drainage Paper 47*. Accessed January 30, 2007 at http://www.fao.org/docrep/T0551E/T0551E00.htm#Contents

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FG Alliance. 2007. "Initial Conceptual Design Report."

South Coast Air Quality Management District (SCAQMD). 2003. *Guidelines for Fugitive Emissions Calculations*. Accessed January 3, 2007 at www.ecotek.com/aqmd/2006/forms_and_instructions_pdf/2003_fugitive_guidelines.pdf

Taylor, G. W. R. 2001. *Trucks and Air Emissions, Final Report*. Prepared for Transportation Systems Branch, Air Pollution Prevention, Environmental Protection Service, Environment Canada. Accessed April 9, 2007 at http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/trucks/trucktoc.htm (last updated December 11, 2002).

U.S. Department of Energy (DOE). 2006a. “Emissions of Greenhouse Gases in the United States 2005.” Report # DOE/EIA-0573(2005). November 2006. Washington, DC.

DOE. 2006b. *The Turbines of Tomorrow*. Accessed January 5, 2007 at http://www.fe.doe.gov/programs/powersystems/turbines/index.html (last updated November 9, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1980. “A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals.” Washington, DC.

EPA. 1990. “New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting.” Draft, October 1990. Washington, DC.

EPA. 2005. “Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations.” Washington, DC.

EPA. 2006a. *National Ambient Air Quality Standards (NAAQS)*. Accessed November 8, 2006 at http://www.epa.gov/air/criteria.html (last updated October 13, 2006).

EPA. 2006b. *EnviroMapper for Envirofacts (Query Mattoon, Illinois)*. Accessed December 28, 2006 at http://www.epa.gov/enviro/emef/ (last updated March 30, 2006).

EPA. 2006c. *eGRID – Emissions and Generation Resource Integrated Database (eGRID)*. Accessed December 1, 2006 at http://www.epa.gov/cleanenergy/egrid/index.htm (last updated October 30, 2006).

EPA. 2007. *Acid Rain Program*. Accessed April 27, 2007 at http://www.epa.gov/airmarkets/progsregs/arp/index.html (last updated February 2, 2007).

U.S. Fish and Wildlife Service (FWS). 2007. *Permit Application, PSD Overview*. Accessed January 27, 2007 at http://www.fws.gov/refuges/AirQuality/permits.html (last updated August 14, 2006).

4.3 Climate and Meteorology

Blue Planet Biomes. 2006. *World Climates*. Accessed December 1, 2006 at http://www.blueplanetbiomes.org/climate.htm (last updated November 7, 2006).

FutureGen Alliance (FG Alliance). 2006a. “Mattoon Dole Site Environmental Information Volume.”

National Oceanic and Atmospheric Administration (NOAA). 2006. *Storm Events*. Accessed December 2, 2006 at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms (updated daily).

The Tornado Project. 1999. *The Fujita Scale*. Accessed December 1, 2006 at http://www.tornadoproject.com/fscale/fscale.htm

4.4 Geology

FutureGen Alliance (FG Alliance). 2006a. “Mattoon Dole Site Environmental Information Volume.”

FutureGen Site Proposal (Mattoon, Illinois). 2006. “Proposal for FutureGen Host Site.” Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

Illinois State Geological Survey (ISGS). 1995a. *Earthquake Occurrence in Illinois*. Accessed October 5, 2006 at http://www.isgs.uiuc.edu/earthquakes/Articles/qk-fct-occur.pdf (last updated November 30, 1999).

ISGS. 1995b. *Damaging Earthquakes in Illinois*. Accessed October 5, 2006 at http://www.isgs.uiuc.edu/earthquakes/Articles/qk-fct-damag.pdf (last updated November 30, 1999).

ISGS. 1997. *Illinois Structural Features – Faults, Grabens, and Flexures*. Accessed October 5, 2006 at http://www.isgs.uiuc.edu/nsdihome/browse/statewide/structfaultsb.gif

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Louie, J. 1996. *What is Richter Magnitude?* Accessed October 5, 2006 at http://www.seismo.unr.edu/ftp/pub/louie/class/100/magnitude.html (last updated October 9, 1996).

Patrick Engineering, Inc. 2006. “2D Seismic Survey of Proposed FutureGen Sites (Final Report).” IL.

U.S. Geological Survey (USGS). 2006. *NEIC: Earthquake Search Results. U.S. Geological Survey Earthquake Database*. Accessed October 6, 2006 at http://eqint.cr.usgs.gov/neic/cgi-bin/epic/epic.cgi?SEARCHMETHOD=3&SLAT2=0.0&SLAT1=0.0&SLON2=0.0&SLON1=0.0&FILEFORMAT=4&SEARCHRANGE=HH&CLAT=39.737&CLON=-88.3&CRAD=193&SUBMIT=Submit+Search&SYEAR=&SMONTH=&SDAY=&EYEAR=&EMONTH=&EDAY=&LMAG=&UMAG=&NDEP1=&NDEP2=&IO1=&IO2=

4.5 Physiography and Soils

Damen, K., A. Faaij and W. Turkenburg. 2003. “Health, Safety and Environmental Risks of Underground CO_2 Sequestration.” Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006a. “Mattoon Dole Site Environmental Information Volume.”

Natural Resources Conservation Service (NRCS). 2006. *Official Soil Series Description (OSD) with Series Extent Mapping Capabilities*. Accessed November 27, 2006 at http://soils.usda.gov/technical/classification/osd/index.html

U.S. Department of Agriculture (USDA). 2006. *Soil Survey of Douglas County, Illinois*. Accessed October 10, 2006 at http://soildatamart.nrcs.usda.gov/Manuscripts/IL041/1/Douglas_IL.pdf

4.6 Groundwater

Bower, K. 2006. *Environmental Geology of Coles County*. Accessed November 30, 2006 at http://ux1.eiu.edu/~kmbower/publications_kmb/Times_Courier_water_new03.doc

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Patrick Engineering, Inc. 2006. "2D Seismic Survey of Proposed FutureGen Sites (Final Report)." IL.

U.S. Environmental Protection Agency (EPA). 2006a. *Designated Sole Source Aquifers in EPA Region V*. Accessed December 15, 2006 at http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg5.pdf

EPA. 2006b. *Underground Source of Drinking Water*. Accessed March 11, 2007 at http://www.epa.gov/safewater/uic/usdw.html (last updated February 28, 2006).

4.7 Surface Water

62 IAC 240.530. "The Illinois Oil and Gas Act: Completion Fluid and Completion Fluid Waste Handling and Storage." Effective June 3, 1997. *Illinois Administrative Code*.

Benson, S., R. Hepple, J. Apps, C. Tsang and M. Lippman. 2002. "Lessons Learned from Natural and Industrial Analogues for Storage of Carbon Dioxide in Deep Gas Formations." Earth Sciences Division, E.O. Lawrence Berkeley National Laboratory, Berkeley, CA.

City of Mattoon and IEPA. 2001. "Phase I Diagnostic-Feasibility Study of Lake Mattoon, Coles/Cumberland/Shelby Counties, Illinois."

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2007. "Initial Conceptual Design Report."

Holloway, S. 1996. "The Underground Disposal of Carbon Dioxide." British Geological Survey, Keyworth, Nottingham, UK.

Illinois Environmental Protection Agency (IEPA). 2006. *Illinois Integrated Water Quality Report and Section 303(d) List- 2006.* Accessed March 13, 2007 at http://www.epa.state.il.us/water/water-quality/report-2006/2006-report.pdf

Illinois State Water Survey (ISWS). 2002. *Historical Climate Data: Precipitation Summary. Station: 115430 Mattoon, IL.* Accessed December 1, 2006 at http://www.sws.uiuc.edu/atmos/statecli/Summary/115430.htm (last updated September 11, 2002).

ISWS. 2004. "Sediment and Water Quality Monitoring for the Hurricane and Kickapoo Creek Watersheds, Coles and Cumberland Counties, Illinois." Champaign, IL.

National Oceanic and Atmospheric Administration (NOAA). 2005. *July Weather Trivia for Illinois*. Accessed December 2, 2006 at http://www.crh.noaa.gov/ilx/trivia/jultriv.php (last updated November 3, 2005).

Patrick Engineering, Inc. 2006a. "Mattoon/Charleston- Water Supply Needs." IL.

Patrick Engineering, Inc. 2006b. "Impacts of Diverting WWTP Effluents from Kickapoo and Cassel Creeks in Coles County." IL.

Reichle, D., J. Houghton, B. Kane and J. Ekmann. 1999. "Carbon Sequestration Research and Development." U.S. Department of Energy, Office of Science, Office of Fossil Energy, Oak Ridge, TN.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

U.S. Geological Survey (USGS). 2006. *National Water Information System: Web Interface. Water Quality Samples for Illinois.* USGS 05591200 Kaskaskia River at Cooks Mills, IL. Accessed March 13, 2007 at http://nwis.waterdata.usgs.gov/il/nwis/qwdata

4.8 Wetlands and Floodplains

10 CFR 1022. "Compliance with Floodplain and Wetland Environmental Review Requirements." U.S. Department of Energy, *Code of Federal Regulations*.

42 *Federal Register* 26951. "Executive Order 11988 – Floodplain Management." Federal Register. May 24, 1977.

42 *Federal Register* 26961. "Executive Order 11990 – Protection of Wetlands." Federal Register. May 24, 1977.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States." U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Emergency Management Agency (FEMA). 2006. "National Flood Insurance Program Flood Insurance Rate Map , Coles County, Illinois (digital, GIS format)." Jessup, MD.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

Illinois Department of Natural Resources (IDNR). 2006. Letter from Michael Branham, Division of Ecosystems and Environment, IDNR, to Dan Wheeler, IL Department of Commerce & Economic Opportunity. September 13, 2006.

U.S. Army Corps of Engineers (USACE). 1987. "Corps of Engineers Wetlands Delineation Manual." Vicksburg, MS.

4.9 Biological Resources

Avian Power Line Interaction Committee (APLIC), Edison Electric Institute and Raptor Research Foundation. 1996. "Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996." Washington, DC.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

Illinois Department of Natural Resources (IDNR). 2006a. Letter from Michael Branham, Division of Ecosystems and Environment, IDNR, to Dan Wheeler, IL Department of Commerce & Economic Opportunity. September 13, 2006.

IDNR. 2006b. Letter from Michael Branham, Division of Ecosystems and Environment, IDNR, to Dan Wheeler, IL Department of Commerce & Economic Opportunity. October 24, 2006.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Patrick Engineering, Inc. 2006. "Impacts of Diverting WWTP Effluents from Kickapoo and Cassell Creeks in Coles County." IL.

U.S. Fish and Wildlife Service (FWS). 2006. Letter from Joyce A. Collins, Assistant Field Supervisor, Marion, Illinois, Suboffice, FWS, to Daniel Wheeler, Illinois Department of Commerce and Economic Development, Office of Coal Development, Springfield, Illinois. April 14, 2006.

4.10 Cultural Resources

16 USC 470. "The National Historic Preservation Act of 1966, as amended through 2000." U.S. Federal Government, *U.S. Code*.

20 ILCS 3410. "Illinois Historic Preservation Act." State of Illinois, *Illinois Compiled Statutes*.

20 ILCS 3420. "Illinois State Agency Historic Resources Preservation Act." State of Illinois, *Illinois Compiled Statutes*.

20 ILCS 3435. "Archaeological and Paleontological Resources Protection Act." State of Illinois, *Illinois Compiled Statutes*.

20 ILCS 3440. "Human Skeletal Remains Protection Act." State of Illinois, *Illinois Compiled Statutes*.

36 CFR 60. "National Register of Historic Places." U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 62. "National Natural Landmarks Program." U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 800. "Protection of Historic Properties." U.S. Department of the Interior, Advisory Council on Historic Preservation, *Code of Federal Regulations*.

765 ILCS 835. "Cemetery Protection Act." State of Illinois, *Illinois Compiled Statutes*.

Finney, F. 2006. "Archaeological Survey Short Report: Phase I Archaeological Survey for Proposed FutureGen Development Near Mattoon, Coles County, Illinois." Prepared for Patrick Engineering, Inc., Springfield, IL, by Upper Midwest Archaeology, St. Joseph, IL.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

King, T. F. 1998. "Cultural Resource Laws and Practice." AltaMira Press, Walnut Creek, CA.

National Park Service (NPS). 2006. *Native American Consultation Database*. Accessed December 6, 2006 at http://home.nps.gov/nacd/ (last updated March 31, 2006).

4.11 Land Use

14 CFR 77. "Objects Affecting Navigable Airspace." Federal Aviation Administration, *Code of Federal Regulations*.

City of Charleston. 1999. *City of Charleston, Illinois Comprehensive Plan*. Accessed January 20, 2007 at http://www.charlestontourism.org/index.asp?Type=B_BASIC&SEC={C45DF8E7-D490-4460-B88B-6620FE211DD2}&DE={2B8CF3E2-D431-4125-9747-87C74FFC75A0}

City of Mattoon. 2006. *City of Mattoon Official Website*. Accessed November 10, 2006 at http://www.mattoonillinois.org/index.shtml

Coles County. 2006. "Coles County, Illinois Comprehensive Plan 2006." Coles County, IL.

Comprehensive Environmental Response, Compensation and Liability Information System Database (CERCLIS). 2006. *Superfund Site Information*. Accessed March 12, 2007 at http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm (last updated December 20, 2006).

De Figueiredo, M. A., D. M. Reiner and H. J. Herzog. 2005. "Framing the Long-Term In Situ Liability Issue for Geologic Carbon Storage in the United States." *Mitigation and Adaptation Strategies for Global Change* 10(4): 647-657.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FutureGen Site Proposal (Mattoon, Illinois). 2006. "Proposal for FutureGen Host Site." Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

Illinois Department of Agriculture (ILDOA). 2001. ***Land Evaluation and Site Assessment*** (Revised 2001). Accessed December 4, 2006 at http://www.agr.state.il.us/Environment/LandWater/LESA.pdf (last updated December 21, 2006).

Illinois Environmental Protection Agency (IEPA). 2006. ***Bureau of Land. Databases***. Accessed October 16, 2006 at http://www.epa.state.il.us/land/database.html

Natural Resources Conservation Service (NRCS). 2000. ***National Resource Inventory. Illinois Highlights. 1997 National Resources Inventory.*** Accessed October 16, 2006 at http://www.il.nrcs.usda.gov/technical/nri/highlights.html (last updated December 2000).

Ordinance No. 96-4835. "Zoning Ordinance of the City of Mattoon, Mattoon, Illinois." City of Mattoon.

U.S. Environmental Protection Agency (EPA). 2006. ***Superfund Information Systems***. Accessed October 16, 2006 at http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm (last updated August 25, 2006).

4.12 Aesthetics

Bureau of Land Management (BLM). 2004. ***Public Lands Managed by the BLM***. Accessed November 11, 2006 at http://www.blm.gov/nhp/facts/index.htm (last updated November 28, 2006).

Finney, F. 2006. "Archaeological Survey Short Report: Phase I Archaeological Survey for Proposed FutureGen Development Near Mattoon, Coles County, Illinois." Prepared for Patrick Engineering, Inc., Springfield, IL, by Upper Midwest Archaeology, St. Joseph, IL.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

U.S. Department of Energy (DOE). 2006a. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

DOE. 2006b. ***FutureGen - Tomorrow's Pollution-Free Power Plant***. Accessed December 28, 2006 at http://www.fossil.energy.gov/programs/powersystems/futuregen/ (last updated December 14, 2006).

4.13 Transportation and Traffic

American Association of State Highway and Transportation Officials (AASHTO). 2004. "A Policy on Geometric Design of Highways and Streets." Washington, DC.

Bureau of Local Roads and Streets. 2006. ***Bureau of Local Roads and Streets Manual: Geometric Design Tables (New Construction/Reconstruction).*** Accessed May 1, 2007 at http://www.dot.state.il.us/blr/manuals/Chapter%2032.pdf

Federal Railroad Administration (FRA). 2006. ***Track Compliance Manual.*** Accessed January 18, 2007 at http://www.fra.dot.gov/downloads/safety/track_compliance_manual/TCM%205.PDF

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

Illinois Department of Transportation (IDOT). 2005a. *Illinois Crash Data 2000 – 2003*. Accessed December 1, 2006 at http://www.dot.il.gov/trafficsafety/crashreports.html

IDOT. 2005b. *Comprehensive Highway Safety Plan*. Accessed December 4, 2006 at http://www.dot.il.gov/illinoisCHSP/plan.html

IDOT. 2005c. *Project Information*. Accessed December 1, 2006 at http://www.dot.state.il.us/projects.html

Transportation Research Board (TRB). 2000. "Highway Capacity Manual." Washington, DC.

4.14 Noise and Vibration

35 IAC 901. "Sound Emission Standards and Limitations for Property Line-Noise-Sources." *Illinois Administrative Code*.

Barksdale. 1991. "The Aggregate Handbook." National Stone Association. Washington DC.

Bolt, Beranek, and Newman 1971. "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances." Prepared for the U.S. Environmental Protection Agency, Washington, DC.

Bolt, Beranek, and Newman. 1973. "Fundamentals of Abatement and Highway." Federal Highway Administration.

Bolt, Beranek and Newman. 1984. "Electric Power Plant Environmental Noise Guide, Volume 1, 2nd edition." Prepared for Edison Electric Institute.

Cowan, J. P. 1994. "Handbook of Environmental Acoustics." John Wiley & Sons, Inc.

Federal Highway Administration (FHWA). 1992. *Highway Traffic Noise*. Accessed December 27, 2006 at http://www.fhwa.dot.gov/environment/htnoise.htm (last updated December 14, 2006).

Federal Transit Administration (FTA). 2006. "Transit Noise and Vibration Impact Assessment." Harris Miller Miller and Hanson, Inc, Washington, DC.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

U.S. Department of Energy (DOE). 2006. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

VIBCO. Undated-a. "High Frequency Silent Models." Wyoming, RI.

VIBCO. Undated-b. "Silent Pneumatic CC Series." Wyoming, RI.

Western Safety Products. 2007. *Aldon Rail Safety Page 6.* Accessed April 3, 2007 at http://www.westernsafety.com/aldon/aldonpage6.html (last updated March 28, 2007).

4.15 Utility Systems

Energy Information Administration (EIA). 2006. "Annual Energy Outlook 2006 with Projections to 2030." Washington, DC.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

North American Electric Reliability Council (NERC). 2006. "2006 Long-Term Reliability Assessment: The Reliability of the Bulk Power Systems In North America." Princeton, NJ.

PowerWorld Corporation. 2006. "Generator Interconnection Study: Mattoon Site." Champaign, IL.

4.16 Materials and Waste Management

35 IAC 808. "Environmental Protection: Special Waste Classifications." *Illinois Administrative Code*.

American Coal Ash Association (ACAA). 2006. *2005 Coal Combustion Product (CCP) Production and Use Survey*. Accessed November 4, 2006 at http://www.acaa-usa.org/PDF/2005_CCP_Production_and_Use_Figures_Released_by_ACAA.pdf

California Integrated Waste Management Board (CIWMB). 2006. *Estimated Solid Waste Generation Rates for Industrial Establishments*. Accessed November 9, 2006 at http://www.ciwmb.ca.gov/WasteChar/WasteGenRates/Industrial.htm (last updated December 7, 2004).

Ciba. 2006. *Water Treatment*. Accessed November 6, 2006 at http://www.cibasc.com/index/ind-index/ind-water_treatment.htm

Energy Information Administration (EIA). 2006. *U.S. Coal Consumption by End Use Sector, by Census Division and State*. Accessed December 7, 2006 at http://www.eia.doe.gov/cneaf/coal/page/acr/table26.html

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FG Alliance. 2007. “Initial Conceptual Design Report.”

FutureGen Site Proposal (Mattoon, Illinois). 2006. “Proposal for FutureGen Host Site.” Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

Illinois Environmental Protection Agency (IEPA). 2005. *Eighteenth Annual Landfill Capacity Report -2004*. Accessed October 10, 2006 at http://www.epa.state.il.us/land/landfill-capacity/2004/index.html

Illinois State Geological Survey (ISGS). 2006. *Illinois Coal Resource Shapefiles*. Accessed December 18, 2006 at http://www.isgs.uiuc.edu/coalsec/coal/coalshapefiles.htm (last updated May 18, 2006).

Morris, R. J. 2003. *Sulphur Surplus in the Making Impacts Refineries*. Accessed October 30, 2006 at http://www.sulphurinstitute.org/Morris.NPRApaper.pdf

Nalco. 2006. *Nalco Locations, North America*. Accessed November 3, 2006 at http://www.nalco.com/ASP/region/region.asp?region=NA

The Innovation Group (TIG). 2002. *Chemical Profiles: Sulfur*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sulfur.htm

TIG. 2003. *Chemical Profiles: Sodium Hypochlorite*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sodium%20Hypochlorite.htm

U.S. Geological Survey (USGS). 2006a. *Mineral Commodity Summaries– Lime*. Accessed December 4, 2006 at http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/lime_mcs06.pdf

USGS. 2006b. *Mineral Industry Surveys – Directory of Lime Plants in the United States in 2005*. Accessed December 4, 2006 at http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/limedir05.pdf

4.17 Human Health, Safety, and Accidents

American Industrial Hygiene Association (AIHA), 1997. “Odor Thresholds for Chemicals with Established Occupational Health Standards.” Fairfax, VA.

Department of Health and Human Services (DHHS). 2006. “The State of Childhood Asthma, United States, 1980–2005.” National Center for Health Statistics. Advance Data from Vital and Health Statistics. Number 381. Revised December 29, 2006.

Ermak, D. L. 1990. “User’s Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air Releases.” Report UCRL-MA-105607, University of California, Lawrence Livermore National laboratory, Livermore, CA.

FutureGen Alliance (FG Alliance). 2006a. “Mattoon Dole Site Environmental Information Volume.”

FG Alliance. 2006b. “Tuscola Site Environmental Information Volume.”

FG Alliance. 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006d. "Odessa Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project EIS Project Description Data Needs Table Operational Parameters and Assumptions Unplanned Starts."

Gale, J. and J. Davison. 2004. "Transmission of CO_2 – Safety and Economic Considerations." *Energy* 29 (9-10): 1319–1328.

Gilmour, M I., M. S. Jaakkola, S. J. London, A. E. Nel and C. A. Rogers. 2006. "How Exposure to Environmental Tobacco Smoke, Outdoor Air Pollutants, and Increased Pollen Burdens Influences the Incidence of Asthma." *Environmental Health Perspectives* 114: 627-633.

Hanna, S. R. and P. J. Drivas. 1987. "Guidelines for Use of Vapor Cloud Dispersion Models." Center for Chemical Process Safety, American Institute of Chemical Engineers. NY.

Interstate Oil and Gas Compact Commission (IOGCC). 2005. "Carbon Capture and Storage: A Regulatory Framework for States - Summary of Recommendations." Oklahoma City, OK.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Mills, W. B., D. B. Porcella, M. J. Ungs, S. A. Gherini, K. V. Summers, L. Mok, G. L. Rupp, G. L. Bowie and D.A. Haith. 1985. "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water." Volume 1. EPA/600/6-85/002a. U.S. Environmental Protection Agency, Washington, DC.

National Institute of Environmental Health Sciences (NIEHS). 1999. "Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields." NIH Publication No. 99-4493.

National Institute of Occupational Health (NIOSH). 1983. *Comprehensive Safety Recommendations for Land-Based Oil and Gas Well Drilling. Publication No. 83-127*. Accessed April 5, 2007 at http://www.cdc.gov/niosh/83-127.html

NIOSH. 1987. "Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Material." NIOSH Publication No. 88-102.

NIOSH. 2007. *Pocket Guide to Chemical Hazards*. *NIOSH Publication No. 2005-149*. Accessed March 12, 2007 at http://www.cdc.gov/niosh/npg/npgsyn-a.html

Office of Pipeline Safety (OPS). 2006. *Hazardous Liquid Pipeline Accident Summary by Commodity. 1/1/2006-12/05/2006.* Accessed March 12, 2007 at http://ops.dot.gov/stats/LQ06_CM.HTM

OPS. 2007. *FOIA On-line Library*. Accessed March 12, 2007 at http://ops.dot.gov/stats/IA98.htm (last updated January 22, 2007).

Oldenburg, C. M. 2005. *Health, Safety, and Environmental Screening and Ranking Framework for Geologic CO_2 Storage Site Selection.* Accessed July 21, 2006 at http://repositories.cdlib.org/cgi/viewcontent.cgi?article=4279&context=lbnl

Quest Consultants Inc. (Quest). 2006. "Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations." November 28, 2006. Norman, OK.

Papanikolau, N., B. M. L. Lau, W. A. Hobbs and J. Gale. 2006. "Safe Storage of CO_2: Experience from the Natural Gas Storage Industry." In *Proceedings of the 8th International Conference on Greenhouse Gas Control Technologies (GHGT-8)*, 19 - 22 June 2006. Trondheim, Norway.

Scherer, G. W., M. A. Celia, J-H Prevost, S. Bachu, R. Bruant, A. Duguid, R. Fuller, S. E. Gasda, M. Radonijic and W. Vichit-Vadkan. 2005. "Leakage of CO_2 through Abandoned Wells: Role of Corrosion of Cement, in Carbon Dioxide Capture for Storage in Deep Geologic Formations." In *Carbon Dioxide Capture for Storage in Deep Geologic Formations – Results from the CO_2 Capture Project, Vol 2 – Geologic Storage of Carbon Dioxide with Monitoring and Verification*. Elsevier Science, London.

Selgrade, M. K., R. F. Lemanske Jr., M. I. Gilmour, L. M. Neas, M. D.W. Ward, P. K. Henneberger, D. N. Weissman, J. A. Hoppin, R. R. Dietert, P. D. Sly, A. M. Geller, P. L. Enright, G. S. Backus, P. A. Bromberg, D. R. Germolec and K. B. Yeatts. 2006. "Induction of Asthma and the Environment: What We Know and Need to Know." *Environmental Health Perspectives* 114: 615-619.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2005*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/osh/os/ostb1619.pdf

USBLS. 2006b. *Fatal Occupational Injuries to Private Sector Wage and Salary Workers, Government Workers, and Self-employed Workers by Industry, All United States, 2005*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/cfoi/cftb0207.pdf

U.S. Census Bureau. 2006. *Topologically Integrated Geographic Encoding and Referencing Database*. Accessed March 12, 2007 at http://www.census.gov/geo/www/census2k.html

U.S. Department of Energy (DOE). 2002. "Major Environmental Aspects of Gasification-Based Power Generation Technologies, Final Report." December, 2002. Washington, DC.

DOE. 2004. "ALOHA Computer Code Application Guidance for Documented Safety Analysis, Final Report." Report DOE-EH-4.2.1.3-ALOHA Code Guidance, June 2004, Office of Environment, Safety and Health, Washington, DC.

DOE. 2006. *Temporary Emergency Exposure Limits (TEELs) [Revision 21 of AEGLs, ERPGs and TEELs for Chemicals of Concern]*. Accessed March 12, 2007 at http://www.eh.doe.gov/chem_safety//teel.html (last updated October 16, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1995. "SCREEN3 Model User's Guide." EPA-454/B-95-004. Research Triangle Park, NC.

EPA. 2000. "Carbon Dioxide as a Fire Suppressant: Examining the Risks." EPA430-R-00-002. February 2000.

EPA. 2006a. *IRIS Database for Risk Information.* Accessed March 12, 2007 at http://www.epa.gov/iris/ (last updated January 25, 2007).

EPA. 2006b. *Acute Exposure Guideline Levels (AEGLs).* Accessed March 12, 2007 at http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (last updated January 9, 2007).

EPA. 2007. *Acute Exposure Guideline Levels (AEGLs): Ammonia Results*. Accessed April 16, 2007 at http://www.epa.gov/oppt/aegl/pubs/results88.htm (last updated August 28, 2006).

4.18 Community Services

City Data (CD). 2002. *City Data (Oakland, Charleston, Mattoon, and Ashmore, Illinois).* Accessed December 1, 2006 at http://www.city-data.com/

Everett, L. 2004. *VA Losing the Ability to Care 'For Him Who Has Borne the Battle'*. Accessed November 30, 2006 at http://www.larouchepub.com/other/2004/3118v_a_hosptls.html

Everett, L. and M. M. Baker. 2004. *LaRouche: Reverse the Policy that Created the Flu Crisis*. Accessed November 30, 2006 at http://www.larouchepub.com/eiw/public/2004/2004_40-49/2004-42/pdf/04-13_41_ecoflu.pdf

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

Hospital-Data (HD). 2006. *Hospital and Nursing Home Profiles*. Accessed November 30, 2006 at http://www.hospital-data.com/

Illinois Criminal Justice Information Authority. (ICJIA). 2004. *A Profile of the Coles County Criminal and Juvenile Justice Systems*. Accessed December 1, 2006 at http://www.icjia.org/public/pdf/CountyProfiles/Coles.pdf

Illinois Homeland Security (IHS). 2003. *Mutual Aid Box Alarm System*. Accessed November 30, 2006 at http://www.ready.illinois.gov/ittf/terrorismreport7.htm

Illinois Hospital Association (IHA). 2006. *IHA Member Hospitals and Health Systems (Region Listing)*. Accessed November 30, 2006 at http://www.ihatoday.org/about/find/regions.pdf

Illinois State Board of Education (ISBE). 2005. *Illinois Public School Enrollment Projections: 2004-05---2012-13.* Accessed December 1, 2006 at http://www.isbe.state.il.us/research/pdfs/public_school_enrollment.pdf

Illinois State Police (ILSP). 2004. *District Quick Finder*. Accessed December 1, 2006 at http://www.isp.state.il.us/districts/

Indiana State Department of Health (IDOH). 2006a. *Hospital Directory for Vigo County*. Accessed November 30, 2006 at http://www.state.in.us/isdh/regsvcs/acc/hospital/ctyfac83.htm

IDOH. 2006b. *Hospital Directory for Vermillion County*. Accessed November 30, 2006 at http://www.state.in.us/isdh/regsvcs/acc/hospital/ctyfac82.htm

Indiana State Police (INSP). 2006. *District Locations*. Accessed December 1, 2006 at http://www.in.gov/isp/districts/terrehaute.html

National Center for Educational Statistics (NCES). 2005. *Public and Private Elementary and Secondary Teachers, Enrollment, and Pupil/Teacher Ratios: Selected Years, Fall 1955 through Fall 2014*. Accessed December 3, 2006 at http://nces.ed.gov/programs/digest/d05/tables/dt05_063.asp

Occupational Safety and Health Administration (OSHA). 1994. *Member of a HazMat Team. January 31, 1994*. Accessed December 2, 2006 at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21384

Office of the Illinois State Fire Marshall (ISFM). 2006. *Fire Department List by County*. Accessed December 2, 2006 at http://www.state.il.us/osfm/NFIRS/R_FD_County_Short.pdf

Quinlivan, J. T. 2003. *Burden of Victory: The Painful Arithmetic of Stability Operations*. Accessed December 2, 2006 at http://www.rand.org/publications/randreview/issues/summer2003/burden.html (last updated August 2, 2006).

Swager, R. 2006. Personal communication. Email from Ronald Swager, Patrick Engineering, Springfield, IL, to Nancy Clark, Potomac-Hudson Engineering, Inc., Bethesda, MD, November 6, 2006.

The Disaster Center. 2005. *Illinois Crime Rates 1960-2005*. Accessed December 1, 2006 at http://www.disastercenter.com/crime/ilcrime.htm

USACOPS (UC). 2005a. *Illinois Police Departments (by County)*. Accessed December 1, 2006 at http://www.usacops.com/il/pollist.html

USACOPS (UC). 2005b. *Indiana Police Departments (by County)*. Accessed December 1, 2006 at http://www.usacops.com/in/pollist.html

U.S. Census Bureau (USCB). 2006. *National Spending per Student Rises to $8,287*. Accessed November 29, 2006 at http://www.census.gov/Press-Release/www/releases/archives/economic_surveys/006685.html

Yahoo Yellow Pages (YYP). 2006a. *Ambulance Service (within 50 miles of Mattoon, Illinois)*. Accessed December 1, 2006 at http://yp.yahoo.com/py/ypResults.py?Pyt=Typ&city=Mattoon&state=IL&uzip=61938&country=us&msa=0000&cs=4&ed=dCMZXK1o2TzlWBx2WFJeVq7jZwb5BDjv2CMSQIwej9xE&tab=B2C&stx=8104713&stp=y&doprox=1&sorttype=distance&beyond=1&desc=Ambulance+Service&qtx=Ambulance&offset=56&FBoffset=1&toggle=&stat=ClkNxtUpper&ls=&lp=

YYP. 2006b. *Fire Protection (in Terre Haute, Indiana)*. Accessed December 1, 2006 at http://yp.yahoo.com/py/ypResults.py?Pyt=Typ&city=Terre+Haute&state=IN&uzip=47807&country=us&msa=8320&cs=4&ed=JiR0Mq1o2Tw8M4UXAx4KaVrA0tp7YSsJYohVWFdIrhp0&tab=B2C&stx=8104709&stp=y&desc=Fire+Protection&qtx=Fire+Department&doprox=1&sorttype=distance&beyond=1&stat=ClkByndLower

4.19 Socioeconomics

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

Illinois Department of Labor (IDOL). 2006. *Coles County Prevailing Wage for November 2006*. Accessed December 1, 2006 at http://www.state.il.us/agency/idol/rates/ODDMO/COLES999.htm

Illinois Hospitality Industry (IHI). 2006. *Illinois Hospitality Industry Health Indicators*. Accessed December 2, 2006 at http://www.tourism.uiuc.edu/itf/indicator/hospitality_current.pdf (last updated January 6, 2006).

Illinois Venture Capital Association (IVCA). 2006. *FAQ about Venture Capital & Private Equity*. Accessed December 1, 2006 at http://www.illinoisvc.org/pages/faq/59.php

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Illinois. Data Series (Unemployment Statistics, July 2006)*. Accessed December 1, 2006 at http://stats.bls.gov/eag/eag.il.htm

USBLS. 2006b. *Unemployment Rate (National Unemployment Rates 1996 to 2006)*. Accessed December 3, 2006 at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=LNS14000000

U.S. Census Bureau (USCB). 2000a. *United States Census 2000. Demographic Profiles*. Accessed December 1, 2006 at http://censtats.census.gov/pub/Profiles.shtml (last updated September 2, 2004).

USCB. 2000b. *Projected Population of the United States, by Age and Sex: 2000 to 2050*. Accessed December 1, 2006 at http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf (last updated August 26, 2004).

USCB. 2000c. *Annual Estimates of the Population by Sex and Five-Year Age Groups for the United States: April 1, 2000 to July 1, 2005*. Accessed December 2, 2006 at http://www.census.gov/popest/national/asrh/NC-EST2005/NC-EST2005-01.xls (last updated June 8, 2006).

USCB. 2000d. Median Age: 2000. *Illinois by County*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF1_U&tm_name=DEC_2000_SF1_U_M00022&_dBy=050&geo_id=04000US17&_MapEvent=displayBy

USCB. 2000e. *Per Capita Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000f. *Median Household Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00024&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000g. *Per Capita Income in 1999: 2000, Illinois by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=050&geo_id=04000US17&_MapEvent=displayBy

USCB. 2000h. *Per Capita Income in 1999: 2000, Indiana by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=050&geo_id=04000US18&_MapEvent=displayBy

USCB. 2000i. *Median Household Income in 1999: 2000, Illinois by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US17&-tm_name=DEC_2000_SF3_U_M00024&-ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=1.9557697048764706E7|dh=1.4455689123E7|dt=gov.census.aff.domain.map.LSRMapExtent|if=gif|cx=-1159354.4733499996|cy=7122022.5|zl=10|pz=10|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=01000US|ds=DEC_2000_SF3_U|sb=50|tud=false|db=040|mn=14412|mx=55146|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00024|sf=N|sg=

USCB. 2000j. *Median Household Income in 1999: 2000, Illinois by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US18&-tm_name=DEC_2000_SF3_U_M00024&-ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=10.50392852716582|dh=6.058983803831548|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-89.504051|cy=39.739275000000006|zl=8|pz=8|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=04000US17|ds=DEC_2000_SF3_U|sb=50|tud=false|db=050|mn=24946|mx=67887|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00024|sf=N|sg=

USCB. 2005a. *Population Pyramids of Illinois*. Accessed December 1, 2006 at http://www.census.gov/population/projections/14PyrmdIL1.pdf (last updated April 20, 2005).

USCB. 2005b. *Illinois: Industry by Sex and Median Earnings in the Past 12 Months (in 2004 Inflation-Adjusted Dollars) for the Civilian Employed Population 16 Years and Over*.

Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-context=st&-qr_name=ACS_2004_EST_G00_S2403&-ds_name=ACS_2004_EST_G00_&-tree_id=304&-redoLog=true&-all_geo_types=N&-_caller=geoselect&-geo_id=04000US17&-format=&-_lang=en

USCB. 2005c. *Percent of Occupied Housing Units that are Owner-Occupied: 2005. United States by State*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=01000US&-tm_name=ACS_2005_EST_G00_M00621&-ds_name=ACS_2005_EST_G00_&-_MapEvent=displayBy&-_dBy=040#?388,250

4.20 Environmental Justice

59 *Federal Register* 7629. “Executive Order Number 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.” February 11, 1994. Federal Register [Volume 59, No. 32].

Council on Environmental Quality (CEQ). 1997. “Environmental Justice Guidance under the National Environmental Policy Act.” Executive Office of the President. December 10, 1997. Washington, DC

FutureGen Alliance (FG Alliance). 2006a. “Mattoon Dole Site Environmental Information Volume.”

U.S. Census Bureau (USCB). 2006. *American FactFinder*. Accessed November 12, 2006 at http://factfinder.census.gov

U.S. Department of Energy (DOE). 2006. *Environmental Justice Definition*. Accessed November 12, 2006 at http://www.lm.doe.gov/env_justice/definition.htm (last updated December 13, 2006).

4.3 CLIMATE AND METEOROLOGY

4.3.1 INTRODUCTION

This section addresses the region's climate and meteorology and the potential impacts on construction and operation of the proposed FutureGen Project.

4.3.1.1 Region of Influence

The ROI for climate and meteorology includes the proposed Mattoon Power Plant and Sequestration Site, and the utility and transportation corridors.

4.3.1.2 Method of Analysis

DOE reviewed the Mattoon EIV (FG Alliance, 2006a) report to assess the potential impacts of climate and meteorology on the proposed FutureGen Project. Factors identified in this section include normal and extreme temperatures, and severe weather events such as tornadoes and floods. There were no uncertainties identified in relation to climate and meteorology at the proposed Mattoon Site.

DOE assessed the potential for impacts based on the following criteria:

- Potential for aspects of the project to fail or cause safety hazards due to temperature variations and extremes; and
- Potential for aspects of the project to fail or cause safety hazards due to a high probability for severe weather events.

4.3.2 AFFECTED ENVIRONMENT

This section describes the central Illinois region's climate and provides information on climate, meteorology, and severe weather events for Coles County.

4.3.2.1 Local and Regional Climate

> The **Köppen Climate Classification System** is the most widely used system to classify world climates. Categories are based on the annual and monthly averages of temperature and precipitation. The Köppen System recognizes five major climatic types, and each type is designated by a capital letter (A through E). Additional information about this classification system is available at http://www.blueplanetbiomes.org/climate.htm (Blue Planet Biomes, 2006).

The proposed Mattoon Power Plant and Sequestration Site is located in Coles County, in the east-central region of Illinois, near the city of Mattoon. This region has a moist, mid-latitude, humid continental climate consistent with the Köppen Climate Classification "Cfa." The Köppen Climate Classification System recognizes five major climate types based on annual and monthly temperature and precipitation averages. Each major type is designated by a capital letter A through E. The letter "C" refers to humid, mid-latitude climates where land/water differences play a large part. These climates have warm, dry summers and cool, wet winters. Further subgroups are designated by a second, lowercase letter that distinguishes seasonal temperature and precipitation characteristics. The letter "f" refers to moist climates with adequate precipitation in all months and no dry season. This letter usually accompanies A, C, and D climates. To further denote climate variations, a third letter was added to the code. The letter "a," found in C and D climates, refers to hot summers where the warmest month is over

72°F (22°C). Maximum precipitation occurs in the spring and minimum precipitation occurs in the winter. Average annual rainfall is about 40 inches (102 centimeters), and measurable precipitation occurs about 100 days per year. Average winter snowfall is around 20 inches (50 centimeters); however, only one snowfall per year generally exceeds 6 inches (15 centimeters) (FG Alliance, 2006a).

Winters in the region are generally cold and summers are generally hot. Average high and low January temperatures are around 33°F (0.6°C) and 16.6°F (-8.6°C), respectively. On average, the temperature falls below 0°F (-17.8°C) 7 or 8 days a year in the winter. In mid-summer, average high temperatures reach 86°F (30°C) and average low temperatures reach 66°F (18.9°C). High temperatures frequently reach 90°F (32.2°C) or more in the summer. Table 4.3-1 summarizes representative temperature, precipitation, and wind speed data. Climate data for this table were assembled from the National Climatic Data Center for the three nearest Illinois climate network stations (Arcola, Bondville, and Champaign) and are based on historical norms derived from 30 years of weather data from 1971 through 2000 (FG Alliance, 2006a).

Table 4.3-1. Seasonal Weather Data

Weather Parameter	Spring	Summer	Fall	Winter
Average Daily Temperature, °F (°C)	67.2 (19.6)	76 (24.4)	50.0 (10.0)	36.5 (2.5)
Precipitation, inches (centimeters)	11.6 (29.5)	10.9 (27.7)	9.7 (24.6)	7.1 (18.0)
Snow, inches (centimeters)	0.7 (1.8)	0.0 (0.0)	4.2 (10.7)	13.1 (33.3)
Average Wind Speed, miles per hour (kilometers per hour)	11.6 (18.7)	8.0 (12.9)	10.3 (16.6)	11.2 (18.0)

°F = degrees Fahrenheit; °C = degrees Celsius.
Source: FG Alliance, 2006a.

A wind rose is a graph created to show the directional frequencies of wind. Wind rose data from 1998 to 2006 are presented in Figure 4.3-1. The wind rose is representative of the percent of time that the wind blows at a particular speed and direction. The concentric circles on the wind rose represent percentage of time. The wind rose is based on climate data from Coles County Memorial Airport located about 7 miles (11 kilometers) east of the proposed power plant site. As the wind rose indicates, the most common wind directions are from the south and south-southwest (FG Alliance, 2006a). For the proposed FutureGen Project, the primary use of wind rose data is for evaluating potential hazardous material releases to estimate plume transport times and determine potential population exposure.

The average annual wind speed in the region is 9.0 mph (14.5 kmph), and winds from the south and south-southwest are most prevalent. Calm winds (below 1.5 mph [2.4 kmph]) prevail around 8 percent of the time on an annual basis. In the winter, the average wind speed is 11.2 mph (18.0 kmph), and the most frequent wind speeds are between 8.0 and 19.6 mph (12.9 to 31.5 kmph). The most prevalent winter winds are from the south, southwest, and northwest. In the spring, the average wind speed is 11.6 mph (18.7 kmph), and the most frequent wind speeds are between 12.7 and 19.6 mph (20.4 and 31.5 kmph). Winds from the south through southwest are most common in the spring, with no apparent secondary maximum from any other direction; however, winds from the northeast are rare. Winds are usually lighter in the summer with an average speed of 8.0 mph (12.9 kmph). The most prevalent wind directions in the summer are from the southwest. In the fall, the average wind speed is 10.3 mph (16.6 kmph), with the most prevalent winds from the south and south-southwest, although winds from the west-northwest are also common. Winds from the northeast are rare in the fall (FG Alliance, 2006a).

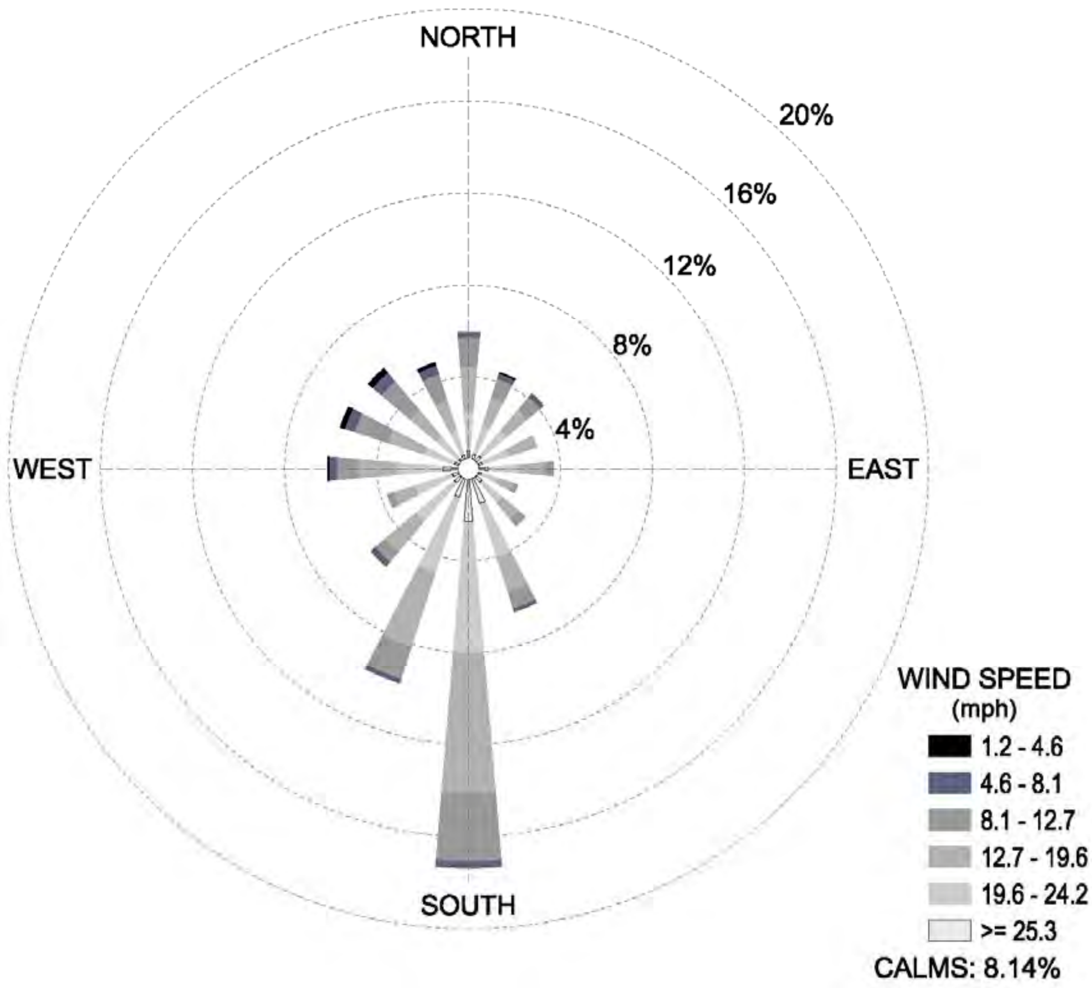


Figure 4.3-1. Wind Rose for the Mattoon Region

The proposed power plant and sequestration site is located in the central plains region of Illinois, which historically experiences a full spectrum of weather phenomena, including extreme heat and cold, ice storms and blizzards, high winds and heavy rainfalls, thunderstorms, localized floods, and tornadoes. Based on historical norms, each year Coles County can expect between 45 and 50 thunderstorms, between one and four tornadoes, and 4 or 5 days with winds that exceed 45 mph (72.4 kmph). Over a 10-year span, the region can expect about 25 hailstorms, 12 snowfalls of 6 inches (15.2 centimeters) or more, and 11 ice storms (FG Alliance, 2006a).

4.3.2.2 Severe Weather Events

Relevant severe weather events for the ROI include frozen precipitation (hail, snow, and ice), tornadoes, floods, and drought. The proposed project site is located hundreds of miles inland from both the Atlantic Coast and the Gulf Coast. For this reason, coastal hurricanes do not occur within the region and have been excluded from discussion.

Hail, Snow, and Ice

On average, each year the Coles County region receives two or three hail storms, one snowfall of 6 inches (15.2 centimeters) or more, and one storm with icy precipitation that forms a glaze on road surfaces, trees, and power lines.

Tornadoes

The National Oceanic Atmospheric Administration (NOAA) documents tornado activity in the region. The Fujita Scale is a standard qualitative metric to characterize tornado intensity based on the damage caused. This scale ranges from F0 (weak) to F6 (violent). From 1950 to 2006, 29 tornadoes were reported in Coles County, including 13 F0 tornadoes, 10 F1 tornadoes, four F2 tornadoes, and two F3 tornadoes. An F3 tornado has not been reported in Coles County since 1974 (NOAA, 2006). Between one and four tornadoes greater than F1 intensity would be expected in Coles County over a 50-year time interval (FG Alliance, 2006a).

The most common metric for tornado strength is the **Fujita Scale**. There are six categories on this scale. F0 and F1 are considered weak, F2 and F3 are strong, and F4 through F6 are violent. Each category represents a qualitative level of damage and an estimated range of sustained wind speed delivered by the tornado. Additional information about the Fujita Scale is available at http://www.tornadoproject.com/fscale/fscale.htm (The Tornado Project, 1999).

Floods

The Kaskaskia River is located about 4 miles (6 kilometers) north of the proposed plant site. During heavy rains, this river can overflow and cause localized flash floods. The NOAA database shows that, between 1999 and 2006, 18 floods have occurred in Coles County. Seven of these floods were county-wide and seven were mainly in the Mattoon region, only one of which caused significant damage (primarily in the Mattoon region). The nearby presence of the Kaskaskia River and the relative flat topography of the region contribute to potential flood conditions in the region (FG Alliance, 2006a). As noted in Section 4.8.2.2, the proposed power plant and sequestration site is not in the 100-year or 500-year floodplains.

Drought

Illinois is located in the Ohio Valley area. This area has suffered notable periods of drought over the past 100 years with extended periods of severe to extreme drought in 1895 to 1896, 1900 to 1901, 1908, 1914, 1930, 1935 to 1937, 1940 to 1942, 1953 to 1954, 1963 to 1964, 1987, and 1996. A statewide network of data collection sites, operated by state and federal agencies, has been established to monitor drought conditions. These sites provide real-time climate, stream flow, aquifer, and reservoir information to water management professionals to develop drought mitigation and response plans. Additional information on the State of Illinois Drought Contingency Plan can be found at http://drought.unl.edu/plan/state%20plans/Illinois.pdf.

4.3.3 IMPACTS

4.3.3.1 Construction Impacts

Power Plant Site

Severe temperature or weather conditions could temporarily delay construction at the proposed power plant site. An ice glaze or snowstorm could prevent material deliveries to and from the site. A hail storm could cause minor damage to equipment at the construction site and extremely low temperatures could also damage equipment and delay construction progress, although such temperature extremes are uncommon.

A flood could impact construction activities at the proposed power plant site; however, the chance for a flood would be very small because the proposed power plant site would be located entirely outside of the 500-year floodplain. A strong tornado could potentially impact construction activities at the proposed power plant site; however, the statistical probability for a tornado greater than F1 intensity in Coles County is relatively low (between one and four occurrences every 50 years), and the proposed power plant site constitutes a small fraction of the county's size. The risks posed on construction safety by climate and severe weather events would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements (FG Alliance, 2006a).

Severe or extreme drought conditions could increase the potential for wildfires in the area. Drought conditions would also increase the number of water trucks needed to reduce fugitive dust emissions and to support other construction activities. In dry, hot weather, construction workers may need to wear a dust mask and work for shorter time intervals between breaks.

Sequestration Site

The proposed sequestration site is on the same property as the proposed power plant site; therefore, direct and indirect impacts of climate on construction at the proposed sequestration site would be the same as those discussed for the proposed power plant site.

Utility Corridors

Severe temperature or weather conditions could temporarily delay construction at the proposed utility corridors. The potential impacts from ice glaze, large snowfall, hail, or tornado would be comparable to those described for the proposed power plant site. Small portions of the proposed electrical transmission corridor are within the 100-year floodplain; however, because this corridor would cross such small portions of the 100-year floodplain and construction activities in the utility corridor would occur over a limited time span, the potential for a flood to have direct or indirect impacts on construction would be low.

Transportation Corridors

Road and rail transportation routes currently extend directly to the proposed power plant site. The proposed upgrade of CH 13 and the intersection of CH 13 and SR 121 would occur adjacent to the site, and the impacts from climate and severe weather would be comparable to those at the proposed power plant site.

4.3.3.2 Operational Impacts

Power Plant Site

It is unlikely that operations at the proposed power plant site would be directly or indirectly affected by temperature extremes in the region. Although summer temperatures would be warm and winters generally bring cold temperatures and sizeable snowfalls, the proposed power plant site would be designed to operate under a wide range of weather conditions.

Because the land around the proposed power plant site is flat, land topography would not influence stack emissions downwash. However, water vaporization from cooling tower operation could potentially contribute to local fog conditions. Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Although this potential impact is referred to as fogging, cooling tower plume touchdown or fogging is usually a temporary event for only a few operational hours. Section 4.2 provides further discussion.

Ice glaze, large snowfall, or hail could disrupt material deliveries to and from the proposed power plant site and cause minor impacts on operations; however, these conditions would be largely mitigated by proper facility design and operational strategies.

The possibility of a tornado in the region poses the potential for both direct and indirect impacts on power plant operations. A strong tornado could directly impact plant operations if sufficient damage were incurred at the plant site. Indirect impacts could occur if a tornado struck nearby communities and affected the ability of workers or supplies to reach the site. However, the statistical probability of a tornado greater than F1 intensity in Coles County is relatively low (between one and four occurrences every 50 years), and the proposed power plant site constitutes a small fraction of Coles County's size, therefore, the chance for significant direct and indirect impacts from a tornado would be low (FG Alliance, 2006a).

It is very unlikely that a flood would cause a direct or indirect impact on operations at the proposed power plant site because the site would be located outside of the 500-year floodplain. The risks posed on operational safety would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements.

Severe or extreme drought conditions could increase the potential for wildfires in the area. Ready availability of water is crucial for both fire protection and daily power plant operations. Because severe to extreme drought conditions are likely over the planned life of the facility, contingency plans and design features must be established to address these conditions to ensure that the necessary water is always available.

Sequestration Site

Because the proposed sequestration site is located on the same property as the proposed power plant site, direct and indirect impacts of climate on operation of the sequestration site would be the same as those discussed for the power plant site.

Utility Corridors

Operation of the proposed underground utilities would not be affected by climate or severe weather because pipelines would be buried at appropriate depths to prevent weather-related damage, such as from freeze and thaw cycles. Operation of the proposed electrical transmission lines could potentially be affected by climate or severe weather conditions in the region. The potential impacts from ice glaze, large snowfall, hail, or tornado would be comparable to those described for the proposed power plant site. A significant ice glaze could down transmission lines and temporarily interrupt electrical service to and from the proposed power plant.

Minor portions of the proposed electrical transmission corridor would cross small areas within the 100-year floodplain; however, the transmission line would be designed to address the possibility of a flood. Therefore, the potential for direct or indirect impacts on operations due to a flood would be low.

Transportation Corridors

Operation of transportation routes to the site could be affected by climate or severe weather conditions in the region. A significant ice glaze, snowfall, or tornado could interrupt the transport of workers or materials to and from the proposed power plant site.

Minor portions of the proposed transportation infrastructure corridors cross small areas within the 100-year floodplain; however, the infrastructure would be designed to address the possibility of a flood. Therefore, direct or indirect impacts on operations due to a flood would be low.

4.4 GEOLOGY

4.4.1 INTRODUCTION

The geologic resources of the proposed Mattoon Power Plant and Sequestration Site, and related corridors are described in this section, followed by a discussion of the potential impacts to these resources.

4.4.1.1 Region of Influence

There are three ROIs for geologic resources. The first ROI includes the land area on the surface that could be directly affected by construction and operation of the FutureGen Project at the proposed Mattoon Power Plant and Sequestration Site. The second ROI includes the subsurface geology related to the radius of the injected CO_2 plume. Numerical modeling indicates that the plume radius associated with injecting 1.1 million tons (1 MMT) of CO_2 per year for 50 years would be 1.2 miles (1.9 kilometers), equal to an area of 2,789 acres (1,129 hectares) (FG Alliance, 2006a). The plume radius and land area above the CO_2 plume are shown in Figure 4.4-1. The third ROI is a wider area (100 miles [161 kilometers]) that was evaluated to include potential effects from seismic activity.

4.4.1.2 Method of Analysis

The geologic setting includes the near-surface geology of the entire project and all deeper strata that make up the proposed sequestration reservoir. DOE evaluated the potential effects of the construction and operation of the proposed project on specific geologic attributes. In addition, DOE assessed the potential for impacts on the project due to geologic forces (e.g., earthquakes). The potential for impacts was based on the following criteria:

- Occurrence of local seismic destabilization (induced seismicity) and damage to structures;
- Occurrence of geologic-related events (e.g., earthquake, landslides, sinkholes);
- Destruction of high-value mineral resources or unique geologic formations or rendering them inaccessible;
- Alteration of geologic formations;
- Migration of sequestered CO_2 through faults, inadequate caprock or other pathways such as abandoned or unplugged wells;
- Human exposure to radon gas; and
- Noticeable ground heave or upward vertical displacement of the ground surface.

DOE based its evaluation on a review of reports from state geologic surveys and information provided in the Mattoon EIV (FG Alliance, 2006a).

DOE identified uncertainties in relation to geological resources at the Mattoon Site. These include the porosity and permeability of the target formation where CO_2 would be sequestered. Analog well data were analyzed; however, site-specific test well data were not collected. A 2D seismic line was shot across the proposed injection site location to provide information on the formations at the sequestration site.

4.4.2 AFFECTED ENVIRONMENT

4.4.2.1 Geology

The proposed Mattoon Power Plant and Sequestration Site is 444 acres (180 hectares) in size. The site is essentially flat with an average slope of between 0.5 and 1 percent. The elevation of the site varies from 718 feet (219 meters) to 679 feet (207 meters) above mean sea level (AMSL).

Illinois is covered with glacial deposits that date from the Pleistocene and Holocene epochs of the Quaternary Period (up to approximately 2 million years before present). Beneath that recent veneer, Illinois is dominated by limestone and shale, which was deposited in shallow-water and coastal environments during the Paleozoic Era, beginning about 570 million years ago.

Figure 4.4-2 is a stratigraphic column of the geology beneath the proposed Mattoon Power Plant and Sequestration Site. The surficial Quaternary glacial deposits are about 100 to 125 feet (31 to 38 meters) thick and are underlain by the Pennsylvanian age McLeansboro Group. This group includes coal seams interbedded with shale-limestone-shale formations. The McLeansboro Group is more than 1,500 feet (457 meters) thick and is underlain by about 0.9 mile (1.4 kilometers) of primarily shale and interbedded sandstones with some limestones and dolomites.

Lying below these strata is the proposed target formation (or sequestration reservoir) for CO_2 injection, the Mt. Simon sandstone formation. This formation is brine saturated and is about 0.2 to 0.3 mile (0.3 to 0.5 kilometer) thick below the project site. The CO_2 injection target would occur at a depth of 1.3 to 1.6 miles (2.1 to 2.6 kilometers). It is the oldest formation of the Paleozoic Era and rests on the pre-Cambrian igneous “basement” rocks. The Mt. Simon is composed of medium- to coarse-grained quartz sandstone, feldspar-bearing sandstone, and thin layers of micaceous shale near the top of the formation. The Mt. Simon is overlain by 500 to 700 feet (152 to 213 meters) of low permeability siltstones and shales of the Eau Claire formation, which would serve as the primary seal for the sequestration reservoir.

The Ordovician-age St. Peter sandstone is proposed as an optional target reservoir. It occurs at a depth of 0.9 mile (1.4 kilometers) below the earth’s surface, which is about 0.4 mile (0.6 kilometer) above the Mt. Simon formation (see Figure 4.4-2). At the Mattoon Site, the St. Peter is estimated to be more than 200 feet (61 meters) thick with good lateral continuity and permeability. Both Mt. Simon and St. Peter reservoirs have been successfully used for natural gas storage in other parts of Illinois. In particular, the Mt. Simon supports 38 natural gas storage reservoirs in Illinois (FG Alliance, 2006a).

Structurally, the principal tectonic feature of this area is the Charleston Monocline. This step-like fold marks the western edge of the greater La Salle Anticlinorium, which extends from southwest Indiana to north central Illinois, a compound anticline consisting of a series of subordinate anticlines and synclines, the whole having the general contour of an arch. The Charleston monocline strikes north-northwest, and its steep limb dips southwest. Structural relief is as great as 0.5 mile (0.8 kilometer) (FG Alliance, 2006a).

> A **monocline** is an open, step-like fold in rock over a large area.

The Mattoon Power Plant and Sequestration Site lies in a very gentle syncline and is about 6 miles (10 kilometers) west of the lower limb of the Charleston Monocline. The axis of a smaller fold, the Mattoon Anticline, passes about 2 miles (3.2 kilometers) east of the Mattoon Site. The Mattoon Anticline trends north-south and provides structural trapping for the Mattoon oil and gas field.

> An **anticline** is an upfolded strata in which layers slope away from the axis of the fold, or central ridge.

It is likely that basement faults controlled the tectonic features discussed above. Although no faults are mapped in the project area, any faults that might exist would come to the surface of the bedrock and would be hidden by the glacial deposits at the earth's surface. It is unlikely that large through-cutting transmissive faults occur within the Paleozoic rocks because of the substantial oil reserves trapped at multiple elevations within the Mattoon anticline (FG Alliance, 2006a). The oil reserves would not be trapped if there were transmissive faults in the anticline.

Because of the possibility of faults associated with the Mattoon Anticline and the greater La Salle Anticlinorium, a regional geologic stress analysis was conducted to yield insight on the orientation of open fractures and possible transmissive faults. Throughout Illinois, the magnitude of the regional earth stresses and their direction are fairly consistent. The stress trend, or principal direction, is west-southwest to east-northeast. Stress values are dependent on depth, and maximum and intermediate horizontal stresses are greater than the vertical stress. The proposed injection site is in an overall compressional (mixed thrust and strike-slip fault) setting. Faults and fractures parallel to the greatest principal stress are more likely to be transmissive and faults or fractures not parallel to this direction are more likely to be sealing (FG Alliance, 2006a).

Geological Resources in the Mattoon Area

Five mature oil fields are located within a 10-mile (16.1-kilometer) radius of the proposed Mattoon Power Plant and Sequestration Site. These fields all have anticlinal closure. The Mattoon Oil Field is located east of the project area, but no oil or gas wells are present within approximately 1.5 miles (2.4 kilometers) of the proposed power plant site. The oil field has produced oil from Mississippian and Devonian strata at depths of 0.3 to 0.6 mile (0.5 to 1 kilometer), although currently many of the wells are plugged and abandoned because of declining production.

Oil and gas leasing is common in the Mattoon area. Three petroleum exploration wells are located above the maximum plume footprint projected for the Mattoon injection well; one well was drilled to the Mississippian, one to the Devonian and one to the Silurian (see Figure 4.4-2). No wells penetrate the primary seal of the Eau Claire formation (FG Alliance, 2006a).

Although coal is present throughout the area, only relatively small areas of Springfield and Herrin Coal are mineable. The Springfield and Herrin Coals occur at average depths of 1,000 to 1,100 feet (305 to 335 meters) in the Mattoon area. There are no active mines in the immediate project area.

Most factors known to cause subsidence are not present in the project area. Such factors include undermining for coal or other resources, and withdrawal of large quantities of water from aquifers. Subsidence has not been detected over areas in Illinois where oil has been extracted (FG Alliance, 2006a).

4.4.2.2 Seismic Activity

The proposed Mattoon Power Plant and Sequestration Site is located roughly 40 to 50 miles (64 to 81 kilometers) northwest of an area of seismic activity known as the Wabash Valley Seismic Zone, which extends from southeastern Illinois into southwestern Indiana. The New Madrid Fault Zone is located roughly 200 miles (322 kilometers) south-southwest of the proposed site in the general area of the common borders of southern Illinois, western Kentucky and Tennessee, and southeastern Missouri. This area has spawned the most powerful earthquakes recorded in the continental United States (Richter magnitudes of 8.0). However, as discussed below, earthquakes centered in the area of the New Madrid Fault Zone have historically not caused damage in central Illinois.

The historical record of earthquakes having epicenters in Illinois begins on January 8, 1795. On that date, a mild earthquake occurred near Fort Kaskaskia on the Mississippi River in southwestern Illinois. During the 200 years since that event there have been about 200 other earthquakes in Illinois. Only nine of these quakes were strong enough to cause even minor damage. The largest Illinois quake ever recorded occurred in southeastern Illinois on November 9, 1968, and measured magnitude 5.4 on the Richter scale (ISGS, 1995a).

A search of the USGS database of historic earthquakes shows that since 1974, 29 earthquakes have occurred within 100 miles (160.9 kilometers) of the proposed Mattoon Power Plant and Sequestration Site. Magnitudes ranged from 2.7 to 5.1. The most recent 2.7 magnitude earthquake centered 83 miles (133.6 kilometers) from the proposed site occurred in December 6, 2005. The closest earthquake was a magnitude 3.0 that occurred on April 24, 1990, and was centered approximately 12 miles (19 kilometers) from the site (USGS, 2006).

As previously discussed, minor earthquakes are known to occur in Illinois, but damaging quakes are very infrequent. Minor damage (e.g., items falling from shelves) from Illinois earthquakes is reported about once every 20 years. Most recently, a Richter magnitude 5.0 earthquake shook southeastern Illinois in June 1987, causing minor structural damage in the Lawrenceville and Olney areas, approximately 60 miles (97 kilometers) south-southeast of the proposed Mattoon Power Plant and Sequestration Site. Serious damage (i.e., major structural damage) from earthquakes occurs every 70 to 90 years. Devastating earthquakes (i.e., almost complete destruction over large areas) are very rare in the central United States, occurring about once every 700 to 1,200 years. The last strong earthquake to strike the Midwest happened on October 31, 1895. The quake, centered just south of Illinois in Charleston, Missouri, had an estimated magnitude of 6.8 on the Richter scale. Although this quake was widely felt throughout the mid-continental United States, it caused serious damage only in the immediate Charleston area (ISGS, 1995b).

4.4.2.3 Target Formation Properties

Characteristics

The thickest and most widespread saline reservoir in the Illinois Basin is the Cambrian-age Mt. Simon sandstone (see Figure 4.4-2). It is overlain by the Eau Claire formation, a very low permeability regional shale, and is underlain by Precambrian igneous rocks that form the “basement.” The Mt. Simon is a regionally extensive formation. Several wells in central Illinois indicate the depth and thickness of the Mt. Simon. It is anticipated that greater than 0.2 mile (0.3 kilometer) of Mt. Simon is present at the proposed Mattoon Power Plant and Sequestration Site. Drilling at the Weaber-Horn No.1 well, located 35 miles (56.3 kilometers) south of the proposed site, penetrated over 0.2 mile (0.3 kilometer) of Mt. Simon sandstone before reaching the Precambrian basement (FG Alliance, 2006a). Because of the structure of the Illinois Basin, the Mt. Simon likely thins to the south of the proposed site, indicating that the Mt. Simon at the proposed Mattoon Site is likely to be thicker than the Mt. Simon encountered at the Weaber-Horn No.1 well.

Depth

Regional data from the Illinois Geological Survey show the expected depth to the top of the Mt. Simon sandstone at the proposed Mattoon Power Plant and Sequestration Site to be approximately 1.3 to 1.6 miles (2.1 to 2.6 kilometers). Bottom hole temperature at the base of the Mt. Simon (1.6 miles [2.6 kilometers]) is estimated to be 145°F (62.8°C) and the bottom hole hydrostatic pressure is estimated to be 3,590 pounds per square inch (psi) (FG Alliance, 2006a). The proposed injection zone would use the entire thickness of the Mt. Simon formation, although significant injection would occur primarily in the more permeable regions of the formation (those with greater effective porosity) as discussed below in *Storage Capacity*. The St. Peter sandstone is proposed as an optional target reservoir at an injection depth of 0.9 mile (1.4 kilometer).

Injection Rate Capacity

Using the entire thickness of the Mt. Simon for injection and using analog data concerning porosity from the Weaber-Horn No.1 well discussed above, it was concluded that the required injection rate would likely be met by one CO_2 injection well. One well would be sufficient if the well's injection rate was equivalent to the low end of injection rates for underground natural gas storage wells currently operating in the Illinois Basin (FG Site Proposal [Mattoon, Illinois], 2006). Furthermore, reservoir modeling indicates that the proposed injection rate could be met with one injection well even if the thickness of porous sandstone is actually found to be as low as approximately 200 feet (61 meters) instead of the currently estimated 585 feet (178.3 meters) (FG Alliance, 2006a).

Storage Capacity

The storage capacity of a reservoir depends on its porosity, permeability, thickness and lateral extent. The Mt. Simon formation is a regionally extensive sandstone with effective porosity (i.e., porosity greater than 12.6 percent) generally occurring in 1- to 2-feet (0.3- to 0.6-meter) thick beds separated by lower permeability rock. Permeability is measured in units of millidarcy (md) and values of 0.001 md or less are almost impermeable, 0.1 md is "tight" or of very low permeability, 1 to about 50 md is to be low permeability, and higher values are permeable.

The Mt. Simon has very large storage capacity because it is laterally extensive regionally and has numerous porous and permeable intervals. Regional well data indicate that the Mt. Simon should be porous at the proposed Mattoon Site. The average porosity of the two regional wells was 20.6 and 15.4 percent and the storability (sum of porosity-thickness product) was 102 and 59.7 pore-feet. The permeability to air was estimated for each interval that exceeded 12.6 percent porosity. The arithmetic average of permeability was 833 and 466 md at the two regional wells, indicating very high permeability.

At the Manlove anticline (located 48 miles [77.2 kilometers] north of the proposed Mattoon Site), the Mt. Simon is used for natural gas storage. One hundred-fifty billion cubic feet (4.2 billion cubic meters) of methane are stored in the uppermost 200 feet (61 meters) of the Mt. Simon sandstone. This is equivalent to approximately 25 million tons (22.7 MMT) of CO_2. The Mt. Simon sandstone likely contains 500 permeable feet (152 permeable meters) to inject and sequester CO_2 below the proposed Mattoon Site. The proposed Mattoon Site would have a much larger volume of reservoir in which to inject CO_2 than what is found at the Manlove anticline.

Seals, Penetrations, and Faults

The Illinois Basin has the largest number of saline natural gas storage fields in the United States. These gas storage fields provide important analogs that can be used to analyze the potential for CO_2 sequestration. These analogs illustrate seal integrity, injection capability, storage capacity, and reservoir continuity in the north-central and central Illinois Basin. The long history, almost 50 years, of successful natural gas storage in the Mt. Simon sandstone is indicative of the containment quality of this saline reservoir.

Primary Seal

The regional geology of central Illinois has been well understood for decades. Regional cross-sectional diagrams of the rock strata in the central part of Illinois show that the Eau Claire formation is a laterally persistent low permeability shale layer above the Mt. Simon and that it is expected to provide a good seal. Gas storage projects in the Illinois Basin all confirm that the Eau Claire is an effective seal in the northern and central portions of the Basin. Analysis of rock cores from the Manlove Gas Storage Field, 54 miles (86.9 kilometers) to the north, shows that the Eau Claire shale has vertical and horizontal permeabilities of less than 0.1 md (FG Site Proposal [Mattoon, Illinois], 2006).

The Weaber-Horn No.1 well, 35 miles (56.3 kilometers) to the south, penetrates over 500 feet (152 meters) of Eau Claire shale overlying the Mt. Simon. It is estimated that the proposed Mattoon Sequestration Site has a minimum of 400 feet (122 meters) and potentially 500 feet (152 meters) of shale that would serve as the primary seal (FG Site Proposal [Mattoon, Illinois], 2006).

EPA's underground injection control (UIC) database of wells was also used to estimate seal qualities. In this database, the Eau Claire formation median permeability and porosity are 0.000026 md and 4.7 percent, respectively. Cores were obtained through 414 feet (126.2 meters) of the Eau Claire at the Ancona Gas Storage Field, located approximately 100 miles (161 kilometers) to the north of Mattoon, and 110 analyses were performed on the recovered core. Most vertical permeability analyses showed values of <0.001 to 0.001 md. Seventeen analyses were in the range of 0.002-0.009 md and 12 analyses were in the range of 0.010-0.099 md. Only five analyses were in the range of 0.100-0.871 md, the latter being the maximum value (FutureGen Site Proposal [Mattoon, Illinois], 2006). For comparison, 0.001 md is very low permeability, 0.1 md is "tight" or of low permeability, and 1 md is slightly permeable. Therefore, approximately 96.5 percent of the cores obtained were to be at least "tight," and it appears that the Eau Claire formation should be a good primary seal.

Secondary Seals

At least two other shale formations may act as secondary seals – the Maquoketa and New Albany Group Shales (see Figure 4.4-2). These formations are located between 0.6 and 0.8 mile (1 to 1.3 kilometers) below the ground surface in the project area, and each is up to 200 feet (61 meters) thick.

In addition to the primary and secondary seals, there are numerous other fine-grained formations that act as areas of low permeability, both within the estimated 0.2 to 0.3 mile (0.3 to 0.5 kilometer) of Mt. Simon rocks, and also in the estimated 1.2 to 1.3 miles (1.9 to 2.1 kilometers) between the top of the Mt. Simon and the ground surface. These seals are capable of retarding CO_2 vertical migration.

Relation of Primary Seal to Active or Transmissive Faults

Mattoon is in the central part of the Illinois Basin, where near-surface rocks are of late Pennsylvanian age and are likely to be horizontal. The older, deeper rocks have a very slight dip. For instance, the New Albany Shale dips southeastward in the Mattoon area at an average rate of roughly 100 feet per mile (18.9 meters per kilometer) (less than 1 degree).

The Illinois Department of Natural Resources (IDNR) has mapped no significant faults within approximately 50 miles (81 kilometers) of Mattoon (ISGS, 1997). The Midwest Geologic Sequestration Consortium provides a structural map of the pre-Cambrian basement rocks of Illinois that shows a major fault present east of Mattoon in central Coles County trending north-northwest/south-southeast. However, this fault is far from the subsurface ROI and is located below the Mt. Simon formation.

Moreover, a recent 2D seismic line indicated no major faulting in the north-south direction at the injection site (Patrick Engineering, 2006).

As previously discussed, Mattoon and the surrounding area are not seismically active and no major earthquakes have affected this area, so it is not expected that seismic vibrations would activate existing faults.

4.4.2.4 Geologic Sequestration Studies, Characteristics, and Risk Assessment

Currently, there are four CO_2 injection projects worldwide under detailed study. These are the Rangely, Weyburn, In Salah, and Sleipner projects. They are located in the United States, Canada, Algeria, and Norway, respectively. Rangely and Weyburn involve enhanced oil recovery (EOR), In Salah involves enhanced gas recovery (EGR) and saline reservoir injection, and Sleipner is a storage project located off shore in the North Sea.

A database of these and other geologic storage facilities was created and used in conducting the human health risk assessment for this EIS (Section 4.17). These studies of natural and industrial analogs for geologic storage of CO_2 (i.e., sites in similar geologic and hydraulic settings with similar human influences) provide evidence for the feasibility of geologic containment over the long term and for characterizing the nature of potential risks from surface leakage, should it occur. A more detailed description of these studies, their characteristics, and the state of risk assessment for geologic sequestration of CO_2 is provided in Section 4.17 and Appendix D.

4.4.3 IMPACTS

4.4.3.1 Construction Impacts

Power Plant Site

The surficial geology of the proposed power plant site includes glacial deposits that are likely about 100 feet (31 meters) thick. There are no geologic features present that would affect construction of the power plant infrastructure. Because there are no economically extractable geologic resources in the surface geology ROI, there would be no impact to the availability of such resources from construction of the power plant. However, aggregate and other geologic resources (e.g., sand) would be required to support construction activities, but these resources are abundant in central Illinois and the quantities required for construction of the power plant would not have a noticeable effect on their availability. Additional discussion of the availability of construction materials is addressed in Section 4.16.

The relatively flat surface topography of the power plant site precludes any potential impacts from landslides or other slope failures during construction. Similarly, because the area is not seismically active and most of the earthquakes in southern Illinois have a Richter magnitude below 3.0, it is not expected that seismic activity would affect construction of the power plant. The project area should not be affected by subsidence (sinking or lowering of the ground surface) because most factors known to cause subsidence are not present in the project area.

Sequestration Site

Because the sequestration reservoir would be located below the power plant site, potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides would be the same for construction at the sequestration site as previously discussed for the power plant site. The injection well and backup well would penetrate over 1.5 miles (2.4 kilometers) of bedrock. It is believed that mineral resources would not be impacted by the installation of the injection well, backup well, or deep monitoring wells (these wells are discussed below).

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed transportation infrastructure corridors as discussed above for the power plant site.

4.4.3.2 Operational Impacts

Power Plant Site

During power plant operations, no additional impacts to geologic resources would be expected. The power plant site's relatively flat surface topography and lack of karst geology precludes any potential impacts from landslides, other slope failures, or sinkhole development during operation. Similarly, because the area is not seismically active and only minor earthquakes have been recorded for the project area, it is not expected that seismic activity would affect operation of the power plant.

Sequestration Site

The potential impacts to geologic resources and impacts to the sequestration site from geologic processes during operation are discussed below.

When CO_2 is injected into a deep brine-saturated (saline) permeable formation in a liquid-like (i.e., supercritical) dense phase, it is immiscible in, and less dense than, water. This would be the case at the proposed Mattoon Site. The CO_2 would displace some of the brine. In addition to displacement of brine, CO_2 may dissolve in or mix with the brine, thereby causing a slight acidification of the water, react with the mineral grains, or be trapped in the pore spaces by capillary forces. Some combination of these processes is likely, depending on the specific conditions encountered in the reservoir.

Geochemical modeling of the potential pH changes was conducted for this EIS. The modeling showed that the pH of the brine in the Mt. Simon formation would be expected to drop from 6.4 to 3.8 over many years, creating acidic brine. However, the Mt. Simon is made up primarily of quartz-rich sedimentary rocks (primarily sandstone) that are extremely resistant to chemical changes. Therefore, acidification of the brine solution would not be expected to substantially alter the Mt. Simon formation.

CO_2 emitted from the power plant would include some H_2S. Because of the significant expense required to separate these two elements, it is possible that the Alliance may conduct tests where greater concentrations of H_2S are included in the gas stream to be sequestered. Therefore, geochemical modeling of the potential changes that could occur to the Eau Claire shale (caprock) from the introduction of H_2S into the reservoir formation was conducted. It was concluded that, because of the mineralogy of the Eau Claire formation, there is no reaction mechanism that could serve as a major sink to decrease the concentration of injected H_2S. It was also noted that the chemical reactions would be unlikely to significantly change the dynamics of the injection behavior of the CO_2 and H_2S mixture, although H_2S can cause precipitation of minerals that would reduce the porosity of the formation (FG Alliance, 2006a).

Increases in pore pressure associated with the injection of CO_2 can decrease friction on existing faults and may cause them to become transmissive or to slip. Injection-induced seismicity at the sequestration site is, however, unlikely for the following reasons:

- High injection pressures are dissipated within a short distance of the injection well where the injection zone is thick and has good porosity. As discussed above, the Mt. Simon has an estimated porous interval of 585 feet (178.3 meters) and it is laterally continuous for hundreds of miles.
- The general compressive tectonic regime of the proposed Mattoon Site suggests that existing faults are not likely to slip as a result of normal field operations, especially if the maximum injection pressure is conservatively set at 85 percent of the fracture opening pressure currently required by Illinois UIC regulations.

Although injection-induced seismicity is unlikely, monitoring would further reduce the possibility of accidentally inducing seismicity on a scale larger than micro-scale (measuring -4 to 0 on the Richter scale).

The injection pressures that would cause new or existing fractures to open in the target reservoir and caprock are not known and would need to be determined as part of the permitting process. Requiring injection pressures to be substantially below the fracture opening and fracture closure pressures would greatly lower the risk of accidental overpressure and induced fracturing of the formation, the seal, or cements in wellbores, as well as lowering the risk of opening existing fractures. Site-specific injection pressure limits may be established as part of the permitting process.

Numerical modeling was conducted to estimate the potential CO_2 plume migration if an undetected transmissive fracture zone or fault was present that through-cuts the Eau Claire formation above the injection point in the Mt. Simon formation. This fracture zone or transmissive fault was assumed to have permeabilities well in excess of the permeability of the Eau Claire formation (four cases were modeled with permeabilities ranging from 0.01 to 1,000 md). Only narrow faults were evaluated because fracture/fault zones larger than 33 feet (10.1 meters) wide could be detected through geophysical methods and investigated before initiation of an injection program. Injection wells would be relocated, if necessary, to avoid such faults.

The results of the numerical modeling of the fault leakage scenario for the proposed Mattoon Site indicate that, for permeabilities of 1 md and higher, the amount of CO_2 leakage through the fault would be relatively small, as measured by the CO_2 flux rates, extent of the plume, and CO_2 gas pressure at the base of the overlying Maquoketa formation. If the fault were 321 feet (97.8 meters) long and had a permeability of 50 md, the steady-state flux rate would be about 173 tons (157 metric tons) of CO_2 per year, or 0.006 percent of the 2.8 million tons (2.5 MMT) per year injection rate. The maximum plume extent occurred for the higher permeability faults and was 1.4 miles (2.3 kilometers) at year 60. The plume extent for the 1 and 0.01 md cases was essentially zero. Significant permeation of the Eau Claire shales is unlikely to occur at fault permeabilities less than 1 md (FG Alliance, 2006a).

The potential for leakage of CO_2 from the sequestration reservoir by means other than faults was also evaluated. The injection and backup wells themselves (and any deep monitoring wells in the target formation) would be one of the likely paths for CO_2 migration from the reservoir, because by their nature they perforate all seals present. This is why proper grouting and sealing of the well bores would be very important. Unknown wells and improperly plugged wells within the subsurface ROI could potentially leak CO_2. The proposed Mattoon Site subsurface ROI is surrounded by operating and abandoned petroleum exploration and production wells, with several hundred within 5 miles (8 kilometers) of the proposed injection site, and almost 60 within 2 miles (3.2 kilometers) (see Figure 4.4-1). The primary oil-bearing formations are shallow (0.3 to 0.6 feet [0.5 to 1.0 kilometer]), and most wells are in this depth interval. The deepest wells penetrate the New Albany secondary seal, as it occurs from about 0.6 mile (1 kilometer) deep. As shown on Figure 4.4-1, two of these wells are located within the estimated radius of the maximum plume extent. However, none of the known wells is deep enough to penetrate the primary seal, the Eau Claire formation (FG Alliance, 2006a). There are likely a number of wells in the area whose status is not known, and there is a likelihood of improperly plugged oil wells existing within the subsurface ROI. However, as part of the site-specific assessment to be conducted on the selected site, geophysical surveys will be conducted to locate lost wells. In addition to the two known wells present in the subsurface ROI, such lost wells, if found to be improperly abandoned, could be plugged and abandoned in a manner to meet state regulations and to prevent leakage. The risk assessment estimates the probability of leakage from such wells (Appendix D).

An earthquake has the potential to affect the injection well. If a fault were penetrated by the well bore, the injection well's casing could be sheared if movement occurred on that fault during a seismic event. However, vibrations from an earthquake would not likely cause faulting or affect the integrity of the well. Minor earthquakes do occur in central Illinois, but the project area is not seismically active. Central Illinois lies in a stable continental area where there is little risk of new faulting. In addition, earthquake epicenters in continental areas are typically deeper than the sedimentary strata that would be penetrated by the well (the depth of the shallowest earthquake recorded within 120 miles (193.1 kilometers) of Mattoon was 1.9 miles [3.1 kilometers]). Thus, it is unlikely that the well's casings would be sheared.

There are several sequestration features that indicate that CO_2 would be retained in the proposed injection formation, the Mt. Simon sandstone, including:

- The Mt. Simon formation likely has about 585 feet (178 meters) of permeable sandstone (interbedded with less permeable layers) and extends laterally for hundreds of miles; therefore, more than adequate storage capacity exists in the proposed sequestration reservoir.
- The remaining interbedded sub-layers (totaling 700 to 800 feet [213.4 to 243.8 meters]) of the Mt. Simon formation that are less permeable should act as barriers to the upward migration of CO_2.
- The predominantly quartz mineralogy of the Mt. Simon formation would cause geochemical reactions to be primarily simple dissolution of the CO_2 in the brine formation water, although the presence of feldspar could cause some geochemical trapping of the CO_2 to occur as well.
- The primary seal, the Eau Claire formation, is a low-permeability shale with an estimated thickness of up to 600 feet (183 meters) in the subsurface ROI area.
- The natural gas industry has successfully stored natural gas in the Mt. Simon formation without fracturing the overlying the Eau Claire formation at 10 underground reservoirs in Illinois at depths shallower than the proposed injection zone (ranging from 0.3 to 0.7 mile [0.5 to 1.1 miles]).
- The IEPA stated that the proposed Mattoon Sequestration Site is located in a part of the state where the regional geology is well known and that the area is "well suited for Class I injection activities." In addition, the IEPA stated that no current or former injection wells penetrate either the proposed injection or confining zones near the Mattoon Sequestration Site (FG Alliance, 2006a).

There are many variables that affect the potential to increase pore pressure enough to cause vertical displacement. Collection of site-specific data, including porosity, permeability, and mean effective stress would allow for future modeling of the predicted pressure increases and subsequent potential for ground heave at the proposed Mattoon Site and surrounding area. If a potential problem is identified, injection pressures could be maintained below the levels that would cause heaving.

The EPA has mapped Coles County as an area of Illinois with a high potential for radon to exceed their recommended upper limit for air concentrations within buildings. Thus, if CO_2 were to escape the sequestration reservoir and increase pore pressures in the vadose zone (near surface unsaturated soils above the water table), it could potentially displace radon, forcing it into buildings. As discussed above, several sequestration features indicate that CO_2 should be retained in the sequestration reservoir. If CO_2 were to leak, however, radon transport induced by CO_2 leakage would be highly localized over the point of CO_2 leakage. The risk assessment conducted for this EIS addressed the potential for adverse impacts from radon displacement (see Appendix D). Data concerning potential existing radon levels from state and local sources were used as the baseline. Using conservative assumptions on increases of radon via displacement by CO_2, it was concluded that the situation with respect to radon would remain unchanged as to whether EPA-established action levels would be exceeded. This indicates that there would be no incremental risks above background from radon at the Mattoon Site.

Mineral rights on the site are intact and would be conveyed on the signing of the contract. All mineral rights needed to conduct sequestration would be acquired. Conflicts with commercial accessibility to high-value mineral resources or unique geologic formations would be managed as part of the acquisition of mineral rights.

The project area should not be affected by subsidence (sinking or lowering of the ground surface) because most factors known to cause subsidence are not present in the project area.

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed transportation infrastructure corridors as discussed above for the power plant site.

4.4.3.3 Fate and Transport of Injected/Sequestered CO_2

As previously mentioned, in saline formations, supercritical CO_2 is less dense than water, which creates strong buoyancy forces that drive CO_2 upwards. After reaching the top of the reservoir formation, CO_2 would continue to migrate as a separate phase until it is trapped as residual CO_2 saturation or in local structural or stratigraphic traps within the sealing formation. In the longer term, significant quantities of CO_2 (up to 30 percent) would dissolve in the formation water and then migrate with the groundwater. Reservoir studies and simulations for the Sleipner Project have shown that CO_2 saturated brine would eventually become denser and sink, thereby eliminating the potential for long-term leakage. These reactions, however, may take hundreds to thousands of years (IPCC, 2005).

The modeling estimated that the plume radius at Mattoon could be as large as 1.2 miles (1.9 kilometers) equal to an area of 2,789 acres (1,129 hectares) after injecting 1.1 million tons (1 MMT) of CO_2 annually for 50 years (FG Alliance, 2006a). The dispersal and movement of the injected CO_2 would be influenced by the geologic properties of the reservoir, and it is unlikely the plume would radiate in all directions from the injection point in the form of a perfect circle.

Geological characteristics of the area (simple sedimentary structure with a low rate of dip; no known transmissive faults or fractures and compressive stress regime; deep reservoir zones in a formation consisting mainly of quartz-rich sandstone layers with up to 585 feet (178.3 meters) of high porosity and permeability sublayers overlain by 300 to 500 feet (91.4 to 152.4 meters) of low permeability shale; and over 6,000 feet (1,829 meters) of overlying mostly fine grained carbonate rock that also includes many sequences of more and less permeable zones) indicate that it would be unlikely that CO_2 would migrate vertically for any significant distance.

However, if a transmissive fracture were present in the subsurface ROI, CO_2 could migrate along its path. Horizontal open fractures within the Mt. Simon would cause the CO_2 to migrate farther laterally than the modeling predicts. Vertical open fractures are more likely at depth than horizontal ones, and fractures or faults trending roughly east-west, if present, may be transmissive. Thus, if such fractures are present in the Eau Claire formation within the ROI, they could promote vertical migration of CO_2. In order for the CO_2 to reach shallow potable groundwater or the biosphere, such fractures would need to penetrate and be open through, or connect in networks through, more than 1.1 miles (1.8 kilometers) of various types of rock. It is unlikely that such fractures exist in the project area due to the presence of significant oil reserves (i.e., trapped fluids); however, further site-specific geologic investigations would be necessary to verify this before initiating injection of CO_2. See Section 4.17 for a detailed discussion of CO_2 transport assumptions and potential associated risks.

4.5 PHYSIOGRAPHY AND SOILS

4.5.1 INTRODUCTION

This section addresses the physiography and soils associated with the proposed Mattoon Power Plant and Sequestration Site and related corridors.

4.5.1.1 Region of Influence

The ROI for physiography and soils is defined as a 1-mile (1.6-kilometer) radius around the proposed power plant, sequestration site, reservoir, and utility corridors.

4.5.1.2 Method of Analysis

DOE reviewed reports from the U.S. Department of Agriculture (USDA), information provided in the Mattoon EIV (FG Alliance, 2006a), and other available public data to assess the potential impacts of the proposed FutureGen Project on physiographic and soil resources. DOE assessed the potential for impacts based on the following criteria:

- Potential for permanent and temporary soil removal;
- Potential for soil erosion and compaction;
- Potential for soil contamination due to spills of hazardous materials; and
- Potential to change soil characteristics and composition.

Some uncertainties were identified in relation to soil resources at the proposed Mattoon Site, such as the porosity and permeability of the various soils where the project infrastructure would be located. Uncertainties, based on the absence of site-specific data, are discussed as appropriate in the following analysis. Prime farmland is discussed in Section 4.11.

4.5.2 AFFECTED ENVIRONMENT

4.5.2.1 Physiography

The proposed Mattoon Power Plant and Sequestration Site is located in Coles County and lies entirely within the Bloomington Ridged Plain of the Central Lowland physiographic province of Illinois. Proposed utility and transportation corridors are also located within the Bloomington Ridged Plain. The Bloomington Ridged Plain is part of the Wisconsinan Till Plain that is characterized by a series of end moraines and ground moraines (USDA, 2006).

> **Moraines** are glacial deposits.
>
> **End moraines** are irregular ridges of glacial sediments that form at the margin or edge of the ice sheet.
>
> **Ground moraines** are rolling-to-flat landscapes that form under the ice sheet.

Coles County was covered by glaciers during the Pleistocene age. Most of the present surface materials and landforms are the result of glacial ice and running water, resulting in nearly level and gently sloping, broad uplands. The greatest change in relief is in areas along major drainage ways, where stream erosion has caused 50- to 65-foot (15- to 20-meter) drops in elevation from the adjacent uplands (USDA, 2006). Physiographically, the proposed Mattoon Power Plant and Sequestration Site consists of very gently rolling to flat surfaces with elevations that vary from approximately 718 feet (219 meters) AMSL to 679 feet (207 meters) AMSL, with average slopes of less than 1 percent. This indicates that there is no landslide potential from natural features. All soils in this area will support vegetative cover that diminishes their erosion potential.

4.5.2.2 Soils

The following section describes the different predominant soils at the proposed power plant and sequestration site and utility and transportation corridors. Descriptions of soil type characteristics and uses are provided in Table 4.5-1.

The soils found within the ROI are agricultural, which is indicative of favorable characteristics for growing vegetation. The presence of crops and vegetation on the ground coupled with low slopes makes the potential for erosion low. The clay till type subsoils and substratum soils located on the proposed power plant and sequestration site are suitable for supporting structures. Phase I Environmental Site Assessments (ESAs) (FG Alliance, 2006a) performed for the site indicate that the soils on the proposed site and corridors are not contaminated. The two primary soils at the proposed plant site are Raub silt loam and Drummer silty clay loam. Other soils present include Toronto silt loam, Wingate silt loam, and Pell silty clay loam (FG Alliance, 2006a) (Table 4.5-1). The proposed sequestration site is located on the plant site; therefore, the soils are the same as the ones described for the proposed plant site. The soils located in the area of the proposed utility corridors include Drummer-Flanagan, Raub-Dana, Xenia-Fincastle-Toronto, Miami-Russell, Drummer-Starks-Brooklyn, and Lawson-Landes-Sawmill Associations (Table 4.5-1).

Table 4.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Brooklyn	• Poorly drained with 0 to 25 percent slopes. Where drained, a perched seasonal high water table is within 12 inches (30 centimeters) of the surface at times between January and May in most years. In the undrained condition, the perched seasonal high water table is within 6 inches (15 centimeters) of the surface at times between November and June in most years. These soils are subject to ponding of about 6 inches (15 centimeters) after heavy rains from November through June. The potential for surface runoff is negligible to medium. Permeability is moderately slow or slow.	• Most areas with a drainage outlet are used to grow corn and soybeans. Undrained areas are primarily grass. Native vegetation is grasses and sedges.
Dana	• Very deep, moderately well drained soils formed in loess and other silty materials. Permeability is moderate and slopes range from 0 to 12 percent. A perched water table is present at a depth of 2.0 to 3.5 feet (0.6 to 1.1 meters) at times between February and April. Surface runoff is negligible to medium.	• Used mostly in the growing of corn, soy beans, and other small grains. Some small areas are used for pasture.
Drummer	• Poorly drained soils formed in loess and over loamy stratified outwash sediments on nearly level or depressional outwash plains, stream terraces, and till plains. The slope ranges from 0 to 2 percent and the potential for surface runoff is negligible to low. Permeability is moderate and water ponds occur for brief periods of time in the spring.	• Cropland is the main use.

Table 4.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Fincastle	• Somewhat poorly drained soils formed in loess or other silty material and in underlying dense till on till plains. Permeability is moderate in the upper portion and very slow in the dense underlying till. Slopes range from 0 to 6 percent.	• Native vegetation is hardwood forest and they are mostly cultivated with corn, soybeans, and wheat and clover grass mixtures.
Flanagan	• Somewhat poorly drained soils formed in loess over glacial till on uplands. Slopes range from 0 to 7 percent, potential for runoff is low to high, and permeability is moderately slow.	• Most areas are used for cultivated crops.
Landes	• Well drained with low potential for surface runoff with 0 to 5 percent slopes. Permeability is moderately rapid in the upper and middle soil layers and rapid in the lower. Flooding from stream overflow is common during the late winter and early spring. A moderately wet phase is recognized that has a seasonal high water table at a depth 4 to 6 feet (1.2 to 1.8 meters) at times between March and May in most years.	• Most areas containing these soils are cultivated with corn, soybeans, and small grains as the principal crops. Native vegetation includes both grasses and deciduous trees.
Lawson	• Somewhat poorly drained with a frequently saturated zone that occurs within depths of 1 to 3 feet (0.3 to 0.9 meters) during the wettest periods of normal years and is apparent. Lawson soils are characterized with 0 to 5 percent slopes. The surface runoff potential is negligible to low. Flooding occurs rarely to frequently for very brief to long durations.	• Many areas are used for forage production. Cultivated areas produce good crop yields where excess water is not a problem. Native vegetation consists of scattered silver maple, white ash, American elm tall prairie grasses, and forbs.
Miami	• Moderately well drained with medium potential for surface runoff on the gentle slopes and high on the steeper slopes (0 to 25 percent), which can range up to 60 percent. Permeability is moderate in the upper part of the solum, moderately slow in the lower part of the solum, and slow or very slow in the underlying dense till. An intermittent perched high water table is at a depth of 2.0 to 3.0 feet (0.6 to 0.9 meters) from December to April in normal years.	• Most areas are cultivated. Corn, soybeans, and small grain are the principal crops. Some areas are wooded. Native vegetation is deciduous hardwood forest.
Pell	• Poorly drained soils formed in loamy glacial till on ground moraines. The slopes range from 0 to 2 percent and surface runoff potential is negligible or low. Surface soil, located from 0 to 15 inches (0 to 38 centimeters), is characterized by black, neutral clay loam.	• The main use is cropland.
Raub	• Somewhat poorly drained soils formed in loess in the underlying loamy till on till plains. Slopes range from 0 to 2 percent; potential for surface runoff is low; and permeability is moderate in loess, moderately slow in the till subsoil, and slow or very slow in the dense till substratum.	• The main land use is for cropland.
Russell	• Well drained with low to high potential for surface runoff with 0 to 25 percent slopes. Depth to an intermittent perched high water table is typically 3.5 to 6.0 feet (1.1 to 1.8 meters) from December to April in most years. In some areas, the depth to the seasonal high water table is greater than 6.0 feet (1.8 meters).	• Most of this soil is cultivated. Corn and soybeans are the principal crops. Native vegetation is mixed hardwoods of oak, hickory, and sugar maple.

Table 4.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Sawmill	• Poorly to very poorly drained with moderate permeability and negligible surface runoff with 0 to 3 percent slopes. Where drained, these soils have an apparent seasonal high water table 12 inches (30 centimeters) above the surface to 12 inches (30 centimeters) below the surface at some time between January and May in most years. In undrained conditions, the apparent seasonal high water table is 6 inches (15 centimeters) above the surface to 6 inches (15 centimeters) below the surface at times between November and June in most years. Flooding can occur for brief to long periods between November and June.	• Many areas of Sawmill soils are cultivated with corn, soybeans, and meadow as the principal crops, and grasses and trees as the native vegetation. Undrained areas are mostly used for pasture or woodland.
Starks	• Somewhat poorly drained with 0 to 25 percent slopes. An intermittent apparent seasonal high water table is present at a depth of 6 to 24 inches (15 to 61 centimeters) below the surface at times between January and May in most years. The potential for surface runoff is negligible to low. Permeability is moderate.	• Most areas are cultivated. Corn, soybeans, and small grain are the principal crops. Some areas are wooded. Native vegetation is deciduous hardwood forest.
Toronto	• Somewhat poorly drained soils formed in loess in the underlying calcareous loamy till. Slopes range from 0 to 6 percent, surface runoff potential is low, and permeability is moderate to moderately slow.	• Nearly all soils are used for cropland.
Wingate	• The Wingate series consists of moderately well drained soils formed in loess and underlying loamy till on till plains. Slopes range from 0 to 10 percent, surface runoff potential is low to medium, and permeability ranges from moderately permeable to moderately slowly permeable.	• The main use is cropland and some is used for pasture.
Xenia	• Moderately well-drained soils formed in loess and underlying loamy till. They are deep to very deep soils that have slopes ranging from 0 to 12 percent. Surface runoff ranges from low to high. There is an intermittent perched water table present at a depth of 1.5 to 2.5 feet (0.5 to 0.8 meters) during the winter and spring.	• Mainly for cultivating corn, soybeans, small grains, and hay. Native vegetation includes oak, hickory, and maple forest.

Source: FG Alliance, 2006a and NRCS, 2006.

4.5.3 IMPACTS

4.5.3.1 Construction Impacts

Direct impacts that could be caused during construction of the proposed facility include removal of soil, soil-blowing and erosion due to wind and motion of equipment, soil compaction, and change in soil composition. Soil removal disturbs soil properties such as permeability and horizon structure, and disturbs vegetation. Soil-blowing could cause the movement of soil, making it unstable as well as unsuitable for vegetation growth. Soil compaction could cause changes in soil characteristics such as permeability, water capacity, surface runoff, root penetration, and water capacity. Indirectly, impacts to soils could result in soil erosion due to runoff and wind, potential decline in nearby surface water quality due to increased sedimentation, potential soil contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. The potential for impacts to soils to affect groundwater is low due to the generally moderate to moderately low permeability of the soils, coupled with a water table ranging from 20 to 125 feet (6 to 38 meters) deep (FG Alliance, 2006a). During the winter and early spring, many of the soils have a perched water table within a couple of feet of the surface. If a spill were to occur during this time, the perched water table could be contaminated. However, immediate cleanup of spills and other BMPs (see Section 3.1.5) would be used to minimize the potential for a spill to contaminate groundwater.

Power Plant Site

Construction at the proposed power plant site would impact up to 200 acres (81 hectares) of soil. Soil impacts would result from construction of the proposed power plant, storage areas, associated processing facilities, research facilities, parking areas, access roads, and the on-site railroad loop. During construction, soil would be removed from areas where the foundations of the structures would be sited. This soil would be placed on a temporary storage site protected from erosion and runoff for reuse as topsoil replacement or as fill. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 200-acre (81-hectare) power plant footprint. Soils impacts would be permanent for areas converted into impervious surface areas (e.g., structure, pads, and parking). Temporary soil compaction would occur in areas of temporary road construction and heavy equipment storage. Soil-blowing and localized erosion would be likely during construction from equipment movement. Construction-related impacts to soils in areas not converted to impervious surfaces would be temporary and these areas would be restored after construction is completed.

Chemical spills could potentially affect up to a 200-acre (81-hectare) area of on-site soil. Chemicals commonly used during construction include oils, paints, solvents, lubricants, and cement. The quantities of these chemicals expected on site during construction are small. The use of segregation, storage, labeling, and adequate handling, as well as secondary containment and other spill prevention techniques, could minimize the potential for a spill to occur. Should a spill occur, it would be contained and would not be expected to permanently impact soil characteristics such as pH, porosity, humidity, and texture. Soils present at the proposed site are abundant throughout the region; therefore, overall impacts would not be adverse. The potential for impacts to prime farmland soil is discussed in Section 4.11.

Sequestration Site

The proposed sequestration site is located on the power plant site; therefore, construction of the associated structures would cause no additional direct and indirect impacts due to the removal of soil and general construction activities. After completion of drilling, soil could be replaced using topsoil separation practices while any extra soil could be used as on-site fill or disposed of off site.

Utility Corridors

The direct and indirect impacts due to the construction of the proposed utility corridors would be relatively minor, consisting of the same types of impacts described for the proposed power plant site. It is estimated that any permanent impact would be related only to the actual footprint of any new towers, where a relatively small amount of soil would have to be removed and compacted to set the structure. There could also be some temporary soil compaction during construction from equipment use and storage.

The proposed potable water pipeline corridor would be 1 mile (1.6 kilometers) long and 20 feet (6.1 meters) wide, affecting an area of 2.4 acres (1.0 hectare). The proposed process water pipeline corridor could be up to 14.3 miles (23 kilometers) long [6.2 miles (10 kilometers) to Mattoon WWTP and

8.1 miles (13.0 kilometers) to Charleston WWTP] and 20.0 feet (6.1 meters) wide, which would affect up to 19.6 acres (7.9 hectares) of soil. The sanitary wastewater pipeline corridor would be 1.25 miles (2.0 kilometers) long and the disturbed width would be 20 feet (6 meters), affecting 3.0 acres (1.2 hectares) of soil. The natural gas pipeline corridor would have a length of 0.25 mile (0.4 kilometer) and an expected width of 20 feet (6.1 meters), affecting 0.6 acre (0.3 hectare) of soil. Because the proposed sequestration site would be located on the proposed power plant site, no CO_2 pipeline would need to be built. In total, 25.6 acres (10.4 hectares) of disturbed land could be susceptible to removal, erosion, or compaction of soils due to construction of utility corridors.

Transportation Corridors

The direct and indirect impacts due to the construction of the proposed transportation corridors would be relatively minor, consisting of the same types of impacts described for the proposed power plant site. Roadway improvements, consisting of a length of 1.3 miles (2.1 kilometers) and width of 25 feet (8 meters), or 3.8 acres (1.5 hectares) of total disturbed soil, would include roadway widening, resurfacing, new shoulders, and storm water management structures (FG Alliance, 2006a). The on-site loop track and main track connections for the rail would require 2.0 miles (3.2 kilometers) of track construction in a corridor 50 feet (15 meters) wide (12.1 acres [4.9 hectares] of total disturbed soil) (FG Alliance, 2006a). In total, up to 15.9 acres (6.4 hectares) of disturbed land could be susceptible to removal, erosion, or compaction of soils due construction of transportation corridors.

4.5.3.2 Operational Impacts

Direct impacts that could occur from operations include soil contamination due to leaks and spills, increased CO_2 concentration in soils due to CO_2 injection failures, and soil erosion due to wind and movement of machinery. Indirect impacts could include disruption of plant growth and subsurface organisms, and groundwater contamination. It is expected that the impacts during operations, with the use of BMPs, would remain at a minimum due to the limited extent and current ecological status of the proposed Mattoon Power Plant and Sequestration Site. The potential to affect groundwater is low due to the generally moderate to moderately low permeability of the soils, coupled with a water table ranging from 20 to 125 feet (6 to 38 meters) deep (FG Alliance, 2006a). It is anticipated that any spills would be identified and addressed before reaching groundwater sources. Revegetation of disturbed areas during operations would minimize the potential for erosion.

Power Plant Site

During the operation of the proposed plant and associated facilities, no new soil disturbance or removal would occur beyond what was described for construction. Storage of hazardous materials, ash, and coal piles could cause soil contamination if in direct contact with the soil. Revegetation of disturbed areas during operations would minimize the potential for erosion.

Sequestration Site

During operations at the proposed sequestration site, soil would not be disturbed; therefore, there would be no environmental impacts associated with operations. Potential impacts due to a pipeline, surface equipment, or well failure are to be minimal, because risk abatement and safety procedures would be in place. Though it is highly unlikely, because of the high volatility of CO_2 at atmospheric pressure, an increase of CO_2 concentration in the soil due to leaks can lower pH, which could in turn cause a disruption in plant growth and occurrence of subsurface organisms (Damen et al., 2003) (e.g., microbes occurring approximately 0.9 mile [1.4 kilometers] under ground; see Section 4.9). Some levels of ground subsidence and heave have been known to be caused by petroleum production/injection operations, disposal well operations, and natural gas storage operations. Since the CO_2 injection at the proposed Mattoon Site would be at great depth and into very well consolidated rocks, the risks of ground movement are small. Furthermore, since differential heave occurs most commonly when the underlying strata are tilted, faulted, or discontinuous and the underlying strata at the proposed Mattoon Site are horizontal, un-faulted, and continuous, there is a very low potential for differential settlement. Thus, if a small amount of ground heave occurred, it would likely have a negligible impact on soils.

Utility Corridors

During operations, the soil would not be disturbed around the utility corridors; therefore, there would be no environmental impacts associated with operations or maintenance of vegetation around the utilities during operation. Access within the utility corridors would occur through existing access roads or through access points constructed and maintained for any new corridors.

Transportation Corridors

During operations, there would be no additional impacts to the soil due to transportation corridor use and maintenance. Impacts could potentially include soil contamination due to spills, soil-blowing, soil compaction, and soil removal.

4.6 GROUNDWATER

4.6.1 INTRODUCTION

This section addresses groundwater resources that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Mattoon Power Plant and Sequestration Site and related corridors.

4.6.1.1 Region of Influence

The ROI for groundwater resources includes aquifers that underlie the proposed power plant and sequestration site, and aquifers that may be used to obtain water for construction and operations support. The horizontal extent varies, depending on the particular aspects of the groundwater resource, as follows:

- A distance of 1 mile (1.6 kilometers) from the proposed power plant site defines the general vicinity that could be affected (but to a lesser degree) by changes in groundwater quantity or quality due to the power plant footprint.
- A distance of 1.2 miles (1.9 kilometers) from each sequestration injection well defines the area that could be affected by potential leaks of CO_2 from the target reservoir to overlying aquifers. This distance is based on modeling, which indicates that CO_2 could migrate up to 1.2 miles (1.9 kilometers) from the site of each injection well. The CO_2 injection is proposed to occur on the power plant site.
- The facility footprint (including utility and transportation corridors) defines where construction or other land disturbances could take place. These areas could be susceptible to changes in groundwater infiltration, discharge, or quality. Damage to, or loss of use of, an existing well (including the potential need for well abandonment) could also occur within the facility footprint.

4.6.1.2 Method of Analysis

DOE reviewed reports from state water authorities and information in the Mattoon EIV (FG Alliance, 2006a) to assess the potential impacts of the proposed FutureGen Project on groundwater resources.

Uncertainties identified in relation to groundwater resources at the Mattoon Site include the porosity, brine saturation, and permeability of the target formation where CO_2 would be sequestered. Analog well data were analyzed; however, site-specific test well data were not collected. Uncertainty also exists concerning the presence of transmissive faults or improperly abandoned wells in the area.

DOE assessed the potential for impacts based on the following criteria:

- Depletion of groundwater supplies on a scale that would affect available capacity of a groundwater source for use by existing water rights holders, interference with groundwater recharge, or reductions in discharge rate to existing springs or seeps;
- Relationship to established water rights, allotments, or regulations protecting groundwater for future beneficial uses;
- Potential to contaminate a public water supply aquifer through acidification of the aquifer due to migration of CO_2; toxic metal dissolution and mobilization; displacement of groundwater with brine due to CO_2 injection; and contamination of aquifers due to chemical spills, well drilling, or well completion failures; and
- Conformance with regional or local aquifer management plans or goals of governmental water authorities.

4.6.2 AFFECTED ENVIRONMENT

This section describes groundwater resources in the project area. In general, this description applies to all proposed project areas, although site-specific data are presented where available and applicable.

4.6.2.1 Groundwater Quality and Uses

Public water supplies in Coles County are generally obtained from surface water, with a small amount obtained from groundwater. Groundwater in the county is normally obtained from sand and gravel aquifers that are contained in unconsolidated material above bedrock. The sand and gravel deposits in the vicinity of the proposed power plant site range in depth from about 20 to 125 feet (6 to 38 meters) below the ground surface. There are no indications that groundwater in the vicinity of the proposed plant site is contaminated (FG Alliance, 2006a). No sole source aquifers have been designated in the vicinity of the proposed project area (EPA, 2006a).

Water availability in these sand and gravel deposits is sporadic due to the highly heterogeneous nature (i.e., varying in size and thickness) of the unconsolidated glacial till. Deeper bedrock aquifers are also present in the area, and potable groundwater can be found at depths of up to approximately 175 feet (53.3 meters) (FG Alliance, 2006a).

A search of the Illinois State Water Service's (ISWS) well database was conducted in August 2006 to identify any private, public, industrial, or commercial wells located within approximately 1 mile (1.6 kilometers) of the proposed power plant site. The search identified 34 private wells that are used for domestic and agricultural uses and one well, constructed in 1919, that is classified as industrial/commercial use. There is no evidence supporting the existence of ongoing industrial or commercial activities at the location of the well constructed in 1919, and it is reported that some of the private wells may now be abandoned, but no records documenting proper abandonment are available (FG Alliance, 2006a). Three private wells were identified at the proposed power plant site. The wells were identified as domestic wells and were drilled in 1914, 1920, and 1978 with depths of 45 feet (13.7 meters), 113 feet (34.4 meters), and 79 feet (24.1 meters), respectively, below the ground surface (FG Alliance, 2006a). Depth to the groundwater surface (i.e., water table) was variable, generally ranging from 10 to 50 feet (3 to 15 meters) below the ground surface; although one well was 113 feet (34.4 meters) deep and was reported to have a static water level of 96 feet (29.3 meters) below the ground surface (FG Alliance, 2006a). However, this data point is so anomalous that it may be an error in measurement.

A search of the ISWS Public, Industrial, and Commercial Survey Database did not identify any public, industrial, or commercial wells in the vicinity of the proposed power plant site (FG Alliance, 2006a).

Hardness and chloride concentrations in groundwater are highly variable in Coles County, and high levels of nitrates, hardness, chlorides, and sulfates can occur in localized areas (Bower, 2006). Water obtained from bedrock wells at depths below approximately 175 feet (53.3 meters) is likely to be highly mineralized and too saline (brine) for most uses (FG Alliance, 2006a).

The community of Ashmore, located approximately 20 miles (32 kilometers) east-northeast of Mattoon, is currently served by two municipal groundwater wells screened in the shallow sand and gravel aquifer located outside the city limits. The wells are reported to be about 44 feet (13 meters) deep and each produce 85 gallons (321.8 liters) per minute. The water is reported to be of good quality, although water from one of the wells contains enough manganese and iron to necessitate treatment before public distribution (Bower, 2006).

The City of Lerna, located approximately 2.5 miles (4.0 kilometers) southeast of Mattoon, also uses groundwater, but the available quantity is considered inadequate for demand with an average withdrawal of 18,600 gallons (70,409 liters) per day (Bower, 2006).

No specific data are available regarding the recharge capacity and transmissivity of the sand and gravel deposits located in the vicinity of the proposed power plant site, but personnel from the ISWS estimated that the vicinity of the proposed power plant site might exhibit a recharge capacity equal to or less than approximately 1 inch (2.5 centimeters) per year (FG Alliance, 2006a).

Recharge capacity and transmissivity are numerical factors that estimate the capacity of an aquifer to recharge with new water and transmit water, respectively.

The only transmissivity data for the area is from three public wells located in Cooks Mills, Illinois, and one public well located in Mattoon (FG Alliance, 2006a). Cooks Mills is approximately 5 miles (8.0 kilometers) north of the proposed power plant site; in 1979, transmissivity values were obtained for each well. The transmissivity values of the three wells were 7,920 gallons per day per foot (98,361 liters per day per meter), 13,200 gallons per day per foot (163,935 liters per day per meter), and 12,160 gallons per day per foot (151,019 liters per day per meter) with well depths of 33 feet (10.1 meters), 30 feet (9.1 meters), and 28 feet (8.5 meters), respectively. The public well in Mattoon was located approximately 4 miles (6 kilometers) southeast of the proposed power plant site, and transmissivity was tested in 1939. The transmissivity of the well was 10,000 gallons per day per foot (124,193 liters per day per meter) with a total depth of 56 feet (17.1 meters).

The target formation for CO_2 sequestration is the Mt. Simon formation. In northern Illinois (within about 80 miles [129 kilometers] of the Wisconsin border, and about 230 miles [370 kilometers] north of Mattoon), the Mt. Simon formation is a freshwater aquifer. The surface recharge area of the Mt. Simon formation lies to the north in Wisconsin where the formation outcrops. Near Mattoon, it is a saline formation that lies beneath several hundred feet of caprock (e.g., the Eau Claire shale and siltstone).

The aquifers that lay beneath the injection site would not fit EPA's definition (EPA, 2006b) of an Underground Source of Drinking Water (USDW), which includes any aquifer or part of an aquifer that:

- Supplies any public water system, or contains a sufficient quantity of groundwater to supply a public water system and currently supplies drinking water for human consumption or contains fewer than 10,000 milligrams per liter of total dissolved solids (TDS); and
- Is not an exempted aquifer.

Following EPA's definition above, the shallow aquifers near the sequestration site cannot be classified as USDW because they do not supply any public water system or have the quantity of water to do so. Furthermore, there are no water quality data to support any claim about the concentration of TDS in the water. The deeper aquifers are salty and not suitable for human consumption.

4.6.3 IMPACTS

4.6.3.1 Construction Impacts

Power Plant Site

Construction activities would not be expected to disturb the groundwater resources beneath the plant or other facilities. The three private wells located at the power plant site would be properly abandoned following state and federal requirements, avoiding any potential contamination of the aquifer. While construction of impervious areas would hinder aquifer recharge in the immediate vicinity of the power plant site, this effect would be minimal, as the size of the aquifer recharge area is much larger than the area of impervious surface that would be created. Water for construction activities would be trucked to the site, so groundwater withdrawals would be unnecessary.

There would be no direct on-site discharge of wastewater to the subsurface. Appropriate Spill Prevention, Control, and Countermeasure (SPCC) plans would be employed to minimize the potential for spills of petroleum, oils, lubricants, or other materials used during construction and to ensure that waste materials are properly disposed of. In the event of a spill, it is unlikely that these materials would reach groundwater sources before cleanup (based on an estimated depth to groundwater of 10 to 50 feet [3 to 15 meters]). Section 4.5 provides further details regarding soil properties, including permeability. In general, no impact on groundwater availability or quality would be anticipated due to construction of the proposed power plant.

Sequestration Site

Because the proposed sequestration site is located on the same property as the proposed power plant site, potential construction impacts would be the same as those for the proposed power plant site, although considerably less impervious cover would be associated with CO_2 injection wells and equipment. One injection well and one backup well would be drilled to a depth of between 1.3 and 1.6 miles (2.1 and 2.6 kilometers) to reach the target injection formation, the Mt. Simon formation. Injection well drilling would use a series of conductor casings to protect shallower groundwater.

Utility and Transportation Corridors

Potential construction impacts would be similar to those discussed for construction of the proposed power plant, with the exception that considerably less impervious area would be created in the corridors.

4.6.3.2 Operational Impacts

Power Plant Site

During operation of the power plant, petroleum, oils, lubricants, and other hazardous materials could be spilled onto the ground surface and potentially impact groundwater resources. However, appropriate SPCC plans would be employed to minimize the potential for such materials used during operation to be released to the surface or subsurface and to ensure that waste materials are properly disposed of. Section 4.5 provides further detail regarding soil properties, including permeability. Since groundwater would not be used as a source for process water, the proposed project would not impact groundwater levels or availability for other uses. Severe drought conditions are regional events that could affect the overall water supply for users in the area, but, since these events are foreseeable, their impact would be minimized through planning.

Sequestration Site

The potential impacts associated with CO_2 sequestration in geologic formations are largely associated with the possibility of leakage. The potential for leaks to occur would depend upon caprock integrity and the reliability of well capping methods and, in the longer term, the degree to which the CO_2 eventually dissolves in formation waters or reacts with formation minerals to form carbonates. The mechanisms that could allow leakage of the injected CO_2 into shallower aquifers are:

- CO_2 exceeds capillary pressure and passes through the caprock;

- CO_2 leaks into the upper aquifer via a transmissive fault;
- CO_2 escapes through a fracture or more permeable zone in the caprock into a shallower aquifer;
- Injected CO_2 migrates up dip, and increases reservoir pressure and permeability of an existing fault; or
- CO_2 escapes via improperly abandoned or unknown wells.

CO_2 would be injected into the Mt. Simon formation at a depth of 1.3 and 1.6 miles (2.1 and 2.6 kilometers) below the ground surface. Subsequently, it would mix with the saline groundwater in the formation. Because CO_2 is less dense than the surrounding groundwater, its buoyancy would cause it to move vertically into lower pressure zones until it reached less permeable strata that would act as a seal (e.g., caprock layer). Over time, the CO_2 would dissolve in the formation water and begin to move laterally with the groundwater flow, unless it found a more permeable conduit, such as a transmissive fault or an improperly abandoned well.

However, vertical migration of CO_2 to near-surface freshwater aquifers would be highly unlikely due to:

- The depth of the injection zone in the Mt. Simon formation;
- The substantial primary seal provided by the Eau Claire shale (500 to 700 feet [152.4 to 213.4 meters] thick);
- The presence of at least two secondary seals; and
- A total of over 1.1 miles (1.8 kilometers) of various strata (much of it being fine grained) between the injection zone and any potable water aquifers in the project area.

Each series of less permeable and more permeable sedimentary layers within the 1.1 miles (1.8 kilometers) between the top of the Mt. Simon formation and the deepest potable aquifers in the project area would be a barrier to upward migration of CO_2. Pressure would force the CO_2 through each layer with lower permeability and then be dissipated due to lateral flow of CO_2 in each layer with higher permeability. There are hundreds of these series and, as a result, extensive vertical movement to potable aquifers would not be likely.

Based on data from the nearest deep well with a geologic log (about 35 miles [56 kilometers] away), significant fractures are not identified or suspected. If any fractures are present, due to the compressive stress within the formation, only vertical fractures are likely to be transmissive and they would have to penetrate and be open through 1.1 miles (1.8 kilometers) of various types of rock to allow CO_2 migration to shallow potable water aquifers. A recent 2D seismic survey line shows relatively flat, parallel reflectors in the Eau Claire/Mt. Simon interval below the "Base of Knox" horizon and above the Precambrian. This suggests a lack of major north-south trending vertical faults at the proposed Mattoon Sequestration Site (Patrick Engineering, 2006). DOE considers it unlikely that such fractures exist in the project area.

Reservoir modeling indicates that the largest plume radius would be approximately 1.2 miles (1.9 kilometers) over 50 years of injection at a rate of 1.1 million tons (1 MMT) per year. CO_2 movement would be expected to be primarily horizontal, with very little upward migration out of the injection zone due to trapping beneath the caprock seal provided by the Eau Claire shale and siltstone. Brine in the Mt. Simon formation would be displaced horizontally (and vertically) for an unknown lateral distance. However, given that the areas where the Mt. Simon formation contains potable water are about 200 miles (322 kilometers) from the injection ROI, and the brine groundwater in the Mt. Simon likely moves at no more than a few centimeters per year, it is very unlikely that the potable parts of this aquifer would be affected.

In addition to displacing brine, CO_2 would also dissolve into the brine over time. In formations like the Mt. Simon with slowly flowing water, reservoir-scale modeling for similar projects shows that, over tens of years, up to 30 percent of the CO_2 would dissolve (IPCC, 2005). Once CO_2 dissolves in the brine groundwater, it could be transported out of the injection site by regional scale circulation or upward migration, but the time scales of such transport are millions of years and are thus not considered an impact for this assessment (IPCC, 2005).

Reactions between the CO_2 and brine would produce carbonic acid, a weak acid that would react with the Mt. Simon formation. This formation is quartz-rich and reacts with minerals very slowly, taking hundreds to thousands of years (IPCC, 2005). Toxic metal displacement and dissolution could be a concern in those areas where injected CO_2 reacts with brine if anomalous concentrations of heavy metals were in the pathway of the brine. These dissolved metals could travel over time and be assimilated by groundwater, causing an incremental increase in the concentration of heavy metals in the water. However, in the ROI, there are no known anomalous concentrations of metals that could pose a risk to the aquifer.

Acidification of the aquifer due to dissolution of CO_2 into water would slightly lower the pH of the groundwater. At the Mattoon Site, acidification of shallower groundwater sources would be very unlikely due to the hundreds of feet of separation between the injection target formation and these aquifers as well as the limited pathways for CO_2 to travel upward and mix with groundwater. Similarly, it would be unlikely that CO_2 injection would contaminate overlying aquifers by displacing brine, because this would require pathways, such as faults or deep wells that penetrate the primary seal. Such faults are not believed to exist at the proposed site.

Any eventual CO_2 and brine contamination of any of the small, surficial groundwater reservoirs in the Mattoon region would be limited to individual cases because this resource is of limited extent in the area, and not used for any public water system.

However, monitoring methods could help detect CO_2 leaks before they migrate into an aquifer and mitigation measures could minimize such impacts should they occur (see Section 3.4).

Utility Corridors

The above discussion for the power plant site also applies to the proposed utility corridors, but to a lesser extent as hazardous materials would not be expected to be on site in the utility corridors unless maintenance activities were occurring.

Transportation Corridors

Traffic accidents could result in hazardous materials spills. The spill response measures discussed for the proposed power plant site would be executed to ensure rapid control and cleanup of any hazardous material spill from a traffic accident.

4.7 SURFACE WATER

4.7.1 INTRODUCTION

Surface water is an important resource in Illinois from which communities receive much of their drinking water. Ready access to an abundant supply of water is an important consideration in siting power plants, because water is necessary for steam generation and process water. Drinking water would also be required for the employees at the proposed power plant and sanitary wastewater would be generated by restrooms, sinks, and shower facilities. The proposed FutureGen Power Plant would not discharge any industrial wastewater, as all process wastewater would be treated by the zero liquid discharge (ZLD) system and recycled back to the power plant. The following analysis examined short-term impacts from construction and long-term impacts from operations to surface water resources from the proposed FutureGen Project.

4.7.1.1 Region of Influence

The ROI consists of the proposed power plant and sequestration site, areas within 1 mile (1.6 kilometers) of all related areas of new construction, and any surface water body above the sequestration reservoir. At the Mattoon Site, the sequestration site is also located on the power plant property.

The ROI for surface water resources is limited in most cases to the proposed power plant and sequestration site and related corridors. Because of the types of land disturbing activities that would occur during construction of the proposed power plant, injection wells, and supporting utilities and infrastructure, the disturbed areas would be susceptible to erosion and changes in surface water flow patterns. The areas could also be affected by spills associated with construction or operations.

The ROI for surface water extends beyond the proposed construction sites. Construction and operation activities would affect a larger area in cases where flow patterns were modified or contamination was carried downstream by surface water drainages.

4.7.1.2 Method of Analysis

DOE reviewed available public data, research, and studies compiled in the Mattoon EIV (FG Alliance, 2006a) to characterize the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Alter stormwater discharges, which could adversely affect drainage patterns, flooding, erosion, and sedimentation;
- Alter infiltration rates, which could affect (substantially increase or decrease) the volume of surface water that flows downstream;
- Conflict with applicable stormwater management plans or ordinances;
- Contaminate public water supplies and other surface waters exceeding water quality criteria or standards established in accordance with the Clean Water Act (CWA), state regulations, or permits;
- Conflict with regional water quality management plans or goals;
- Affect capacity of available surface water resources;

- Conflict with established water rights or regulations protecting surface water resources for future beneficial uses;
- Alter a floodway or floodplain or otherwise impede or redirect flows such that human health, the environment or personal property is affected; or
- Conflict with applicable flood management plans or ordinances.

DOE reviewed reports from the U.S. Geological Survey (USGS), U.S. EPA, and IEPA, and reviewed information provided in the Mattoon EIV (FG Alliance, 2006a) to assess the potential impacts of the proposed FutureGen Project on surface water resources. Surface water data analysis was limited to locations that have the potential for permanent impacts (i.e., power plant and sequestration site). Site-specific surface water data for these areas were not collected. Data were evaluated from area discharge points and sample locations monitored by the agencies previously mentioned. Best professional judgment was applied to determine the likelihood of surface water impairments in the area. Uncertainties and unavailable data are discussed as appropriate in the following analysis.

To avoid or limit adverse impacts, emphasis is placed on adhering to applicable laws, regulations, policies, standards, directives, and BMPs. Most importantly, careful pre-planning of construction and operational activities would allow potential impacts to be minimized before they occur.

4.7.2 AFFECTED ENVIRONMENT

The proposed power plant and sequestration site consists of 444 acres (180 hectares) and is located approximately 1 mile (1.6 kilometers) northwest from the community of Mattoon. Figure 4.7-1 shows the proposed power plant and sequestration site, proposed utility corridors, and surface water resources in the area. Average annual precipitation in Mattoon totals 40 inches (102 centimeters) and local storms have been known to produce flash floods and torrential rainfall, resulting in decreased infiltration and increased surface water runoff (ISWS, 2002; NOAA, 2005). Severe thunderstorms occur infrequently, are of short duration, and cause damage in narrow belts or localized areas (City of Mattoon and IEPA, 2006).

As noted in Section 4.5, the soils in Coles County are of the Saybrook-Dana-Drummer soil association. This soil association is moderately to well drained; with low to medium surface runoff and 0 to 20 percent slopes (ISWS, 2004). The primary soils at the site are the Raub silt loam and Drummer silty clay loam. These soils cover the majority of the site. Other soils present include the Toronto silt loam, Wingate silt loam, and Pell silty clay loam (FG Alliance, 2006a). Soils are discussed in further detail in Section 4.5, but are mentioned briefly here to facilitate the discussion of surface water runoff.

Power Plant and Sequestration Site

The proposed Mattoon Power Plant and Sequestration Site is located in the southernmost portion of the Upper Kaskaskia watershed, but the ROI extends south into the Little Wabash watershed (see Section 4.8). The Kaskaskia/Little Wabash watershed divide serves as the watershed divide between the Upper Mississippi River and Ohio River basins (see Figure 4.7-1 for watershed divides). Within the ROI, the majority of the surface water runoff ultimately drains to the Kaskaskia River and Lake Shelbyville via Whitley Creek and associated drainage channels (FG Alliance, 2006a). Lake Shelbyville is located about 8 miles (12.9 kilometers) west of the site. A small part of the surface water runoff within the ROI (within the southeast portion of the 1 mile [1.6 kilometer] ROI) flows into the Little Wabash River via overland flow, roadside ditches and unnamed tributaries. There are currently no surface water reservoirs, lakes, or ponds within the ROI (FG Alliance, 2006a). The nearest lake is Lake Paradise, which is approximately 4 miles (6.4 kilometers) to the south of the proposed plant and sequestration site. Lake Mattoon is about 7 miles (11.2 kilometers) south of the proposed site.

Utility Corridors

The proposed water supply line corridor is located within the Embarras River watershed. Surface runoff within the ROI for the pipeline flows into the Embarras River via Cassell Creek, Riley Creek, and their tributaries. The proposed pipeline would cross five surface water bodies: Cassell Creek, Riley Creek, and three tributaries to Riley Creek. There is one pond within the ROI for the pipeline, located near the crossing of the proposed pipeline corridor with Interstate 57 (see Figure 4.7-1). Riley Creek is designated to be used for aquatic life purposes and is impaired for pH and total nitrogen (Table 4.7-1) (IEPA, 2006). Cassell Creek is not listed as impaired (IEPA, 2006).

The 138-kilovolt (kV) transmission corridors are located within the Kaskaskia River watershed and the Little Wabash River watershed. Surface waters within the ROI include Lake Mattoon and Lake Paradise, the Little Wabash River, Whitley Creek and tributaries, and roadside ditches.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected surface waters. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

4.7.2.1 Surface Water Quality

There are limited water quality and quantity monitoring data for surface waters within the ROI because many of the surface waterbodies have intermittent flows. Surface water quality and quantity data are not collected on the roadside ditches and unnamed tributaries within the ROI. Whitley Creek, the nearest surface water to the proposed plant and sequestration site, has been assessed by the IEPA and has been determined to meet its designated use (e.g., not impaired) for aquatic life propagation. Insufficient data are available to determine if Whitley Creek meets other designated uses, including fish consumption, primary and secondary, and aesthetic quality (IEPA, 2006).

Surface waters near the proposed Mattoon Power Plant and Sequestration Site that are on the IEPA's list of impaired waters are presented in Table 4.7-1 (IEPA, 2006). IEPA assigns a category (Cat.) for each water body, based on the level of support for each designated use and the causes of impairment. Applicable categories listed in Table 4.7-1 are defined as follows (IEPA, 2006):

- Category 2. Attaining some of the designated uses; no use is threatened; and insufficient or no data and information is available to determine if the remaining uses are attained or threatened.
- Category 4C. Impaired or threatened for one or more designated uses but does not require the development of a total maximum daily load (TMDL); impairment is not caused by a pollutant.
- Category 5. The water quality standard is not attained.

4.7.2.2 Process Water Supply and Quality

The proposed process water sources to support the operations of the proposed power plant are the combined effluents from the Mattoon WWTP and possibly the addition of the Charleston WWTP. Based on effluent data collected from January 1, 2004 through December 31, 2005, the WWTPs have average effluent flows of 4.4 million gallons per day (MGD) (16.7 million liters per day [MLD]) for Mattoon, and 2.6 MGD (9.8 MLD) for Charleston (FG Alliance, 2006a). The proposed power plant requires 3,000 gallons per minute (11,356 liters per minute) or 4.3 MGD (16.4 MLD). To supplement the facility needs during periods of low-flow from the combined wastewater effluents, the proposed facility plans could include an on-site 7-acre (2.8-hectare), 25 million-gallon (95 million-liter) surface water storage reservoir to store excess combined wastewater effluent and stormwater runoff from the proposed power plant site. Depending on future design studies, the reservoir may or may not require lining. If effluent from the Mattoon WWTP is the only source of process water, then a reservoir with a capacity of 200 million gallons (757 million liters) would be required. This could be accomplished with a reservoir at least 40 acres (16.2 hectares) in size.

In 2000, IEPA commissioned a diagnostic-feasibility study of Lake Mattoon, including Lake Paradise, to evaluate the suitability of Lake Mattoon as a drinking water source (City of Mattoon and IEPA, 2001). Lake Paradise and Lake Mattoon provide public drinking water supply for the residents of Mattoon, Humboldt, Negoa, and for Lake Land College. The main inflow tributary is the Little Wabash River. Areas of concern identified in this study were siltation and nutrient loading, attributed to agricultural and residential practices in the watershed, residential development along a large portion of the shoreline, and the presence of rough fish.

Monitoring data are available for the effluents of the Mattoon and Charleston WWTPs for the years 2006 and 1996, respectively. Monitoring data are also available from U.S. EPA's STORET Web Interface for the Kaskaskia River near Cooks Mill, Illinois. Table 4.7-2 summarizes water quality data available for the effluents, which are the proposed process water sources (FG Alliance, 2006a; FG Alliance, 2007; USGS, 2006). Process water sources would likely require pre-treatment to meet the design values for the proposed power plant.

Table 4.7-2. Water Quality Data Summary

Constituent	Formula	Units	Design Value	Mattoon WWTP Sept. 2006	E[1]Charleston Aug. 1996	Kaskaskia River at Cooks Mills, USGS Gage 05591200[2]
Calcium	Ca	mg/L	75	43	34	70
Magnesium	Mg	mg/L	16	16	17	31
Potassium	K	mg/L	3	17	9.5	2
Sodium	Na	mg/L	20	71	52	22
Bicarbonates	HCO_3	mg/L	240	53	-	238
Chlorides	Cl	mg/L	25	-	-	34
Silica	SiO_2	mg/L	4	6.8	-	-
Sulfates	SO_4	mg/L	58	67	-	52
Nitrate	NO_3	mg/L	7	26	-	-

Table 4.7-2. Water Quality Data Summary

Constituent	Formula	Units	Design Value	Mattoon WWTP Sept. 2006	E[1]Charleston Aug. 1996	Kaskaskia River at Cooks Mills, USGS Gage 05591200[2]
TDS	TDS	mg/L	460	530	362	211
TOC	TOC	mg/L	3	7.7	7.3	5
Temperature	-	°F	60	-	73.2	57
pH	pH	-	8.0	-	7.1	7.4

[1] Sampling point within stream at discharge of effluent into Cassell Creek.
[2] Values shown are averages for period of record; Period of Record 01-01-1990 to 09-30-2006.
mg/L = milligrams per liter; °F = degrees Fahrenheit.
Sources: FG Alliance, 2006a; FG Alliance, 2007; and USGS, 2006.

Average and Low-Flow Volumes

The total combined effluent from the Mattoon and Charleston WWTPs has an average daily flow of 7 MGD (26.5 MLD) from January 2004 through December 2005 (Patrick Engineering, 2006a). Table 4.7-3 provides the effluent flow data for the two proposed sources for the calendar years 2004 and 2005. During this period, there were a total of 179 non-consecutive days when the combined daily effluent was less than 4.3 MGD (16.3 MLD).

The receiving streams for effluent discharges from the Mattoon and Charleston WWTPs are Kickapoo Creek and Cassell Creek, respectively. Hydrologically based design flow methods have been developed to answer questions relating to water quality and stream flows. Most states currently recognize hydrologically based design flow methods. The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years. The 7Q10 flow measurement above the Mattoon WWTP discharge point on Kickapoo Creek is 0.15 cubic feet per second (96,947 gallons per day [366,985 liters per day]) (Patrick Engineering, 2006b). The 7Q10 flow measurement above the Charleston WWTP discharge point on Cassell Creek is 0.0 cubic feet per second (0.0 gallons per day [0.0 liters per day]) (Patrick Engineering, 2006b). As noted above, a 7-acre (2.8-hectare), 25-million-gallon (95-million-liter) surface water storage reservoir is proposed to supplement the operational process water requirements during low-flow conditions. The proposed water storage reservoir would be constructed on the proposed power plant site.

Table 4.7-3. Effluent Flow Data from the Mattoon and Charleston WWTPs

	Mattoon WWTP						Charleston WWTP					
	Maximum		Minimum		Average		Maximum		Minimum		Average	
	MGD	MLD	MGD	MLD	MGD	MLD	MGD	MLD	MGD	MLD	MGD	MLD
2004	10.74	40.65	0.80	30.28	4.90	18.55	8.59	32.52	0.33	1.25	3.08	11.66
2005	10.70	40.50	1.30	49.21	3.91	14.80	5.19	19.65	0.41	1.55	2.22	8.40

MGD = million gallons per day; MLD = million liters per day.
Source: FG Alliance, 2006a.

4.7.3 IMPACTS

4.7.3.1 Construction Impacts

Water would be required during construction for dust suppression and equipment washdown and would most likely be trucked to the site; no water would be withdrawn from surface waters. BMPs would be used to contain water used for dust suppression and equipment washdown, minimizing the impacts to surface waters to the extent practicable. This activity would be addressed in a NPDES Permit. Proposed grades in paved areas and for building first floor elevations would be as close to existing grade as feasible to minimize side slopes, limiting potential erosion. All temporarily disturbed areas would be seeded to re-establish vegetative cover after construction.

Because there would be over 1 acre (0.4 hectare) of disturbance, the construction contractor would need to apply for a general NPDES Permit No. ILR10 from the IEPA, which requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP). The general NPDES permit includes erosion control and pollution prevention requirements and refers to the IEPA Urban Manual for specific construction standards, material specifications, planning principles, and procedures. The plans are required to include site-specific BMPs. Operating stormwater pollution prevention restrictions and BMPs would be dictated by the NPDES permit.

A **Storm Water Pollution Prevention Plan** consists of a series of phases and activities to characterize the site and then select and carry out actions to prevent pollution of surface water drainages.

Impacts due to construction activities would likely include erosion due to equipment moving, surfacing and leveling activities, and alteration of surface structures resulting in effects to local hydrology. In addition, Section 404 of the CWA (hereafter referred to as Section 404) requires permits for jurisdictional waterbody (wetland) crossings, which would be implemented before construction. Section 404 permits require the use of BMPs during and after construction and often times include mitigation measures for unavoidable impacts.

Power Plant and Sequestration Site

There are currently no surface water reservoirs, lakes, or ponds within the ROI for the proposed power plant and sequestration site (FG Alliance, 2006a). The only surface water resource located within the ROI is Whitley Creek, and no process or potable water would be drawn from the creek. Once constructed, increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation. Area soils have low to moderate surface water runoff due to soil permeability and slopes (ISWS, 2004). Implementation of BMPs to address, mitigate, and control stormwater runoff would minimize to the extent practicable any potential impacts to downstream surface water resources such as Whitley Creek, the Kaskaskia River, and the Little Wabash River.

Utility Corridors

Pipelines

The proposed corridors for the process water supply lines would run from the Charleston and Mattoon WWTPs to the proposed site. The proposed effluent line from the Charleston WWTP to the Mattoon WWTP would parallel a current bike path and former railway line. The proposed corridor is located within the Embarras River watershed. Surface runoff within the ROI for the pipeline flows into the Embarras River via Cassell Creek, Riley Creek, and their tributaries. The proposed pipeline would cross five surface water bodies: Cassell Creek, Riley Creek, and three tributaries to Riley Creek. There is one pond within the ROI for the pipeline, located near the crossing of the proposed pipeline corridor with Interstate 57 (see Figure 4.7-1). Riley Creek is designated to be used for aquatic life purposes and is impaired for pH and total Nitrogen (Table 4.7-1) (IEPA, 2006). Cassell Creek is not listed as impaired (IEPA, 2006).

Temporary impacts to surface waters from the construction of the process water pipeline and other underground utility lines using trenching methods could include stream diversion/piping flows around the crossing, increased turbidity and sedimentation during construction, streambed disturbance, and removal of streambank vegetation. Directional drilling under surface waters would avoid these impacts. Construction conducted near surface water resources could indirectly create sedimentation from runoff and could increase water turbidity as a temporary impact. BMPs that could be required under Section 404 of the CWA permitting would be implemented both during and after construction. The BMPs would help reduce temporary impacts by controlling sedimentation and turbidity, restoring stream crossings to their original grade, and stabilizing streambanks after construction.

The construction of new pipelines along the utility corridors would require hydrostatic testing of the lines to certify the material integrity of the pipeline before use. These tests consist of pressurizing the pipelines with water and checking for pressure losses due to pipeline leakage. Hydrostatic testing would be performed in accordance with U.S. Department of Transportation (DOT) pipeline safety regulations. Withdrawal of hydrostatic test water could temporarily affect downstream users and aquatic organisms (primarily fish) if the diversion constitutes a large percentage of the source's total flow or volume. Potential impacts include temporary disruption of surface water supplies, temporary loss of habitat for aquatic species, increased water temperatures, depletion of dissolved oxygen levels, and temporary disruption of spawning, depending on the time of withdrawal and current downstream users. These impacts could be minimized by obtaining hydrostatic test water from bodies of water with sufficient flow or volume to supply required test volumes without significantly affecting downstream flow.

Although no source has been specified, the water for the hydrostatic test could be provided by the intake on the Upper Kaskaskia River or by the City of Mattoon public water supply. Both of these sources would likely have sufficient capacity to enable these tests. The amount of water required to complete these tests on all newly constructed pipelines is unknown until preliminary designs for the proposed power plant and utilities have been completed to scale the appropriate size pipe.

Water used for hydrostatic testing is required to be pumped to a lined on-site pit or leak free above ground container. No hydrostatic testing or well testing water may be discharged to the surface (62 IAC 240.530). No chemical additives would be introduced to the water used to hydrostatically test the new pipeline, and no chemicals would be used to dry the pipeline after the hydrostatic testing. Hydrostatic testing would be conducted in accordance with applicable permits.

Power Transmission Corridor

An existing 138-kV transmission line lies 0.5 mile (0.8 kilometer) east of the proposed power plant site. If this existing line were used, a new corridor would run 0.5 mile (0.8 kilometer) east of the site to the existing line. This corridor is located within the Kaskaskia River watershed, near the Kaskaskia/Little Wabash watershed divide. Other than roadside ditches, there are no surface water bodies along this corridor. Surface water runoff along this corridor would drain to the Kaskaskia River via overland flow, existing roadside ditches, unnamed tributaries to Whitley Creek, and into Whitley Creek itself.

If a 345-kV transmission line is required, its proposed corridor would run south of the site to the Neoga substation. The proposed corridor is located within the Little Wabash River watershed and parallels an existing 138-kV transmission line (Figure 4.7-1). Surface runoff along the corridor would drain to the Little Wabash River via overland flow, unnamed tributaries, and Lake Mattoon and Lake Paradise. The proposed transmission line would cross several unnamed tributaries, Lake Mattoon, and the Little Wabash River itself. The Little Wabash River is designated to be used for aquatic life, primary contact recreation, and public water supply purposes (IEPA, 2006). Lake Mattoon is designated to be used for its aesthetic resources, while Lake Paradise is designated to be used for its aesthetic resources and aquatic life (IEPA, 2006). Both these water bodies are currently impaired (see Table 4.7-1).

Transportation Corridors

No new transportation corridors are proposed; however, only upgrades to existing roads and new transportation spurs within the proposed power plant footprint could occur. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

4.7.3.2 Operational Impacts

Potential operational impacts would consist largely of surface water runoff from the proposed power plant site and potential spills (i.e., fuel, chemicals, grease, etc.). Potentially, the site could discharge sanitary sewer waste. The method of on-site waste systems has not been determined (see discussion in Section 4.15). Appropriate permits would be secured before any discharges. Discharge frequency, quantity, and quality would be subject to permit requirements. Mitigation of runoff, recycling of materials, and pollution prevention measures would reduce or eliminate the potential for operational impacts to surface waters. A pollution prevention program would be implemented to reduce site spills (i.e., fuel, paint, chemicals, etc.). Adherence to applicable laws, regulations, policies, standards, directives, and BMPs would avoid or limit any potential adverse operational impacts to surface waters.

Stormwater runoff from the proposed power plant and sequestration site would be expected to have minimal impact on surface water resources. Stormwater could be collected and recycled into the process water to support the operations of the proposed power plant. The following discussion details the impacts specific to the location of operations.

Power Plant and Sequestration Site

The nearest major surface water bodies to the proposed power plant and sequestration site are Lake Paradise and the Upper Kaskaskia River. Lake Paradise is 4 miles (6.4 kilometers) south of the proposed plant site in the Little Wabash watershed. The Upper Kaskaskia River is located 4 miles (6.4 kilometers) north of the proposed plant site in the Upper Kaskaskia River watershed. During heavy rains, this river can overflow and cause localized flash floods. The NOAA database shows that, between 1999 and 2006, 18 floods have occurred in Coles County. Seven of these floods were county-wide and seven were mainly in the Mattoon region, only one of which caused significant damage primarily in the Mattoon region. The nearby presence of the Kaskaskia River and the relative flat topography of the region contribute to potential flood conditions in the region (FG Alliance, 2006a). As noted in Section 4.8.2.2, the proposed power plant site and sequestration areas are not in the 100-year or 500-year floodplains.

The State of Illinois operates under a common law water rights system. There are no allocated water rights associated with this project. The proposed power plant would use 3,000 gallons per minute (11,356 liters per minute) or 4.3 MGD (16.4 MLD) of process water during normal operations. Process water would be supplied by the effluent from the Mattoon WWTP and possibly the Charleston WWTP, and the on-site ZLD system. Based on effluent data collected from January 1, 2004 through December 31, 2005, the WWTPs have average effluent flows of 4.4 MGD (16.7 MLD) for Mattoon, and 2.6 MGD (9.8 MLD) for Charleston (FG Alliance, 2006a). The average combined effluent of the WWTPs is 7.0 MGD (26.5 MLD).

An analysis of monthly effluent data from these two plants indicated that there were 179 nonconsecutive days over 24 months (2004 and 2005) where the combined daily effluent amount was below 4.3 MGD (16.3 MLD) (FG Alliance 2006a). Supplemental water could be available from the City of Mattoon to augment effluent flows below 4.3 MGD (16.3 MLD). In addition, treated water (including water from any pretreatment) from the power plant could also be used to supplement periods of lower flows. The establishment of an on-site storage reservoir would reduce the need to augment operational flows with water from the City of Mattoon.

Use of treated effluent for process water supply would reduce the amount of wastewater discharged by both WWTPs to area surface water bodies. The estimations of flow apportionment to each WWTP have yet to be determined. This could have a positive impact by reducing water quality impairments, such as temperature and nitrogen. Recognized hydrologically-based design flow methods, such as the 7Q10 flow, are used to estimate stream flows. The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years. The 7Q10 flow measurement above the Mattoon WWTP discharge point on Kickapoo Creek is 0.15 cubic feet per second (96,947 gallons per day [366,985 liters per day]), indicating sufficient upstream water to maintain stream flow even in dry conditions (Patrick Engineering, 2006b). The 7Q10 flow measurement above the Charleston WWTP discharge points on Cassell Creek is 0 cubic feet per second (0 gallons per day [0 liters per day]), indicating the possibility of intermittent flow in dry conditions (Patrick Engineering, 2006b). However, only a small portion of the Charleston WWTP discharge is proposed to be diverted to the proposed power plant for process water. The Mattoon WWTP would likely supply the bulk of the required processed water, with the Charleston WWTP supplying backup process water in times of shortfall. It is unlikely that the entire effluent flow from either WWTP would be diverted.

The Charleston WWTP discharge into Cassell Creek is 0.6 mile (1.0 kilometer) upstream from the confluence of Cassell Creek with the larger Riley Creek (Patrick Engineering, 2006b). The majority of Cassell Creek (7.5 miles [12.1 kilometers]) is upstream of the outfall and the diversion of a portion of the effluent would have minimal impact on Cassell Creek, and even less impact on Riley and Kickapoo Creeks (Patrick Engineering, 2006b). Although the diversion of effluent from Cassell and Kickapoo Creeks would result in lower flow conditions in these water bodies, diverting the effluent discharge would return these creeks to more natural flows and conditions.

The City of Mattoon receives its water supply from Lake Paradise and Lake Mattoon, which are located in the Little Wabash River Basin. The Mattoon WWTP discharges into Kickapoo Creek, which is part of the Embarras River Basin. Use of the WWTP effluent by the proposed power plant would minimize the amount of water that is transferred from the Little Wabash to the Embarras River Basin (Patrick Engineering, 2006b). Sufficient water resources exist to sustain operations of the proposed power plant; therefore, no effects to downstream users are anticipated as a result of operations of the proposed power plant.

During operations, slag and coal piles would be stored on site. Although, the actual configuration has yet to be determined, for the purposes of this analysis, it is presumed that these storage areas would be stored in open air, lined areas. Implementation of BMPs and a stormwater management system would capture the runoff from the coal piles, and direct it to the ZLD system for on-site treatment. Further mitigation could include covering the slag and coal pile areas to prevent contact with precipitation and eliminate stormwater runoff. Minimal effects to downstream surface water resources would be anticipated because the proposed power plant would be a zero emissions facility.

Increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation. Runoff from the site due to industrial activities would require implementing a stormwater management program to reduce or eliminate any potential surface water quality impacts. The general NPDES permit would include erosion control and pollution prevention requirements. Operating stormwater pollution prevention restrictions and BMPs would be dictated by the NPDES permit.

The proposed sequestration reservoir is located below the proposed power plant and sequestration site. A short pipeline (0.5 mile or less) would connect the plant to the primary and back-up injection wells. Overland tributaries and intermittent flows from the proposed site flow into Whitley Creek in the Kaskaskia River watershed. Whitley Creek to the north, in the Upper Kaskaskia River watershed, and Little Wabash River to the south, in the Little Wabash Watershed, cross the projected sequestration plume.

In surface waters lacking buffering capacity, such as freshwater and stably stratified waterbodies, the pH could be significantly altered by increases in CO_2 (Benson et al., 2002). The persistence and amount of CO_2 being leaked are primary factors which determine the severity of the impacts from increased CO_2 in the soil and surface water (Damen et al., 2003). The risk of a CO_2 leak from the sequestration reservoir is dependent upon the reservoir and other site specific variables, such as the integrity of the well and cap rock and the CO_2 trapping mechanism (Reichle et al., 1999). CO_2 sequestration is maintained via a sealed caprock, which can be compromised via, rapid release of CO_2 through natural events or unplugged wells, or slow leaks of CO_2 through rock fractures and fissures. These are influenced by the characteristics (e.g., porosity) of the caprock material. As discussed in Section 4.4, the potential for CO_2 leakage from the proposed Mattoon Sequestration Reservoir is small, but it could occur. A risk analysis was completed to assess the likelihood of such failures occurring, as discussed in Section 4.17 (Tetra Tech, 2007).

Although the risk of a CO_2 leak is minimal, a CO_2 leak from the pipeline transporting the CO_2 to the injection site can increase concentration of CO_2 in the soil, which would lower the pH and negatively affect the mineral resources in the affected soil (Holloway, 1996). This, in turn would lower the pH of the surface waters in the affected area, potentially resulting in calcium dissolution and altering the concentration of trace elements in the surface water (Damen et al., 2003; Benson et al., 2002; Holloway, 1996). Seepage of sequestered gases from the reservoir would not impact surface water because the solubility of the CO_2 in the gases in water would keep the concentration of CO_2 less than 0.2 percent (Tetra Tech, 2007).

The persistence and amount of CO_2 being leaked are primary factors that determine the severity of the impacts from increased CO_2 in the soil and surface water (Damen et al., 2003). In the unlikely event of a major CO_2 pipeline rupture above a waterbody, the extent of impact would be limited to a minimal and localized decrease in pH of the affected waterbody. A monitoring program would be implemented to detect CO_2 leaks, should they occur. Mitigating actions would be implemented immediately to reduce the likelihood of adverse impacts to surface water bodies.

Utility Corridors

Normal operations of the power transmission corridors and pipelines for the proposed site would not affect surface water resources. Occasional maintenance may require access to buried portions of the utilities; however, BMPs would be used to avoid any indirect impacts (e.g., sedimentation and turbidity) to adjacent surface waters.

Transportation Corridors

Operation of the power plant would use existing transportation corridors, and therefore, would have no impact on surface water resources. Any upgrades to existing corridors would require a separate analysis.

4.8 WETLANDS AND FLOODPLAINS

4.8.1 INTRODUCTION

This section discusses wetlands and floodplains identified in the affected environment that may be affected by the construction and operation of the proposed FutureGen Project at the Mattoon Power Plant and Sequestration Site and related corridors. This section also provides the required floodplain and wetland assessment for compliance with 10 CFR Part 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements," and Executive Orders 11988, "Floodplain Management," and 11990, "Protection of Wetlands (May 24, 1977)."

4.8.1.1 Region of Influence

The ROI for wetlands and floodplains of the proposed Mattoon Power Plant and Sequestration Site includes the proposed power plant and the area within 1 mile (1.6 kilometers) of the boundaries of the proposed power plant and sequestration site, and utility and transportation corridors.

4.8.1.2 Method of Analysis

DOE reviewed research and studies in the Mattoon EIV (FG Alliance, 2006a) to characterize the affected environment. Additionally, DOE received correspondence from the IDNR (IDNR, 2006) that provided site-specific information regarding wetlands and potential mitigation measures (see Appendix A). DOE also conducted site visits in August 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause construction of facilities in, or otherwise impede or redirect flood flows in, the 100- or 500-year floodplain or other flood hazard areas;
- Conflict with applicable flood management plans or ordinances; and
- Cause filling of wetlands or otherwise alter drainage patterns that would affect wetlands.

4.8.2 AFFECTED ENVIRONMENT

4.8.2.1 Wetlands

All tributaries to Waters of the U.S., as well as wetlands contiguous to and adjacent to those tributaries, are subject to federal jurisdiction and potential permitting constraints under Section 404. These resources are referred to as jurisdictional, or regulated by federal and state agencies. To be contiguous or tributary, there must be a continuous surface water connection between the surface water bodies. This surface water connection can be either surface flowing water at regular intervals of time, or a continuum of wetlands between the two areas. Open water features (e.g., upland stock ponds) within the Federal Emergency Management Agency (FEMA) designated 100-year floodplain that have associated emergent vegetation fringe are also jurisdictional Waters of the U.S. Isolated wetlands (those that have no apparent regulatory connection to Section 404 resources) and are not jurisdictional unless protected under a bylaw.

IDNR has the authority to regulate wetlands under the Interagency Wetland Policy Act of 1989 (IWPA) for projects that receive funding or technical assistance from the state. The IWPA defines federal money that passes through a state agency as state funding. Isolated, farmed, and U.S. Army Corps of

Engineers (USACE) jurisdictional wetlands are state jurisdictional wetlands under the IWPA. IDNR accepts the procedures outlined in the 1987 USACE Wetland Delineation Manual for delineating wetlands. The IWPA requires mitigation for all adverse impacts regardless of the size of the impacted area or the wetland quality.

The local USACE Regulatory Branch makes jurisdictional determinations. Activities such as mechanized land clearing, grading, leveling, ditching, and redistribution of material require a permit from the USACE to discharge dredged or fill material into wetlands. Permit applicants must demonstrate that the activity avoided wetlands and minimized the adverse effects of the project to the extent practicable. Compensation is generally required to mitigate most impacts that are not avoided or minimized.

Specialized Ecological Services conducted wetland delineations for jurisdictional wetlands and Waters of the U.S. during the week of August 19, 2006, using procedures outlined in the 1987 USACE Wetland Delineation Manual (USACE, 1987). A review of generally recognized wetland texts and manuals, field investigations, and online database searches was also performed to support and document wetland presence (FG Alliance, 2006a). IDNR has the authority to regulate jurisdictional wetlands through Section 404 and the IWPA. IDNR also has peripheral authority through the Illinois Rivers, Lakes, and Streams Act.

Based on the IDNR site survey and a review of available resources, several wetland areas subject to Section 404 and IWPA jurisdiction exist within the proposed Mattoon Power Plant and Sequestration Site and related areas of new construction, particularly the utility corridors. Wetlands encountered during field surveys were listed by size, National Wetlands Inventory (NWI) classification, vegetation community quality, and jurisdiction, and are discussed below. Eight of the 18 wetland areas (1, 6, 7, 11, 12, 13, 16, and 17) in Table 4.8-1 are subject to Section 404 and were reported to the IDNR as newly mapped, meaning they did not appear on any preliminary references consulted, but were identified as jurisdictional wetlands during the field survey (FG Alliance, 2006a). Table 4.8-1 provides several NWI wetland categories and mapped wetlands by type, using the Cowardin et al. classification scheme (Cowardin et al., 1979). Figure 4.8-1 shows the general location of mapped wetlands identified using the Cowardin et al. classification scheme (Cowardin et al., 1979).

Power Plant Site

A small man-made pond (Wetland Area 7) located in the northeast corner of the ROI is the only wetland area subject to jurisdiction on the proposed Mattoon Power Plant and Sequestration Site. The palustrine unconsolidated bottom wetland type occurs in various water regimes from permanently flooded to intermittently flooded, and is characterized by the lack of large stable surfaces for plant and animal attachment. Though shrubby willows and isolated silver maple were present, the wetland is dominated by herbaceous species such as barnyard grass, *Amaranthus* sp., rice cutgrass, and pinkweed.

Sequestration Site

Wetland Area 18 was identified near the site, but not within the ROI. This wetland is included in the analysis due to its size and proximity to the ROI and an adjacent tributary to Whitley Creek. This wetland type is typically characterized by riparian forest habitats dominated by trees greater than 20 feet (6 meters) tall that are regularly inundated by normal high-water flows.

Utility Corridors

Field investigations verified the presence of jurisdictional forested floodplains in the 345-kV transmission line corridor. Wetland Areas 1 through 6 were identified along the process water corridor. Wetland Areas 8 through 17 were identified along the transmission line corridor. Four wetland cover types, palustrine forested, palustrine emergent, palustrine unconsolidated bottom, and palustrine scrub-shrub, were identified within the utility corridors. The majority of wetlands encountered throughout the ROI are categorized as palustrine forested wetlands, which are described in the Power Plant and Sequestration Site sections above. The palustrine emergent wetland type includes meadows, marshes, and vegetated ponds. Emergent wetlands are characterized by erect, rooted, and herbaceous hydrophytes that are usually present for most of the growing season. The palustrine scrub-shrub wetland type includes areas dominated by woody vegetation less than 20 feet (6 meters) tall, such as small willows.

Wetlands identified within the utility corridors include forested floodplains and drainage ways associated with numerous creeks and tributaries. Wetland Areas 1 and 4 are associated with Riley Creek and are characterized by tree species such as box elder (*Acer negundo),* green ash *(Fraxinus pennsylvanica),* honey locust (*Gleditsia triacanthos),* red mulberry *(Morus rubra),* American elm (*Ulmus americana),* common hackberry (*Celtis occidentalis*), and black walnut (*Juglans nigra*). Herbaceous vegetation includes Canada clearweed (*Pilea pumila*), great ragweed (*Ambrosia trifida*), marshpepper smartweed (*Polygonum hydropiper),* Virginia wild rye (*Elymus virginicus),* stinging nettle (*Urtica dioica*), small-spike false-nettle (*Boehmeria cylindrical*), and white avens (*Geum canadense*). Recorded sightings of the protected eastern sand darter (*Ammocrypta pellucida*) have occurred near Wetland Area 4 and the nearby Riley Creek Natural Area.

Wetland Area 5 is a forested drainageway associated with Cassell Creek. The dominant species of this forested wetland include black willow (*Salix nigra*), eastern cottonwood (*Populus deltoides*), common hackberry, Canada clearweed, ivy-leaf morning glory (*Ipomea hederaceae*), Virginia wild rye, stinging nettle, and rice cutgrass (*Leerzia orzoides*).

Wetland Areas 8 and 9 are forested branches of Copperas Creek, and Wetland Area 10 is adjacent to the main channel of the creek. The dominant species of these forested wetlands include black willow, green ash, American sycamore, eastern cottonwood, and common hackberry. Herbaceous vegetation includes Virginia wild rye, creeping water primrose (*Jussiaea repens),* Asiatic dayflower (*Commelina communis*), dotted smartweed (*Polygonum punctatum),* marsh muhly (*Muhlenbergia glomerata*), lesser burdock (*Arctium minus*), Canada clearweed, and white snakeroot (*Eupatorium rugosum*).

Wetland Area 11 is located in the forested periphery of Lake Mattoon. Wetland hardwood vegetation at this site is dominated by pin oak (*Quercus palustris),* eastern cottonwood, and green ash. Herbaceous vegetation includes Virginia wild rye, Frank's sedge (*Carex frankii*), marshpepper smartweed, and white avens.

Wetland Areas 12, 13, and 16 are forested floodplains associated with the Little Wabash River. These wetlands are dominated by hardwood vegetation such as American sycamore, black willow, post oak (*Quercus stellata*), black walnut, eastern cottonwood, osage orange (*Maclura pomifera),* common hackberry, and green ash. Herbaceous vegetation includes dotted smartweed, marshpepper smartweed, pinkweed (*Polygonum pensylvanicum),* reed canary grass *(Phalaris arundinacea),* barnyard grass (*Echinochloa crusgalli),* Japanese bristle grass (*Setaria faberi),* Canada clearweed, poison ivy (*Toxicodendron radicans),* white avens, chufa sedge (*Cyperus esculentus*), and rice cutgrass.

Wetland Area 18 is an unconfirmed forested wetland associated with an unnamed tributary of Whitley Creek located west of the proposed Mattoon Power Plant Site. This area is not located within the ROI, but due to its size (25 acres [10 hectares]) and potential hydrological connection to Wetland Area 7 and Whitley Creek, it has been included in this analysis. Based on the NWI and USGS topographic maps, bottomland hardwood vegetation is probably the dominant community type. Typical species observed in similar wetlands of the region include common hackberry, green ash, black walnut, osage orange, white mulberry (*Morus alba),* eastern cottonwood, American elm, and black willow. Herbaceous vegetation observed in similar wetlands includes Asiatic dayflower, chufa sedge, Virginia wild rye, white avens, Canada clearweed, marshpepper smartweed, poison ivy, and stinging nettle.

Wetland Areas 2 and 6 are palustrine emergent drainage channels that flow into Riley and Cassell creeks, respectively. The wetlands are vegetated with prairie cordgrass (*Spartina pectinata),* great ragweed, poison ivy, broad-leaf cattail (*Typha latifolia),* pinkweed, Frank's sedge, and common milkweed (*Asclepias syriaca).*

Wetland Area 14 is an emergent wetland associated with an unnamed tributary to the Little Wabash River. Though the stream has a closed tree canopy due to adjacent upland forest species, the wetland itself is only vegetated with sparse herbaceous species including stinging nettle, Canada clearweed, and smoother sweetcicely (*Osmorhiza longistylis*).

Wetland Area 3 is a palustrine scrub-shrub drainage channel that flows into Riley Creek and is vegetated with reed canary grass, Frank's sedge, and field bindweed (*Convolvulus arvensis*). Shrubby black willow is also present. Wetland Areas 15 and 17 are palustrine scrub-shrub communities associated with the Little Wabash River and its crossing. The dominant species of this scrub-shrub wetland include black willow, eastern cottonwood, white mulberry, honey locust, American sycamore, black cherry (*Prunus serotina*), and common hackberry. Herbaceous species of the wetland include Virginia wild rye, Canada clearweed, white vervain (*Verbena urticifolia),* coral-berry (*Symphoricarpos orbiculatus*), reed canary grass, poison ivy, and fowl manna grass (*Glyceria striata*).

Transportation Corridors

Because no new transportation corridors are proposed outside of the proposed power plant and sequestration site, this EIS does not provide further description of wetlands. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

4.8.2.2 Floodplains

A review of FEMA flood insurance rate maps for unincorporated Coles County, digitized by the ISWS, indicates that the proposed Mattoon Power Plant and Sequestration Site does not lie within a 100- or a 500-year floodplain (Figure 4.8-2) (FEMA, 2006). The site is located approximately on the divide between the Ohio and Mississippi River basins. Though the sites are not located within the 100- or 500-year floodplains, within the last 7 years, several floods have occurred in the Mattoon region, with one flood causing significant damage. It is expected that a 500-year flood would marginally extend the inundation areas of the transmission and cooling water corridors compared to the 100-year inundation areas.

Two locations along the proposed 345-kV transmission line are located within the 100-year floodplain for the Little Wabash River. Two locations along the proposed wastewater effluent pipeline from Charleston to Mattoon are within the 100-year floodplain for Riley and Cassell creeks.

4.8.3 IMPACTS

4.8.3.1 Construction Impacts

Direct impacts to wetland habitats would be related to heavy equipment and construction activities, and could include soil disturbance and compaction, dust, vegetation disturbance and removal, root damage, erosion, and introduction and spread of non-native species. The addition of silt, resuspension of sediment, or introduction of pollutants (e.g., fuels and lubricants) related to, and in the immediate vicinity of, construction activities could degrade the quality of native wetlands.

The proposed FutureGen Project could result in some localized, direct, and adverse construction impacts to wetlands. Filling or modifying portions of wetlands, if avoidance is not feasible, would permanently alter hydrologic function and wetland vegetation, and result in direct habitat loss. Potential habitat degradation of wetlands and waters downstream could also occur if flow into adjacent areas is reduced. Construction impacts would be minimized by limiting the areas disturbed and preventing runoff from entering wetlands during construction. Section 404 jurisdiction would also be required for permit approval.

The amount of mitigation required for the proposed power plant site and other project components (e.g., utility corridors) is not known at this time. Ratios have been established by the USACE regarding mitigation. For example, a 2:1 ratio would require 2.0 acres (0.8 hectares) of wetland creation for every acre (0.4 hectare) of wetland loss. Typical mitigation ratios for unavoidable impacts to wetlands would be 1:1 for open water and emergent wetlands, 1.5:1 for shrub wetlands, and up to 2:1 for forested wetlands. The appropriate type and ratio of mitigation would be determined through the Section 404 permitting process.

Power Plant and Sequestration Site

The potential area of impact for Wetland Area 7, located within the proposed Mattoon Power Plant Site, is about 0.05 acre (0.02 hectare) and is considered a low quality farm pond. Permanent wetland habitat loss could result from vegetation clearing or filling, although it is likely that this wetland could be avoided during construction of the proposed power plant. If the pond area were to be cleared of vegetation or filled during construction, then the proposed mitigation would be to replace the wetland area at a ratio consistent with USACE and IWPA requirements. Mitigation could be designed to establish emergent wetlands that could satisfy the replacement requirement. No impacts to the 100-year or 500-year floodplain would occur due to the construction of the proposed Mattoon Power Plant.

Wetland Area 18 is not located within the proposed site or the related areas of new construction and, therefore, would not be impacted. If inadvertently impacted due to revisions in final site design and layout, the wetland would be mitigated in-place, in-kind by replacing soil and planting vegetation. Potential impacts to wetlands could be minimized by locating any proposed facilities outside of any identified wetland locations. No impacts to the 100-year or 500-year floodplain would occur due to the construction of the proposed sequestration site.

Utility Corridors

Construction of both the proposed 345-kV transmission line and the process water supply pipelines could affect up to 29.2 acres (11.8 hectares) of wetlands. The majority of wetlands in the transmission line corridor are currently forested wetlands (28.9 acres [11.7 hectares]). During transmission line construction, Wetland Areas 8 through 17 would be altered. Temporary disturbances would result from vegetation removal and subsequent soil compaction for construction equipment access and placement of transmission lines. Transmission line poles would be located outside wetland areas; therefore, no permanent impacts are anticipated.

The effect to wetlands along the transmission line corridor would be minimized by limiting the areas disturbed if, based upon the results of the Midwest Independent System Operator (MISO) study (see Section 4.15), it is determined that existing corridors could be used to parallel or upgrade existing lines. Direct impacts to Wetland Areas 12 and 13 could be reduced from 6.5 acres (2.6 hectares) to approximately 0.3 acre (0.1 hectare), if the proposed transmission line follows the corridor of a nearby gas pipeline. Additionally, by relocating the proposed transmission line corridor to the west, the impacts associated with Wetland Area 16 could be reduced from 22.0 acres (8.9 hectares) to approximately 0.3 acre (0.1 hectare). Impacts would also be minimized if the MISO confirms that connection can take place at existing 138-kV substation 2 miles (3 kilometers) south. No wetlands would be impacted in this scenario. Additionally, impacts to Wetland Areas 2, 3, 4, and 5 could be completely avoided by constructing a larger reservoir on the proposed power plant site to eliminate the need for the Charleston leg of the water supply pipeline. Potential impacts to wetlands located along the transmission line corridor that could not be avoided by use of existing corridors could be mitigated in-place, in-kind by replacing soil and planting appropriate vegetation at a ratio consistent with USACE and IWPA requirements. The permanent conversion of forested wetlands to emergent wetlands would require mitigation at a ratio consistent with federal and state requirements.

The process water supply corridor also uses existing ROWs for much of its length, minimizing the amount of vegetation to be disturbed. Wetland Areas 1 through 6, including a small forested wetland area (0.2 acre [0.8 hectare]), and 0.03 acre (0.01 hectare) of emergent and scrub-shrub wetland types, would be altered during construction. Temporary disturbances would result from construction equipment access and trenching of underground utilities. Any impacts to wetlands located along the primary process water corridor that could not be avoided by use of existing corridors or directional drilling could be mitigated in-place, in-kind by replacing soil and planting appropriate vegetation. Impacts to Wetland Areas 4 and 5 should be avoided due to recorded sightings of the protected eastern sand darter in the vicinity. Riley Creek Natural Area is also a concern with regard to affecting these wetland areas because it may support the eastern sand darter. To minimize potential impacts on the eastern sand darter and the Riley Creek Natural Area, wetlands and waterways should be directionally drilled if they are crossed. A more detailed discussion of the potential impacts to the eastern sand darter can be found in Section 4.9. These impacts could be avoided by choosing to construct a larger reservoir and eliminating pipeline construction.

The process water pipeline construction would be in accordance with the IDNR Office of Water Management's "State Wide Permit #8-Underground Pipelines & Utility Crossings" to reduce impacts to mapped floodplain areas. The locations along the proposed transmission line that cross a mapped 100-year floodplain would be regulated under the IDNR Office of Water Resources, and would be covered under a statewide permit.

Temporarily adding or excavating fill during construction within the floodplain would have no permanent impact on the lateral extent, depth, or duration of flooding in the floodplain areas traversed. Construction within floodplain areas would not result in increases of the 100-year flood elevation by any measurable amount because the floodway is unconstrained and there are no barriers to floodflow passage. This area has experienced several flood events over the last 7 years. The site is located approximately on the divide between the Ohio and Mississippi River basins, which precludes the possibility that the site lies within a 500-year floodplain. A 500-year flood would be expected to marginally extend the inundation areas of the transmission corridor and cooling water corridor compared to the 100-year inundation areas.

Depending upon final design and construction activities, other federal, state, and local authorities may have jurisdiction over dredging, filling, grading, paving, excavating, or drilling in the floodplain that would require permits. The USACE has authority to regulate the discharge of dredged or fill materials into waterways and adjacent wetlands through Section 404. The IEPA provides water quality certification as required by Section 401 of the CWA. Concurrent with its review of the proposed FutureGen Project to determine appropriate National Environmental Policy Act (NEPA) requirements, DOE would also determine the applicability of the floodplain management and wetlands protection requirements contained within 10 CFR Part 1022.

Transportation Corridors

No new transportation corridors are proposed outside of the proposed power plant site footprint. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen upgrades or new transportation corridors would require a separate analysis.

4.8.3.2 Operational Impacts

Power Plant and Sequestration Site

Operations at the proposed power plant and sequestration site would have no impact on wetlands or floodplains. All activities associated with the proposed power plant would occur on previously disturbed surfaces outside of wetland and floodplain areas.

Utility Corridors

The proposed transmission line corridor would be maintained without trees to provide maintenance access and safety. Forested wetlands that experienced tree removal during construction of the utilities would be permanently converted to emergent wetlands, and tall-growing vegetation would be cut and maintained at a height low enough to prevent interference with the conductors. No additional wetland conversion would result from operations. The resulting wetland and other vegetation communities in the corridor would be similar to those on other transmission line ROWs in the vicinity. Maintenance would likely be conducted using mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in proximity to streams and wetlands could be a potentially damaging indirect effect on vegetation and aquatic resources. Following approved herbicide usage instructions, however, would likely reduce this concern. The proposed process water corridor would be allowed to revegetate and there would be no additional impacts to wetlands or floodplains.

Transportation Corridors

Operation of the proposed power plant would use existing transportation corridors and, therefore, would have no impact on wetlands or floodplains. Any upgrades to existing corridors would require a separate analysis.

4.9 BIOLOGICAL RESOURCES

4.9.1 INTRODUCTION

This section discusses both aquatic and terrestrial vegetation and habitat, as well as threatened, endangered, and protected species identified in the affected environment that may be impacted by the construction and operation of the proposed FutureGen Project.

4.9.1.1 Region of Influence

The ROI for biological resources is defined as 5 miles (8 kilometers) surrounding the proposed power plant and sequestration site and utility corridors.

4.9.1.2 Method of Analysis

DOE reviewed the results of research and studies compiled in the Mattoon EIV (FG Alliance, 2006a) to characterize the affected environment. This information included data on wetland, aquatic, and threatened and endangered species. In addition, DOE reviewed information on the aquatic resources and potential impacts of process water diversions from Kickapoo and Cassell creeks (Patrick Engineering, 2006). DOE also conducted site visits in August 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause displacement of terrestrial communities or loss of habitat;
- Diminish the value of habitat for wildlife or plants;
- Cause a decline in native wildlife populations;
- Interfere with the movement of native resident or migratory wildlife species;
- Conflict with applicable management plans for wildlife and habitat;
- Cause the introduction of noxious or invasive plant species;
- Alter drainage patterns causing the displacement of fish species;
- Diminish the value of habitat for fish species;
- Cause a decline in native fish populations;
- Interfere with the movement of native resident or migratory fish species;
- Conflict with applicable management plans for aquatic biota and habitat;
- Cause loss of a wetland habitat;
- Cause the introduction of non-native wetland plant species;
- Affect or displace special status species; and
- Cause encroachment on or affect designated critical habitat.

4.9.2 AFFECTED ENVIRONMENT

4.9.2.1 Vegetation

Aquatic

Power Plant and Sequestration Site

Whitley Creek drains the proposed Mattoon Power Plant and Sequestration Site westward into the Kaskaskia River, which flows into the Mississippi River. However, the proposed power plant site has no surface water resources with the exception of a small farm pond in the property's northeast corner. This pond is a human-made impoundment, and surface water was present during field investigation. Although shrubby willows (*Salix interior*) and isolated maple (*Acer saccharinum*) are present along the pond border, the predominant vegetation is herbaceous. Barnyard grass (*Echinochloa crusgalli*), amaranths (*Amaranthus* spp.), rice cutgrass (*Leersia oryzoides*), and Pennsylvania smartweed (*Polygonum pennsylvanicum*) are typical herbaceous species observed along the fringe of the pond. Two types of wetland communities are present within the ROI: emergent waterway and forested waterway/floodplain. Small rivers and farm ponds are also present. These wetland areas are discussed in greater detail in Section 4.8.

The sequestration site is located on the same property as the proposed power plant site; therefore, descriptions of the power plant site also apply to the sequestration site. The sequestration plume does, however, extend beyond the perimeter of the proposed power plant site. The aquatic habitat within this portion of the sequestration plume site is limited to a small section of a tributary to Whitley Creek. No information was available, and neither DOE nor the Site Proponent conducted surveys regarding the presence of in-stream aquatic vegetation. Typical species whose presence is expected along the creek include common hackberry (*Celtis occidentalis*), green ash (*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), Osage orange (*Maclura pomifera*), white mulberry (*Morus alba*), eastern cottonwood (*Populus deltoides*), American elm (*Ulmus americana*), and black willow (*Salix nigra*). Herbaceous vegetation observed in adjacent wetlands included *Aster* sp., Asiatic dayflower (*Commelina communis*), yellow nutsedge (*Cyperus esculentus*), Virginia wild rye (*Elymus virginicus*), white avens (*Geum canadense*), clearweed (*Pilea pumila*), marshpepper knotweed (*Polygonum hydropiper*), poison ivy (*Toxicodendron radicans*), and stinging nettle (*Urtica dioica*).

Utility Corridors

Within the proposed project area, the proposed utility corridors contain the most aquatic vegetation. Any drainage from the proposed process water supply corridor flows into Kickapoo Creek and the Embarras River via Riley Creek. The Embarras River flows into the Wabash River, Ohio River, and ultimately the Mississippi River. Riley Creek and its tributaries have zero 7-day, 10-year low flows (7Q10 flows), whereas the Embarras River (nearest its confluence with Kickapoo Creek) and Kickapoo Creek have 4.6 cubic feet (0.13 cubic meters) per second and 2.0 cubic feet (0.06 cubic meters) per second 7Q10 flows, respectively. In the vicinity of the proposed process water supply corridor, Riley Creek is approximately 50 feet (15.2 meters) wide with 5- to 10-foot (1.5- to 3-meter) banks.

The lands within the proposed 345-kV transmission line corridor drain into the Little Wabash, Wabash, Ohio, and Mississippi rivers. The Little Wabash River and its tributaries have zero 7Q10 flows. In the vicinity of the proposed 345-kV transmission line corridor, the Little Wabash River ranges from less than 10 feet (3.0 meters) wide to approximately 30 feet (9.1 meters) wide with 5- to 10-foot (1.5- to 3.0-meter) banks. The proposed 0.25-mile (0.4-kilometer) long natural gas pipeline, 1-mile

(1.6-kilometer) long potable water pipeline, and 1.25-mile (2-kilometer) long wastewater main would be constructed within existing ROWs that do not contain any aquatic habitat.

No information was available, and neither DOE nor the Alliance conducted surveys regarding the presence of in-stream aquatic vegetation. Dominant canopy species adjacent to the creeks and river include white ash (*Fraxinus americanus)*, black walnut, common hackberry, and American elm. Herbaceous vegetation in the area includes clearweed, marshpepper knotweed, Virginia wild rye, stinging nettle, false nettle (*Bohmeria cylindrical)*, and white avens. Riley Creek was clear of vegetation during the site proponent's field work in August 2006. Pasture, residential area, wooded area, and row crops occur in the vicinity of the proposed 345-kV transmission line corridor.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

Power Plant and Sequestration Site

The terrestrial landscape within the proposed project area consists predominantly of agricultural land dedicated to the production of corn and soybean crops. These croplands are typically managed to support single plant species in rotation, and management of the monoculture precludes the establishment of non-agricultural native vegetation. There are areas of woodland near the west edge of the site containing typical upland species such as oak (*Quercus* spp.), hickory (*Carya* spp.), and white ash. Natural terrestrial habitat within the ROI is limited predominantly to the riparian corridors along the Kaskaskia River, Riley Creek, Little Wabash River, and their tributaries, as discussed above.

Utility Corridors

The terrestrial habitat along the proposed corridors for electric transmission, natural gas, potable water, and process water consist predominantly of monotypic stands of row crops. Occasional grassed waterways, constructed to drain water quickly from the cropland, are generally planted with non-native vegetation. The riparian corridor associated with Riley Creek and the Little Wabash River contains some native tree and herbaceous species, as previously discussed, that may provide habitat for a variety of animal species. However, due to the intensive agricultural history of the region, these areas are ecologically degraded. The riparian corridor is limited to a narrow band of non-agricultural vegetation, which can only support a limited number of species. Additional terrestrial areas within the related areas in or near the proposed utility corridors include a golf course and farmsteads with landscaped lawns. No known aquatic plant and animal management plans exist for the project area.

> **Riparian** areas are those located on the banks of a natural course of water (i.e., adjacent to a river or stream).

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected terrestrial environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

4.9.2.2 Habitats

Aquatic

Because no permanent aquatic habitats occur within the proposed power plant site, the site does not contain fish or aquatic invertebrates. Neither DOE nor the site proponent has conducted surveys to identify fish and macroinvertebrates present in any of the streams and rivers that the 345-kV line and process water supply line would potentially cross, nor above the sequestration reservoir. However, typical fish species found in streams and rivers in the area include bluntnose minnow (*Pimephales notatus*), sand shiner (*Notropis ludibundus*), highfin carpsucker (*Carpiodes velifer*), red shiner (*Cyprinella lutrensis*), and striped shiner (*Luxilus chrysocephalus*) (FG Alliance, 2006a). Proposed transmission line configuration and location would not be determined until further study is completed. As such, the exact locations of stream crossings, if any, and therefore descriptions of aquatic habitat in those locations, are unknown at this time. However, general descriptions were included in Section 4.9.2.1.

Terrestrial

The proposed power plant and sequestration site, 345-kV transmission line corridor, and process water supply line corridor are all predominantly monotypic agricultural croplands. As such, with the exception of riparian corridors along Riley Creek and Little Wabash River and their tributaries, wildlife found within the proposed project areas would be limited to common species such as raccoons (*Procyon lodor*), white-tailed deer (*Odocoileus virginianus*), skunks (*Mephitus mephitus*), and various rodents. The riparian corridors contain upland tree species such as white oak (*Quercus alba*), white ash, basswood (*Tillia americana*), honey locust (*Gleditsia triacanthos*), and hickory, with floodplain species such as red maple (*Acer rubrum*), silver maple, and eastern cottonwood in lower areas adjacent to the river.

4.9.2.3 Federally Listed Threatened and Endangered Species

According to the U.S. Fish and Wildlife Service (FWS) (FWS, 2006), the only federally listed species that may occur within the proposed project vicinity is the endangered Indiana bat (*Myotis sodalis*). This species occupies caves and abandoned mines during the winter and uses tree cavities for roosting the remainder of the year. Potential habitat within the project area for the Indiana bat is limited to wooded riparian habitat and the woodland area on the western edge of the proposed sequestration site.

4.9.2.4 Other Protected Species

One state-listed fish species, the threatened eastern sand darter (*Ammocrypta pellucida*) may occur in Riley Creek and its tributary, Cassell Creek, located near the Riley Creek Natural Area and the proposed process water supply line. The proposed process water supply could divert water from the WWTP effluent of the Cities of Charleston and Mattoon, reducing the discharge into Cassell Creek and Kickapoo Creek, respectively. The closest known location of the eastern sand darter is approximately 2.6 miles (4.2 kilometers) downstream of the confluence of Kickapoo Creek and the Embarras River. The eastern sand darter does not normally inhabit this section of Riley Creek because of competition with and predation by other native fish populations; however, a fish kill in 2001 allowed the sand darter to move into the area (Patrick Engineering, 2006).

The state-listed threatened Kirtland's snake (*Clonophis kirtlandii*) has been found 1 mile (1.6 kilometers) from the proposed process water supply line corridor, near the City of Charleston. Kirtland's snake occurs in damp habitats, such as wet meadows and wet prairies, near water bodies.

Because most of the project area is cropland, the only potential habitat occurs within riparian areas along the proposed 345-kV transmission line and process water supply corridors.

4.9.3 IMPACTS

4.9.3.1 Construction Impacts

Power Plant and Sequestration Site

Placement of fill during construction could directly impact a small farm pond at the proposed power plant and sequestration site. This would result in the loss of aquatic habitats and species; however, this impact would be minimal due to the pond's low-value aquatic habitat. The pond does not provide any habitat for federally or state-listed rare, threatened, or endangered species and similar habitat is plentiful in the project vicinity. Furthermore, the Alliance could likely avoid this pond during the site layout and planning process. Project construction would not directly impact any other permanent streams or ponds. Standard stormwater management practices for construction activities (e.g., placement of silt fencing around disturbed areas) would prevent indirect impacts, such as sedimentation to off-site surface waters.

Project construction could require the removal of up to 200 acres (81 hectares) of cropland to accommodate the power plant envelope (plant buildings and associated structures). Because this cropland does not provide high-quality wildlife habitat and similar agricultural land is prevalent in the area, effects on wildlife and displacement of terrestrial communities would be minimal. Some small, less mobile species that inhabit the cropland, such as rodents, could be lost during construction; however, these species are plentiful and the loss of a few individuals would not affect the overall population. The proposed power plant site does not contain habitat for any federally or state-listed rare, threatened, or endangered species. Additionally, construction at the proposed power plant site is unlikely to cause a proliferation of noxious weeds because the disturbed area would become an industrial facility with little vegetation.

While construction of the injection wells would alter up to 10 acres (4 hectares) at the sequestration site, this would not alter additional habitat, as the injection wells would be located at the proposed power plant site. Temporary impacts to vegetation would result from truck access during the required seismic surveys of the sequestration site, before injection well construction. Although no known federally or state-listed rare, threatened, or endangered species occur within the proposed power plant and sequestration site, potential habitat for the federally listed Indiana bat occurs in the woodland at the western edge of the sequestration site. The proposed injection well, and any associated habitat disturbance, would be localized and sited away from this area. As such, no potential Indiana bat habitat would be disturbed during construction.

Utility Corridors

Removal of vegetation during construction of the proposed utility corridors could affect riparian habitat by increasing the potential for soil erosion in newly disturbed areas. The potential for this impact would be related to the corridor lengths, the habitat that they traverse, and the type of utility (i.e., aboveground versus belowground). Generally, the use of existing ROWs would reduce the potential for these impacts.

The length of the electric transmission line corridor would vary between 0.5 and 16 miles (0.8 and 25.7 kilometers) for the 138-kV line (Option 1) or 345-kV line (Option 2), respectively. The results of on-going studies by MISO, the regional transmission authority, would determine the selection of electric transmission options. Option 1 would require between 0.5 and 2.5 miles (0.8 and 4.0 kilometers);

however, up to 2 miles (3.2 kilometers) would be an existing ROW that has been acquired by the City of Mattoon. Option 2 would require 16 miles (25.7 kilometers) of new line and ROW to connect the power plant with the substation. The vegetation within the corridor would require periodic trimming for corridor maintenance, thereby permanently removing areas of forest within the corridor. Tree cover loss would be minimized by paralleling existing transmission lines, upgrading existing transmission lines, or using existing maintained ROWs. Direct impacts to aquatic communities, including streams and wetlands, would be avoided. Transmission lines would be above ground, limiting earth disturbance and fill activities to the pole locations. Poles supporting the electric transmission lines would also be located outside of sensitive habitats such as streams and wetlands. Indirect impacts, such as increased stream temperatures due to loss of riparian tree canopy, could result from clearing of trees along the stream within the electric transmission line corridor; however, this impact would be considered minimal as the majority of the corridors are located in agricultural areas with limited stream shading.

The proposed process water pipelines would be 6.2 miles (10.0 kilometers) long and 8.1 miles (13.0 kilometers) long to connect to the Mattoon and Charleston WWTPs, respectively. The proposed 8.1-mile (13.0-kilometer) pipeline from the Charleston WWTP to Mattoon would parallel a ROW for the Lincoln Prairie Grass Bike Trail/former railway line. The pipeline would continue on the bike trail ROW into Mattoon. The 6.2-mile (10.0-kilometer) long process water pipeline from the Mattoon WWTP would be on existing public ROW for all but 2 miles (3.2 kilometers), which would require construction in new ROW. These pipelines would be built using standard pipeline construction techniques and directional drilling under sensitive areas such as wetlands, streams, and rivers. In addition, the proposed potable water and sanitary wastewater mains (1 mile [1.6 kilometers] and 1.25 miles [2.0 kilometers], respectively) would be built within existing ROWs. The proposed natural gas pipeline (0.25 mile [0.4 kilometer]) would be built on agricultural land adjacent to the proposed power plant. After construction, the land above the pipelines would be revegetated with native species, maintaining wildlife habitat similar to current conditions and limiting the proliferation of noxious weeds. Overall, due to the small amount of vegetation expected to be disturbed, impacts would be minimal.

Construction activities would temporarily displace wildlife species using these corridors. The use of open cuts to cross Riley Creek and the Riley Creek Natural Area for the proposed process water supply line could affect the state-listed eastern sand darter by causing sedimentation into Riley Creek and its tributary, Cassell Creek. The IDNR recommends that pipelines under Riley Creek and Cassell Creek be directionally drilled to avoid these impacts (IDNR, 2006a).

Although there are no known occurrences of any federally or state-listed rare, threatened, or endangered species within the proposed utility corridors, habitat for both the federally listed Indiana bat and the state-listed Kirtland’s snake occurs within the riparian areas of the proposed transmission line and process water supply corridors.

If the Indiana bat is present, the species could be directly impacted through temporary loss of habitat or casualty. Bats typically would inhabit older trees with cavities. Construction during the breeding season (April 1 to September 15) would potentially affect the bat by removing trees and disturbing breeding and roosting bats. Construction in these areas outside of the breeding season would not likely affect the Indiana bat. Potential disturbance would be minimized by placing the lines within existing ROWs, thereby eliminating the need to remove trees. If the proposed Mattoon Power Plant Site was selected, an Indiana bat survey conducted before construction would avoid the loss of bats or preferred habitat.

If Kirtland’s snake is present, the species could be directly impacted through temporary loss of habitat or casualty. To minimize potential impacts to Kirtland’s snake, IDNR recommends that the following measures would be incorporated into construction plans: (1) construction crews would be educated to identify the snake and relocate any individuals encountered to appropriate off-site habitat; (2) trenches would be backfilled immediately after piping is installed, if possible; (3) if trenches must be left open, they would be covered with plywood or similar material at the end of the day and covered with enough dirt to keep snakes from entering; and (4) trenches that have not been backfilled would be inspected for the snake at the beginning of each day, and an IDNR biologist would be contacted to capture and release any snakes trapped in the open trench. These measures would minimize the potential for impacts to Kirtland's snake. Should Mattoon host the FutureGen Project, consultation with IDNR would ensure that proper protection measures are in place before construction.

Transportation Corridors

No new transportation corridors are proposed; only upgrades to existing roads and new transportation spurs within the proposed power plant footprint. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

4.9.3.2 Operational Impacts

Power Plant and Sequestration Site

Operating the proposed power plant, injection wells, and utilities would have minimal effect on biological resources. Noise during proposed project operations would be slightly elevated in the absence of mitigation (see Section 4.14). However, wildlife species that are found near the proposed power plant and sequestration site, such as white-tailed deer, skunks, and raccoons, are adapted to the noise found in areas of human development. Air emissions due to routine operation would result in small increases in ground-level pollutant concentrations that should be below levels known to be harmful to wildlife and vegetation or affect ecosystems through bio-uptake and biomagnification in the food chain (see Section 4.2). Because there are no high-quality or sensitive aquatic or wildlife receptors near the proposed power plant and sequestration site, air emissions would not impact biological communities.

A limited number of site characterization seismic surveys would be required during operation of the sequestration site, resulting in temporary impacts to vegetation due to truck access within the survey plots.

Microbes occurring approximately 0.9 mile (1.4 kilometers) under ground within the sequestration reservoir could be affected by sequestration. Microbes are likely to exist in almost every environment, including the proposed sequestration reservoirs, unless conditions prevent their presence. CO_2 sequestration has the potential to destroy these localized microbial communities by altering the pH of the underground environment. However, it is also possible that CO_2 sequestration would not harm microbial communities (IPCC, 2005). The potential loss of localized microbial populations within the sequestration reservoir would not constitute an appreciable difference to the world's total microbial population.

No additional impacts are anticipated during normal operations. Plants are not predicted to be impacted by gradual CO_2 release from the reservoir, although effects in the immediate vicinity of the injection wells could result from a rapid CO_2 release (see Section 4.17).

Utility Corridors

The proposed transmission line and process water supply corridors would be maintained without trees to provide maintenance access and for safety reasons. Corridor maintenance would likely use both mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in close proximity to streams and wetlands could be potentially damaging. Following approved herbicide usage instructions would eliminate this concern. The proposed process water, potable water, and wastewater mains, as well as the natural gas pipeline, would be allowed to revegetate once construction is complete; therefore, no impacts would be likely during operations.

If a leak or rupture in the CO_2 pipeline occurred, respiratory effects to biota due to atmospheric CO_2 concentrations would be limited to the immediate vicinity along the pipeline where the rupture or leak occurred. While heat generated from the supercritical fluid in the CO_2 pipeline could potentially affect surface vegetation, pipeline construction techniques that would contain the heat through insulation and installation depth would prevent this impact. Soil gas concentrations vary depending on soil type; therefore, effects on soil invertebrates or plant roots could occur close to the segment of the pipeline that ruptured or leaked (see Section 4.17).

The proposed transmission line could potentially affect raptors and waterfowl located near the line due to collision or electrocution. Designing the line in accordance with current guidelines (APLIC et al., 1996) would minimize the potential for these effects.

Diverting the Mattoon and Charlestown WWTP discharges from Kickapoo and Cassell creeks would reduce the flow in these streams. The effects of diverting these discharges on surface water quality and quantity are discussed in Section 4.7.3. The 7Q10 flow measurements above the discharge points are 0.15 cubic feet (0.004 cubic meters) per second and 0.0 cubic feet (0.0 cubic meters) per second in Kickapoo and Cassell creeks, respectively (Patrick Engineering, 2006). This indicates that, in drier conditions, it is possible that Cassell Creek could be intermittent downstream of the discharge point if all of the Charleston WWTP effluent were diverted. The Charleston WWTP effluent would be the backup process water supply, with only a portion being diverted in times of shortfall from the Mattoon WWTP effluent. As such, it is unlikely that the entire effluent discharge would ever be diverted from Cassell Creek.

The confluence of Cassell Creek with the larger Riley Creek is 0.6 mile (1.0 kilometer) downstream of the discharge location. In the most extreme conditions, 0.6 mile (1.0 kilometer) of Cassell Creek would be dry, adversely affecting aquatic conditions. Because Riley Creek flows are greater than those for Cassell Creek, the impact of the reduced effluent discharge on Riley Creek would be minimal. Diverting the effluent discharge from Kickapoo Creek would also reduce the flow downstream from the discharge point, although the impact on aquatic resources would likely be less extreme than that on Cassell Creek because stream flow would be maintained even in dry conditions. The existing flows in Kickapoo and Cassell creeks just below the discharge points are unknown and, therefore, it is not possible to conduct an analysis to determine the percentage of aquatic habitat that would be affected. It is known that the Kickapoo Creek 7Q10 flow just upstream of its confluence with Riley Creek is 2.0 cubic feet (0.06 cubic meters) per second. This is several miles downstream of the discharge location, so it is unknown how much of this flow is the result of effluent discharge versus tributaries. Although the diversion of effluent from Cassell and Kickapoo creeks would result in lower flow conditions in these streams, diverting the effluent discharge would return these streams to more natural flows, and potentially more natural aquatic conditions.

As discussed previously, the 2001 fish kill allowed the eastern sand darter to populate these sections of Kickapoo and Riley creeks, most likely due to lack of competition. As the ecosystem recovers and fish populations return to previous levels, it is possible that the eastern sand darter would disappear from Riley Creek. Additionally, the nearest known location of the sand darter is approximately 2.6 miles (4.2 kilometers) downstream of the confluence of Kickapoo Creek and the Embarras River. Although diverting the effluent discharges from the Kickapoo and Cassell creeks would reduce the flow downstream, the effects of the reduced flow on aquatic habitat in the larger Kickapoo Creek and Embarras

River is expected to be minimal. Because it is unlikely that the eastern sand darter naturally occurs in Cassell Creek, where reduced effluent discharge would have the greatest impact, any impacts to the species would be minimal. IDNR sent a letter to the Illinois Department of Commerce and Economic Opportunity concurring with this determination (IDNR, 2006b) (see Appendix A).

Transportation Corridors

Other than a potential minimal increase in road kill, there would be no impact to biological resources due to increased traffic on existing roads and the new transportation spurs located at the proposed power plant and sequestration site.

7. ODESSA SITE

7.1 CHAPTER OVERVIEW

This chapter provides information regarding the affected environment and the potential for impacts on each resource area in relation to construction and operation of the FutureGen Project at the proposed Odessa Site. To aid the reader and to properly address the complexity of the FutureGen Project, as well as the need to evaluate four sites (two in Illinois and two in Texas), this Environmental Impact Statement (EIS) was prepared as two separate volumes. Volume I of the EIS includes the purpose and need for the agency action, a description of the Proposed Action and Alternatives, and a summary of the potential environmental consequences. Volume II addresses the affected environment and potential impacts for each of the four proposed alternative sites. Presenting the affected environment immediately followed by the potential impacts on each resource area allows the reader to more easily understand the relationship between current site conditions and potential project impacts on a particular resource.

Volume II is organized by separate chapters for each proposed site: Chapter 4-Mattoon, Illinois; Chapter 5-Tuscola, Illinois; Chapter 6-Jewett, Texas; and Chapter 7-Odessa, Texas.

This chapter is organized by resource area as follows:

Each resource section provides an introduction, describes the region of influence (ROI) and the method of analysis, and discusses the affected environment and the environmental impacts from construction and operation of the FutureGen Project at the candidate site. The affected environment discussion describes the current conditions at the proposed power plant site, sequestration site, and utility and transportation corridors. This is followed by a discussion of potential construction and operational impacts. A summary and comparison of impacts for all four candidate sites are provided in the EIS Summary and in Chapter 3. Unavoidable adverse impacts, mitigation measures, and best management practices (BMPs) for all four candidate sites are also provided in Chapter 3.

7.1.1 POWER PLANT FOOTPRINT

The specific configuration of the power plant, rail loop, and access roads within the candidate sites would be determined after site selection, during the site-specific design phase. For purposes of analysis, the impact assessment for the proposed power plant site assumed a representative configuration or layout depicted in Chapter 2, Figure 2-18. The proposed power plant site would involve up to 200 acres (81 hectares) to house the proposed power plant, coal and equipment storage, associated processing facilities, research facilities, railroad loop surrounding the power plant envelope, and a buffer zone; the site could ultimately be located anywhere within the larger power plant parcel. Therefore, impact discussions in this chapter identify environmentally sensitive areas to be avoided and address potential impacts to be evaluated, avoided, or mitigated within the entire power plant parcel.

7.1.2 NO-ACTION ALTERNATIVE

As discussed in Chapter 2, Proposed Action and Alternatives, the No-Action Alternative is treated in this EIS as the "No Build" Alternative. That is, under the No-Action Alternative, the Alliance would not undertake a FutureGen-like project in the absence of Department of Energy (DOE) funding assistance. In the unlikely event that the Alliance did undertake a FutureGen-like project in the absence of DOE funding assistance, impacts might be similar to those predicted in this EIS. However, the Alliance would not be subject to the oversight or the mitigation requirements of DOE.

One goal of the FutureGen Project would be to test and prove a technological path toward minimization of greenhouse gas (GHG) emissions from coal-fueled electric power plants. Should the FutureGen Project prove successful and the concept of carbon dioxide (CO_2) capture and geologic sequestration receive widespread application across the U.S. and around the world, the current trend of increasing CO_2 emissions to the atmosphere from coal-fueled power plants could be reduced. In the absence of concept proof, industry and governments may be unwilling to initiate all of the technological changes that would help to significantly reduce current trends and consequential increase of CO_2 concentrations in the Earth's atmosphere.

Impacts associated with the No-Action Alternative are provided in Chapter 3.

7.1.3 ODESSA SITE

Proposed Odessa Power Plant Site

The proposed Odessa Site is located on approximately 600 acres (243 hectares) 15 miles (24.1 kilometers) southwest of the City of Odessa in Ector County, Texas. Key features of the Odessa Site are listed in Table 7.1-1. The proposed site is located just north of I-20 and is north of the Town of Penwell and a Union Pacific Railroad. The land has historically been used for ranching as well as oil and gas activities. Potable water and process water would be obtained by developing new well fields nearby or from several existing water well fields ranging from 24 to 54 miles (38.6 to 86.9 kilometers) from the proposed plant site. Sanitary wastewater would be treated through construction and operation of an on-site treatment system. The proposed power plant would connect to the power grid via existing high voltage transmission lines located approximately 1.8 miles (2.9 kilometers) from the site. Natural gas would be obtained from an existing gas pipeline that traverses the proposed plant site. The proposed sequestration site would be located 58 miles (93.3 kilometers) south of the proposed power plant site on 43,200 acres (17,118 hectares) on University of Texas land. An existing CO_2 pipeline would transport the power plant's CO_2 to the sequestration site, although up to 14 miles (22.5 kilometers) of new CO_2 pipeline would be installed to connect the proposed power plant and the proposed sequestration site to the existing pipeline. Following Table 7.1-1, Figures 7.1-1, 7.1-2, and 7.1-3 illustrate the Odessa Power Plant Site, utility corridors, and sequestration site, respectively.

7.10 CULTURAL RESOURCES

7.10.1 INTRODUCTION

Section 106 of the National Historic Preservation Act of 1996 (NHPA) and its implementing regulations at 36 CFR Part 800 (incorporating amendments effective August 5, 2004) require federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings.

Historic properties are a specific category of cultural resources. Cultural resources are any resources of a cultural nature (King, 1998). As defined at 36 CFR 800.16[l][1], a historic property is a cultural resource that is any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior. Historic properties include artifacts, records, and remains related to and located within such properties, as well as properties of traditional religious and cultural importance to Native American tribes or Native Hawaiian organizations, and properties that meet National Register criteria for evaluation (36 CFR 60.4).

36 CFR Part 800 outlines procedures to comply with NHPA Section 106. At 36 CFR Part 800(a), federal agencies are encouraged to coordinate Section 106 compliance with any steps taken to meet NEPA requirements. Federal agencies are to also coordinate their public participation, review, and analysis to meet the purposes and requirements of both the NEPA and the NHPA in a timely and efficient manner. The Section 106 process has been initiated for this undertaking with the intent of coordinating that process with the DOE's obligations under NEPA regarding cultural resources.

For purposes of this document, cultural resources are:

- Archaeological resources, including prehistoric and historic archaeological sites;
- Historic resources, including extant standing structures;
- Native American resources, including Traditional Cultural Properties (TCPs) important to Native American tribes; or
- Other cultural resources, including extant cemeteries and paleontological resources.

Participants in the Section 106 process include an agency official with jurisdiction over the FutureGen Project, the ACHP, consulting parties, and the public. Consulting parties include the State Historic Preservation Officer; Native American tribes and Native Hawaiian organizations; representatives of local

The **National Historic Preservation Act** of 1966 (16 USC 470), establishes a program for the preservation of historic properties throughout the Nation.

The **National Register** criteria for evaluation states that:

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

government; and applicants for federal assistance, permits, licenses, and other approvals. Additional consulting parties include individuals and organizations with a demonstrated interest in the FutureGen Project due to their legal or economic relation to the undertaking or affected properties, or their concern with the effects of undertakings on historic properties. In Texas, the State Historic Preservation Officer is the executive director of the Texas Historical Commission (THC).

If the proposed project would encompass any state-owned lands or use any public funding supplied by the State of Texas or its subdivisions, the project falls under the jurisdiction of the Antiquities Code of Texas (FG Alliance, 2006d). A building or archaeological site listed in the NRHP may also be designated as a State Archeological Landmark (SAL) by the THC. A cultural resources planning document is published for the Central and Southern Planning Region of Texas (Mercado-Allinger et al., 1996), but there are currently no published planning documents for the portion of the state in which the proposed Odessa Power Plant Site is located.

7.10.1.1 Region of Influence

The ROI for cultural resources includes (1) the proposed power plant site and area within 1 mile (1.6 kilometers) of the proposed power plant site boundaries; (2) all related areas of new construction and those within 1 mile (1.6 kilometers) of said areas; and (3) the land area above the proposed sequestration reservoir(s). NHPA Section 106 states the correlate of the ROI is the Area of Potential Effects (APE).

> The **Area of Potential Effects** is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if such properties exist (36 CFR 800.16[d]).

Adverse effects to archaeological, paleontological, and cemetery resources are generally the result of direct impacts from ground disturbing activities. Therefore, the APE for such resources coincides with those areas where direct impacts from the construction and operation of the proposed facility would occur. Adverse effects to historic resources (i.e., standing structures) may occur through direct impacts that could change the character of a property's use or the physical features within a property's setting that contribute to its historic significance. Adverse effects may occur through indirect impacts that could introduce visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features. For historic resources, the APE encompasses the ROI as defined above. TCPs may be subject to both direct and indirect impacts.

7.10.1.2 Method of Analysis

DOE reviewed the results of research and studies performed by the Alliance to determine the potential for impacts based on the following criteria:

- Archaeological Resources – Cause the potential for loss, isolation, or alteration of archaeological resources eligible for NRHP listing.
- Historic Resources – Cause the potential for loss, isolation, or alteration of the character of a historic site or structure eligible for NRHP listing. Introduce visual, audible, or atmospheric elements that would adversely affect a historic resource eligible for NRHP listing.
- Native American Resources – Cause the potential for loss, isolation, or alteration of Native American resources, including graves, remains, and funerary objects. Introduce visual, audible, or atmospheric elements that would adversely affect the resource's use.
- Other Cultural Resources
  - Paleontological Resources – Cause the potential for loss, isolation, or alteration of a paleontological resource eligible for listing as a National Natural Landmark (NNL).
  - Cemeteries – Cause the potential for loss, isolation, or alteration of a cemetery.

The Alliance conducted archival research to determine whether cultural resources are known to exist or may exist within the APE/ROI. The research was conducted at the THC, Texas Archaeological Research Laboratory (TARL), Texas General Land Office (GLO); and in the THC's Texas Archaeological Sites Atlas Database (THC, 2006) and the National Park Service (NPS) National Register Information System (NPS, 2006a) database. The Alliance also reviewed existing literature and publications pertaining to previous cultural resource studies in the region (FG Alliance, 2006d; Miller and Yost, 2006).

To identify the potential for TCPs, the Alliance used NPS's Native American Consultation Database (NPS, 2006b; Patterson, 2001). This study also incorporated background research and pedestrian reconnaissance survey results of the proposed power plant site conducted by Miller and Yost (2006). No survey in association with the proposed FutureGen Project was conducted within the ROI for related areas of new construction or land above the sequestration reservoir.

The Alliance conducted archival research at the University of Texas, Austin, Vertebrate Paleontology Laboratory and in the NPS NNL database to determine the potential for significant paleontological specimens within the ROI (NPS, 2004). The Alliance also interviewed Dr. Ernest Lundelius, retired director of the Vertebrate Paleontology Laboratory.

Paleontological resources are generally geological in nature rather than cultural, but several environmental regulations have been interpreted to include fossils as cultural resources. The Antiquities Act of 1906 refers to historic or prehistoric ruins or any objects of antiquity situated on lands owned or controlled by the U.S. Government, but the term "objects of antiquity" has been interpreted by the NPS, Bureau of Land Management (BLM), U.S. Forest Service (USFS); and other federal agencies to include fossils. An area rich in important fossil specimens can potentially be a NNL as defined in the NPS's National Registry of Natural Landmarks (NRNL) (36 CFR 62.2). Paleontological resources are not analyzed under Section 106 of the NHPA unless they are recovered within culturally related contexts (e.g., fossils included within human burial contexts, a mammoth kill site).

7.10.2 AFFECTED ENVIRONMENT

7.10.2.1 Archaeological Resources

Power Plant Site

Records maintained by the THC and TARL, and found in the Texas Archaeological Sites Atlas Database (THC, 2006), show no previously recorded archaeological or historical sites within the proposed plant site and its ROI. The Alliance noted that prehistoric archaeological sites in the region are typically located near major drainages or around Pleistocene lake bed margins. The ROI is essentially a level plain with no major drainages or lake beds. No evidence of prehistoric or historic archaeological artifacts was found and no standing structures were identified within the ROI. It was also noted that calcium carbonate nodules (i.e., caliche) on the ground surface indicate that Holocene-age soils are very shallow and, as a result, there is a very low potential for the presence of buried prehistoric archaeological sites in the ROI (Miller and Yost, 2006).

Sequestration Site

Two linear surveys along the I-10 corridor have been conducted within the ROI for the sequestration site, covering a small percentage of the total ROI. No archaeological sites were identified within the ROI as a result of these surveys. One previously recorded archaeological site is within the ROI for the sequestration site. Site 41PC1 is recorded as a multi-component site containing an Archaic-age ring midden and bedrock mortar holes, as well as historic metal fragments.

Utility Corridors

Electrical Transmission Line

Records maintained by the THC and TARL, and found in the Texas Archaeological Sites Atlas Database (THC, 2006), indicate that no previously recorded archaeological sites have been identified and no formal archaeological surveys have been conducted of the two proposed transmission line corridors within the ROI.

Water Supply Pipeline

An unspecified percentage of the CCWIS corridor ROI has been previously surveyed, mainly in the portion of the ROI within Monahans Sandhills State Park. Seventeen archaeological sites are located within the ROI, all recorded as prehistoric lithic scatters or campsites in interdunal blowouts. Sites 41WK41 and 41WK42 are within the proposed corridor boundaries. Three of the 17 sites are potentially eligible for SAL designation, but these three sites are not located within the proposed corridor boundaries.

No archaeological survey has been conducted within the Smith corridor and no archaeological sites have been previously identified.

Two previous archaeological surveys encompassed a very small portion of the WTWSS corridor. There are no previously identified archaeological sites within the ROI.

One previous archaeological survey encompassed a very small portion of the Jackson corridor. There are no previously identified archaeological sites within the ROI.

Two previous archaeological surveys encompassed a small portion of the Texland corridor. Site 41AD25 was recorded outside the corridor for the Texland water supply line. The site is recorded as a small prehistoric campsite consisting of burned caliche and lithic debitage.

One previous archaeological survey encompassed a very small portion of the Whatley corridor. There are no previously identified archaeological sites within the ROI.

CO_2 Pipeline

No archaeological survey has been conducted within the ROI for the CO_2 pipeline corridor east of the proposed power plant, and there are no previously identified archaeological sites within its ROI.

No archaeological survey has been conducted within the ROI for the CO_2 pipeline corridor west of the proposed sequestration site, and there are no previously identified archaeological sites within its ROI.

One archaeological survey has been conducted within the ROI for the CO_2 pipeline corridor east of the proposed sequestration site. No archaeological sites were identified within the ROI by that survey and there are no previously recorded archaeological sites elsewhere within the ROI.

7.10.2.2 Historic Resources

There are no documented historic properties listed in or potentially eligible for listing in the NRHP or SAL within the ROI for the proposed power plant site, related areas of new construction (including the proposed transmission line corridors, water supply pipeline corridors, and CO_2 pipeline corridors), or land above the sequestration reservoir. Historical markers in the region identify general areas of historical interest. The area around Penwell is identified as the "Birthplace of Ector County's Oil Boom." Historical markers near the Texland water supply corridor identify the original townsite of Andrews, the Early Settlers of Andrews County, and the resting place of Dorsie M. Pinnel. There is also a historical marker near the Jackson water supply corridor identifying the Town of Goldsmith. There are no historical markers in or near the proposed sequestration site.

7.10.2.3 Native American Resources

No publicly documented TCPs are known to exist within the ROI for the proposed power plant site, related areas of new construction, or land above the sequestration reservoir. Consultation with federally recognized Native American tribes that may have an interest in the project area was initiated by letter on December 6, 2006 (see Appendix A). The following tribes received the consultation letter:

- Apache Tribe of Oklahoma
- The Comanche Tribe of Oklahoma
- The Kiowa Tribe of Oklahoma
- The Fort Sill Apache Tribe of Oklahoma
- The Wichita Tribe of Oklahoma
- The Ysleta Del Sur Pueblo of Texas
- The Mescalero Apache Reservation of New Mexico

Regional Directors for the Bureau of Indian Affairs in the Southern Plains and Southwest Regions also received copies of the consultation letter. The Bureau of Indian Affairs Eastern Oklahoma Regional Office and the Southern Plains Regional Office both responded that they do not have jurisdiction over the alternative sites in Texas (see Appendix A). To date, one Native American tribe has responded to consultation letter. The Ysleta Del Sur Pueblo of Texas has stated that they do not wish to continue receiving information on the project (see Appendix A).

7.10.2.4 Other Cultural Resources

Cemeteries

The presence of cemeteries within the project ROI was determined through an examination of USGS topographic quadrangles, records maintained by the THC and TARL, and Texas Archaeological Sites Atlas Database (THC, 2006). One cemetery was identified within the ROI. The Andrews West County Cemetery is located within the ROI of the proposed Andrews water supply pipeline corridor, but is outside the boundaries of the proposed corridor.

Paleontological Resources

The proposed power plant site and its ROI are within the Texas Permian Basin, an area known to be productive for paleontological remains (UTA, 1996). The ROI is situated on a northwest-southeast trending band of Quaternary alluvium (UTA, 1970) that has elsewhere yielded the remains of extinct megafauna including mammoth, horse, and giant armadillo. The Odessa Meteor Crater NNL is approximately 10 miles (16 kilometers) east of the ROI for the proposed power plant site.

7.10.3 IMPACTS

7.10.3.1 Construction Impacts

Construction impacts to known or unknown cultural resources would be primarily direct and result in earth-moving activities that destroy some or all of a resource. As with any land-disturbing project, the potential for discovery or disturbance of unknown cultural resources exists, particularly in areas with no prior land disturbance. Although consultation with Native American tribes has not revealed TCPs in areas where disturbance could take place, this consultation is ongoing (see Appendix A) and the presence of these resources remains somewhat uncertain. However, before construction, previously unsurveyed areas with a potential for cultural resources would be surveyed. Potential impacts to cultural resources discovered during construction would be mitigated through avoidance or through other measures, including those identified through consultation with the THC or the respective Native American tribes.

Because the ROI is located within a fossil-rich region, there is potential for direct impact to undiscovered paleontological resources. However, because fossil-bearing rock formations are extensive throughout the region, anticipated impacts to unique or irreplaceable paleontological resources are low.

Power Plant Site

Prehistoric archaeological resources in the region are generally located near major drainages or around Pleistocene lakebed margins. Such landscape features are absent in the ROI for the proposed power plant site, and thus prehistoric archaeological sites would not be expected. Miller and Yost (2006) found no historic archaeological sites, standing structures, or cemeteries within the ROI. Therefore, no direct or indirect impacts would be anticipated from construction of the proposed power plant to archaeological or historical resources listed in or eligible for listing in the NRHP or SAL.

Sequestration Site

Monument Draw, Tunas Draw, Sixshooter Draw, and associated tributaries to those draws are present in the ROI for the sequestration site. Such landscape features were a focus of prehistoric occupation; therefore, there would be potential for direct impacts to unrecorded prehistoric archaeological sites in the ROI. Historic structures are not present on USGS topographic maps, suggesting that there is a low potential for historic resources within the ROI and for impact to such resources. In addition, no cemeteries are located within the ROI. Therefore, no direct or indirect impacts would be anticipated from construction activities at the proposed sequestration site to historical resources listed in or eligible for listing in the NRHP or SAL.

Utility Corridors

Water Supply Pipeline

The six proposed water supply corridors range in length from 24 to 59 miles (38.6 to 86.9 kilometers) and cross a variety of landforms and landscape features that have low, moderate, or high potential for prehistoric archaeological sites. Thus, there would be potential for direct impacts to unrecorded prehistoric archaeological sites along each of the six proposed water supply pipeline corridors. In the case of the CCWIS line, a number of prehistoric archaeological sites have been recorded in or near the ROI.

USGS maps also show structures along each of the proposed corridors. If any of those structures are more than 50 years old, they may represent historic resources that could be subject to direct or indirect impacts. A cemetery is located within the ROI of the proposed Texland corridor, but it is located outside of the proposed corridor boundary and would not be directly affected.

Electrical Transmission Line

Neither proposed transmission line corridor crosses landforms or landscape features likely to contain prehistoric archaeological sites, resulting in a low potential for the presence of such sites. Thus, there would be no anticipated direct impacts to prehistoric archaeological sites. No structures are evident within the proposed transmission line corridor north of the proposed power plant and no historic resources would be expected. However, structures are present within the ROI for the proposed transmission line corridor south of the power plant. If any of those structures are more than 50 years old, they may represent historic resources that could be subject to direct or indirect impacts. No cemeteries are present within the ROI.

CO_2 Pipeline

The CO_2 corridor east of the proposed power plant does not cross landforms or landscape features likely to contain prehistoric archaeological sites. Thus there would be no anticipated direct impacts to prehistoric archaeological sites. USGS maps show structures within the ROI for this pipeline, but none are within the proposed corridor boundaries and only a low potential for direct or indirect impacts to historic resources exists. No cemeteries are present.

The CO_2 corridors east and west of the sequestration site cross landforms, including drainages and mesa tops, where potential for the presence of prehistoric archaeological sites exists. Therefore, there would be potential for direct impacts to unrecorded prehistoric sites. USGS maps show structures along the west corridor, but not along the east corridor. If any of the structures along the west corridor are more than 50 years old, they may represent historic resources that could be subject to direct or indirect impacts. No cemeteries are present.

Transportation Corridors

Construction of a new access road to the proposed power plant site is proposed (FG Alliance, 2006d). If the proposed access road crosses high potential landforms such as major drainages that have not been previously surveyed, there would be potential for direct impacts to unrecorded prehistoric archaeological sites and accompanying direct or indirect impacts to historic resources. No construction of off-site rail spurs would be required.

7.10.3.2 Operational Impacts

The potential for impacts to cultural resources related to the proposed FutureGen Project operations would be limited to indirect impacts that could alter the historic character of a resource or its setting. There is minimal potential for direct impacts (e.g., a historic façade becoming coated with dust or ash) as a result of operations. Because there are no known cultural resources in areas where the proposed FutureGen Project operations would take place, no direct or indirect impacts are anticipated.

7.11 LAND USE

7.11.1 INTRODUCTION

This section identifies land uses that may be affected by the construction and operation of the proposed FutureGen Project at the Odessa Power Plant Site, sequestration site, and related corridors. It addresses the existing land use environment as well as potential effects on land uses and land ownership, relevant local and regional land use plans and zoning, airspace, public access and recreation sites, identified contaminated sites, and prime farmland. It also addresses potential effects related to subsurface rights for the proposed sequestration site.

7.11.1.1 Region of Influence

The ROI for land use includes the area within 1 mile (1.6 kilometers) of the boundaries of the proposed Odessa Power Plant Site, sequestration site, and all related areas of new construction, including proposed utility corridors.

7.11.1.2 Method of Analysis

DOE reviewed information provided in the Odessa EIV (FG Alliance, 2006d) and other relevant land use information, including the TPWD website, Federal Aviation Administration (FAA) regulations, and reports related to contaminated sites. DOE also reviewed aerial photographs and made site visits to note site-specific land use characteristics. There are no comprehensive land use plans or zoning ordinances that apply to the proposed power plant site, sequestration site, or utility corridors.

DOE assessed the potential impacts based on whether the proposed FutureGen Project would:

- Introduce structures and uses that are incompatible with land uses on adjacent and nearby properties;
- Introduce structures or operations that require restrictions on current land uses on or adjacent to a proposed site;
- Conflict with a jurisdictional zoning ordinance and a jurisdictional noise ordinance; or
- Conflict with a local or regional land use plan or policy.

7.11.2 AFFECTED ENVIRONMENT

The proposed Odessa Power Plant Site consists of a 600-acre (243-hectare) parcel of land 15 miles (24.1 kilometers) from the City of Odessa in an unincorporated area of south-central Ector County. It is situated approximately 16 miles (26 kilometers) southwest of the City of Odessa and just north of the small, nearly abandoned town of Penwell, Texas. The site is located approximately 158 miles (254 kilometers) south of Lubbock, 160 miles (257 kilometers) west of San Angelo, 180 miles (290 kilometers) southwest of Abilene, and 269 miles (433 kilometers) east of El Paso, Texas.

Located just north of I-20, the site and its environs are in a rural area where land use has historically been and currently is dominated by oil and gas activities and cattle ranching. The plant site and surrounding area are arid, with some dry, intermittent creek beds located in the general vicinity. The nearby town of Penwell, which is located immediately south of the site and the Union Pacific Railroad line that borders the site, was established after an oil discovery in 1929. Penwell's population peaked at a reported 3,000 in 1930–1931, and declined dramatically after the 1930s. The reported 2000 population of Penwell was only 74 individuals (FG Alliance, 2006d). This number appears to be considerably larger than is actually the case; during the site visit on November 29, 2006, DOE personnel noted only a few occupied (and habitable) residences in the town, two on the south side of I-20 and one on the north side of I-20 near the proposed plant site within the remnants of the former Penwell main community. A fourth residence is located in the fields south of I-20 and southeast of the site, near the edge of the 1-mile (1.6-kilometer) ROI. An individual knowledgeable of the project site and town indicated that the population of the town may be as low as 12 (Haner, 2006).

Aerial photographs and USGS topographic maps indicate that there are no permanent surface waters within the proposed power plant site boundaries. The closest significant water body is the Upper Pecos River, located more than 30 miles (48 kilometers) south of the site.

The proposed Odessa Sequestration Site area is located in a semi-arid, sparsely populated area adjacent to (i.e., north and south of) I-10 in Pecos County, Texas. The proposed injection site is located on an approximately 42,320-acre (17,126-hectare) property approximately 58 miles (93.3 kilometers) south of the proposed Odessa Power Plant Site and approximately 3 miles (4.8 kilometers) east of Fort Stockton. DOE personnel observed no more than three residences within the proposed sequestration area during the site visit in November 2006, and only one may actually be located on the land above the sequestration reservoir.

7.11.2.1 Local and Regional Land Use Plans

DOE identified no local or regional land use plans applicable to the proposed Odessa Power Plant Site, sequestration site, or utility corridors.

7.11.2.2 Zoning

DOE identified no local zoning districts or development standards applicable to the proposed Odessa Power Plant Site, sequestration reservoir, or utility corridors.

7.11.2.3 Airspace

There are two public airport facilities located within a 25-mile (40-kilometer) radius of the proposed Odessa Power Plant Site. The closest public airport is the Odessa-Schlemeyer Airport, located approximately 17 miles (27 kilometers) from the site at 7000 Andrews Highway in Odessa. The next closest airport is the Roy Hurd Memorial Airport, located 22 miles (35 kilometers) from the site at the intersection of I-20 and Loop 464 between Thorntonville and Monahans. The primary airport in the region is the Midland International Airport. Midland International is located 36 miles (58 kilometers) east-northeast of the proposed Odessa Power Plant Site.

The nearest airport to the sequestration site or any of the utility corridors is Andrews County Airport, which is located just east of the town of Andrews, approximately 2 miles (3 kilometers) east of the Texland water line corridor and 4.5 miles (7.2 kilometers) east of the Jackson water line corridor.

Because the proposed project would include a 250-foot (76-meter) heat recovery steam generator (HRSG) stack and 250-foot (76-meter) flare stack at the power plant site, DOE reviewed FAA regulations to determine their applicability to the project. In administering 14 CFR Part 77—Objects Affecting Navigable Airspace—the prime objectives of the FAA are to promote air safety and the efficient use of the navigable airspace. Pursuant to 14 CFR Part 77, the FAA must be notified if any of the following construction or alteration is being examined:

(1) Any construction or alteration of more than 200 feet (61 meters) in height above the ground level at its site.

(2) Any construction or alteration of greater height than an imaginary surface extending outward and upward at one of the following slopes:

(i) 100 to 1 for a horizontal distance of 20,000 feet (6,096 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with at least one runway more than 3,200 feet in actual length, excluding heliports; or

(ii) 50 to 1 for a horizontal distance of 10,000 feet (3,048 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with its longest runway no more than 3,200 feet (975 meters) in actual length, excluding heliports (14 CFR 77).

7.11.2.4 Public Access Areas and Recreation

According to the TPWD website, there are no recreational areas within the proposed power plant site or its associated ROI (FG Alliance, 2006d). However, DOE personnel noted the West Texas Raceway Park, a public drag strip and raceway, during the November 2006 site visit in Penwell along FM 1601 on the south side of I-10, approximately 0.8 mile (1.3 kilometers) southeast of the plant site. Reportedly, this track was at one point the most active such drag strip in this part of Texas, and is now used approximately 6 months out of the year (Haner, 2006; Vest, 2006). This drag strip is also within the ROI of the potential southern electrical transmission line corridor.

The TPWD website identified one recreational area within the northern part of the ROI of the Texland water line corridor (FG Alliance, 2006d) near the proposed Texland water source. This is presumed to be Florey Park, an Andrews County park, located 8 miles (13 kilometers) north of the town of Andrews on U.S. Interstate Highway 385 (I-385). This 17-acre (7-hectare) park is Andrews County's largest multi-use facility, with 24 full hook-up camp sites and 218 sites with water and electricity, two volleyball courts, a basketball court, a tennis court, and a croquet court (Andrews County, 2006).

DOE personnel observed one recreational area within the land above the proposed sequestration reservoir. This is a roadside picnic area along westbound I-10 at the junction of SR 67 (Exit 273 on I-10). Identified on some maps as "Fourteen Mile Park," this area is essentially a highway pull-off rest stop with four individual, canopied picnic tables with barbeque grills and trash cans. There are no other facilities (e.g., restrooms) at this picnic area.

7.11.2.5 Contaminated Sites

Horizon Environmental Services, Inc., performed a Phase I Environmental Site Assessment on the proposed Odessa Power Plant Site in April 2006 (Horizon Environmental Services, 2006). The results of that investigation do not indicate any significant recorded or observed soil contamination on the proposed Odessa Power Plant Site. In addition, a review of state records indicates that there is no known groundwater contamination on or within 1 mile (1.6 kilometers) of the proposed power plant site (TGPC, 2005). Individuals familiar with the site for many years indicated they were not aware of any large spills, leaks, or other events that could have potentially contaminated soil or groundwater (Haner, 2006). However, given the widespread and historic use of land on the site and in the majority of the utility corridors for petroleum and gas production, it is possible that oil or chemical leaks from this production and pipeline transfer have occurred on the site or within the corridors over the years.

7.11.2.6 Land Ownership and Uses

Power Plant Site

As noted above, the proposed 600-acre (243-hectare) Odessa Power Plant Site is located in a rural area where land use has been dominated historically by ranching and oil and gas activities. The site contains unimproved roads and structures related to oil and gas well activities. Several pipelines and overhead electric distribution lines also traverse its boundaries. The aerial photograph in Figure 7.11-1 shows the general land use on the site and within the ROI.

The property within the proposed Odessa Power Plant Site boundary is wholly owned by a single property owner. Various utility and oil/gas companies have easements or access to subsurface oil and gas resources on the site as well. Within the proposed power plant site ROI are lands owned by 11 major property owners, including Texas Pacific Land Trust, Ector County Sheriff's Department, Rhodes and Sons Land Company, Quell Petroleum Services, the University of Texas, and others. More than 200 minor property owners have holdings within the ROI in and around the town of Penwell.

Historical aerial photographs of the proposed Odessa Power Plant Site indicate that the site has changed little since 1954, with the exception of oil and gas activities beginning in the 1980s. The entire site consists of scrub rangeland. The site is located within an area of relatively high oil and gas well development, particularly on adjacent lands to the south and west. Railroad Commission of Texas (RCT) records indicate that six permitted or developed natural gas and oil wells are located on the proposed Odessa Power Plant Site; however, individuals familiar with the site indicated that only one oil well and one gas well on the site itself are active as of late November 2006 (Haner, 2006). In addition, at least 218 permitted or developed oil and gas wells are present within the ROI. One crude oil pipeline system, one natural gas pipeline system, and one condensate pipeline system traverse the proposed power plant site at various locations. In addition to these pipeline systems, at least three other crude oil pipeline systems, one other natural gas pipeline system, and one refined products pipeline system are found within the ROI. Historical aerial photographs do not reveal that any other structures or improvements were historically present on the proposed power plant site (Horizon Environmental Services, 2006).

TWDB records revealed two documented water wells within the ROI (FG Alliance, 2006d). The nearest of these two wells is located along the north side of the Union Pacific Railroad track near the southwestern corner of the proposed power plant site boundary. There is no evidence of water wells on the proposed power plant site.

As noted previously, only three occupied (and habitable) residences remain in the town of Penwell, which is now essentially a ghost town. A fourth ranch house is located in the fields south of I-20 and southeast of the site, near the edge of the 1-mile (1.6-kilometer) ROI. Several businesses are still operating in the town within the plant site ROI: Rhodes Welding Company (construction, welding, scrap dealing), Holloman (utility and pipeline construction, who were reportedly leaving the area in December 2006), Quinn Pumps (service and repair of oil equipment pumps), the U.S. Postal Service's Penwell Post Office, West Texas Raceway Park, and Energen Resources' East Penwell San Andres Unit (i.e., oil field) office. Only Rhodes Welding and Quinn Pumps are located in the former main part of Penwell near the proposed plant site.

Sequestration Site

The sequestration site is located in a remote rural area where land use has been dominated historically by ranching and oil and gas activities, although relatively fewer oil and gas activities are visible in the vicinity of the sequestration reservoir compared to the northern portion of the project area. The area straddles I-10, with the majority of the area situated south of the interstate. Several pipelines traverse the area. The land above the sequestration reservoir is owned entirely by the University of Texas. Various companies have oil and gas leases on some of the University lands in the area, but these appear to be outside the land area above the sequestration reservoir.

Recent aerial photography indicates that the area has seen little commercial growth with the exception of oil and gas activities beginning in the 1980s. The majority of the area consists of scrub rangeland with a very low population density. During a site visit on November 30, 2006, DOE personnel observed one ranch house in the vicinity of University Road in the western portion of the sequestration reservoir area, several miles south of I-10. Two or three other residences and livestock ranches or companies occur along Rural Road 2023 near the southeastern-most area of the sequestration reservoir, but these may actually be outside of the land area above the sequestration reservoir.

A minimum of 14 permitted or developed natural gas and oil wells exist within the land area above the proposed sequestration reservoir. A minimum of 11 natural gas pipeline systems exist within or across from the area. TWDB records indicate a minimum of 11 documented water wells occurring within the area (FG Alliance, 2006d).

No cemeteries, churches, libraries, schools, prisons, nursing homes, hospitals, recreational areas (other than the previously mentioned roadside picnic area along I-10), or historic areas are shown on USGS topographic maps, and none were observed during the November 2006 site visit. The only nearby area of relatively high population density is the previously mentioned town of Fort Stockton, Texas, located at least 10 miles (16 kilometers) west of the sequestration area along I-10.

The University of Texas, which has the surface rights to the land above the proposed Odessa Sequestration Reservoir, has historically provided access for subsurface activities (e.g., seismic surveys, pipeline construction, well drilling, and well operations) on these lands through easements (FG Alliance, 2006d). Complete title searches for subsurface rights at the injection sites, proposed Odessa Sequestration Reservoir, and a 0.25-mile (0.4-kilometer) buffer, including questions of who owns the rights to the reservoir and what those specific rights are, have not been researched for inclusion in this EIS. Entities with potential property rights include the land surface owners (i.e., the University of Texas), mineral and resource interest owners, royalty owners, and reversionary interest owners (that is, owners of an interest in a reservoir that becomes effective at a specified time in the future [de Figueiredo et al., 2005]). The University has indicated, however, that it would grant a 50-year lease for the land at the sequestration site, and subsurface monitoring access in perpetuity (FG Alliance, 2006d). Mineral and resource rights are discussed in further detail in Section 7.4.

Utility Corridors

Based on a review of topographic maps, the Odessa EIV (FG Alliance, 2006d) includes information concerning the additional land uses, including undifferentiated structures, pipelines, permitted or developed gas and oil wells, water wells, sensitive receptors, and major road crossings, that could occur in the utility corridor ROIs. Table 7.11-1 describes a summary for the potential electric transmission line, process water supply, and CO_2 corridors and ROIs.

Table 7.11-1. Comparison of Land Uses Within the Potential Utility Corridors.

Corridor	Total Length (miles [kilometers])	Structures	Gas/Oil/CO_2 Pipelines	Gas/Oil Wells	Water Wells	Sensitive Receptors[1]	Major Roads[2]
Electric Transmission Lines							
North	0.7 (1.1)	7	2	51	0	0	0
South	1.8 (2.9)	99	7	264	7	1	1
Process Water Pipelines							
CCWIS	28 (45.1)	179	9	1,103	43	1	2
Smith	26 (41.8)	7	22	192	13	1	0
WTWSS	37 (59.5)	147	25	838	66	1	3
Jackson	54 (86.9)	606	36	2,496	93	1	6
Texland	49 (78.9)	392	43	2,709	141	2	5
Whatley	24 (38.6)	173	16	1,234	28	1	3
CO_2 Pipelines							
East of Plant	2 (3.2)	61	11	113	8	1	0
East of CO_2 Res.	7 (11.3)	5	8	37	7	0	0
West of CO_2 Res.	5 (8.0)	4	4	5	1	0	0

[1] Sensitive Receptors = cemeteries, churches, libraries, schools, prisons, nursing homes, hospitals, recreational areas, or historic areas.
[2] Major Roads = State or County Roads.
Source: Compiled from FG Alliance, 2006d.

Electric Transmission Line Corridors

The electric transmission line corridor north of the proposed Odessa Power Plant Site extends from the plant site northward approximately 0.7 miles (1.1 kilometers) through scrubland, while the southern corridor extends from the plant site southward approximately 2 miles (3.2 kilometers), generally following FM 1601. Both corridors and ROIs are located in remote rural areas where land use has been dominated historically by ranching and oil and gas activities (Horizon, 2006). The ROIs each cross one unimproved road related to oil and gas well activities, while the southern corridor crosses I-20. Both ROIs are located in areas of extensive oil and gas well development, and several pipelines also traverse the ROIs. Gas and oil wells, water wells, and a few structures are located within the ROI of both corridors, but the majority of any non-oil/gas development is located within the southern ROI along FM 1601 and in the town of Penwell, including three or four residences and approximately four businesses. The town of Penwell is located within the ROIs of both corridors near the proposed Odessa Power Plant Site. As indicated previously, as of November 2006 only three residences were noted to exist on either side of I-20 in Penwell. As noted in the Table 7.11-1, topographic maps identify approximately 99 undifferentiated residential and commercial structures, including one church, existing within the ROI of the southern corridor (FG Alliance, 2006d). However, DOE concludes that this number is likely substantially overstated based on the current status of the town of Penwell, which is virtually abandoned. In addition, the identified church (Penwell Church) may not exist, and was not located by DOE personnel during the November 2006 site visit.

Process Water Pipeline Corridors

Of the six potential water supply pipeline corridors, three (Jackson, Texland, and Whatley) extend northward from the plant site through Ector and Andrews counties, with the proposed Jackson line supply field located just into Gaines County; two (WTWSS and Smith) extend westward through Ector and Winkler counties; and one (CCWIS) extends southwestward through Ector, Winkler, and Ward counties. As with most of the general project area, these lines and their ROIs are located in a remote rural area where land use has been dominated historically by ranching and oil and gas activities (Horizon Environmental Services, 2006). They generally cross a few county roads or state roads, as well as a number of unimproved roads, many of which are related to oil and gas well activities. Pipelines (including oil, gas, and CO_2) are located throughout the potential water line corridors and their ROIs, as shown in Table 7.11-1.

As shown in Table 7.11-1, the northern lines (Jackson, Texland, and Whatley) generally have the highest number of wells, pipelines, roads, and structures. The towns of Wickett, Thorntonville, and Monahans are located along I-10, well south of the CCWIS line ROI. The town of Goldsmith (population 253), which is located just west of the proposed Jackson corridor, represents the area of highest population density within the Jackson line ROI. Goldsmith is also located near the Whatley and Jackson lines, but the town appears to be well outside the ROI for either of these lines. The town of Andrews (population 9,652) is located just east of the proposed Texland corridor boundary and is the area of highest population density within the Texland line ROI. Andrews has a minimum of 14 public and private schools, two libraries, 41 churches, and one general hospital (FG Alliance, 2006d). One recreational area, the previously mentioned Florey Park campground facility, is located within the Texland ROI. The towns of Magwalt and Kermit are located in the general vicinity of the WTWSS line ROI, but their corporate boundaries do not extend into the ROI.

CO_2 Pipeline Corridors

The CO_2 pipeline corridors and ROIs are located in the same rural area where land use has been dominated historically by ranching and oil and gas activities. As shown in Table 7.11-1, the ROIs cross only the occasional unimproved road related to oil and gas well activities. Several pipelines also traverse the ROIs. The pipeline and ROI that would connect the plant with the existing line east of the proposed plant site is located within an area of extensive oil and gas well development. The lines connecting the sequestration reservoir is also in an area of oil and gas development, but by observation appeared less developed for these uses than in the northern part of the project site. As noted in Table 7.11-1, topographic maps depict approximately 61 undifferentiated residential and commercial structures existing within the ROI of the CO_2 pipeline (FG Alliance, 2006d). However, this number is likely substantially overstated based on the current nearly abandoned status of the town of Penwell.

The CO_2 pipeline corridors lie west and east of the proposed sequestration reservoir, extending from existing north-south running CO_2 pipelines west and east of the reservoir area. The proposed corridors are located in Pecos County, south of and parallel to I-10, in areas of little development other than oil and gas activities and ranching. The town of Fort Stockton, Texas, is located 10 to 20 miles (16 to 32 kilometers) west of these lines.

7.11.2.7 Prime Farmland

> The U.S. Department of Agriculture (**USDA**) Natural Resource Conservation Service's (**NRCS**) website defines prime farmland as land that has the best combination of physical characteristics for producing food, feed, forage, and oilseed crops and is available for these uses (NRCS, 2000).

Predominant soils on the proposed Odessa Power Plant Site include Conger Loam, Ratliff Association, and Upton-Reagan Association soils. No prime or unique farmland soils exist on the proposed Odessa Power Plant Site (NRCS, 2006). Within the utility corridors, only two Andrews County soils (Ratliff, gently undulating; and Portales clay loam) found within the Jackson and Texland water line corridors are considered prime when irrigated. No other prime or unique farmland soils are found within the sequestration area or other utility corridors.

7.11.3 IMPACTS

7.11.3.1 Construction Impacts

Power Plant Site

Construction of the FutureGen Project at the proposed Odessa Power Plant Site would have little notable impact on existing land use on the site or within the 1-mile (1.6-kilometer) ROI of the site. The project would require a laydown area for construction equipment and materials and would require construction of a power plant, rail loop, parking area, coal storage site, visitor center, and research and development center. Project construction on the site itself would result in the loss of up to 200 acres (81 hectares) of land currently used for oil and gas activities and cattle ranching. The use of at least one active oil well and one active gas well on the project site would likely be lost or the wells relocated, depending on final design and layout of the facility. Project construction would have only a minor impact on the one residence and two businesses located on the southern side of the Union Pacific tracks near the southern border of the site, related to possible temporary access delays during construction. However, overall land use on these properties would not be affected.

DOE's review of relevant databases identified no contaminated sites on the site or within its ROI. As mentioned previously, however, it is possible that oil or chemical leaks from oil production and pipeline transfer have occurred over the years. If evidence of a leak or spill is identified in soils during construction, project construction would cease while the area is assessed to determine the extent of contamination and to minimize potential health impacts to construction workers. Any such investigations and subsequent remediation, if necessary, would be performed in accordance with appropriate federal and State of Texas regulations.

The one public access/recreational area within the ROI (West Texas Raceway Park) would not be affected by construction at the proposed Odessa Power Plant Site. Because the proposed site is well outside the 20,000-foot (6,096-meter) radius within which FAA Part 77 Airspace Obstruction Analysis is required, and because there is no military restricted use airspace in the vicinity of the proposed site, construction of the power plant would have no notable effect on airspace. However, signal lights would be required atop the HRSG and flare stacks, because FAA regulations require such lighting for any structure of more than 200 feet (61 meters) high (14 CFR Part 77).

Sequestration Site

Construction at the Odessa Sequestration Site would have little direct or indirect impact in terms of the overall land use in the vicinity of the proposed sequestration site (i.e., ranchland and some oil and gas production). Up to 10 acres (4 hectares) would be disturbed for the areas surrounding the injection wells and equipment and access roads needed to reach the injection sites. No other direct or indirect impacts on land uses, including land use plans, airspace, sensitive receptors, public access/recreation, or other uses would be expected.

Utility Corridors

Construction in the proposed pipeline corridors would have temporary, minor effects on land use during the actual construction period due to trenching, equipment movement, and material laydown. The ability to use current lands for their existing uses (primarily cattle ranching and gas and oil development) along each of the utility corridors would be temporarily lost during construction. This would be particularly true for utilities requiring subsurface construction (i.e., water and CO_2 pipelines). Based on their length and estimated number of pipelines, wells, and road crossings in the utility corridors and ROIs (see Table 7.11-1), the Texland and Jackson water lines would likely have the largest temporary impact on existing land uses of any of the water lines. Temporary impacts to mostly scrubland along the 24- to 54-mile (39- to 87-kilometer) potential process water pipeline corridor would occur.

The CO_2 pipeline at the sequestration site would result in minimal temporary impacts on land use than the western line because of its length, wells, and pipelines crossings. The eastern CO_2 line would cause temporary impacts to 7 miles (11 kilometers) of land; whereas, the western line would cause temporary impacts to 0.5 mile (0.8 kilometer) of land. However, either of the lines would result in only minimal impacts on existing land use (ranchland). Neither the southern electric transmission line nor the CO_2 line from the plant would result in any major impacts because they would generally follow existing ROW (FM 1601 and the Union Pacific Railroad line, respectively). Because of the open land, sparse population, and low number of structures located throughout all corridors, it is expected that the underground utilities could be routed in most places to avoid conflicts with any structures other than pipeline or road crossings. After construction is complete, the areas would be regraded and revegetated in accordance with conditions of any applicable permits, and most original land uses should be able to continue.

It is possible that some towns in the near vicinity of the water line corridors (e.g., the town of Andrews near the proposed Texland line) may have specific requirements regarding construction and location of utility lines, but none have yet been identified. Construction of project utilities through any such incorporated areas would be coordinated with the local governments as necessary.

The proposed Odessa Power Plant Site could connect to existing 138-kV transmission lines located within approximately 0.7 miles (1.1 kilometers) north of the site and 1.8 miles (2.9 kilometers) south of the site. Temporary impacts to scrubland would occur depending upon which alternative was chosen. Land permanently lost would be limited to the placement of new utility poles.

Transportation Corridors

Direct and indirect impacts from construction of the proposed transportation infrastructure would be primarily limited to the power plant site and sequestration site, and would be limited to a loss of some existing range and scrub lands. In addition, the Union Pacific Railroad has reportedly agreed to allow an underpass to be constructed beneath the railroad berm along the southern boundary of the power plant site at the intersection of Avenues C and G in Penwell to allow southern access to the site (Haner, 2006; Vest, 2006). The railroad underpass would result in only temporary loss of the use of parts of Avenues C and G during construction. In addition, Ector County has reportedly agreed to allow construction of (or construct themselves) a road that would allow access/egress to the plant site from the north and east, presumably from FM 866 to the east of the site (Haner, 2006; Vest, 2006), which would result in the loss of a small amount of additional range and scrub land.

7.11.3.2 Operational Impacts

Power Plant Site

Operation of the FutureGen Project at the proposed Odessa Power Plant Site, would render up to 200 acres (81 hectares) of existing ranchland generally unusable for other purposes over the plant's lifetime. Up to three oil and gas production wells would be displaced or relocated. However, there would be little notable impact on existing land use in the immediate site vicinity or within the 1-mile (1.6-kilometer) ROI of the site. The remaining 400 acres (162 hectares) on the site could continue to be used for existing purposes. The proposed plant would be generally compatible with overall non-ranchland land use in the vicinity of the plant site (i.e., oil and gas production). Other than three or four residences and a few businesses within the ROI, no other development is present in the area. The lands associated with these residences and businesses would not be affected during project operation. The nearest large facilities are a Cemex cement plant and a limestone quarry located east of plant site outside of the ROI, both of which are compatible with the proposed power plant. No local or regional land use plans are in place, so no such plans would be affected. No zoning or development standards are in effect, so construction and operation of the project at the proposed Odessa Power Plant Site could proceed without such local approvals.

The one public access/recreational area within the ROI (West Texas Raceway Park) would not be affected by the proposed power plant and could continue operations without impact.

Sequestration Site

Operation of the injection sites would be compatible with the overall land use in the vicinity (i.e., ranchland and some oil and gas production). Less than 10 acres (4 hectares) at the injection site would be unavailable for future ranching or other uses. The Texas Administrative Code (Title 30, Chapter 331) and the State Water Code (Chapter 27) contain requirements relating to underground injection wells and controls. These regulations would need to be adhered to during project construction and operation. No other impacts on land uses, including land use plans, airspace, sensitive receptors, public access/recreation, prime or unique farmland, or other uses would be expected.

As mentioned previously, the University of Texas has indicated that it would grant a 50-year lease for the sequestration activities, and surface and subsurface monitoring access in perpetuity (FG Alliance, 2006d). Any applicable subsurface rights for minerals or oil and gas resources would still need to be acquired or otherwise negotiated.

Utility Corridors

Lands devoted to aboveground utility structures (e.g., electrical transmission towers) would be unavailable for future use as ranchland or other uses, although the remainder of the electrical transmission line corridor could continue to be grazed. Permanent loss of mostly scrubland would occur along the 0.7 to 1.8 mile (0.6 to 1.6 kilometer) transmission line corridor, but only at the pole locations. Depending on the depth below grade of the underground utilities and the need to retain a cleared ROW, it would be likely that most lands above these utilities could continue to be used for ranching and other passive uses. Future subsurface activities (e.g., oil and gas drilling) would not be possible in the immediate utility corridor once the utilities are installed. The use of potential prime farmland areas in Andrews County affected by the Texland and Jackson water lines, if any, could potentially be lost to active farming. No other direct or indirect impacts on land uses, including land use plans, airspace, sensitive receptors, public access/recreation, prime or unique farmland, or other uses would be expected. The Andrews County Airport is located in the general vicinity (i.e., east of) the proposed Texland water line and field, but operation of the line would not interfere with any aircraft activities.

Transportation Corridors

The proposed transportation infrastructure would result in the loss of ranch and scrub land on the power plant site and in areas where access roads are needed to reach the injection sites and utility ROWs. Most or all of the new transportation infrastructure to the power plant site (e.g., railroad spurs and access roads) would occur on the site itself, so additional impacts would be minimal. The additional access road from the east, if built, would result in the loss of ranch and scrub land similar to the other parts of the project. However, if the county constructs the road of their own accord, any land use impacts could be an indirect impact of the project.

7.12 AESTHETICS

7.12.1 INTRODUCTION

This section identifies viewsheds and scenic resources that may be affected by construction and operation of the proposed FutureGen Project at the Odessa Power Plant Site, sequestration site, and related corridors. It addresses the appearance of project features from points where those features would be visible to the general public, and takes into account project characteristics such as light and glare. The distance from which the proposed power plant and associated facilities would be visible depends upon the height of the structures associated with the facilities, including buildings, towers, and electrical transmission lines, as well as upon the presence of existing intervening structures and local topography. Effects on visual resources can result from alterations to the landscape, especially near sensitive viewpoints, or an increase in light pollution.

7.12.1.1 Region of Influence

The ROIs for aesthetic resources include areas from which the proposed Odessa Power Plant Site and all related areas of new construction would be visible. The ROIs are defined as 10 miles (16.1 kilometers) surrounding the proposed power plant site, 1 mile (1.6 kilometers) around the proposed sequestration site and on either side of the proposed electrical transmission line corridor, and immediately adjacent to the proposed underground utility corridors.

7.12.1.2 Method of Analysis

DOE identified land uses and potential sensitive receptors in the ROIs of the proposed power plant site, sequestration site, and utility corridors based on site visits and information included in the Odessa EIV (FG Alliance, 2006d). The EIV includes analyses of 1968-1971, 1974, 1979, 1981, and 1991 topographic maps as well as recent aerial photography (USDA-FSA-APFO, 2004). DOE used two approaches to assess the potential impacts of the proposed FutureGen Project on aesthetic resources. First, DOE applied Geographic Information System (GIS)-based terrain modeling, combined with height information associated with the proposed project facilities (i.e., the 250-foot [76-meter] HRSG stack and 250-foot [76-meter] flare stack), to determine the distance from which the facilities could be seen if there were no intervening structures or vegetation to screen the view. Secondly, DOE considered two artistic concepts of the proposed FutureGen Power Plant to depict a range of aesthetic approaches to the project. One concept is of a typical power plant with minimal screening and architectural design, while the second concept includes extensive screening and architectural design. DOE compared and contrasted the two concepts to assess the relative level of visual intrusiveness for each concept.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect a national, state, or local park or recreation area;
- Degrade or diminish a federal, state, or local scenic resource;
- Create visual intrusions or visual contrasts affecting the quality of a landscape; and
- Cause a change in a BLM Visual Resource Management classification.

7.12.2 AFFECTED ENVIRONMENT

7.12.2.1 Landscape Character

Natural and human-created features that give the landscape its character include topographic features, vegetation, and existing structures. The topography of the proposed Odessa Power Plant Site is flat to slightly sloping in a northeast to southwest direction. Surface elevation ranges from approximately 2,980 to 2,930 feet (908 to 893 meters) above mean sea level (MSL).

The proposed Odessa Power Plant Site (Figure 7.12-1) consists of approximately 600 acres (243 hectares) of open land. The site and its surrounding environs are located in a rural area where land use has been dominated historically by ranching and oil and gas activities. Considerable grazing in the region has created a rather homogenous environment dominated by scrub rangeland interspersed with approximately 50 percent bare ground. The mesquite shrubs that dominate the ROI are approximately 2 to 3 feet (0.6 to 0.9 meters) tall, on average. A more detailed description of the vegetation of the proposed Odessa Power Plant Site is provided in Section 7.9.

The proposed Odessa Power Plant Site contains unimproved roads, a few structures related to oil and gas well activities, pipelines, and overhead electric utility lines. In addition, the Union Pacific Railroad and I-20 parallel the southern edge of the site.

The largely abandoned, historic oil town of Penwell, shown in Figure 7.12-2, is located south of the proposed Odessa Power Plant Site boundaries, but inside the ROI. The town of Penwell began to develop rapidly after J.H. Penn discovered oil in 1929 (TSHA, 2001). Currently, the town has a population of less than 100 people (and perhaps as few as a dozen people [Haner, 2006]) and is composed of three or four residential structures, oil and gas related industrial structures, and several commercial businesses (see Section 7.11). The town is bordered on the north by the Union Pacific Railroad and spreads southward to encompass a post office, residences, and other structures south of I-20. A concrete factory is located approximately 1.5 miles (2.4 kilometers) southeast of the proposed Odessa Power Plant Site.

Figure 7.12-1. Proposed Odessa Power Plant Site

Figure 7.12-2. Town of Penwell

The oil industry has continuously affected the character of the surrounding landscape since the 1920s. Numerous oil well pads and associated industrial structures are still present in the general vicinity of the proposed Odessa Power Plant Site, particularly southwest of the site.

As previously discussed in Section 7.10, no archaeological sites are located on the proposed Odessa Power Plant Site or within its ROI. Additionally, according to the TPWD website, there are no recreational areas within the ROI of the proposed power plant site (TPWD, 2006).

The proposed Odessa Sequestration Site (Figure 7.12-3) is located in a semi-arid, sparsely populated area adjacent to I-10 in Pecos County, Texas. DOE personnel observed no more than three residences within the sequestration site vicinity during the site visit in November 2006, and only one is suspected to be actually located within the ROI.

The related areas of new construction associated with the proposed power plant include two potential transmission line corridors, six potential water supply pipeline corridors, and three potential CO_2 pipeline corridors. The proposed construction corridor ROIs consist primarily of open land similar to the Odessa Power Plant Site ROI; that is, a rather homogeneous environment dominated by scrub rangeland of mesquite shrubs interspersed with about 50 percent bare ground, with a very low population density. Only two or three of the possible water lines would be located anywhere near populated areas. Table 7.11-1 in Section 7.11 summarizes the level of development within the corridors, including structures, pipeline, wells, sensitive receptors, and major roads.

Figure 7.12-3. Proposed Odessa Sequestration Site

With respect to aesthetic resources, the corridors of primary interest are the two potential transmission line corridors, where any new transmission line would be visible at a distance. Both traverse areas devoted to developed natural gas and oil wells (Horizon Environmental Services, 2006). Topographic maps indicate approximately seven structures existing within the ROI of the 0.5-mile (0.8-kilometer) transmission line corridor north of the proposed power plant site, and about 99 structures existing within the ROI of the 1-mile (1.6-kilometer) transmission line corridor south of the proposed power plant site (FG Alliance, 2006d). However, the map sources for this information are more than 15 years old and it is not known how representative they are of current development. For example, the count of 99 structures within the southern transmission corridor includes the town of Penwell, where most structures are abandoned.

No BLM or USFS Visual Resources Management classifications or designated scenic vistas are located within the visual resources ROI (Herrera, 2006).

7.12.2.2 Light Pollution Regulations

Light pollution is defined as the night sky glow cast by the scattering of artificial light in the atmosphere. According to the online database of Texas laws and regulations maintained by Texas Legislation Online (TLO), Texas has three state codes referencing light pollution (TLO, 2006):

- In 2001, Local Government Code Chapter 240, Subchapter B, authorized counties to regulate outdoor lighting in the vicinity of the George Observatory near Houston, Stephen F. Austin University at Nacogdoches, and within a 57-mile (91.7-kilometer) radius of the McDonald Observatory in southwest Texas.

- In 1999, Health and Safety Code Subtitle F, Light Pollution, Chapter 425, stated that all new or replacement state-funded outdoor lighting must be from cutoff luminaries if the rated output of the fixtures is greater than 1,800 lumens.
- In 1995, Transportation Code Chapter 315, Subchapter A, authorized municipalities to regulate artificial lighting and outlined their responsibilities. This did not include unincorporated areas in counties.

These state codes do not apply to the area within the proposed Odessa Power Plant Site or associated ROI. Additionally, within Ector County there are no local ordinances, plans, or goals for light pollution abatement (Smith, 2006).

7.12.3 IMPACTS

7.12.3.1 Construction Impacts

Power Plant Site

During construction at the proposed Odessa Power Plant Site, the residents of the one inhabited residence in Penwell north of I-20 would have a nearly unobstructed view of the construction site and equipment moving on and off the site during the 44-month construction period, which would be a direct short-term impact. Motorists passing by on I-20 would also have an unobstructed view of the construction. With respect to the site layout, the visual impact at the residence in Penwell would be reduced if the facility were laid out such that the less intrusive features, including administrative offices and similar buildings and parking areas, were located nearest the residence, and the more industrial features and coal storage piles were located farthest from the residence.

Sequestration Site

During construction at the proposed Odessa Sequestration Site, motorists passing by on I-10 could potentially view construction at one or more of the well sites, as well as equipment moving on and off the site during the construction of the injection wells, which would be a direct short-term impact.

Utility Corridors

During construction along the proposed process water and CO_2 pipeline corridors, equipment used for trenching, pipe laying, and other construction activities would be visible only to viewers immediately adjacent to the pipeline corridors and construction laydown areas. This would constitute a direct short-term impact on those nearest the corridors during the construction period, which would vary depending upon the number of construction crews and the selected corridor. A single crew laying 1 mile (1.6 kilometers) of pipeline per week (FG Alliance, 2006d) would complete CO_2 pipeline construction in two to seven weeks, and process water pipeline construction in 28 to 54 weeks.

Construction along the electrical transmission line corridor would be visible from within the 1-mile (1.6-kilometer) ROI, including I-20 and FM 1601. This would be a direct short-term impact for the duration of the transmission line construction period, which is estimated to be up to 120 days (FG Alliance, 2006d).

Transportation Corridors

Construction of the railroad underpass near the proposed power plant site would be visible from motorists on I-20 and from those using Avenues C and G during construction, which would be a direct short-term impact for the construction period.

7.12.3.2 Operational Impacts

Power Plant Site

Major equipment for the power plant would include the gasifier and turbines, a 250-foot (76-meter) tall HRSG stack, a 250-foot (76-meter) tall flare stack, synthesis gas cleanup facilities, coal conveyance and storage systems, and particulate filtration systems. Additionally, the project would include on-site infrastructure such as a rail loop for coal delivery, plant roads and parking areas, administration buildings, ash handling and storage facilities, water and wastewater treatment systems, and electrical transmission lines, towers, and a substation.

Once construction is complete, the tallest structures associated with the proposed Odessa Power Plant Site would include the main building, stacks, and communications towers. The maximum proposed height of the facility is 250 feet (76 meters). People in the three or four Penwell residences located near the proposed Odessa Power Plant Site, as well as those located farther north and south of the site, would have a nearly unobstructed view of the power plant. DOE's terrain analysis indicates that the facility would be visible for a distance of 7 to 8 miles (11.3 to 12.9 kilometers).

For those viewing the plant from the adjacent roads or nearby residences, or from a greater distance, the appearance of the facilities would depend upon the degree of architectural development and visual mitigation included in the design. Figures 7.12-4 and 7.12-5 show two points on a range of conceptual IGCC plant designs. Figure 7.12-4 is an artist's rendering of an IGCC facility proposed for Orlando, Florida (DOE, 2006a). This rendering shows a plant with minimal screening or enclosure of the facility components. Figure 7.12-5 is the artist's conceptual design of the proposed FutureGen Power Plant that was used during the scoping process for this EIS (DOE, 2006b). This rendering shows a plant with a high degree of architectural design, including enclosure of most of the plant features.

The proposed facility is still in the design stage, and decisions have not yet been made about the final configuration or appearance of the power plant. A plant design similar to Figure 7.12-4 would create a more industrial appearance. Although still very large in scale, a plant design similar to Figure 7.12-5 would have a less industrial appearance, and would be visually less intrusive than the plant design shown in Figure 7.12-4. As noted above in Section 7.12.3.1, the visual impact at nearby residences would be reduced if the facility were laid out such that the less intrusive features, including administrative offices and similar buildings and parking areas, were located nearest the residences, and the more industrial features and coal storage piles were located farthest from the residences.

Regardless of the final appearance of the proposed power plant, plant lighting and the flare would be highly visible at night, especially from the few nearby residences. The lights would likely be visible for approximately 7 to 8 miles (11.3 to 12.9 kilometers) or more at night. The facility, including the vapor plumes, would likely be visible for a comparable distance. Intervening buildings, vegetation, and topography would reduce the visibility of the plant from some vantage points.

Because there are no BLM visual resource management classifications or designated scenic vistas in the power plant site, sequestration site, or transmission line ROIs, the project would not have any effect on those classifications. Additionally, because there are no light pollution standards applicable in the area, the plant would create no conflict with such standards. Nonetheless, the choice of appropriate outdoor lighting and the use of various design mitigation measures (e.g., luminaries with controlled candela distributions, well-shielded or hooded lighting, directional lighting) could reduce the amount of nighttime glare associated with the plant lighting.

Sequestration Site

Once construction is complete, the tallest structures associated with the proposed Odessa Sequestration Site would be about 10 feet (3.0 meters) tall. Some wellheads would be visible to those passing by on the adjacent roads, but would not be visible from a distance. Thus, the project would create a direct, minor visual intrusion for those nearest the site.

Utility Corridors

Once construction is complete, the pipeline corridors would be returned to their pre-construction condition and would have essentially the same appearance as before construction. However, pump stations or compressor stations that could be associated with proposed pipelines would be noticeable to those traveling on adjacent roads.

On the proposed transmission line corridor, the visibility of the line would depend upon the size and height of structures that would be needed. The southern transmission line corridor passes directly adjacent to the town of Penwell on FM 1601, and the line would be permanently visible to the few residents there, creating a long-term direct impact.

Transportation Corridors

Once construction at the railroad underpass is complete, the transportation corridors would appear similar to other transportation infrastructure already in place, and there would be no additional visual impact. Operation of the power plant would result in pump stations and compressor stations on the sequestration site that would be noticeable to those traveling on adjacent roads.

7.13 TRANSPORTATION AND TRAFFIC

7.13.1 INTRODUCTION

This section discusses the roadway and railroad networks that may be affected by the construction and operation of the proposed FutureGen Project at the Odessa Power Plant Site.

7.13.1.1 Region of Influence

The ROI for the proposed Odessa Power Plant Site includes roadways within a 50-mile (80.5-kilometer) radius of the boundaries of the site (see Figure 7.13-1). The proposed Odessa Power Plant Site is bordered on the south by I-20. The subject site is located approximately 15 miles (24.1 kilometers) southwest of Odessa. The proposed Odessa Power Plant Site contains unimproved roads and structures related to oil and gas well activities. Because all vehicle trips to the site would be via FM 1601 from the I-20 interchange, the analysis focuses on the 1-mile (1.6-kilometer) corridor of collector-distributor roads along I-20, which passes through Odessa.

7.13.1.2 Method of Analysis

DOE reviewed information provided in the Odessa EIV (FG Alliance, 2006d), which characterizes elements in the roadway hierarchy within the ROI based on function (e.g., city street and rural arterial), traffic levels, and observed physical condition. The EIV also includes traffic data obtained from the Texas Department of Transportation (TxDOT). The number of vehicle trips generated during construction and operations was based on data provided in the Odessa EIV (FG Alliance, 2006d).

LOS is a qualitative measure that describes operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000).

Traffic impacts were assessed using the planning methods outlined in the Transportation Research Board's "2000 Highway Capacity Manual" (2000 HCM) (TRB, 2000), which assigns a level of service (LOS) to a particular traffic facility based on operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000); and The American Association of State Highway and Transportation Officials' (AASHTO) "A Policy on the Design of Highways and Streets" (the Green Book) (AASHTO, 2004), which describes LOS in more qualitative terms. The Green Book defers to the 2000 HCM to define LOS by facility type. The measures of effectiveness to assign LOS vary depending on the traffic facility. Highway Capacity Software Plus (HCS+) was used to perform capacity analysis.

For two-lane highways, the measure of effectiveness in assessing operations is the percent of time spent following another vehicle. LOS A through LOS F are assigned to a facility based on this measure of effectiveness. The LOS depends on the Highway Class (I or II), lane and shoulder widths, access-point density, grade and terrain, percent of heavy vehicles, and percent of no-passing zones within the analysis segment. Class I highways, according to the 2000 HCM, are highways where a motorist expects to travel at relatively high speeds. They are typically primary links in a state or national highway network and serve long-distance trips. A Class II highway typically operates at lower speeds and most often serves shorter trips. Class II also includes scenic or recreational routes. Table 7.13-1 defines each LOS category for Class I and II two-lane highways.

Table 7.13-1. Level of Service Criteria, Two-Lane Highways

LOS	Class I Two-Lane Highway		Class II Two-Lane Highway
	Percent Time Spent Following Another Vehicle	Average Travel Speed (mph [kmph])	Percent Time Spent Following Another Vehicle
A	< 35	>55 (88.5)	< 40
B	> 35 - 50	> 50 - 55 (80.5 – 88.5)	> 40 - 55
C	> 50 - 65	> 45 - 50 (72.4 – 80.5)	> 55 - 70
D	> 65 - 80	> 40 - 45 (64.4 – 72.4)	> 70 - 85
E	> 80	≤ 40 (64.4)	> 85

LOS F applies whenever the flow rate exceeds the capacity of the highway segment.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For multi-lane highways, the primary measure of effectiveness is density, measured in passenger cars per mile per lane. The traffic density is based on the free-flow speed, ranging from 45 to 60 mph (72.4 to 96.6 kph). The LOS depends on the lane width, lateral clearance, median type, number of access points, free-flow speed, and percent of heavy vehicles. Table 7.13-2 defines the LOS criteria for each free-flow speed on a multi-lane highway.

Table 7.13-2. Level of Service Criteria, Multi-Lane Highways

Free-Flow Speed (mph [kmph])	Criterion	LOS				
		A	B	C	D	E
60 (96.6)	Maximum density (pc/mi/ln)	11	18	26	35	40
55 (88.5)		11	18	26	35	41
50 (80.5)		11	18	26	35	43
45 (72.4)		11	18	26	35	45

LOS F is not included in the table; vehicle density is difficult to predict due to highly unstable and variable traffic flow.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For basic freeway segments, the measure of effectiveness is density, measured in passenger cars per mile per lane. The LOS depends on the lane width, lateral clearance, number of lanes, interchange density, free-flow speed, and percent of heavy vehicles. Table 7.13-3 defines the LOS criteria for each free-flow speed.

The Green Book describes LOS in qualitative terms as follows: LOS A represents free flow, LOS B represents reasonably free flow, LOS C represents stable flow, LOS D represents conditions approaching unstable flow, and LOS E represents unstable flow; and LOS F represents forced or breakdown flow (AASHTO, 2004).

Table 7.13-3. Level of Service Criteria, Basic Freeway Segments

LOS	Passenger Cars Per Mile Per Lane
A	0 – 11
B	>11 – 18
C	>18 – 26
D	>26 – 35
E	>35 – 45
F	>45

LOS = Level of Service.
Source: TRB, 2000.

No information is available for turning movements at specific intersections within the ROI. Therefore, intersection LOS has not been estimated for this analysis. However, DOE identified key intersection and evaluated the LOS qualitatively based on relative traffic volumes on intersecting roadways.

Though there are accident reduction factors that can be used to estimate a reduction in crashes based on a specific type of highway improvement, there are no methods available for estimating the increase in crashes due to increased roadway volume. In addition, specific recent accident data for the roadways around the proposed Odessa Power Plant Site are not available. DOE qualitatively assessed potential safety impacts in this analysis.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Increase traffic volumes as to degrade LOS conditions on roadways;
- Alter traffic patterns or circulation movements;
- Alter road and intersection infrastructure;
- Conflict with local or regional transportation plans;
- Increase rail traffic compared to existing conditions on railways in the ROI; and
- Conflict with regional railway plans.

7.13.2 AFFECTED ENVIRONMENT

7.13.2.1 Roads and Highways

The proposed Odessa Power Plant Site is located approximately 15 miles (24.1 kilometers) southwest of Odessa in Ector County, Texas. The proposed Odessa Power Plant Site is located along FM 1601, north of the Union Pacific Railroad ROW, and approximately 0.5 mile (0.8 kilometer) north of I-20 (Figure 7.13-2).

The proposed Odessa Sequestration Site is located in a sparsely populated area adjacent to I-10 in Pecos County, Texas, 58 miles (93.3 kilometers) south of the proposed Odessa Power Plant Site, 3 miles (4.8 kilometers) east of Fort Stockton, and about 60 miles (96.6 kilometers) south of the Midland-Odessa International Airport. Access to the site would be via I-10.

TxDOT Highways/Roadways

Primary access to the proposed Odessa Power Plant Site would be provided via the I-20 corridor, which runs east-west. I-20 is designated as a Functional Class 1-rural freeway. It is also on the Department of Defense (DoD) Strategic Highway Network (STRAHNET), providing defense access, continuity, and emergency capabilities for movement of personnel and equipment. I-20 is also designated by DOE as the Hazardous Material Route for the Waste Isolation Pilot Plant site, situated west of the proposed Odessa Power Plant Site in New Mexico (FG Alliance, 2006d). The State of Texas does not have truck route designations for their highway or roadway network.

The posted speed on I-20 in the vicinity of the proposed power plant site is 70 mph (112.7 kmph). There is currently a simple diamond interchange at the junction of I-20 and FM 1601. I-20 is accessed via four ramps connecting its main lanes to the parallel, two-way frontage roads existing on the north and south sides. The frontage roads have at-grade intersections with FM 1601. The vertical clearance for FM 1601 under I-20 overpass structures is 18 feet (5.5 meters), 7 inches (17.8 centimeters), which exceeds the TxDOT Bridge Design Standards minimum requirement of 16 feet (4.9 meters), 6 inches (15.2 centimeters) (FG Alliance, 2006d).

The nearest improved road providing access to the proposed power plant site is FM 1601, which borders the site and is both in excellent condition and rated to carry any trucks that would be required to enter the facility (FG Alliance, 2006d). FM 1601 terminates south of the Union Pacific ROW. Therefore, access to the proposed Odessa Power Plant Site would require northerly extension of FM 1601 across the Union Pacific ROW. TxDOT would participate jointly in a public/private partnership to prioritize and extend FM 1601 north of its current terminus (FG Alliance, 2006d). Ector County has agreed to build an additional access road to the proposed site on the eastern side of the property from FM 866 if the site is selected for the proposed FutureGen Project (FG Alliance, 2006d).

Key intersections in the vicinity of the proposed plant site include:

- I-20 North Connector-Distributor (C-D) Road and FM 1601; and
- I-20 South C-D Road and FM 1601

Programmed Transportation Improvements

Neither capacity improvement work nor funding is currently programmed by TxDOT at this location (FG Alliance, 2006d).

7.13.2.2 Railroads

Texas ranks second nationally in the number of freight railroads (40) (TxDOT, 2005). The Surface Transportation Board categorizes rail carriers into three classes based upon annual earnings. The earnings limits for each class were set in 1991 and are adjusted annually for inflation.

Class I – Gross annual operating revenues of $277.7 million or more

Class II – Non-Class I railroad operating 350 or more miles and with gross annual operating revenues between $40 million and $277.7 million

Class III – Gross annual operating revenues of less than $40 million

Texas has three major Class I railroads for long distance or interstate freight shipments. One of these Class I railroads, the Union Pacific, has a railway running along the southern border of the proposed Odessa Power Plant Site. This rail line offers access to resources in Mexico, Wyoming, the West Coast, Midwest, Gulf Coast, and Appalachia.

Union Pacific's track elevation within the ROI ranges from 0.5 to 0.6 mile (0.8 to 1.0 kilometer) above MSL. The track elevation at the proposed Odessa Power Plant Site is approximately 0.5 mile (0.8 kilometer) AMSL (FG Alliance, 2006d). The maximum track grade within the ROI is 1 percent. Union Pacific serves the coal-rich PRB in Wyoming and coal fields in Illinois, Colorado, and Utah, transporting more than 250 million tons (226.8 million metric tons) of coal annually (FG Alliance, 2006d).

Union Pacific's track structure within the ROI is Federal Railroad Administration Class 5, suitable for 70-mph (112.7-kmph) operation (FG Alliance, 2006d). However, coal cars can only operate at a maximum of 50 mph (80.5 kmph) per timetable (FG Alliance, 2006d). Rail and ties were re-laid within the ROI during 2002 and 2003. The rail is 136 pounds (61.7 kilograms) and continuous-welded (FG Alliance, 2006d). The track structure has a gross weight capacity of 286,000 pounds (129,727 kilograms) per rail car; however, it can vary depending on the type of railcar loaded (e.g., varying number of axles and spacing, and speed at which load would be handled) (FG Alliance, 2006d). Union Pacific operates trains through the ROI 24 hours per day for the entire year (FG Alliance, 2006d).

Because FM 1601 terminates south of the Union Pacific ROW, access to the proposed Odessa Power Plant Site would require northerly extension of FM 1601 across the Union Pacific ROW. Based on the needs of the proposed Odessa Power Plant Site, construction of either an at-grade or a grade-separated railroad crossing would be required, subject to negotiations with and approval by Union Pacific (FG Alliance, 2006d).

7.13.2.3 Local and Regional Traffic Levels and Patterns

Regional Traffic

The average daily traffic (ADT) volume along I-20 just east of the I-20/FM 1601 interchange was 14,640 vehicles per day (vpd) in 2005. The 2005 ADT on FM 1601 was 690 vpd (FG Alliance, 2006d). Typically, morning and afternoon peak hour volumes range from 8 to 12 percent of the ADT. Peak hour truck percentages are typically slightly lower than the daily truck percentage because truckers generally travel in off-peak hours (Table 7.13-4). However, to be conservative, DOE maintained the existing daily truck percentages for this analysis.

Table 7.13-4. 2005 Average Daily and Peak Hour Traffic Volumes

Roadway	ADT (vpd)	Truck ADT[1] (vpd)	Weekday Peak Hour Volume[2] (vph)	Weekday Peak Hour Truck Volume[2] (vph)	LOS[3]
I-20	14,690	1,469	1,469	147	A
FM 1601	690	69	69	7	A

[1] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
[2] DOE estimate of peak hour volume and LOS assumes peak hour equals 10 percent of ADT.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.
Source: FG Alliance, 2006d.

The ADT volumes translate to LOS A for both I-20 and FM 1601, and both would have ample capacity to accommodate any future traffic increase. Based on the existing roadway LOS reported in Table 7.13-4, the key intersections near the proposed Odessa Power Plant Site should all be operating at LOS A.

Truck Traffic

No truck traffic volumes were available for I-20 and FM 1601 adjacent to the site. DOE assumed that the existing volumes include 10 percent trucks. Based on this assumption, in 2005 there were approximately 1,469 trucks per day using I-20, and approximately 69 trucks per day using FM 1601. These roadways are designed to carry this level of truck traffic.

Rail Traffic

The proposed Odessa Power Plant Site would be served by the Union Pacific Railroad, which borders the site to the south. The Union Pacific Railroad operates 13 to 21 trains per day in the vicinity of the proposed Odessa Power Plant Site seven days a week for the entire year (Walden, 2006).

In order to establish a new at-grade railroad crossing, a petition would need to be filed with the Interstate Commerce Commission (ICC) by either the railroad (or the track owner), the Local Roadway Authority, or TxDOT. It is ICC policy to require signals and gates (at a minimum) if permission is granted to install a new at-grade railroad crossing. The petitioner is generally assessed all installation costs. Alternatively, an underpass would be constructed beneath the railroad berm along the southern boundary of the proposed power plant site to provide vehicle access to the proposed site (FG Alliance, 2006d).

7.13.3 IMPACTS

7.13.3.1 Construction Impacts

Power Plant Site

Based on the necessary permitting and design requirements, DOE expects that the earliest year that construction would begin on the proposed power plant and related infrastructure is 2009 (FG Alliance, 2006e). Table 7.13-5 shows 2009 No-Build traffic volumes, which DOE projected to the construction year by applying a background growth rate of 0.5 percent per year to 2005 volumes. DOE determined this growth rate by reviewing TxDOT project study documentation (TxDOT, 2006a, 2006b).

Table 7.13-5. 2009 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[1,2] (vpd)	Weekday Peak Hour Volume[1] (vph)	Weekday Peak Hour Truck Volume[1,2] (vph)	LOS[3]
I-20	14,986	1,499	1,499	150	A
FM 1601	704	70	70	7	A

[1] DOE estimate based on 1 percent growth per year from 2005.
[2] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Based on the 2009 No-Build volumes, DOE estimated each roadway's capacity (Table 7.13-5). Because there is no predicted change in the roadway LOS between the 2005 existing conditions and 2009 No-Build conditions, DOE concluded that there would be no change in LOS at key intersections near the proposed Odessa Power Plant Site. All intersections are expected to continue to operate at LOS A under the No-Build condition.

Over a 44-month construction period (2009 to 2012), the construction workforce is estimated to average 350 workers on a single shift (FG Alliance, 2006e), with a peak of 700 workers. DOE assumed that 100 percent of the construction workforce would likely arrive at the proposed construction site in single-occupant vehicles. The analysis of construction conditions also assumes the peak period of construction in order to estimate the highest load of potential impact during construction.

Given the proposed site's location approximately 15 miles (24.1 kilometers) west of Odessa, which is 50 percent of the Midland/Odessa metropolitan area, DOE expects a majority of workers to come from the Odessa area via I-20. The balance of trips would come to the proposed site via I-20 from the west. DOE assumes that access to the proposed site would be provided via an improved FM 1601 (FG Alliance, 2006d).

DOE assumed that the construction workforce would work a 10-hour workday, five days per week. Construction work force trips would generally occur before the morning peak hours (7:00 am to 9:00 am) and coincide with the afternoon peak hours (4:00 pm to 6:00 pm). It is unlikely that many if any trips would occur during mid-day because construction workers typically do not leave a job site during the 30-minute lunch period.

Based on these construction workforce estimates, DOE estimated the percent change in ADT and peak-hour traffic volumes from 2009 No-Build conditions for the likely routes to the site during the expected 44-month construction period (Table 7.13-6). The largest construction traffic impact would occur on FM 1601, which would experience a 221 percent increase in ADT.

As shown in Table 7.13-6, the number of passenger vehicle trips by construction workers would be relatively small in terms of available roadway capacity, and direct traffic impacts due to construction could be accommodated by the roadway system. The roadway that would experience the most direct impact during construction of the proposed Odessa Power Plant would be FM 1601 because all construction-related trips would use this roadway en route to and from the proposed Odessa Power Plant Site. However, FM 1601 would operate at LOS D (approaching unstable flow) during construction compared to LOS A (representing free flow). Given that the predicted 2009 use of this roadway is estimated at 70 vehicles during the peak weekday hour (Table 7.13-6), most of those experiencing the LOS D conditions would be the construction workforce arriving and leaving the proposed site, rather than other users, but is accepatable for a temporary condition during construction (TxDOT, 2006c) The capacity analysis summary for the 2009 Construction Conditions of the project area roadways is shown in Table 7.13-6. Given that the roadways would be operating at LOS D or better, there is no reason to conclude that there would be any notable increase in traffic accidents.

Based on the volumes and LOS on these roadways during construction, the two key intersections of FM 1601 with the I-20 C-D Roads should be able to accommodate these daily and peak hour traffic volumes. Traffic signals may be required at the intersections to accommodate changes in the turning volumes at those intersections during construction.

In addition to worker traffic, materials and heavy equipment would be transported to the proposed site on trucks from I-20 and via the adjacent rail line. Heavy equipment would remain at the proposed site for the duration of its use. The City of Odessa is served by several large construction material supply firms, offering both concrete and asphalt, within 20 miles (32.2 kilometers) of the proposed Odessa Power Plant Site**.** Material deliveries and return trips by empty trucks would likely occur throughout the workday. DOE estimates that there would be a maximum of 40 truck trips per day (20 entering and 20 exiting the site) delivering materials to the proposed site during construction. These trips are included in the 2009 Construction Conditions analysis. Based on these activity estimates, DOE estimated the percent change in ADT and peak hour traffic volumes from 2009 No-Build conditions for the likely routes to the site during the expected 44-month construction period (Table 7.13-6). As noted, the largest construction traffic impact would occur on FM 1601, which would see a 221 percent increase in daily traffic during construction at the proposed Odessa Power Plant Site.

Table 7.13-6. 2009 Average Daily and Peak Hour Construction Traffic Volumes

Roadway	ADT[1] (vpd)	Change in ADT[1] (percent)	Peak Hour Volume[2] (vph)	Change in Peak Hour Volume[2] (percent)	LOS[3]
I-20	16,542	10	2,253	50	A
FM 1601	2,260	221	824	1,071	D

[1] DOE estimate based on peak workforce of 700 workers arriving at site in single-occupancy vehicles, plus 40 truck trips per day (20 entering and 20 exiting the site).
[2] DOE derived peak hour volumes assuming half of all passenger car trips occur in peak hour and truck trips are evenly distributed over a 10-hour construction work day.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Sequestration Site

There would be much less construction activity at the proposed Odessa Sequestration Site and along the CO_2 pipeline connecting the proposed sequestration site and the proposed Odessa Power Plant Site, than at the power plant site. Construction traffic to the proposed sequestration site would have a negligible effect on roadways and traffic.

Utility Corridors

All underground utilities (potable water, process water, wastewater, natural gas, and CO_2) would either be on site or are proposed to be constructed using open trenching (FG Alliance, 2006d). Though there would be a need for staging areas for this construction, DOE assumes that all roadways would maintain one lane of traffic in each direction during construction. Construction of the process water pipeline could last for approximately four to 12 months (FG Alliance, 2006d), depending on the length of the corridor chosen. During this time there would be minor disruptions to traffic, but they would not create a substantial direct impact to traffic operations.

Construction of the utility lines would require approximately 110 persons for all construction to occur concurrently (FG Alliance, 2006d). In the most conservative case, all construction workers would travel in single-occupant vehicles. Therefore, there would be approximately 220 additional daily trips on the roadway network during construction of the utilities. Assuming that construction operations typically start earlier than the morning peak period of traffic, 110 trips would take place before the morning peak hour. The 110 afternoon trips made by construction workers leaving job sites would likely coincide with the afternoon peak period. Given the proposed locations of the utility corridors, these trips would be spread out on various roadways in the ROI and would not be expected to have any appreciable direct impact on traffic operations.

Transportation Corridors

FM 1601 currently terminates south of the Union Pacific ROW. Therefore, access to the proposed Odessa Power Plant Site would require a northerly extension of FM 1601 across the Union Pacific ROW. Union Pacific has agreed to allow an underpass be constructed beneath the railroad berm along the southern boundary of the proposed Odessa Power Plant Site, at the intersection of FM 1610 and Avenue G in Penwell to allow southern access to the site (FG Alliance, 2006d). An underpass would provide a better traffic safety option than an at-grade crossing.

Ector County has agreed to allow construction (or construct themselves) a road that would allow access/egress to the proposed plant site from the north and east, presumably from FM 866 east of the proposed site (Haner, 2006; Vest, 2006). The railroad underpass would result in only a temporary loss of the use of parts of FM 1601 and Avenue G during construction.

The roadway improvement project would require approximately two years to construct. This project would require approximately 30 workers to complete, adding an additional 60 trips per day to the roadway network (30 trips before the morning peak period and 30 trips coinciding with the afternoon peak period (Table 7.13-6).

A new private rail loop from the Union Pacific Railroad would be constructed on the proposed Odessa Power Plant Site. Construction of the new track would require approximately nine to 11 months that could be spread over more than one construction season. At most, 18 construction workers would be traveling to and from the site, resulting in an additional 36 trips per day on the roadway network. Eighteen of those trips would take place before the morning peak period, assuming that construction activities typically begin earlier than the regular work day. The other 18 trips would occur during the afternoon peak period, assuming a 10-hour work day. Given that all roadways would be operating at LOS D or better during construction (see Table 7.13-6), these trips would not be expected to appreciably change traffic operations on the roadway network.

During connection of the rail loop to the existing Union Pacific Railroad, railroad safety flaggers would be required. The construction could have some temporary impacts on Union Pacific Railroad operations while the connection between the new rail loop and the mainline is completed. This temporary impact could be avoided by completing the connection during hours when the Union Pacific track has the least traffic.

7.13.3.2 Operational Impacts

The FutureGen Project is expected to begin operating in the Year 2012 (FG Alliance, 2006e). Table 7.13-7 shows 2012 No-Build traffic volumes, which DOE projected to the opening year by applying a background growth rate of 0.5 percent per year to 2005 volumes. This growth rate was determined through review of other TxDOT project documentation on TxDOT's website (TxDOT, 2006a, 2006b). Based on the 2012 No-Build volumes, DOE estimated the capacity of each roadway (Table 7.13-7).

Table 7.13-7. 2012 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	2012 No-Build ADT[1] (vpd)	2012 No-Build Truck ADT[1,3] (vpd)	2012 No-Build Peak Hour Volume[1] (vph)	2012 No-Build Peak Hour Truck Volume[1,3] (vph)	LOS[2]
I-20	15,212	1,521	1,521	152	A
FM 1601	715	72	72	7	A

[1] DOE estimate based on 1 percent growth per year from 2005.
[2] DOE used HCS+ to perform capacity analysis.
[3] No truck data were available. DOE assumed 10 percent trucks, which is consistent with surrounding roadways.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Power Plant Site

The operating workforce for the proposed power plant would be approximately 200 employees (FG Alliance, 2006e), of which 80 administrative personnel would work a regular office day (9:00 am to 5:30 pm), and 40 shift workers would work a daytime shift (7:00 am to 3:30 pm) and each of the two nighttime shifts. The workforce would result in 160 new peak hour trips in both the morning and afternoon peak periods. For this analysis, DOE assumed that these employees would arrive at the proposed power plant in single-occupant vehicles and that the trip distribution would be the same as for the construction worker trips, the majority coming from Odessa via I-20 and reaching the proposed plant site via FM 1601. A portion of the workforce would come from the west via I-20. A single access gate would be located on FM 1601 (FG Alliance, 2006d).

A small number of delivery trucks would travel to the proposed power plant to support personnel, and administrative functions and deliver spare parts. Coal would be delivered primarily by rail. Other bulk materials used by the plant and byproducts are expected to be delivered or removed from the proposed Jewett Power Plant Site by truck. DOE estimates that 13 trucks per week would be required for delivery of materials, while 98 trucks per week would be required for removal of byproducts, including slag, sulfur, and ash. DOE estimated the number of trucks required based on the estimated annual quantities of materials/byproducts (FG Alliance, 2006e). Based on these estimates and assuming an even distribution of trucks over each day of the week, materials delivery would require four truck trips per day, two entering and two exiting, and byproduct removal would result in an additional 28 trips per day, 14 entering and 14 exiting. These trips are included in the 2012 Build ADT and peak hour traffic volumes shown in Table 7.13-8. The change in ADT and peak hour volumes between 2012 No-Build and 2012 Build conditions is also shown in Table 7.13-8.

Table 7.13-8. 2012 Average Daily and Peak Hour Build Traffic Volumes

Roadway	2012 Build ADT[1] (vpd)	Change in ADT[1] (percent)	2012 Build Peak Hour Volume[2] (vph)	Change in Peak Hour Volume[2] (percent)	LOS[3]
I-20	15,644	3	1,685	11	A
FM 1601	1,147	61	235	230	B

[1] DOE derived ADT using the maximum operating workforce (200 people; 400 vpd) passenger car trips (FG Alliance, 2006a) and assuming 32 operations-related truck trips daily (16 arriving and 16 exiting the site).
[2] DOE derived peak hour volumes assuming that administration and 1/3 of shift workers arrive in peak hour, and that four truck trips occur in each peak hour.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

These volumes would result in no significant direct impact on the roadways surrounding the proposed Odessa Power Plant Site. The 2012 Build conditions capacity analysis summary is given in Table 7.13-8. FM 1601, which would be the most affected roadway due to the trips made by employees, would operate at LOS B (reasonably free flow) under the 2012 Build conditions compared to LOS A (free flow) under 2012 No-Build conditions. Given that the roadways would be operating at LOS B or better, there is no reason to conclude that there would be any notable increase in traffic accidents.

Based on the volumes and LOS on these roadways under the proposed operating conditions, DOE concluded that the key intersections would be able to accommodate these daily and peak hour traffic volumes. Traffic signals may be required at the key intersections to accommodate changes in turning volumes at those intersections.

The primary component of materials transport would be the delivery of coal to the plant by rail, by using the rail loop constructed for the purpose. DOE anticipates that coal deliveries would require five 100-unit trains per week, or 10 entering or exiting train trips per week (FG Alliance, 2006e). This would represent a 7 to 11 percent increase in the number of trains on the Union Pacific main line through Odessa, which currently accommodates 91 to 147 trains per week (13 to 21 freight trains seven days per week).

Sequestration Site

There would be very little operational traffic to and from the proposed Odessa Sequestration Site and essentially no direct traffic or roadway impact.

Utility Corridors

The proposed utility corridors would have negligible impact on traffic operations and roadway LOS once the proposed Odessa Power Plant is operating. There would be no direct impact to traffic unless there is a problem with a utility line that requires open trenching to repair. It is expected that this would be an infrequent occurrence, thus having little to no long-term impact on traffic.

Transportation Corridors

The proposed rail loop on the proposed Odessa Power Plant Site would have very little direct impact on rail operations on the Union Pacific main line. The rail lines have the capacity to absorb the 5 to 9 percent increase in rail traffic.

7.14 NOISE AND VIBRATION

7.14.1 INTRODUCTION

Noise is defined as any sound that is undesired or interferes with a person's ability to hear something. The basic measure of sound is the sound pressure level (SPL), commonly expressed as a logarithm in units called decibels (dB). Vibration, on the other hand, consists of rapidly fluctuating motions having a net average motion of zero that can be described in terms of displacement, velocity, or acceleration. This chapter provides the results of the analyses completed for both noise and vibration. Specific details of the noise and vibration analysis are provided in sequence under each subsection, with the results of the noise analysis presented first followed by those of the ground-borne vibration analysis.

7.14.1.1 Region of Influence

The ROI for noise and vibration includes the area within 1 mile (1.6 kilometers) of the proposed Odessa Power Plant Site boundary and within 1 mile (1.6 kilometers) of the boundaries of all related areas of new construction, including the proposed sequestration site and the utility and transportation corridors.

7.14.1.2 Method of Analysis

This section provides the methods DOE used to assess the potential noise and vibration impacts of construction and operational activities related to the proposed Odessa Power Plant Site, sequestration site, and related corridors. In preparing the noise and vibration analysis, DOE evaluated information presented in the Odessa EIV (FG Alliance, 2006d) and estimated increases in ambient noise and ground-borne vibration levels, and evaluated potential impacts on sensitive receptors.

DOE assessed the potential for impacts based on the following criteria:

- Conflicts with a jurisdictional noise ordinance;
- Permanent increases in ambient noise levels at sensitive receptors during operations;
- Temporary increases in ambient noise levels at sensitive receptors during construction;
- Airblast noise levels in excess of 133 dB;
- Blasting peak particle velocity (PPV) greater than 0.5 inches per second (in/sec) (12.7 millimeters per second [mm/sec]) at off-site structures; and
- Exceeding the Federal Transit Administration's (FTA) distance screening and human annoyance thresholds for ground-borne vibrations of 200 feet (61 meters) and 80 velocity decibels (VdB).[1]

Noise Methods

Generally, ambient conditions encountered in the environment consist of an assortment of sounds at varying frequencies (FTA, 2006). To account for human hearing sensitivities that are most perceptible at frequencies ranging from 200 to 10,000 Hertz (Hz) or cycles per second, sound level measurements are often adjusted or weighted and the resulting value is called an "A-weighted" sound level.

> The **A-weighted** scale is the most common weighting method used to conduct environmental noise assessments and is expressed as a dBA.

A-weighted sound measurements (dBA) are standardized at a reference value of zero decibels (0 dBA), which corresponds to the threshold of hearing, or SPL, at which people with healthy hearing

[1] FTA threshold standards are not applicable to this project, but were used as a basis for comparing effects.

mechanisms can just begin to hear a sound. Because the scale is logarithmic, a relative increase of 10 decibels represents an SPL that is nearly 10 times greater. However, humans do not perceive a 10-dBA increase as 10 times louder; rather, they perceive it as twice as loud (FTA, 2006). Figure 7.14-1 lists measured SPL values of common noise sources to provide some context.

The following generally accepted relationships (Bolt et al., 1973) are useful in evaluating human response to relative changes in noise level:

- A 2- to 3-dBA change is the threshold of change detectable by the human ear in ambient conditions;
- A 5-dBA change is readily noticeable; and
- A 10-dBA change is perceived as a doubling or halving of the noise level.

The SPL that humans experience typically varies from moment to moment. Therefore, a variety of descriptors are used to evaluate noise levels over time. Some typical noise descriptors are defined below:

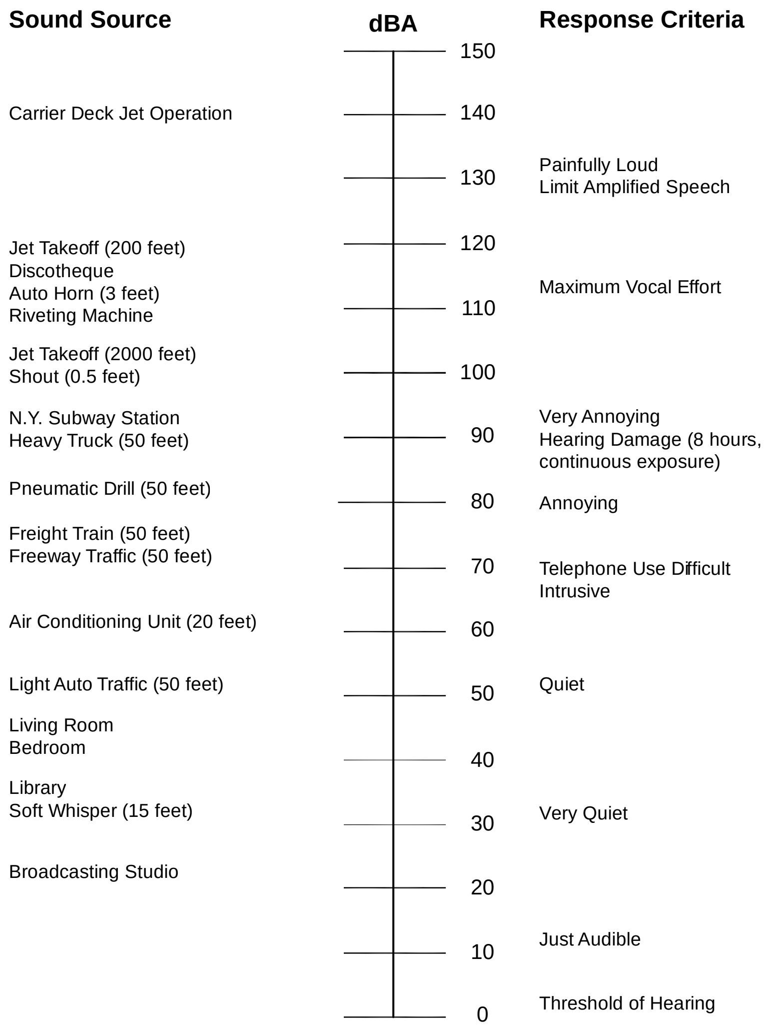
- A L_{eq} is the continuous equivalent sound level. The sound energy from fluctuating SPLs is averaged over time to create a single number to describe the mean energy or intensity level. Because L_{eq} values are logarithmic expressions, they cannot be added, subtracted, or compared as a ratio unless that value is converted to its root arithmetic form.
- L_{max} is the highest, while L_{min} is the lowest SPL measured during a given period of time. These values are useful in evaluating L_{eq} for time periods that have an especially wide range of noise levels.

For this analysis, DOE evaluated noise levels generated by stationary (i.e., fixed location) sources such as construction-related and power plant operating equipment, and mobile (i.e., moving) sources such as construction-related vehicle trips and operational deliveries by rail, car, and truck. DOE predicted stationary source noise levels during construction and normal plant operations at the closest sensitive receptor location in direct line-of-sight of proposed project facilities by summing anticipated equipment noise contributions and applying fundamental noise attenuation principles. DOE used the following logarithmic equation (Cowan, 1994) to predict noise levels at the sensitive receptor location selected for the stationary source analysis:

$SPL_1 = SPL_2 - 20 \text{ Log } (D_1/D_2) - A_e$, where:

- SPL_1 is the noise level at a sensitive receptor due to a single piece of equipment operating throughout the day;
- SPL_2 is the equipment noise level at a reference distance D_2;
- D_1 is the relative distance between the equipment noise source and a sensitive receptor;
- D_2 is the reference distance at which the equipment level is known; and
- A_e is a noise level reduction factor applied due to other attenuation effects.

DOE compared the calculated results to the existing ambient noise levels. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment are not available. In lieu of project-specific data, DOE used comparable noise data predicted for the proposed Orlando IGCC power plant facility (DOE, 2006) to estimate the increase in the noise level at any sensitive receptors in the vicinity of the proposed Odessa Power Plant Site. Any residences, schools, hospitals, nursing homes, houses of worship, and parks within the 1-mile (1.6-kilometer) ROI were considered sensitive receptors in this analysis.



Source: Barksdale, 1991

Figure 7.14-1. SPL Values of Common Noise Sources

For mobile sources, DOE estimated noise levels using traffic noise screening techniques to compare the vehicle traffic mix data for the future Build and No-Build traffic conditions on each roadway studied. DOE calculated the ratio of the future Build and future No-Build traffic volumes using the following equation (FHWA, 1992):

Predicted Change in Noise Level (dBA) = 10 Log (Future Build PCE/Future No-Build PCE), where
one heavy truck = 28 passenger car equivalents (PCEs)

In applying this equation, a doubling of traffic means future Build conditions are predicted to be twice the future No-Build condition. A doubling in the vehicle traffic volume would result in a 3-dBA increase in the noise level (10 Log [2/1] = 3 dBA). A ten-fold increase in traffic would result in a +10 dBA change (10 Log [10/1] = 10 dBA).

For this analysis, DOE considered a 3-dBA increase in the ambient noise level at sensitive receptors located adjacent to the project-related transportation routes as a threshold indicating that further detailed noise analysis (e.g., modeling) would be needed during evaluation of the final design to determine if the impacts would be potentially significant. Otherwise, DOE concluded that the anticipated increase in noise levels resulting from project-related activities would not be noticeable and would require no further analysis.

Vibration Methods

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration.

The concept of vibration is easily understood in terms of displacement as it relates to the distance a fixed object (e.g., floor) moves from its static position. Common measurements of velocity are not well understood by the average person. For example, the preferred vibration descriptors used to assess human annoyance/interference and building damage impacts are the root-mean-square (RMS) vibration velocity level and PPV, respectively. The RMS vibration level is expressed in units of VdB. The PPV, expressed in in/sec or mm/sec, represents the maximum instantaneous speed at which a point on the floor moved from its static position (FTA, 2006).

Generally, the background vibration velocity level encountered in residential areas is 50 VdB or lower (FTA, 2006). The threshold of perception for humans to experience vibrations is 65 VdB. Typical sources of vibration include the operation of mechanical equipment indoors, slamming of doors, movement of trains on rails, and ground-breaking construction activities such as blasting and pile driving. The effects on vibration-sensitive receptors from these activities can range from feeling the window and the building floor shake, to rumbling sounds, to causing minor building damage (e.g., cracks in plaster walls) in rare cases. The criterion for minor structural damage is 100 VdB, or 0.12 in/sec (3.05 mm/sec) in terms of PPV, for fragile buildings (FTA, 2006).

DOE performed the vibration analysis using progressive levels of review. Initially, DOE prepared a vibration screening analysis to evaluate the potential effects that ground-borne vibrations generated by project-related construction and operational activity would have on adjacent sensitive receptors, including humans, buildings, and vibration-sensitive equipment. If the results of this preliminary analysis showed that screening thresholds would be exceeded, DOE applied further vibration study methods to determine if the impacts would be potentially significant.

7.14.2 AFFECTED ENVIRONMENT

7.14.2.1 Power Plant Site

The proposed Odessa Power Plant Site and the land area within 1 mile (1.6 kilometers) of the site boundary are located in a rural, light industrial, desert ranch land that includes extensive oil and gas development. As such, ambient noise levels within the boundary of the proposed site and the 1-mile (1.6-kilometer) ROI are generally expected to be typical of a rural environment ranging from a L_{eq} value of 47 to 57 dBA (NYSDEC, 2000). Sensitive receptor locations near the proposed Odessa Power Plant are shown in Figure 7.14-2.

No sensitive receptors are located within the boundary of the proposed Odessa Power Plant Site. However, there are a few occupied residences within the ROI in the mostly abandoned community of Penwell just south of the proposed power plant site. The Town of Penwell's northern boundary essentially coincides with the Union Pacific Railroad and the town spreads southward to encompass I-20. During a site visit conducted on November 29, 2006, DOE personnel observed two residences on the south side of I-20 (SL-2 and SL-3) and one on the north side of I-20 (SL-1) within the 1-mile (1.6-kilometer) ROI. A fourth residence is located in the fields south of I-20 and southeast of the site, near the edge of the ROI. The closest noise-sensitive receptor is the single occupied residence on the north side of I-20 (SL-1), approximately 0.5 miles (0.8 kilometers) from the southern boundary of the proposed site. Periodic increases in the ambient noise levels may occur at the residential receptors that are located near I-20. Based on the posted speed of 70 miles per hour (113 kilometers per hour), traffic noise levels would exceed 55dBA during commuting hours (FG Alliance, 2006d) and could increase to as much as 85 dBA in the vicinity of the receptors (FHWA, 1998). Currently, 13 to 21 trains per day travel on the Union Pacific Railroad (Walden, 2006). When trains pass by, the maximum noise levels could intermittently spike to a level of 90 dBA.

7.14.2.2 Sequestration Site

The proposed sequestration site is located in a remote rural environment adjacent to I-10 in Pecos County, Texas. The sequestration site is primarily open rangeland used for ranching and oil and gas activities, and is located about 58 miles (93.3 kilometers) south of the proposed Odessa Power Plant Site and 9 miles (14 kilometers) east of Fort Stockton, Texas. No sensitive receptors were observed during the November 29, 2006, site visit. However, one recreational area known as the Fourteen Mile Park was observed along I-10 at the junction of SR 67 (I-10 Exit 273). This park is a roadside rest stop with canopied picnic tables, barbeque grills, and no restrooms. No noise measurements were taken in this area; however, due to its proximity to a major interstate highway, ambient noise levels are anticipated to be high, ranging from 57 to 67 dBA (NYSDEC, 2000). Using Federal Highway Administration's (FHWA) Traffic Noise Model, Technical Manual lookup table, DOE predicted that vehicles traveling on I-10 at 70 miles per hour (113 kilometers per hour) would generate noise contributions of up to 85 dBA for heavy trucks and up to 75 dBA for cars at receptors 60 feet (18 meters) from the centerline of the road (FHWA, 1998). Based on the transient nature of traffic noise, DOE chose to use typical urban environment noise levels as a conservative estimate of the ambient noise level in the area.

7.14.2.3 Utility Corridors

The related areas of new construction associated with the proposed power plant comprise two electrical transmission line corridors spanning either 1.8 or 0.7 miles (2.9 or 1.1 kilometers), six water supply pipeline corridors ranging from 24 to 54 miles (38.6 to 86.9 kilometers), and three CO_2 pipeline corridors, one of which would connect the plant to an existing pipeline operated by Kinder Morgan and two pipeline extensions that would connect into the injection wells. The connection to the existing pipeline from the proposed plant site is approximately 2 miles (3.2 kilometers) to the east, and the pipeline connections into the two proposed injection well sites are approximately 5 miles (8.0 kilometers) to the east and 7 miles (11.3 kilometers) to the west from the existing Kinder Morgan pipeline. Like the proposed Odessa Power Plant Site, the ROIs for the related areas of new construction are open rangeland that is primarily used for ranching and oil and gas activities. As a result, the ambient noise levels along these corridors are expected to be typical of a rural setting.

7.14.2.4 Transportation Corridors

Two residences are located along the local access route (FM 1601) leading to the proposed Odessa Power Plant Site south of I-20. Only one residence is located adjacent to I-20.

7.14.2.5 Regulatory Setting

The State of Texas and Ector County do not have noise or vibration standards applicable to activities proposed for the FutureGen Project. However, the FTA establishes guidelines and threshold standards for noise and vibration related to projects affecting transit facilities (FTA, 2006).

FTA established guidelines and methods to perform noise and vibration impact assessments for proposed projects involving transit facilities (FTA, 2006). To assess noise impacts, FTA recommends applying the same methods described in Section 7.14.1.2 to identify receptors that the project could potentially affect and to estimate noise contributions from project related mobile and stationary sources. To determine if the proposed transit project would significantly increase ambient conditions at a particular sensitive receptor, FTA established incremental change and absolute daytime/nighttime limits. For vibration, FTA recommends progressive levels of analysis depending on the type and scale of the project, the stage of project development, and the environmental setting. Such analysis typically begins with a screening process, which evaluates relative distance information between the source of ground-borne vibrations and the vibration-sensitive receptors that have been identified. If the relative distance from the source of ground-borne vibrations to a residential receptor is greater than 200 feet (61 meters), FTA guidelines indicate that it is reasonable to conclude that no further consideration of potential vibration impacts is needed (FTA, 2006). Otherwise, FTA provides criteria to assess the impacts of human annoyance, as well as building and vibration-sensitive equipment damage using detailed quantitative analyses to predict VdB and PPV values generated by the proposed project.

7.14.3 IMPACTS

7.14.3.1 Construction Impacts

Construction of the proposed Odessa Power Plant is expected to be typical of other power plants in terms of schedule, equipment used, and other related activities. Noise and vibration would be generated by a mix of mobile and stationary equipment noise sources, including bulldozers, dump trucks, backhoe excavators, graders, jackhammers, pile drivers, cranes, pumps, air compressors, and pneumatic tools during construction of the proposed power plant and the related utilities. For the purposes of this analysis, DOE considered the proposed project site an area-wide stationary source with construction equipment operating within its boundary. The results of DOE's noise and vibration analyses show that the proposed project would not exceed any of the criteria listed in Section 7.14.1.2 within the 1-mile (1.6-kilometer) ROI. However, minor mobile source construction noise impacts may potentially occur at the two residential sensitive receptors located south of I-20.

Power Plant Site

Noise levels generated during construction at the proposed Odessa Power Plant Site would vary depending upon the phase of construction. Typical power plant construction activity entails the following phases:

- Site preparation and excavation;
- Foundation and concrete pouring;
- Erection of building components; and
- Finishing and cleanup.

DOE anticipates that construction noise contributions would be greatest at the site during the initial site preparation and excavation phase due to the almost constant loud engine and earth breaking noises generated by the use of heavy equipment such as a backhoe excavator, earth grader, compressor, and dump truck. In addition, noise level increases are anticipated along the off-site routes leading to the site because of entry/exit truck movements, especially during the foundation and concrete pouring construction phase. The other phases would generate less audible noise because the equipment used for these activities (e.g., crane) generally would be transient in nature or would not generate much noise. Table 7.14-1 provides standard noise levels for construction equipment measured at a reference distance of 50 feet (15 meters).

Table 7.14-1. Common Equipment Sources and Measured Noise Levels at a 50-foot (15-meter) Reference Distance

Equipment	Noise Level in dBA
Backhoe Excavator	85
Bulldozer	80
Grader	85
Dump Truck	91
Concrete Mixer	85
Crane	83
Pump	76
Compressor	81
Jackhammer	88
Pile Driver	101

dBA = A-weighted decibels.
Source: Bolt et al., 1971.

To evaluate the potential maximum effects of the anticipated noise level increases on the sensitive receptors located to the south of the site boundary, DOE predicted equipment source noise levels using the logarithmic equation described in Section 7.14.1.2. First, the combined noise level expected from the three noisiest pieces of equipment (excavator, grader, and dump truck) used during the initial phase of construction was attenuated over a distance of approximately 0.5 miles (0.8 kilometers) to the nearest residential receptor. The averaged existing ambient and distance-attenuated noise levels were then logarithmically summed to predict a resultant noise level of 63.7 dBA at the receptor location, as shown in Table 7.14-2. This represents a very conservative (that is, a maximum) noise prediction estimate because sound waves generated by the noisiest pieces of equipment are assumed to start from the site boundary and continuously propagate in open air. In addition, the result does not account for any decibel-reducing factors due to atmospheric and ground effects.

A comparison of the predicted noise level of 63.7 dBA with the estimated ambient noise level of 62.0 dBA, at the closest sensitive receptor, shows that the change in ambient noise levels due to construction of the proposed Odessa Power Plant would be less than 2 dBA, and therefore would not be noticeable. There are only three or four residences and no schools within the ROI and none of the residences is within a radius corresponding to a greater than 3 dBA increase in noise level.

Table 7.14-2. Estimated Noise Level at Closest Sensitive Receptor Location

	Noise Level (dBA)	Distance
Combined Equipment Noise Level	85 + 85 + 91 = 93	50 feet (15 meters)
Combined Equipment Noise Level Attenuated Over Distance	59	n/a
Anticipated Ambient Noise Levels at Closest Receptor Location	62	0.5 miles (0.8 kilometers)
Resultant Noise Level at Closest Sensitive Receptor Location	63.7 dBA	

dBA = A-weighted decibels; n/a = not applicable.

During power plant startup, steam blowdown would be required toward the end of the construction phase. The blowdown activity would consist of several blows to test the IGCC system, including the gasifier steam lines, HRSG, and steam turbine. DOE anticipates that very loud noises as high as 102 dBA would be generated during all steam blows. The blowdown noise is assumed to originate at the center of the property and would attenuate to approximately 67 dBA at the property boundary and 61 dBA at the closest sensitive receptor. Adding the predicted construction noise contribution to the estimated ambient level of 62 dBA, the resultant noise level would increase by less than 3 dBA. Precautionary measures that could be taken to mitigate this impact include limiting steam blows to the daytime hours and providing advance notice to citizens residing near the power plant before commencing plant blowdown activity. Blowdown activities generally would last no more than 2 weeks.

DOE anticipates no vibration impacts during construction because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment, are not located within the 200-foot (61-meter) distance screening and human annoyance threshold for ground-borne vibrations defined by FTA guidance (2006).

Sequestration Site

Construction at the sequestration site would be limited to the installation of CO_2 injection wells. No noise or vibration impacts would be anticipated because there are no sensitive receptors in the vicinity of the proposed injection well locations. Noise level increases during construction would be less than 3 dBA at the nearest residences.

Utility Corridors

Transmission Corridors

Construction of the proposed transmission line in either of the corridor options would occur mostly in open rangeland primarily used for ranching and oil and gas activities. A temporary increase in noise due to construction may occur, but no major noise and vibration impacts would be anticipated at the three residences identified near I-20 because of their distance from the corridors and because the duration of construction would be limited to less than 4 months. Temporary construction activities would include activities such as installing concrete footings and erecting poles using an excavator, boom truck, and handheld tools at discrete intervals along either of the northern transmission corridors (less than 1 mile [1.6 kilometers]) or the southern corridor (less than 2 miles [3.2 kilometers]).

Pipeline Corridors

Trench excavations to install the process/potable water pipelines and CO_2 pipelines would occur at a rate of 1 mile/week (1.6 kilometers/week). During this period, elevated noise levels would be experienced by sensitive receptors located in the vicinity of the proposed construction site. However, due to the temporary and linear nature of the pipeline construction, minimal noise, and vibration impacts would be anticipated. Equipment used for these types of short-term linear and limited ground disturbance construction activities includes an excavator and a dump truck.

Transportation Corridors

If the Odessa Power Plant Site is selected for the FutureGen Project, access to the site would be provided by a new underpass under the railway. It is also possible that an additional access route would be constructed on the east side of the site. The ambient noise levels along the transportation routes could likely increase as a result of construction-related truck trips entering or leaving the proposed site. To determine the extent of the anticipated noise level increases, DOE examined the existing and projected Build and No-Build traffic data for each roadway and applied a factor to account for the greater noise energy generated by the movement of trucks compared to passenger cars when traveling along roadways adjacent to sensitive receptors. Traffic noise screening results listed in Table 7.14-3 show that construction-related vehicles (e.g., passenger cars and trucks) traveling on I-20 and FM 1601 to and from the proposed power plant would not have major noise impacts on nearby noise-sensitive receptors. An incremental change of less than 1 dBA was predicted at receptors located along I-20. However, a 6.6 dBA change was predicted along FM 1601, based on roadway traffic data. As such, the residence located adjacent to this roadway segment would be expected to experience a noticeable change in the ambient noise levels. Because of the proximity of the residences to a major interstate highway, the impacts may not be considered annoying because ambient noise in this area is also influenced by heavy traffic on I-20. As shown in Table 7.14-3, traffic volumes on I-20 are much greater than FM 1601. Furthermore, the construction of an access roadway to the east of the proposed site would divert some traffic from FM 1601, resulting in reduced noise levels along that roadway segment.

Table 7.14-3. Projected Noise Level Increase during Construction

Transportation Roadway Segment	Existing Peak Hour Volume	Future No-Build Peak Hour Volume	Project New Total/Truck Trips	Future Build Peak Hour Volume	Projected Noise Level Increase
I-20, east of FM 1601	1,469/147	1,499/150	754/6	2,253/156	0.7 dBA
FM 1601, north of I-20	69/7	70/7	754/6	824/13	6.6 dBA

Peak hour traffic data and project new trips are provided as total/truck volumes.
Build/No-Build Year: 2009.
Percent truck data I-20 and FM 1601 were assumed to be 10 percent.
AM peak and PM peak hour volumes are the same.
Project New Total/Truck Trips were obtained from Table 7.13-8 in Section 7.13.
dBA = A-weighted decibels.

DOE anticipates no vibration impacts at sensitive receptors during construction because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment are not located within the 200-foot (61-meter) distance screening and human annoyance threshold for ground-borne vibrations defined by FTA guidance (2006).

7.14.3.2 Operational Impacts

The projected noise levels calculated using the noise screening and analysis methods described in Section 7.14.1.2 show that none of the criteria listed would be exceeded due to the operation of the proposed power plant facility. In addition, no operational impacts would be expected at the constructed CO_2, natural gas, cooling, and potable water pipeline corridors because they would be buried underground. The electrical transmission line may generate some additional noise in the existing ambient environment; however, the results of the impacts analysis show that any noise impacts would be minimal.

Power Plant Site

The principal equipment noise sources during plant operation include the gas combustion turbine/generator, steam turbine/generator, heat recovery systems, turbine air inlets, exhaust stack, six-cell mechanical-draft cooling tower, coal crusher, coal mill, pumps (e.g., feed, circulating), fans, and compressors, as well as noise from piping flow and flared gas. For the most part, these noise sources would be enclosed inside of a building. In addition, noise sources within the building would be fitted with acoustical enclosures or other noise dampening devices to attenuate sound. Conversely, noise generated by equipment installed without full enclosures and exposed to the outside environment (e.g., flare) could potentially increase the ambient noise levels in the surrounding community.

To determine the impacts of normal plant operations, DOE used a noise prediction algorithm to estimate projected equipment noise contributions at the closest sensitive receptor location. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment are not available. DOE used comparable noise data estimated for the proposed Orlando IGCC power plant facility (DOE, 2006) to determine the potential effects of operational noise on sensitive receptors in the vicinity of the proposed Odessa Power Plant Site. Using the predicted noise level of 53 dBA at 0.6 miles (1.0 kilometer) that was obtained in the model run completed for the Orlando gasification project (DOE, 2006), DOE used the logarithmic distance attenuation formula to derive an estimated source noise level of 89 dBA for the proposed Odessa Power Plant.

DOE applied the source noise level to the proposed 600-acre (243-hectare) site to compute the attenuated noise level at the property boundary, assuming the noise sources would be at the center of the property. Based on a relative distance of 0.5 miles (0.8 kilometers) from center of property to the site’s perimeter, DOE predicted a noise level of 55 dBA at the property boundary. The predicted noise level at the closest sensitive receptor is 49 dBA. The noise contribution of the power plant added to the existing ambient environment results in an increase of the ambient noise level to 51 dBA, an increase of less than 3 dBA.

During coal deliveries, noise would be by unloading/loading activities such as the movement of containers, placement of coal feedstock on conveyor systems, and surficial contact of rail containers with other metallic equipment. Based on the estimated number of coal deliveries anticipated for the proposed power plant site, DOE estimated an hourly L_{eq} of 69 dBA from unloading/loading activities at the rail yard using the noise prediction equations listed in Table 5-6 of FTA’s guidance document (FTA, 2006). To determine the maximum effects on nearby receptors, DOE assumed that the rail yard noise would occur along the site boundary closest to the receptor. Adding the predicted values for plant operational noise at the site boundary (59 dBA) to that of rail yard noise, a combined noise level of 69 dBA was estimated to be generated at the site boundary during unloading/loading activity, which would result in a noise increase of less than 3 dBA at the nearest residence (SL-1).

The foregoing analysis does not include additional intermittent noise and vibrations that may be generated by rail car shakers if they are used to loosen coal material from the walls of the rail cars during unloading. Typically, the shakers are mounted on a hoist assembly and are used intermittently for a 10-second period to induce material movement in the rail car (Bolt et al., 1984). Pneumatic or electric rail car shakers could generate noise levels up to 118 dBA (VIBCO, Undated-a; VIBCO, Undated-b; Western Safety Products, 2007). If the shaker is used on every rail car, it is estimated that the shaker would be used 253 to 428 times per week. Final design of the coal handling equipment should consider the noise and vibration contributions from the rail car shakers. Limiting unloading/loading activities to an enclosed structure or screened area or siting these types of activities at the farthest distance from noise-sensitive receptors would further reduce any potential noise effects.

During unplanned or unscheduled restarts of the power plant, combustible gases would be diverted to the flare for open burning. Potential noise sources from flare operation that could affect nearby receptors include steam-turbulent induced noise in piping flow and noise generated by pulsating or fluttering flames from the incomplete combustion of the gases. These noise sources could temporarily increase the ambient noise levels in the vicinity of the flare to a range of 96 to 105 dBAs. Positioning the flare unit at a location farthest away from a receptor and implementing measures to control the flow of flare gas or steam through piping connected to the flare unit and the incomplete combustion of gases would reduce any potential impacts. Measures to minimize these short-term impacts would be addressed during the final conceptual design of the IGCC power plant.

Sequestration Site

Operations at the sequestration site would entail pumping CO_2 underground. Only minimal noise impacts would be anticipated during operation and maintenance at the injection well head. No noise impacts would be anticipated in the remainder of the proposed sequestration site because there would be little or no activity there. Noise level increases during operations would be less than 3 dBA at the nearest residences.

Ground-borne vibrations could be experienced by nearby receptors during borehole micro-seismic testing and surface seismic surveys performed at the sequestration injection site.

Utility Corridors

Transmission Corridors

No notable impacts would be anticipated from operation of the electrical transmission lines. However, under wet weather conditions, the transmission lines may generate audible or low frequency noises, commonly referred to as a “humming noise.” The audible noise emitted from transmission lines is caused by the discharge of energy (corona discharge) that occurs when the electrical field strength on the conductor surface is greater than the “breakdown strength” (the field intensity necessary to start a flow of electric current) of the air surrounding the conductor. The intensity of the corona discharge and the resulting audible noise are influenced by atmospheric conditions. Aging or weathering of the conductor surface generally reduces the significance of these factors.

Corona noise would not be noticeable because humans are generally insensitive to low frequency noise. However, in some cases, corona noise could be annoying to receptors that are located very near the transmission lines. To mitigate this occurrence, transmission lines are now designed, constructed, and maintained to operate below the corona-inception voltage.

Corona noise is caused by partial discharge on insulators and in air surrounding electrical conductors of overhead power lines.

Pipeline Corridors

The CO_2 pipeline would be buried except where it is necessary to come to the surface for valves and metering. Although valve spacing has not been determined at this time, a typical distance between metering stations is 5 miles (8 kilometers). Typically, these features are installed on concrete pads and surrounded by fencing. Alternatively, these features could be enclosed in metal buildings. These features do not have to be above ground; it is not uncommon for valves and meters to be located below grade in concrete vaults. Limited noise impacts from equipment above ground would be anticipated along the proposed CO_2 pipeline corridor during plant operation.

No noise or vibration impacts would be anticipated at the other proposed pipeline corridors during plant operation.

Transportation Corridors

Additional traffic resulting from operational truck trips entering or leaving the proposed site is expected to increase the ambient noise levels at the sensitive receptors located near I-20 and FM 1601. To determine the extent of the anticipated noise level increases, the existing traffic and the proposed Build and No-Build traffic data were evaluated for each roadway using the noise energy ratio described in Section 7.14.1.2. Results show that vehicle trips on roadways leading to the proposed Odessa Power Plant Site would have minimal effects on noise-sensitive receptors near I-20 during normal plant operations because the predicted change in the ambient noise level would be much less than 3 dBA (Table 7.14-4). Minor impacts, however, would be anticipated at FM 1601 because a 3.1 dBA incremental change was predicted. Construction of an access roadway to the east of the proposed site would divert some traffic from FM 1601, resulting in reduced noise levels along that roadway segment.

Table 7.14-4. Projected Noise Level Increase during Plant Operation

Transportation Roadway Segment	Existing Peak Hour Volume	Future No-Build Peak Hour Volume	Project New Total/Truck Trips	Future Build Peak Hour Volume	Projected Noise Level Increase
I-20, east of FM 1601	1,469/147	1,521/152	164/4	1,685/156	0.2 dBA
FM 1601, north of I-20	69/7	71/7	164/4	235/11	3.1 dBA

Peak hour traffic data and project new trips are provided as total/truck volumes.
Build/No-Build Year: 2012.
Percent truck data on I-20 and FM 1601 was assumed to be 10 percent.
Project New Total/Truck Trips were obtained from Table 7.13-12 in Section 7.13.
dBA = A-weighted decibels.

Five 100-unit trains per week for coal deliveries would use the Union Pacific Railroad adjacent to the power plant site. Based on estimated noise levels listed in FTA's guidance document (FTA, 2006), L_{max} values ranging from 76 to 88 dBAs are anticipated from the locomotive, rail cars, whistles/horns, and track switches/crossovers as the freight train passes by any nearby receptor. The L_{max} values are based on an operating speed of 30 mph (48.3 kmph), as measured approximately 50 feet (15.2 meters) from the track's centerline. Comparing the number of the additional rail trips projected for coal deliveries during plant operations with the existing 13 to 21 daily rail trips (Walden, 2006), DOE estimated that the number of trains on the line would increase by 11 percent (less than 2 additional trains per day).

No vibration impacts are anticipated because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment, are not located within the 200-foot (61-meter) perimeter defined by FTA's distance screening threshold guidance (FTA, 2006). The closest vibration-sensitive receptor that could possibly be affected by ground-borne vibrations generated by project-related rail deliveries is approximately 0.5 miles (0.8 kilometers) from the Union Pacific Railroad.

7.15 UTILITY SYSTEMS

7.15.1 INTRODUCTION

This section identifies utility systems that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Odessa Power Plant Site, sequestration site, and related utility corridors. It addresses the ability of the existing utility infrastructure to meet the needs of the proposed FutureGen Project while continuing to meet the needs of other users, and also addresses the question of whether construction of the proposed FutureGen Project could physically disrupt existing utility system features (i.e., pipelines, cables, etc.) encountered during construction.

7.15.1.1 Region of Influence

The ROI for utility systems includes two components: (1) the existing infrastructure that provides process and potable water, sanitary wastewater treatment, electricity, and natural gas to nearby existing users and that would also provide service to the proposed project; and (2) pipelines, transmission lines, and other utility lines that lie within or cross the proposed power plant site, sequestration site, or utility corridors.

7.15.1.2 Method of Analysis

Based on data provided in the Odessa EIV (FG Alliance, 2006d), DOE performed a comparative assessment of the FutureGen Project utility needs versus the existing infrastructure to determine if the proposed project would strain any of the existing systems. Additionally, DOE used data provided in the EIV (FG Alliance, 2006d) to identify the presence of utility infrastructure that could be affected by project construction.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect the capacity of public water utilities directly or indirectly;
- Require extension of water mains involving off-site construction for connection with a public water source;
- Require water supply for fire suppression that would exceed water supply capacity;
- Affect the capacity of public wastewater utilities;
- Require extension of sewer mains involving off-site construction for connection with a public wastewater system; and
- Affect the capacity and distribution of local and regional energy and fuel suppliers.

7.15.2 AFFECTED ENVIRONMENT

The site and its surrounding environs are located in a rural area where land use has historically been and currently is dominated by oil and gas activities and cattle ranching. Railroad Commission of Texas (RCT) records indicate that six permitted or developed natural gas and oil wells are located on the proposed Odessa Power Plant Site. The Union Pacific Railroad line borders the site. An existing CO_2 pipeline is 2 miles (3.2 kilometers) to the east and two other existing lines lie to the west 5.1 miles (8.0 kilometers) away and the east 7 miles (11.3 kilometers) away. One crude oil pipeline system, one natural gas pipeline system, and one condensate pipeline system traverse the proposed power plant site at various locations. In addition to these pipeline systems, at least three other crude oil pipeline systems, one other natural gas pipeline system, and one refined products pipeline system are found within the ROI. The proposed power plant site has two nearby 138-kV transmission lines, one approximately 0.7 mile

(1.1 kilometers) and the second approximately 1.8 miles (2.9 kilometers) from the site. Other transmission lines of 69 kV and above exist within roughly a 30-mile (48.3-kilometer) radius of the site.

The proposed sequestration site would be located approximately 58 miles (93.3 kilometers) south of the proposed Odessa Power Plant Site, and 3 miles (4.8 kilometers) east of Fort Stockton. Several pipelines traverse the area. A minimum of 14 permitted or developed natural gas and oil wells exist within the land area above the proposed sequestration reservoir. A minimum of 11 natural gas pipeline systems are found within or crossing the area. TWDB records indicated a minimum of 11 documented water wells occurring within the area (FG Alliance, 2006d).

7.15.2.1 Potable Water Supply

No potable water supply currently exists at the proposed Odessa Power Plant Site. Sufficient groundwater is available within comparatively short distances from the proposed power plant site for use as a water supply source for the facility. The facility would require 4.2 gallons (15.9 liters) per minute of potable water. The groundwater sources include the Ogallala (High Plains aquifer system), Pecos Valley, Edwards-Trinity Plateau, and Dockum and Capitan aquifers. Each of these aquifers or some combination of them could furnish all of the facility's required water supply. Potable water for the power plant could be developed from new well fields in these aquifers or acquired from several existing or proposed well fields in the area.

7.15.2.2 Process Water Supply

A water pipeline owned by the WTWSS adjoins the proposed Odessa Power Plant Site and may provide some of the required process water for the proposed Odessa Power Plant. This 10-inch (25.4-centimeter) pipeline supplies brackish water to oil-field operations for injection support makeup water for secondary and tertiary oil-field recovery operations in Ector and Andrews counties. According to Gary Haner, P.E. (FG Alliance, 2006d) of Engineered Pipeline Systems, Inc., serving as a representative of the Permian Basin Regional Planning Commission, the WTWSS currently delivers 2,230 gallons (8,441 liters) per minute of brackish water to its customers. WTWSS's source of water is a privately owned well field from the voluminous Capitan Reef aquifer. Primary process water could be supplied to the FutureGen Power Plant from six existing well fields that draw water from one or more of the following aquifers: Ogallala (High Plains aquifer system), Pecos Valley, Edwards-Trinity Plateau, and Dockum and Capitan aquifers. Each of these aquifers or some combination of them can furnish all of the 4.3 MGD (16.3 MLD) required process water supply for the facility.

The six well fields that could provide process water to the power plant include:

- Jackson in the High Plains aquifer, located to the north approximately 54 miles (86.9 kilometers).
- Texland in the High Plains and Dockum aquifers, located to the north approximately 49 miles (78.9 kilometers).
- Whatley in the High Plains and Dockum aquifers, located to the north approximately 24 miles (38.6 kilometers).
- WTWSS in the Capitan Reef aquifer, located to the west-northwest approximately 37 miles (59.5 kilometers).
- Smith in the Pecos Valley and Dockum aquifers, located to the west-northwest approximately 26 miles (41.8 kilometers).
- CCWIS in the Capitan Reef aquifer, located to the west-southwest approximately 28 miles (45.1 kilometers).

7.15.2.3 Sanitary Wastewater System

No sanitary wastewater lines currently exist near the proposed Odessa Power Plant Site. Sanitary wastewater would be treated and disposed of by constructing and operating an on-site wastewater treatment system to accommodate the 6,000 gallons (22,712 liters) per day capacity.

7.15.2.4 Electricity Grid, Voltage, and Demand

The proposed Odessa Power Plant Site is located in the Electric Reliability Council of Texas (ERCOT) region, which serves a 200,000-square-mile (518,000-square-kilometer) area. ERCOT is the regional reliability organization for this part of the country, charged with operating and ensuring reliability for the transmission system. Within the ERCOT region, the proposed Odessa Power Plant Site is located in the West Regional Transmission Planning Group. Peak demand in the ERCOT region occurs during the summer months. As of 2006, the total peak demand in the ERCOT region was 61,656 MW, and this is forecast to increase to 69,034 MW by 2011, representing a growth rate of 2.3 percent per year. If this growth is extrapolated to 2015, peak demand would reach 75,686 MW by 2015. Annual electric energy usage in the region was 299,219 gigawatt-hours (GWh) in 2005 (ERCOT, 2006a). Energy usage is forecast to grow at 2.1 percent per year, which would result in potential energy requirements of 368,338 GWh by 2015 (NERC, 2006).

In 2006, ERCOT had 70,498 MW of net resources. This is expected to grow to 70,987 MW by 2011, which would result in very low reserve margins of 4.5 percent in 2011. There are, however, several thermal plants that have been proposed for construction in the region, which together could increase the margin to as much as 23.5 percent (NERC, 2006); therefore, the reserve margin in 2012 is expected to be from a low of 4.5 percent to a high of 23.5 percent. The proposed Odessa Power Plant Site would connect with one of two 138-kV transmission lines, one 0.7 mile (1.1 kilometers) and the other 1.8 miles (2.9 kilometers) from the site (FG Alliance, 2006d).

> Annual average sales of electrical energy in the U.S. are expected to grow from 3,567,000 GWh in 2004 to 5,341,000 GWh by 2030—an increase of about 50 percent (EIA, 2006). The FutureGen Project is scheduled to go on line in 2012 and may contribute toward meeting this need; however, its primary purpose is to serve as a research and development project.

7.15.2.5 Natural Gas

A natural gas pipeline owned and operated by ATMOS Energy traverses the proposed Odessa Power Plant Site. The 20-inch (50.8-centimeter) diameter pipeline has a capacity of 12 million cubic feet (339,802 cubic meters) per hour at 450 pounds per square inch (3.1 megapascals), which would exceed the required 1.8 million cubic feet (50,970 cubic meters) per hour for the plant.

7.15.2.6 CO_2 Pipeline

An existing CO_2 pipeline is located 2 miles (3.2 kilometers) east of the Odessa Power Plant Site.

7.15.3 IMPACTS

7.15.3.1 Construction Impacts

During construction, construction equipment, particularly trenching equipment, could accidentally sever or damage existing underground lines. Additionally, construction equipment could damage power or telephone poles and lines if the equipment were to come into contact with them. However, all of the proposed ROWs have sufficient width to allow for the safe addition of project-related lines without interfering with the existing utilities if standard construction practices are followed. Estimated construction requirements for new utility infrastructure are presented in Table 7.15-1.

Table 7.15-1. Utility System Construction Requirements

Infrastructure Element	Equipment	Duration	Manpower
Potable water pipeline Using same source as process water source	Same as process water	Same as process water	Same as process water
Process water pipeline Proposed groundwater source 24 to 54 miles (38.6 to 86.9 kilometers)	Heavy and light construction equipment, incl. 2 D-6 dozers, trencher, 3 track hoes, 2 rubber-tired back hoes, 3 561 sidebooms, motor grader, and small vehicles and implements	1 week per mile	30
Sanitary wastewater pipeline Plan to create an on-site wastewater system	n/a	n/a	n/a
Transmission line 0.7 mile (1.1 kilometers) or less than 2 miles (3.2 kilometers)	Heavy and light construction equipment such as dozers, boom trucks, pole-hauling trucks, etc.	120 days	50
Natural gas pipeline Using existing line that enters site at northwest corner	n/a	n/a	n/a
CO_2 pipeline Existing 58-mile (93.3-kilometer) pipeline to sequestration site. Construction of new tie-ins from plant and sequestration area to existing pipelines. Total of 7 to14 miles (11.3 to 22.6 kilometers) of new pipeline	Heavy and light construction equipment, incl. 2 D-6 dozers, trencher, 3 track hoes, 2 rubber-tired back hoes, 3 561 sidebooms, motor grader, and small vehicles and implements	1 week per mile	30

n/a = not applicable.
Source: FG Alliance, 2006d.

Power Plant Site

The 200-acre (81-hectare) envelope, which includes the power plant footprint and railroad loop, could ultimately be located anywhere within the proposed 600-acre (242-hectare) Odessa Power Plant Site. The 200-acre (81-hectare) envelope could accommodate surface facilities required for an on-site sanitary wastewater treatment facility. The existing pipelines and wells (see Figure 7.15-1) would need to be taken into account during final siting of the power plant and related facilities to avoid being damaged. It is possible that some existing lines might need to be re-routed, which would result in a short-term effect on existing services.

Sequestration Site

Construction at the proposed Odessa Sequestration Site could potentially affect existing gas pipelines that cross the site. The existing pipelines would have to be taken into account during final siting of the sequestration wells to avoid damage to the existing lines. Utility needs would be limited to the provision of an electric service line to operate pumps and other equipment.

Utility Corridors

Potable Water Supply

Potable water would be supplied from the same potential sources as process water, and would use new ROWs and pipelines as described in the Process Water Pipeline Corridor subsection.

Process Water Supply

The six existing well fields identified as potential process water sources would require pipelines and new ROWs from 24 to 54 miles (37 to 87 kilometers) long. It is likely that only one or two of these well fields would be used, resulting in one or two new water pipelines. The pipelines generally cross a few county or state roads, as well as a number of unimproved roads, many of which are related to oil and gas well activities.

Sanitary Wastewater System

No sanitary wastewater pipelines currently exist near the proposed Odessa Power Plant Site. Sanitary wastewater would be treated by constructing and operating an on-site wastewater system, so no off-site sanitary sewer pipelines would be required.

Transmission Line System

The ERCOT Screening Study (ERCOT, 2006b) evaluated both the 138-kV and 345-kV alternatives. However, the 138-kV case was proposed for the Odessa Power Plant. The interconnection would require only the construction of a substation and a short transmission line to reach the existing transmission system. The corridor is expected to be approximately 70 feet (21.3 meters) wide and the two optimal corridors would be 0.7 mile (1.1 kilometers) and 1.8 miles (2.9 kilometers), respectively.

In addition, the WTWSS water pipeline that currently terminates at the power plant site could provide supplemental process water.

Natural Gas Pipeline

A natural gas pipeline owned and operated by ATMOS Energy traverses the proposed power plant site. No new off-site natural gas pipeline construction would be required.

CO_2 Pipeline

The CO_2 from the proposed power plant site would be piped to the proposed sequestration reservoir by a network of mostly existing CO_2 pipelines that are currently used for EOR in the region. A new 2-mile (3.2-kilometer) pipeline would need to be constructed to connect the plant to the sequestration site, and one or two lengths of new CO_2 pipeline up to 14 miles (22.6 kilometers) would connect the sequestration site to existing CO_2 pipelines.

7.15.3.2 Operational Impacts

All of the proposed operational requirements for potable and process water, sanitary wastewater, and natural gas are well within the capacities of the systems that already exist or would be developed, as described below. A feasibility report from ERCOT (2006b) indicates that loads from the plant could be accommodated by the existing distribution system with minor upgrades and would be compatible with existing mitigation schemes that are already planned in relation to projected load and supply growth in the area.

Power Plant Requirements

Potable Water Supply

Section 7.6 provides details on the proposed potable water supply for the proposed Odessa Power Plant. The well yields range from a low of about 100 gallons (378.5 liters) per minute to around 2,500 gallons (9,400 liters) per minute. Further study is required to determine the formations(s) and number of wells. For 200 employees using 30 gallons (113.6 liters) of potable water a day, the potable water consumption rate would average 4.2 gallons (15.9 liters) per minute, which would be negligible compared to the water supply capacity.

Process Water Supply

Section 7.6 provides details on the proposed process water supply for the proposed Odessa Power Plant. The six well fields identified could individually provide the process water requirement of 4 million gallons (15 million liters) per day. These water sources could also provide fire protection water for the power plant. Due to the number of available water options, there would be sufficient water for the proposed Odessa Power Plant so that there would be no adverse effect on other users.

Sanitary Wastewater System

Because the proposed Odessa Power Plant would use a ZLD system, there would be no process-related wastewater associated with the project. The daily sanitary wastewater effluent from the facility would be limited to the sanitary needs of a workforce of 200 employees. Assuming 30 gallons (114 liters) of sanitary wastewater per employee per day (FG Alliance, 2006e), the wastewater needs would equal 6,000 gallons (22,712 liters) per day. No wastewater pipelines currently exist near the proposed Odessa Power Plant Site. Sanitary wastewater would be treated and disposed of by construction and operation of a new on-site wastewater treatment system. Therefore, the operational requirements of the project would have no adverse effect on any existing wastewater treatment plant's ability to meet current and future treatment needs.

Transmission Line System

The proposed power plant would provide a nominal 275 MW of capacity. The project would operate at an 85 percent plant factor over the long term, which would result in an average output of 2.0 GWh of energy per year.

The ERCOT Security Screening Study (ERCOT, 2006b) indicates that the transfer limit of the proposed FutureGen facility would be at least 275 MW for the two optimal 138-kV lines with some upgrades. The improvements include upgrading several 138-kV lines and various upgrades to terminal equipment. Analysis with additional generation under development in the area indicates that additional transmission improvements are necessary to transmit 275 MW from the site. It appears that these improvements could be made before proposed power plant operation in 2012. There are several contingency overloads that could be mitigated before 2012 with minor upgrades that ERCOT has already analyzed to accommodate projected load and supply growth in the area. Even if 1,200 MW of new generation is added near the site, the proposed FutureGen facility would have transfer capability of at least 275 MW with mostly minor upgrades that do not require the acquisition of a new ROW or a Certificate of Convenience and Necessity (CCN) from the Public Utility Commission of Texas (PUCT). Some of these proposed projects may have received the air quality permits that are required before construction can begin. However, they still lack interconnection agreements, which must also be in place in order for a new project to transmit its power from the plant to consumers. Thus, the reserve margin in 2012 is expected to be anywhere between 4.5 percent and 23.5 percent.

If the needed transmission system upgrades are not completed by 2012, the application of a Special Protection Scheme or Remedial Action Plan could allow the proposed Odessa Power Plant to operate in curtailed mode until the needed transmission is constructed. Curtailment occurs when the system controller from the Independent System Operator (in this case, ERCOT) observes a thermal or voltage limit overload for an operating situation or, upon performing a contingency analysis, predicts a thermal or voltage limit overload for a planned project. If this occurs ERCOT would notify the participant or power source that new transmission facilities must be completed to avoid this problem. If the facility is predicted to cause an overload, it would have to operate in a curtailed mode. If the power source is already operating and an overload is apparent, ERCOT would issue a directive to curtail the production of energy from a particular facility or more than one facility on a pro-rata basis if several facilities are involved in causing the overload.

Natural Gas Pipeline

A natural gas pipeline (owned and operated by ATMOS Energy) traverses the proposed power plant site. No new off-site natural gas pipeline construction would be required. The 20-inch (50.8-centimeter) diameter pipeline has a capacity of 200,000 standard cubic feet (5,663 standard cubic meters) per minute at 450 pounds per square inch (3.1 megapascals). This is more than sufficient to supply the demands of the proposed FutureGen Project (startup: 500 standard cubic feet per minute at 450 psi [3.1 megapascals] to 30,000 standard cubic feet [900 cubic meters] per minute). Thus, the operational needs of the project would not have an adverse effect on the ability of the system to supply existing and other future demands for natural gas. A new tap and delivery system would be required.

CO_2 Pipeline

The existing pipelines have sufficient excess capacity to accommodate the volume of CO_2 expected from the proposed Odessa Power Plant. However, new segments of pipeline and ROW would be required between the plant site and sequestration site to the existing CO_2 pipelines.

Sequestration Site

Once construction was completed, the operation of the injection wells at the sequestration site would have no effect on the operation of other existing utilities along the corridors.

Utility Corridors

Once construction was completed, the operation of project-related utilities would have no effect on the operation of other utilities sharing the corridors.

7.16 MATERIALS AND WASTE MANAGEMENT

7.16.1 INTRODUCTION

Construction and operation of the FutureGen Project would require a source of coal, access to markets for sulfur products, a means to reuse by-products such as slag, and the ability to capture and sequester CO_2 and dispose of any waste that is generated. This section discusses the capabilities of the proposed Odessa Site to meet each of these requirements. It describes the impact of the demands posed by the FutureGen Project on the supply of construction and operational materials in the region. It also discusses the impacts to regional waste management resources.

7.16.1.1 Region of Influence

The ROI includes waste management facilities; industries that could use the FutureGen by-products; and the suppliers of construction materials, coal, and process chemicals used in the construction and operation of the proposed FutureGen Project (power plant, sequestration site, CO_2 distribution system, and associated utilities and transportation infrastructure). The extent of the ROI varies by material and waste type. For example, the ROI for construction material suppliers and solid waste disposal facilities is small (within about 50 miles [80 kilometers] of the proposed Odessa Site) because these types of resources are widely available and the large volumes of materials that would be needed or waste that would be generated are costly to transport over large distances. Treatment and disposal facilities for hazardous waste are less common, and the associated ROI would generally be within 100 miles (161 kilometers) or multi-state. The ROI for coal and process chemicals, as well as the sulfur product, includes the State of Texas and could extend farther if the cost or value of the commodity makes it economical to transport over a greater distance.

7.16.1.2 Method of Analysis

DOE evaluated impacts by comparing the demands posed by construction and operation of the FutureGen power plant, sequestration site, utility corridors, and transportation infrastructure to the capacities of materials suppliers and waste management facilities within the ROI. The analysis also evaluated regional demand and access to markets for sulfur products. DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause new sources of construction materials and operational supplies to be built, such as new mining areas, processing plants, or fabrication plants;
- Affect the capacity of existing material suppliers and industries in the region;
- Create waste for which there are no commercially available disposal or treatment technologies;
- Create hazardous waste in quantities that would require a treatment, storage or disposal (TSD) permit;
- Affect the capacity of hazardous waste collection services and landfills;
- Create reasonably foreseeable conditions that would increase the risk of a hazardous waste release; and
- Create reasonably foreseeable conditions that would increase the risk of a hazardous material release.

DOE reviewed information provided in the Odessa Site EIV (FG Alliance, 2006d) and proposal (FG Site Proposal [Odessa, Texas], 2006). Letters of interest, bid prices, and other prospective material supplier information were identified for use in the EIS. DOE then consulted waste management and

material supplier information compiled by state agencies and trade organizations to confirm availability of these resources in the ROI. Uncertainty regarding the specific technologies that would be employed in the FutureGen facility and variability in the potential coal feeds made it difficult to quantify operational materials requirements and waste generation. The maximum value for each item was used in the analysis to bound the potential impacts of the technologies that could be selected. Limited information is available regarding materials requirements or waste generation for construction. DOE used NEPA documentation and design information for facilities of similar scope and size to augment the FutureGen-specific information.

7.16.2 AFFECTED ENVIRONMENT

The Odessa Power Plant Site is approximately 600 acres (243 hectares) of open land. The site and its surroundings are located in a remote rural area where land use has been dominated historically by ranching and oil and gas activities. The proposed site contains unimproved roads and structures related to oil and gas activities. Several oil and gas wells are located on the site and may contain small amounts of petroleum hydrocarbons. The property is adjacent to an interstate highway, electric transmission lines, and railroad ROW. An existing network of CO_2 pipelines adjoin the proposed power plant site and link it to the proposed sequestration site (Horizon Environmental Services, 2006).

The TCEQ verified that the proposed site is not on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and that no unremediated hazardous waste identified or listed pursuant to Section 3001 of the Resource Conservation and Recovery Act (RCRA) has been disposed of at the proposed Odessa Power Plant Site (TCEQ, 2006a).

7.16.2.1 Construction Materials

A number of suppliers and producers of construction materials are available in the area offering concrete, asphalt, and aggregate materials. A sample of the surrounding industry is provided below, including the suppliers' capacity where the information is available (FG Alliance, 2006d).

Concrete

A number of large and small companies in the Midland/Odessa area are available to provide concrete for the FutureGen facility. Most companies can set up portable concrete plants at the site to meet the demand.

- Vines Ready Mixed Concrete is the largest supplier of concrete in the area with a capacity of 100 cubic yards (76 cubic meters) per hour. It has existing plants in Odessa, Midland, Big Spring, Crane, Monahans, and Pecos.
- Transit Mix Concrete and Materials Company is located in Midland. It has the capability to deliver over 1 million square feet (93,000 square meters) of concrete.
- Odessa Concrete Supply Company is capable of producing 850 cubic yards (650 cubic meters) per day.
- Pruett Ready Mix, Inc. in Odessa is capable of producing 200 cubic yards (153 cubic meters) per day.

Asphalt

Jones Brothers Dirt and Gravel Contractors, Inc. in Odessa is the largest supplier of asphalt in the region with a capacity of 2,500 tons (2,268 metric tons) of asphalt per day.

Aggregate and Fill Material

Aggregate suppliers in the Midland/Odessa area include Transit Mix Concrete and Materials Company, Jones Brothers Dirt and Gravel Contractors, Inc., Barnett Sand and Gravel, and Capitol Aggregates. Fill material is readily available throughout the region. The largest suppliers include Jones Brothers Dirt and Paving Contractors, Inc., Vines Ready Mixed Concrete, and Van Zandt Paving. Earthwork at the site would also provide earth fill on the site.

7.16.2.2 Process-Related Materials

Coal Supply Environment

Figure 7.16-1 shows the locations of coal mines and probable locations of coal deposits in relation to the proposed Odessa Power Plant Site. Six different ranks of coal could be delivered to the Odessa Power Plant Site. These six coal types are:

- PRB
- Petroleum Coke
- Pennsylvanian
- Illinois
- Texas Lignite
- Mexican Bituminous

The availability of low cost Texas Lignite, PRB coal, and Gulf Coast Petroleum Coke would provide the FutureGen facility with several fuel options.

Most coal would be delivered by rail to the Odessa Power Plant Site. The Union Pacific railway runs along the southern border of the property. This rail line offers access to coal resources in Mexico, Wyoming, the West Coast, Midwest, Gulf Coast, and Appalachia. Union Pacific services most of the mines in the PRB and other fuel regions available to FutureGen. The proposed site also has access to I-20, which is less than 1 mile (1.6 kilometers) from the site. This would provide the option of trucking closer ranks of test fuels, such as Petroleum Coke. Coal and transportation price projections for the Odessa Site are provided in Table 7.16-1.

The Energy Information Administration’s 2005 Annual Energy Outlook forecasts average delivered coal prices to electric utilities to be $24.42 per ton ($26.86 per metric ton) in 2015 (FG Site Proposal (Odessa, Texas), 2006).

Process Chemical Supply Markets

The process chemicals required by the proposed project are common water treatment and conditioning chemicals that are widely used in industry with broad regional and national availability. Large suppliers of water and waste treatment chemicals include Ciba, Kemira, Nalco, Stockhausen, and SNF.

Table 7.16-1. Coal Price Projections

	Coal Cost	Rail Transport Cost	Delivered Cost
	Dollars per Ton (Dollars per metric ton) of Coal		
Powder River Basin	8-9 (8.80-9.90)	13 (14.30)	21-22 (23.10-24.20)
Texas Lignite	10-12 (11-13.20)	3 (3.3)	13-15 (14.30-16.50)
Pennsylvanian	26-28 (28.60-30.8)	7 (7.70)	33-35 (36.30-38.50)
Illinois Basin	27-29 (29.70-31.90)	7 (7.70)	34-36 (37.40-39.60)

All costs in 2005 dollars. Prices projected for the year 2011.
Source: FutureGen Site Proposal (Odessa, Texas), 2006.

7.16.2.3 Sulfur Markets

The technologies that would be available for sulfur removal at the proposed power plant are similar to the technologies employed in the petroleum refining industry. These treatment technologies result in the production of elemental/molten sulfur that has a high market value. U.S. production of sulfur was 13.6 million tons (12.3 MMT) in 2002 (TIG, 2002). The sulfur is used as an additive in numerous chemical, pharmaceutical, and fertilizer applications within the State of Texas and throughout the region. Prices in 2005 averaged $51 to $53 per ton in Houston, and the current prices are at $60 to $63 in Houston (FutureGen Site Proposal [Odessa, Texas], 2006). One company, Martin Resources has operations in Kilgore and throughout Texas. The company uses molten sulfur in its fertilizer business and, in addition, collects and transports sulfur for others (Martin, 2006).

The worldwide supply of sulfur is expected to exceed demand by 5.4 and 5.9 million tons (4.9 and 5.4 MMT) in 2006 and 2011, respectively. The surplus could increase up to 12.1 million tons (11 MMT) in 2011, if clean fuel regulations continue to be implemented worldwide. However, the Sulphur Institute, an international non-profit organization founded by the world's sulfur producers to promote and develop uses for sulfur, sees market potential in developing plant nutrient sulfur products and sulfur construction materials, especially sulfur asphalt. The estimate for the plant nutrient sulfur market is 10.5 million tons (9.5 MMT) annually by 2011. The Sulphur Institute estimates the potential consumption of sulfur in the asphalt industry in North America could reach 0.45 million tons (0.41 MMT) by 2011 (assuming sulfur captures 5 percent of the 30 million ton (27 million metric ton) asphalt market and an average of 30 percent by weight of asphalt replaced by sulfur). Tests on asphalt made with sulfur show it to have a greater resistance to wheel rutting and cracking than conventional asphalt (Morris, 2003).

7.16.2.4 Recycling Facilities

The bottom slag and ash produced by the gasifier would likely have local and regional markets for reuse. The American Coal Ash Association (ACAA), a non-profit organization that promotes the beneficial use of coal combustion products, reported that 96.6 percent of the bottom slag and up to 42.9 percent of the ash generated by power plants in 2005 was beneficially used rather than disposed of. Primary uses of slag are as blasting grit and as roofing granules, with lesser amounts in structural and asphalt mineral fills. Ash is primarily used in concrete products, structural fills, and road base construction. The ACAA expects the demand for coal combustion products to increase in the next few years. Some of the increase would be due to federal and state transportation departments promoting the use of coal combustion products for road construction (ACAA, 2006).

7.16.2.5 Sanitary Waste Landfills

TCEQ permits landfills receiving nonhazardous waste by type. Type I landfills are sanitary waste landfills and Type IV landfills are construction and demolition debris landfills (30 Texas Administrative Code [TAC] 330.5). TCEQ (30 TAC 330.3 and 30 TAC 330.173) defines nonhazardous industrial waste in three classes: Class 1, 2, and 3, and establishes what landfills are acceptable for disposal of the waste classes as presented below.

- Class 1 waste—Any industrial solid waste or mixture of industrial solid waste that because of its concentration, or physical or chemical characteristics is toxic, corrosive, flammable, a strong sensitizer or irritant, a generator of sudden pressure by decomposition, heat, or other means, or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed. Waste that is Class 1 only because of asbestos content may be accepted at any Type I landfill that is authorized to accept regulated asbestos-containing material. With approval of the TCEQ Executive Director, Type I and IV landfills can receive Class 1 industrial solid waste and hazardous waste from conditionally exempt small quantity generators, if properly handled and safeguarded in the facility (30 TAC 330.5).
- Class 2 waste—Any individual solid waste or combination of industrial solid waste that are not described as Hazardous, Class 1, or Class 3. Class 2 industrial solid waste, except special waste as defined in §330.3 of this title, may be accepted at any Type I landfill provided the acceptance of this waste does not interfere with facility operation. Type I and Type IV landfills may accept Class 2 industrial solid waste consistent with the established limitations.
- Class 3 waste—Inert and essentially insoluble industrial solid waste, usually including, but not limited to, materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable. Class 3 industrial solid waste may be disposed of at a Type I or Type IV landfill provided the acceptance of this waste does not interfere with facility operation.

Sanitary waste planning in Texas is the responsibility of 24 Councils of Governments. The Odessa Power Plant Site is located within the Permian Basin Regional Planning Commission, which according to TCEQ has approximately 177 years of sanitary landfill capacity remaining (TCEQ, 2006b).

Table 7.16-2 lists the municipal waste landfills in the region and their remaining disposal capacity. Space on the 600-acre (243-hectare) proposed plant site would be available for a landfill if needed. Figure 7.16-2 shows the location of these facilities in relation to the proposed Odessa Power Plant Site. The nearest waste disposal facility that accepts nonhazardous industrial waste is Waste Control Specialists, LLC, located in Andrews, which is also permitted as a hazardous waste disposal facility.

Table 7.16-2. Nearby Sanitary Waste Landfills

Landfill	City	Remaining Disposal Capacity in Place (yd^3 [m^3])[1]	Remaining years of Disposal Capacity[1]	Approximate Distance from Site (miles [km])
Landfills Accepting Classes 2 and 3 Nonhazardous Industrial Waste				
Charter Waste Landfill	Odessa	37,160,727 (28,411,414)	130	15 (24)
City of Midland Landfill	Midland	36,982,713 (28,275,313)	177	43 (69)
Monahans Landfill	Monahans	1,353,253 (1,034,636)	41	21 (34)
Landfills Accepting Class 1 Nonhazardous Industrial Waste				
Waste Control Specialists	Andrews	5,000,000 (3,822,774)	Not Available	60 (96)

[1] Capacity as of September 2005.
yd^3 = cubic yards; m^3 = cubic meters; km = kilometers.
Source: TCEQ, 2006b.

The proposed facility would have the option of disposing of its nonhazardous waste by constructing and operating an on-site landfill, as allowed under the Texas Health and Safety Code. The Texas Health and Safety Code, §361.090, Regulation and Permitting of Certain Industrial Solid Waste Disposal, allows the collection, handling, storage, processing, and disposal of industrial nonhazardous solid waste on site without obtaining a permit or authorization from the TCEQ. A notification to the TCEQ of the on-site waste management activity in accordance with 30 TAC 335.6 and deed recordation in accordance with 30 TAC 335.5 would be required for land disposal of waste.

7.16.2.6 Hazardous Waste Treatment, Storage, or Disposal Facilities

The nearest hazardous waste disposal facility is Waste Control Specialists, LLC, located in Andrews, Texas, approximately 60 miles (96.6 kilometers) from the proposed power plant site (see Figure 7.16-2). The existing capacity of the facility is over 5.0 million cubic yards (3.8 million cubic meters). The only other hazardous waste disposal facility in Texas is U.S. Ecology Texas, located in Robstown, Texas, near Corpus Christi (FG Alliance, 2006d).

7.16.3 IMPACTS

7.16.3.1 Construction Impacts

Power Plant Site

Power plant construction materials would consist primarily of structural steel beams and steel piping, tanks, and valves. Locally obtained materials would include crushed stone, sand, and lumber for the proposed facilities and temporary structures (e.g., enclosures, forms, and scaffolding). Components of the facilities would also include concrete, ductwork, insulation, electrical cable, lighting fixtures, and transformers.

Waste from construction of the proposed facilities would include excess materials, metal scraps, and pallets, crates, and other packing materials. Excess supplies of new materials would be returned to vendors or be retained for future use. Surplus paint and other consumables, partial spools of electrical cable, and similar leftover materials would also be retained for possible future use in maintenance, repairs, and modifications. Scrap metal that could not be reused on site would be sold to scrap dealers. Other scrap materials could also be recycled through commercial vendors. Packaging material (e.g., wooden pallets and crates), support cradles used for shipping large vessels and heavy components, and cardboard and plastic packaging would be collected in dumpsters and periodically transported off site for disposal.

Construction equipment would include cranes, forklifts, air compressors, welding machines, trucks, and trailers. Operation of heavy equipment would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor.

Petroleum products are sometimes spilled at construction sites as a result of equipment failure (split hydraulic lines, broken fittings) or human error (overfilled tanks). To mitigate the impacts of spills, use of petroleum products, solvents, and other hazardous materials would be restricted to designated areas equipped with spill containment measures appropriate to the hazard and volume of material being stored on the construction site. Refueling, lubrication, and degreasing of vehicles and heavy equipment would take place in restricted areas. A SPCC Plan would be prepared in accordance with 40 CFR 112.7.

Personnel would be trained to respond to petroleum and chemical spills and the necessary spill control equipment would be available on site and immediately accessible.

The proposed Odessa Power Plant Site includes up to 200 acres (81 hectares) to allow for the power plant, coal and equipment storage, associated processing facilities, research facilities, the railroad loop surrounding the power plant envelope, and a buffer zone. Debris would be generated as a result of clearing and grading. Only about 60 acres (24 hectares) of the site would be required for the facilities comprising the power plant envelop (see Figure 2-18). Any excavated material could be used as fill on the site. This debris would be disposed on site or transported to an off-site landfill for disposal.

The waste requiring disposal could be disposed of on site, if an on-site landfill was developed, or at permitted off-site landfills. Ample room would be available for an on-site solid waste landfill.

Area sanitary landfills would have ample capacity to receive project construction waste. Because the quantity of waste from project construction would be small in comparison with the landfill capacity and waste quantities routinely handled, disposal of this waste would not be expected to have an impact.

Sequestration Site

The proposed sequestration site is located 58 miles (93.3 kilometers) away from the Odessa Power Plant Site. The component to be constructed at the sequestration site would include injection wells, associated piping, and an access road. Road construction is discussed below. The materials needed are piping and concrete for seaming. Sources for these construction materials are well established nationally; none of the quantities of materials required would create demand or supply impacts.

The materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris. Heavy equipment would be used that require fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 7.16-2 and Section 7.16.2.6. There would be no impact to waste collection services or disposal capacity.

Utility Corridors

The following utility corridors and pipelines would be constructed to support the proposed FutureGen facility:

- 1.8-mile (2.9-kilometer) long transmission line in existing ROW and new substation (option involving 0.7-mile (1.1-kilometer) long transmission line in new ROW is also being evaluated).
- Water (process and potable) supply pipeline corridor up to 54 miles (87 kilometers) using new ROW (maximum case, several options being evaluated).
- On-site wastewater treatment system.
- 2- to 14-mile (3- to 22.6-kilometer) long CO_2 pipeline using new ROW to connect to existing 58-mile (93.3-kilometer) CO_2 pipeline.

The existing corridors would require minimal clearing of vegetation and grading, creating land clearing debris that may require removal from the site. The new ROW may require more extensive land clearing and grading. However, construction debris disposal capacity is available at area landfills.

The construction of the pipelines, transmission lines, transmission substation, and wastewater treatment system would require pipe, joining and welding materials including compressed gases, steel cable and structures, and insulated wiring for transmission lines, and building construction materials such as lumber and masonry materials. Sources for these construction materials are well established nationally; and the quantities of materials required to construct the infrastructure would not create demand or supply impacts.

Construction materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris. Heavy equipment would be used that require fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 7.16-2 and Section 7.16.2.6. There would be no impact to waste collection services or disposal capacity.

Transportation Corridors

Roads

The proposed Odessa Power Plant Site would be served by a nearby interstate highway and an access road adequate for coal delivery trucks. Another access road would be constructed by Ector County (FG Alliance, 2006d). On-site roads would be needed at the power plant site and possibly the sequestration site.

The materials needed for on-site road construction are concrete, aggregate, and asphalt. Road construction results in minimal waste due to the ability to recycle and reuse these materials. Excavated soil would be used for fill elsewhere along the route and asphalt would be recycled. Road construction would require heavy equipment that would need fuel, oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Table 7.16-2 and Section 7.16.2.6. There would be no impact to waste collection services or disposal capacity.

Rail

The materials needed for construction of an on-site loop track would be steel for rails and pre-cast concrete railbed ties, and rock for ballast. The sources for rails and railbed ties are well established nationally; none of the quantities of materials required for constructing a rail spur would create demand or supply impacts. Furthermore, these materials would be ordered in the correct sizes and number, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill accepting construction debris.

In addition, to the materials to be installed, construction of the rail spur would require fuel, oils, lubricants, and coolants for heavy machinery, and compressed gasses for welding. Should any of these require disposal, they would be special waste or hazardous waste and shipped to a permitted hazardous waste treatment and disposal facility. Precautions would be taken to mitigate the impacts of petroleum and chemical spills and personnel would be trained and equipped to respond to spills when they occur.

Solid and hazardous waste disposal capacity in the region is detailed in Table 7.16-2 and Section 7.16.2.6. There would be no impact to waste collection services or disposal capacity.

7.16.3.2 Operational Impacts

Power Plant Site

The FutureGen Project would be capable of using various coals. Lignite coal is found in much of Texas. A vast belt of lignite coal stretches from Louisiana, across Texas, and into northern Mexico. For purposes of analysis, the following coals were evaluated:

- Northern Appalachian Pittsburgh seam;
- Illinois Basin from the states of Illinois, Indiana and Kentucky; and
- PRB from Wyoming.

Coal consumption would vary depending on the gasification technology and type of coal. Table 7.16-3 provides the range of values based on the conceptual design for the FutureGen facility. The Case 3B option is a smaller, side-stream power train that would enable more research and development activities than the main train of the power plant. To estimate the operating parameters for analysis of impacts in this EIS, DOE assumed this smaller system could be paired with any of the other designs under consideration. For these fuel types, the maximum coal consumption rate would be approximately 254 tons (230 metric tons) per hour (FG Alliance, 2007) or up to 1.89 million tons (1.71 MMT) per year based on 85 percent availability (FG Alliance, 2006e). This represents 1.9 percent of the 101 million tons (91.6 MMT) of coal of all types consumed by electric utilities within the state in 2005 (EIA, 2006). Coal would be delivered to the proposed Odessa power plant site by rail and stored in two coal piles, each providing storage capacity for approximately 15 days of operation (FG Alliance, 2006e). If required, run-off from the coal storage areas would be collected and treated in the plant's zero liquid discharge (ZLD) wastewater treatment system.

Table 7.16-3. Coal Consumption

Coal Gasification Technology	Type of Coal (pounds [kilograms] per hour)		
	Pittsburgh	Illinois Basin	Powder River Basin
Case 1	224,745 (101,943)	248,370 (112,659)	281,167 (127,535)
Case 2	213,287 (96,745)	244,153(110,746)	353,809 (160,485)
Case 3A	208,425 (94,540)	238,577 (108,217)	342,790 (155,487)
Case 3B (optional)[1]	97,625 (44,282)	111,791 (50,708)	154,349 (70,012)

[1]Case 3B is an optional add-on to the other technology cases (1, 2, 3A) but is considered unlikely to be implemented.
Source: FG Alliance, 2007.

The estimated consumption of process chemicals by the proposed power plant is presented in Table 7.16-4. The table also provides the estimated on-site storage requirements assuming a 30-day chemical supply would be maintained at the power plant site. Potential impacts from storage of the chemicals are discussed in Section 7.17. These chemicals are commonly used in industrial facilities and widely available from national suppliers. The materials needed in the largest quantities are for sulfuric acid, sodium hypochlorite, and lime. The polymer and antiscalants and stabilizers needed for the cooling tower, makeup water, and wastewater systems are not specified and a variety of products are available from national suppliers. A large producer of water treatment specialty chemicals is Ciba (Ciba, 2006).

Table 7.16-4. Process Chemicals Consumption and Storage

Chemical	Annual Consumption (tons [metric tons])	Estimated Storage On Site (gallons [liters])
Selective Catalytic Reduction (NO_x emission control)		
Aqueous Ammonia (19 percent)	1,333 (1,209)	28,700 (108,641)
Cooling Tower		
Sulfuric Acid (98 percent)	8,685 (7,879)	94,200 (356,586)
Antiscalant	0.47 (0.42)	8 (30)
Sodium Hypochlorite	1,684 (1,527)	32,900 (124,540)
Make-up Water and Wastewater Treatment Demineralizers		
Sodium Bisulfite	12 (10.9)	155 (587)
Sulfuric Acid	106 (95.8)	1,150 (4,353)
Liquid Antiscalant & Stabilizer	27 (24.5)	443 (1,677)
Clarifier Water Treatment		
Lime	1,237 (1,122)	7,380 (27,936)
Polymer	295 (268)	5,020 (19,003)
Acid Gas Removal		
Physical Solvent	11,300 gallons (42,775 liters)	940 (3,558)

Source: FG Alliance, 2007.

The coal gasification process would annually consume approximately 8,790 tons (7,974 metric tons) of sulfuric acid, 1,680 tons (1,524 metric tons) of sodium hypochlorite, and 1,240 tons (1,125 metric tons) of lime. As discussed in Section 7.16.2.3, the sulfur market is expected to have a surplus for the next few years as production increases, so additional demand would not adversely impact the sulfur market. Sodium hypochlorite has producers located across the U.S. including Texas. The U.S. sodium hypochlorite production capacity is vastly underused. Industrial sodium hypochlorite production capacity is estimated at 1.55 billion gallons (5.87 billion liters) per year (TIG, 2003). The current (2006) demand is projected to be 292 million gallons (1.1 billion liters), less than 20 percent of the production capacity (TIG, 2003). Worldwide production of lime was 141 million tons (128 MMT) in 2005, with the U.S. producing 22 million tons (20 MMT) (USGS, 2006a). Chemical Lime, one of the ten largest lime producers in the United States, operates plants in Texas, including nearby Bosque County (USGS, 2006b). Given that the chemicals required to operate the FutureGen facility are common industrial chemicals that are widely available and produced in large quantities in the United States, the chemical consumption impact would be minimal.

The by-products generated by the proposed power plant would be sulfur, bottom slag, and ash. As previously discussed, there are established markets and demand for these materials.

Sulfur production would depend on the gasification technology and the type of coal used. The maximum amount of sulfur generated would be 133 tons (121 metric tons) per day (FG Alliance, 2007) for an annual maximum of 41,232 tons (37,406 metric tons) based on 85 percent availability. The U.S. production of sulfur in 2002 was 13.6 million tons (12.4 MMT). The maximum potential FutureGen sulfur production represents 0.30 percent of the U.S. production. Supply of sulfur exceeds demand; however, new uses of sulfur are being promoted by sulfur producers that should help balance supply and demand of sulfur. The worldwide supply was estimated to exceed demand by up to 12.1 million tons (11 MMT) in 2011 without the development of new markets. The FutureGen maximum production would increase this surplus by less than 0.34 percent.

As previously noted, operation of the FutureGen Project would require a source of sulfuric acid. Assuming a complete conversion to sulfuric acid, the sulfur produced by the FutureGen facility would be sufficient to generate about 126,000 tons (115,000 metric tons) per year of sulfuric acid. This would be sufficient to meet the demand for sulfuric acid at the power plant site.

The FutureGen facility would generate an estimated 96,865 tons (87,875 metric tons) of bottom slag or ash annually based on the three primary technology cases (1, 2, and 3A) (FG Alliance, 2007). If Case 3B were implemented, the amount of slag or ash would increase by approximately 49 percent over the base case. Nearly all of the bottom slag (96.6 percent) produced in the U.S. enters the market and is beneficially used, and the availability of bottom slag is expected to decrease (ACAA, 2006). Based on the 2006 statistics from ACAA for beneficial use of slag, 3.4 percent of the bottom slag that would be generated annually would be disposed as waste (see Table 7.16-5). Further characterization would be necessary to determine whether the quality of the slag produced by the proposed power plant would support this level of reuse. Based on the average of the ACAA (2006) statistics for bottom ash and fly ash, 58.1 percent of the ash that would be generated annually would be disposed as waste (see Table 7.16-5). The recycled bottom slag and ash produced by the proposed power plant would not be expected to have an adverse impact on the market, as future supply is expected to be equal to or less than the demand.

Much of the industrial waste generated by FutureGen would likely be Class 2 or 3 and eligible for disposal in Type 1 municipal solid waste landfills. Other waste generated by FutureGen such as environmental controls waste (e.g., clarifier sludge) could potentially be classified as a Class 1 industrial waste and would be eligible for disposal in Type 1 municipal landfills that are approved for Class 1 industrial waste disposal by TCEQ. Table 7.16-2 lists the area landfills and their disposal capabilities. The estimated waste generation for the Odessa Power Plant is presented in Table 7.16-5. In addition to the waste listed in Table 7.16-5, the FutureGen facility may generate small amounts of hazardous waste such as solvents and paints from maintenance activities.

Table 7.16-5. Waste Generation

Waste	Annual Quantity (tons [metric tons])	Classification
Unrecycled bottom slag (Cases 1, 2, 3B)	3,290 (2,985) [1]	Special waste (Coal combustion byproduct)
Unrecycled ash (if non-slagging gasifiers are used)	56,280 (51,056)[2]	Special waste (Coal combustion byproduct)
ZLD (wastewater system) clarifier sludge	1,545 (1,402)	Industrial waste
ZLD filter cake	5,558 (5,042)	Industrial waste
Sanitary solid waste (office and break room waste)[3]	336 (305)	Municipal solid waste

[1]Based on ACAA (2006) statistics, DOE assumed that all but 3.4 percent of total slag production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[2]Based on ACAA (2006) statistics, DOE assumed that 41.9 percent of total ash production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[3]Quantity estimated for 200 employees using an industrial waste generation rate of 9.2 pounds (4.2 kilograms) per day per employee (CIWMB, 2006).
Source: FG Alliance, 2007, except as noted.

Chemical waste would be generated by periodic cleaning of the heat recovery steam generator and turbines. This waste would consist of alkaline and acidic cleaning solutions and wash water. They are likely to contain high concentrations of heavy metals. Chemical cleaning would be performed by outside contractors who would be responsible for the removal of associated waste products from the site. Precautions would be taken to prevent releases by providing spill containment for tanks used to store cleaning solutions and waste.

Other waste would include solids generated by water and wastewater treatment systems, such as activated carbon used in sour water treatment. Sulfur-impregnated activated carbon would be used to remove mercury from the synthesis gas. This mercury sorbent would be replaced periodically and the spent carbon would likely be hazardous waste. The spent carbon would be regenerated and reused at the site. It could also be returned to the manufacturer for treatment and recycling or transferred to an off-site hazardous waste treatment facility. Used oils and used oil filters would be collected and transported off site by a contractor for recycling or disposal.

The FutureGen facility would have the option of disposing of its nonhazardous waste in an on-site landfill, if one was developed. In addition, the operator could dispose of its industrial waste streams (Class 2 and 3) in a municipal landfill. Class 1 nonhazardous industrial waste could be disposed at area municipal landfills accepting that waste. TCEQ concluded that the Permian Basin Regional Planning Commission area had more than 100 years of remaining landfill capacity at the 2005 rate of disposal (TCEQ, 2006b). Capacity at hazardous waste landfills is also substantial. The nearby hazardous waste landfill has remaining capacity of over 5.0 million cubic yards (3.8 million cubic meters). Given the sanitary and hazardous waste disposal capacities available in the region, the impact of disposal of FutureGen-generated waste would be minimal. Given the small amount of hazardous waste (e.g., paints and solvents) that would be generated and the availability of commercial treatment and disposal facilities, the on-site waste management activities are not expected to require a RCRA permit.

Sequestration Site

During normal operations, the sequestration site components would generate minimal waste due to routine maintenance and workers presence. The waste could be special/hazardous (e.g., lubricants and oils) and sanitary waste (e.g., packaging and lunch waste). The minimal waste quantities would not impact disposal capacities of area landfills and waste collection services.

Several pre-injection hydrologic tests would be performed during site characterization to establish the hydrologic storage characteristics and identify the general permeability characteristics at the sequestration site. The following water-soluble tracers may be used:

- Potassium bromide (as much as 220 lb [100 kg])
- Fluorescein (as much as 132 lb [60 kg])
- 2,2-dimethyl-3-pentanol (as much as 4.4 lb [2.0 kg])
- Pentafluorobenzoic acid (as much as 8.8 lb [4.0 kg])

A suite of gas-phase tracers would be co-injected with the CO_2 to improve detection limits for monitoring. The tracers expected to be used include:

- Perfluoromethylcyclopentane (as much as 330 lb [150 kg])
- Perfluoromethylcyclohexane (as much as 2,646 lb [1,200 kg])
- Perfluorodimethylcyclohexane (as much as 330 lb [150 kg])
- Perfluorotrimethylcyclohexane (as much as 2,646 lb [1,200 kg])
- SF_6 (as much as 66 lb [30 kg])

- ^{3}He (as much as 0.033 lb [15 g])
- ^{78}Kr (as much as 0.44 lb [200 g])
- ^{124}Xe (as much as 0.088 lb [40 g])

The last three are stable, non-radioactive, isotope noble gas tracers. Tracers are a key aspect of the planned monitoring activities for the FutureGen sequestration site. The tracers would 1) contact the CO_2, water, and minerals, 2) limit the problem of interference from naturally occurring CO_2 background concentrations, and 3) provide a statistically superior monitoring and characterization method because of the redundancy built in by using multiple tracers. Tracers would be purchased in the required amounts and would be consumed (injected into the subsurface) as a result of the site characterization and monitoring activities.

Utility Corridors

During normal operations, the utility corridors and pipelines would not require additional materials and would not generate waste, other than cleared vegetation, if necessary, that could be disposed of at a non-hazardous waste landfill.

Transportation Corridors

Roads

On-site roads would require periodic re-surfacing at a frequency dependent on the level of use and weathering. Asphalt removed from the road surface would be recycled. Road re-surfacing would involve heavy equipment that would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and appropriately managed by the construction contractor.

Rail

Maintenance of the rail spur would consist of replacing the rails and equipment at a frequency dependent on the level of use and weathering. Replacement materials would be obtained in the correct sizes and quantities from established suppliers and the small amount of waste remaining after materials are reused or recycled would be disposed of in a permitted facility. Any special or hazardous waste (e.g., oils and coolants) generated during rail replacement would be managed by the contractor.

7.17 HUMAN HEALTH, SAFETY, AND ACCIDENTS

7.17.1 INTRODUCTION

This section describes the potential human health and safety impacts associated with the construction and operation of the proposed project. The health and safety impacts are evaluated in terms of the potential risk to both workers and the general public. The level of risk is estimated based on the current conceptual design of the proposed project, applicable health and safety and spill prevention regulations, and expected operating procedures.

Federal, state, and local health and safety regulations would govern work activities during construction and operation of the proposed project. Additionally, industrial codes and standards also apply to the health and safety of workers and the general public.

7.17.1.1 Region of Influence

The ROI for human health, safety, and accidents is the area within 10 miles (16.1 kilometers) of the boundaries of the proposed power plant site, sequestration site, and CO_2 pipeline. At the proposed Odessa Sequestration Site, modeling of the deep saline formation with an injection rate of 1.1 million tons (1 MMT) per year for 50 years produced a CO_2 plume radius of 1.0 mile (1.6 kilometers) (FG Alliance, 2006d). Because this is a first of its kind research project, 10 miles (16.1 kilometers) was chosen as a conservative distance in terms of the ROI for the sequestration site.

7.17.1.2 Method of Analysis

DOE performed analyses to evaluate the potential effects of the proposed power plant and sequestration activities on human health, safety, and accidents. The potential for occupational or public health impacts was based on the following criteria:

- Occupational health risk due to accidents, injuries, or illnesses during construction and normal operating conditions;
- Health risks (hazard quotient or cancer risk) due to air emissions from the proposed power plant under normal operating conditions;
- Health risks due to unintentional releases associated with carbon sequestration activities; and
- Health risks due to terrorist attack or sabotage at the power plant or carbon sequestration site.

Potential occupational safety impacts were estimated based on national workplace injury, illness, and fatality rates. These rates were obtained from the U.S. Bureau of Labor Statistics (USBLS) and are based on similar industry sectors. The rates were applied to the anticipated numbers of employees for each phase of the proposed project. From these data, the projected numbers of Total Recordable Cases (TRCs), Lost Work Day (LWD) cases, and fatalities were calculated. These analyses are presented in Section 7.17.2.

The calculated cancer risks and hazard quotients for the air emissions under normal operating conditions are summarized in Section 7.17.3.1. Potential hazards from the accidental release of toxic/flammable gas for different plant components were evaluated by Quest (2006). This study addressed failure modes within the proposed plant boundary and was performed to identify any systems or individual process unit components that would produce a significantly larger potential for on-site or off-site impact based on different plant configurations. The results are summarized in Section 7.17.3.2.

Potential health effects were evaluated for workers and the general public who may be exposed to releases of captured gases (CO_2 and H_2S) during pre- and post-sequestration conditions. Gas releases were evaluated at the proposed plant, during transport via pipeline, at the sequestration site, and during subsurface storage (Tetra Tech, 2007). The results of these risk analyses are summarized in Section 7.17.4.

The potential impacts from a terrorism or sabotage event were determined by examining the results of the accident analysis of major and minor system failures or accidents at the proposed plant site and gas releases along the CO_2 pipeline(s) and at injection wells. The results of this analysis are provided in Section 7.17.5.

7.17.2 OCCUPATIONAL HEALTH AND SAFETY

7.17.2.1 Typical Power Plant Health and Safety Factors and Statistics

Power Plant Construction

Table 7.17-1 shows the injury/illness and fatality rates for the most recent year (2005) for utility related construction. These rates are expressed in terms of injury/illness per 100 worker-years (or 200,000 hours) for TRCs, LWDs, and fatalities.

Power Plant Operation

Because of the gasification and chemical conversion aspects of the proposed power plant, it would operate more like a petrochemical facility rather than a conventional power plant. As a result, occupational injury/illness rates for the petrochemical manufacturing sector were used in the analysis of the proposed power plant operation (Table 7.17-1). These rates are presented for TRCs, LWDs, and fatality rates.

Table 7.17-1. Occupational Injury/Illness and Fatality Data for Project Related Industries in 2005

Industry	2005 Average Annual Employment (thousands)[1]	Total Recordable Case Rate (per 100 workers)[1]	Lost Workday Cases (per 100 workers)[1]	Fatality Rate (per 100 workers)[2]
Utility system construction	388.2	5.6	3.2	0.028
Petrochemical Manufacturing	29.2	0.9	0.4	0.001
Electric power transmission, control, and distribution	160.5	5.1	2.4	0.0062
Natural Gas Distribution	107.0	5.9	3.2	0.0025

[1] Source: USBLS, 2006a.
[2] Source: USBLS, 2006b.

Transmission Lines and Electro-Magnetic Fields

Magnetic fields are induced by the movement of electrons in a wire (current); and electric fields are created by voltage, the force that drives the electrical current. All electrical wiring, devices, and equipment, including transformers, switchyards, and transmission lines, produce electromagnetic fields (EMF). The strength of these fields diminishes rapidly with distance from the source. Building material, insulation, trees, and other obstructions can reduce electric fields, but do not significantly reduce magnetic fields. Electrical field strength is measured in kilovolts per meter, or kV/m. Magnetic field strength is expressed as a unit of magnetic induction (Gauss) and is normally expressed as a milligauss (mG), which is one thousandth of a Gauss. The average residential electric appliance typically has an electrical field of less than 0.003 kV/ft (0.01 kV/m). In most residences, when in a room away from electrical appliances, the magnetic field is typically less than 2 mG. However, very close to an appliance carrying a high current, the magnetic field can be thousands of milligauss.

Electric fields from power lines are relatively stable because line voltage does not vary much. However, magnetic fields on most lines fluctuate greatly as current changes in response to changing loads (consumption or demand).

Transmission lines contribute a relatively small portion of the electric and magnetic fields to which people are exposed. Nonetheless, over the past two decades, some members of the scientific community and the public have expressed concern regarding human health effects from EMFs during the transmission of electrical current from power plants. The scientific evidence suggesting that EMF exposures pose a health risk is weak. The strongest evidence for health effects comes from observations of human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults (NIEHS, 1999). The National Institute of Environmental Health Sciences (NIEHS) report concluded that, "extremely low-frequency and magnetic field exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard" (NIEHS, 1999). While a fair amount of uncertainty still exists about the EMF health effects issue, the following determinations have been established from the information:

- Any exposure-related health risk to an individual would likely be small;
- The types of exposures that are most biologically significant have not been established;
- Most health concerns relate to magnetic fields; and
- Measures employed for EMF reduction can affect line safety, reliability, efficiency, and maintainability, depending on the type and extent of such measures.

CO_2 and Natural Gas Pipeline Safety

More than 1,500 miles (2,414 kilometers) of high-pressure long distance CO_2 pipelines exist in the U.S (Gale and Davison, 2004). In addition, numerous parallels exist between CO_2 and natural gas transport. Most rules and regulations written for natural gas transport by pipeline include CO_2. These regulations are administered and enforced by DOT's Office of Pipeline Safety (OPS). States also may regulate pipelines under partnership agreements with the OPS. The rules are designed to protect the public and the environment by ensuring safety in pipeline design, construction, testing, operation, and maintenance. Risks associated with pipeline activities are determined to be low (IOGCC, 2005). However, in pipelines that carry captured CO_2 for sequestration, other gases may be captured and transported as well, and could affect risks posed to human health and the environment. For the proposed FutureGen Project, the captured gases might contain up to 100 parts per million by volume (ppmv) of H_2S in the pipeline on a routine basis, and should any of the captured gases escape to the environment, risks from exposure to H_2S would have to be estimated, as well as risks from CO_2 exposure.

Table 7.17-1 shows the occupational injury/illness and fatality rates for 2005 for operation of natural gas distribution systems. These rates are expressed in terms of injury/illness rate per 100 workers (or 200,000 hours) for TRCs, LWDs, and fatality rates. These rates are used to indicate occupational injuries associated with pipelines, although the properties and types of hazards of natural gas are different from those of CO_2. Because natural gas is highly flammable, these rates are determined to be conservative in relation to CO_2 pipelines.

7.17.2.2 Impacts

This subsection describes potential occupational health and safety risks associated with construction and operation of the proposed project. Features inherent in the design of project facilities as well as compliance with mandatory regulations, plans, and policies to reduce these potential risks are summarized within each risk category.

Construction

Power Plant Site

Potential occupational health and safety risks during construction of the proposed power plant and facilities are expected to be typical of the risks for major industrial/commercial construction sites. Health and safety concerns include: the movement of heavy objects, including construction equipment; slips, trips, and falls; the risk of fire or explosion from general construction activities (e.g., welding); and spills and exposures related to the storage and handling of chemicals and disposal of hazardous waste.

Risk of Fire or Explosion from General Construction Activities

Contractors experienced with the construction of coal and gas-fired electricity generating plants and refineries would be used on the proposed project. Construction specifications would require that contractors prepare and implement construction health and safety programs that are intended to control worker activities as well as establish procedures to prevent and respond to possible fires or explosions. The probability of a significant fire or explosion during construction of the proposed project has been determined to be low. With implementation of BMPs and procedures described in the following paragraphs, health and safety risks to construction workers and the public would also be low.

During construction, small quantities of flammable liquids and compressed gases would be used and stored on site. Liquids would include construction equipment fuels, paints, and cleaning solvents. Compressed gases would include argon, acetylene, helium, nitrogen, and O_2 for welding. Potential risk hazards associated with the use of flammable liquids and compressed gases would be reduced by compliance with a construction health and safety program and proper storage of these materials when not in use, in accordance with all applicable federal, state, and local regulations. The construction health and safety program would include the following major elements:

- An injury and illness prevention program;
- A written safety program (including hazard communication);
- A personnel protection devices program; and
- On-site fire suppression and prevention plans.

Storage and Handling of Hazardous Materials, Fuels and Oils

Hazardous materials used during construction would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of materials would be stored in a flammable storage locker, and drums and tanks would be stored in a secondary containment. Storage of the various types of chemicals would conform to Occupational Safety and Health Administration (OSHA) and applicable state guidelines. Construction personnel would be trained in handling chemicals, and would be alerted to the dangers associated with the storage of chemicals. An on-site Environmental Health and Safety Representative would be designated to implement the construction health and safety program and to contact emergency response personnel and the local hospital, if necessary. MSDS for each chemical would be kept on site, and construction employees would be made aware of their location and content.

To limit exposure to uncontrolled releases of hazardous materials and ensure their safe handling, specific procedures would be implemented during construction, including:

- Lubrication oil used in construction equipment would be contained in labeled containers. The containers would be stored in a secondary containment area to collect any spillage.
- Vehicle refueling would occur at a designated area and would be closely supervised to avoid leaks or releases. To further reduce the possibility of spills, no topping-off of fuel tanks would be allowed.
- If fuel tanks are used during construction, the fuel tank(s) would be located within a secondary containment with an oil-proof liner sized to contain the single largest tank volume plus an adequate space allowance for rainwater. Other petroleum products would be stored in clearly labeled and sealed containers or tanks.
- Construction equipment would be monitored for leaks and undergo regular maintenance to ensure proper operation and reduce the chance of leaks. Maintenance of on-site vehicles would occur in a designated location.
- All paint containers would be sealed and properly stored to prevent leaks or spills. Unused paints would be disposed of in accordance with applicable state and local regulations.

Overall, BMPs would be employed that would include good housekeeping measures, inspections, containment maintenance, and worker education.

Spill Response and Release Reporting

Small quantities of fuel, oil, and grease may leak from construction equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations. If a large spill from a service or refueling truck were to occur, a licensed, qualified waste contractor would place contaminated soil in barrels or trucks for off-site disposal.

The general contractor's responsibility would include implementation of spill control measures and training of all construction personnel and subcontractors in spill avoidance. Training would also include appropriate response when spills occur, and containment, cleanup, and reporting procedures consistent with applicable regulations. The primary plan to be developed would describe spill response and cleanup procedures. In general, the construction contractor would be the generator of waste oil and miscellaneous hazardous waste produced during construction and would be responsible for compliance with applicable federal, state, and local laws, ordinances, regulations, and standards. This would include licensing, personnel training, accumulation limits, reporting requirements, and record keeping.

During construction, the potential exists for a major leak during the chemical cleaning of equipment or piping before it is placed into service. This method of cleaning could consist of an alkaline degreasing step (in which a surfactant, caustic, or NH_3 solution is used), an acid cleaning step, and a passivation step. Most of the solution would be contained in permanent facility piping and equipment. The components of the process that would be most likely to leak are the temporary chemical cleaning hoses, pipes, pump skids, and transport trailers. The cleaning would be within curbed areas, and spills would be manually cleaned up and contaminated materials disposed of in accordance with the applicable regulations.

Due to the limited quantities and types of hazardous materials used during construction, the likelihood of a spill reaching or affecting off-site residents would be low.

Medical Emergencies during Construction

Selected construction personnel would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid or stabilization of the victim(s) until professional medical attention could be attained. Any injury or illness that would require treatment beyond first aid would be referred to the local hospital.

Worker Protection Plan

The construction contractor would develop, implement and maintain a Worker Protection Plan. This plan would implement OSHA requirements (1910 and 1926) and would define policies, procedures, and practices implemented during the construction process to ensure protection of the workforce, environment, and the public. The minimum requirements addressed by the Worker Protection Plan would include:

- Environment, Safety, and Health Compliance
- Working Surfaces
- Scaffolding
- Powered Platforms, Manlifts, and Vehicle-Mounted Platforms
- Fall Protection
- Cranes, Derricks, Hoists, Elevators, and Conveyors
- Hearing Conservation
- Flammable and Combustible Liquids
- Hazardous Waste Operations
- Personal Protective Equipment
- Respiratory Protection
- Confined Space Program
- Hazardous Energy Control
- Medical and First Aid
- Fire Protection
- Compressed Gas Cylinders
- Materials Handling and Storage
- Hand and Portable Powered Tools
- Welding, Cutting and Brazing
- Electrical Safety
- Toxic and Hazardous Substances
- Hazardous Communications
- Heat Stress

Industrial Safety Impacts

Based on data for the construction of similar projects, the construction workforce would average about 350 employees, with a peak of about 700 during the most active period of construction. Since the nature of the activities to be performed across all areas of the proposed project would be similar in scope, industrial safety impacts were calculated for the proposed project and not for each construction sector. Based on the employment numbers during the construction phase, the TRCs, LWDs, and fatalities presented in Table 7.17-2 would be expected. As shown in Table 7.17-2, based on the estimated number of workers during construction, no fatalities would be expected (calculated number of fatalities is less than one).

Table 7.17-2. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Construction

Construction Phase	Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
Average	350	20	11	0.098
Peak	700	40	22	0.196

Sequestration Site

Accidents are inherently possible with any field or industrial activities. Well drilling can lead to worker injuries due to: being struck with or pinned by flying or falling parts and equipment; trips and falls; cuts, bruises, and scrapes; exposure to high noise; and muscle strains due to overexertion. Catastrophic accidents could involve well blowouts, derrick collapse, exposure to hydrogen sulfide and other hazardous gases, fire, or explosion. Although catastrophic accidents frequently involve loss of life as well as major destruction of equipment, they represent only a small percentage of the total well drilling occupational injury incidence and severity rates. Most well drilling injuries (60 to 70 percent) were reported by workers with less than six months of experience (NIOSH, 1983). To avoid well drilling accidents, a worker protection plan and safety training (particularly for new workers) would be instituted, covering all facets of drilling site safety.

Utility Corridors

Risks and hazards associated with construction of power lines, substations, and pipelines would be addressed through the Worker Protection Plan. Many of these types of construction activities may be undertaken by public utilities or companies specializing in this type of work and would be governed by their worker protection programs.

Transportation Infrastructure Corridors

Risks and hazards associated with construction activities for access roads, public road upgrades, and the rail loop would be addressed through the Worker Protection Plan. Construction activities on public roads may be undertaken by city or county public works departments and would be governed by their worker protection programs.

Operational Impacts

Two categories of accidents could occur that would pose an occupational health and safety risk to individuals at the proposed power plant, on the CO_2 pipeline, at the CO_2 sequestration site, or in the proposed project vicinity; risk of fire or explosion either from general facility operations or specifically from a gas release (e.g., syngas, hydrogen, natural gas, H_2S, or CO_2); and risk of a hazardous chemical release or spill. Risk assessments evaluating accidents (e.g., explosions and releases) were performed to evaluate potential impacts for both workers and the public. The results of these assessments are summarized in Sections 7.17.3.2 and 7.17.4.

Power Plant Site

The operation of any industrial facility or power plant holds the potential for workplace hazards and accidents. To promote the safe and healthful operation of the proposed power plant, qualified personnel would be employed and written safety procedures would be implemented. These procedures would provide clear instructions for safely conducting activities involved in the initial startup, normal operations, temporary operations, normal shutdowns, emergency shutdowns, and subsequent restarts. The procedures for emergency shutdowns would include the conditions under which such shutdowns are required and the assignment of emergency responsibilities to qualified operators to ensure that procedures are completed in a safe and timely manner. Also covered in the procedures would be the consequences of operational deviations and the steps required to correct or avoid such deviations. Employees would be given a facility plan, including a health and safety plan, and would receive training regarding the operating procedures and other requirements for safe operation of the proposed power plant. In addition, employees would receive annual refresher training, which would include the testing of their understanding of the procedures. The operator would maintain training and testing records.

The proposed power plant would be designed to provide the safest working environment possible for all site personnel. Design provisions and health and safety policies would comply with OSHA standards and consist of, but not be limited to, the following:

- Safe egress from all confined areas;
- Adequate ventilation of all enclosed work areas;
- Fire protection;
- Pressure relief of all pressurized equipment to a safe location;
- Isolation of all hazardous substances to a confined and restricted location;
- Separation of fuel storage from oxidizer storage;
- Prohibition of smoking in the workplace; and
- Real-time monitoring for hazardous chemicals with local and control room annunciation and alarm.

Industrial Safety Impacts

The operational workforce is expected to average about 200 employees. As shown in Table 7.17-3, the number of calculated fatalities for operation of this facility would be less than one.

Table 7.17-3. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
200	2	1	0.002

Risk of Fire or Explosion

Operation of the proposed facility would involve the use of flammable and combustible materials that could pose a risk of fire or explosion. The potential for fire or explosion at the proposed power plant would be minimized through design and engineering controls, including fire protection systems. The risks of fire and explosion could be minimized also through good housekeeping practices and the proper storage of chemicals. Workers would consult MSDS information to ensure that only compatible chemicals are stored together. Impacts of a potential large or catastrophic explosion are discussed in Section 7.17.3.2.

Risk of Hazardous Chemical Release or Spill

Chemicals and hazardous substances would be delivered, used, and stored at the proposed project site during operation. Petroleum products used on site during operation would be stored following the same guidelines described for construction. During operation, the worst-case scenario would be a major leak during chemical cleaning of equipment and associated piping.

The presence of hazardous environments during normal operations is not anticipated. Plant equipment would be installed, maintained, and tested in a manner that reduces the potential for inadvertent releases. Scheduled and forced maintenance would be planned to incorporate engineering and administrative controls to provide worker protection as well as mitigate any possible chemical releases. Facility and spot ventilation would provide for the timely removal and treatment of volatile chemicals. Worker practices and facility maintenance procedures would provide for the containment and cleanup of non-volatile chemicals. Personnel and area monitoring will provide assurance that worker exposures are maintained well below regulatory limits.

Seven chemical compounds are identified that could produce harmful effects in exposed individuals. The severity of these effects is dependent on the level of exposure, the duration of the exposure, and individual sensitivities to the various chemical compounds. Table 7.17-4 describes chemical exposure limits, potential exposure routes, organs targeted by the compounds, and the range of symptoms associated with exposures to these chemicals. The occupational exposure limits are defined in Table 7.17-5. Potential public exposures to accidental releases of these chemicals are described in Section 7.17.3.2.

While some of the chemicals listed in Table 7.17-4 would be generated during proposed power plant operation, others are stored on site and the potential for personnel exposure as the result of minor spills or leaks, while low, exists.

Table 7.17-5. Definitions of Occupational Health Criteria

Hazard Endpoint	Description
NIOSH REL C	NIOSH recommended exposure limit (REL). A ceiling value. Unless noted otherwise, the ceiling value should not be exceeded at any time.
NIOSH REL ST	NIOSH REL. Short-term exposure limit (STEL), a 15-minute TWA exposure that should not be exceeded at any time during a workday.
NIOSH REL TWA	NIOSH REL. TWA concentration for up to a 10-hour workday during a 40-hour work week.
OSHA PEL C	Permissible exposure limit (PEL). Ceiling concentration that must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure.
OSHA PEL TWA	PEL. TWA concentration that must not be exceeded during any 8-hour work shift of a 40-hour workweek.
IDLH	Airborne concentration from which a worker could escape without injury or irreversible health effects from an IDLH exposure in the event of the failure of respiratory protection equipment. The IDLH was evaluated at a maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection should be permitted. In determining IDLH values, NIOSH evaluated the ability of a worker to escape without loss of life or irreversible health effects along with certain transient effects, such as severe eye or respiratory irritation, disorientation, and incoordination, which could prevent escape. As a safety margin, IDLH values are based on effects that might occur as a consequence of a 30-minute exposure.

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.

The FutureGen Project would use aqueous NH_3 in a selective catalytic reduction process to remove NO_X and thousands of pounds could be stored on-site. Three scenarios for the accidental release of NH_3 were evaluated using the EPA's ALOHA model: a leak from a tank valve, a tanker truck spill, and a tank rupture. (See Appendix F for summary of how the model was used, a description of input data, and the results of sensitivity analyses.) Health effects from inhalation of NH_3 can range from skin, eye, throat, and lung irritation; coughing; burns; lung damage; and even death. Impacts of NH_3 releases on workers and the public depends on the location of the releases, the meteorological conditions (including atmospheric stability and wind speed and direction) and other factors. The criteria used to examine potential health effects, are defined in Table 7.17-6 and Table 7.17-7.

Table 7.17-6. Hazard Endpoints for Individuals Potentially Exposed to an Ammonia Spill

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
1 hour	NH_3	Adverse effects	30	AEGL 1
		Irreversible adverse effects	160	AEGL 2
		Life Threatening	1,100	AEGL 3

[1]See Table 7.17-7 for descriptions of the AEGL endpoints.
AEGL = Acute Exposure Guideline Level.

Table 7.17-7. Description of Hazard Endpoints for Ammonia Spill Receptors

Hazard Endpoint	Description
AEGL 1	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
AEGL 2	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.
AEGL 3	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

AEGL = Acute Exposure Guideline Level.
Source: EPA, 2007.

Leakage of 400 pounds (180 kilograms) of aqueous NH_3 solution (19 percent NH_3) from a tank, through a faulty valve was selected as a plausible upper-bound accidental spill. It was assumed that this release would create a one-centimeter deep pool, with a surface area of 211 square feet (19.6 square meters). The temperature of the solution was assumed to be 106°F (41.1°C), based on the maximum daily air temperature in Odessa for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 2,949 feet (899 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 7.17-8). Individuals exposed within a distance of 1,339 feet (408 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur only within 568 feet (173 meters) of the spill. Thus, only workers (assumed to be within 820 feet [250 meters] of a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 5 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters).

For the tanker truck spill scenario, it was assumed that all 46,200 pounds (20,956 kilograms) of the 19 percent NH_3 solution in the truck may be spilled on the ground surface. It was assumed that this release would create a ten-centimeter deep pool, with a surface area of 2,454 square feet (228 square meters). The temperature of the solution was assumed to be 106°F (41.1°C), based on the maximum daily air temperature in Odessa for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 meters/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 15,584 feet (4,750 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 7.17-8). Individuals within a distance of 6,562 feet (2,000 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 2,277 feet (694 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters), but not inside a building.

For the tank rupture spill scenario, it was assumed that all 104,355 pounds (13,400 kilograms) of the 19 percent NH_3 solution in one of two on-site storage tanks may be released within the diked area around the tank. The tank discharge was assumed to create a 92-centimeter deep pool with a surface area of 601 square feet (55.8 square meters). Again the temperature of the solution was conservatively assumed to be 106^{o}F (41.1 ^{o}C). The same atmospheric conditions as above, and EPA's ALOHA model with a source duration of 1 hour were used to calculate downwind atmospheric NH_3 concentrations. Concentrations within 9,186 feet (2,800 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 7.17-8). Individuals within a distance of 3,281 feet (1,000 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,132 feet (345 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters).

The meteorological conditions specified for these analyses (F stability class) result in conservative estimates of exposure. At Odessa, this stability class occurs about 5 percent of the time. Simulations of the other six stability classes showed that the predicted distances to a given criteria were no more than 35 percent of the distance for the conservative stability class F. The stability class (D8), which gave the second highest results, occurs about 20 percent of the time. Since NH_3 produces a distinct, pungent odor at low concentrations (approximately 17 ppmv (AIHA, 1997), it is expected that most workers and the public in the vicinity of an accident would quickly evacuate under the scenarios discussed above. Depending on the size and location of the accident, the public would be alerted to the appropriate response such as shelter-in-place procedures or evacuation for the public living near the accident.

Table 7.17-8. Effects of an Ammonia Spill at the Proposed Power Plant

Release Scenario	Gas	Effect[1]	Distance (feet [meters])
NH_3 leaky valve (400 pounds, 19 percent solution)	NH_3	Adverse Effects	2,949 (899)
		Irreversible adverse effects	1,339 (408)
		Life threatening effects	568 (173)
NH_3 tanker truck spill (46,200 pounds, 19 percent solution)	NH_3	Adverse Effects	15,584 (4,750)
		Irreversible adverse effects	6,562 (2000)
		Life threatening effects	2,277 (694)
NH_3 tank rupture (104,355 pounds, 19 percent solution)	NH_3	Adverse Effects	9,186 (2800)
		Irreversible adverse effects	3,281 (1000)
		Life threatening effects	1,132 (345)

Multiply distance in feet by 0.3048 to convert to meters.
[1] See Table 7.17-6 and Table 7.17-7 for an explanation of the effects.

Sections 7.17.3.2 and 7.17.4 discuss scenarios involving equipment failure or rupture at the proposed power plant site, along utility corridors, and at the injection site.

Medical Emergencies

All permanent employees at the facility would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid treatment or stabilization of the victim(s) until professional medical attention is obtained. Any injury or illness that requires treatment beyond first aid would be referred to the plant's medical clinic or to a local medical facility.

Coal Storage

The National Fire Protection Association (NFPA) identifies hazards associated with storage and handling of coal, and gives recommendations for protection against these hazards. NFPA recommends that any storage structures be made of non-combustible materials, and that they be designed to minimize the surface area on which dust can settle, including the desirable installation of cladding underneath a building's structural elements.

Coal is susceptible to spontaneous combustion due to heating during natural oxidation of new coal surfaces. Also, coal dust is highly combustible and an explosion hazard. If a coal dust cloud is generated inside an enclosed space and an ignition source is present, an explosion can ensue. Dust clouds may be generated wherever loose coal dust accumulates, such as on structural ledges; or if there is a nearby impact or vibration due to wind, earthquake, or even maintenance operations. Because of coal's propensity to heat spontaneously, ignition sources are almost impossible to eliminate in coal storage and handling, and any enclosed area where loose dust accumulates is at great risk. Further, even a small conflagration can result in a catastrophic "secondary" explosion if the small event releases a much larger dust cloud.

A Quonset hut-type building for on-site coal storage is being examined (FG Alliance, 2006e). This structure would protect the pile from rain and wind which would otherwise foster spontaneous combustion in open-air piles and cause air and runoff pollution. Internal cladding would prevent dust accumulation on the structure. A breakaway panel may provide for accidental overloading and ventilation at the base, and exhaust fans or ventilation openings ensure against methane or smoke buildup. Dust suppression/control techniques would be employed. Fire detection and prevention systems may also be installed.

The surfaces of stored coal can be unstable, and workers can become entrapped and subsequently suffocate while working on stored coal piles (NIOSH, 1987). NIOSH recommendations for preventing entrapment and suffocation would be followed.

Sequestration Site

Industrial Safety Impacts

The operational workforce for the proposed sequestration site would have up to 20 employees. Since this proposed site would not be a permanently staffed facility, these personnel would be rotated from the permanent site pool. Based on these employment numbers, during operation of the proposed power plant, the TRCs, LWDs, and fatalities presented in Table 7.17-9 would be expected. As shown in Table 7.17-9, the number of calculated fatalities for operation of this facility would be less than one.

Table 7.17-9. Calculated Annual Occupational Injury and Fatality Cases for Sequestration Site Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Utility Corridors

Risk of Fire or Explosion

The proposed transmission line connector would be located high above ground (typically between 50 to 100 feet [15.2 to 30.5 meters] high). Only qualified personnel would perform maintenance on the proposed transmission lines. Sufficient clearance would be provided for all types of vehicles traveling under the proposed transmission lines. The operator of the line would establish and maintain safe clearance between the tops of trees and the proposed transmission lines to prevent fires. Ground and counterpoise wires would be installed on the proposed transmission system, providing lightning strike protection and thereby reducing the risk of explosion. However, a brush fire could occur in the rare event that a conductor parted and one end of the energized wire fell to the ground, or perhaps in the event of lightning strikes. Under these rare circumstances, the local fire department would be called upon.

Releases or Potential Releases of Hazardous Materials to the Environment

Hazardous materials used during maintenance of the proposed transmission facilities would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of fuel, oil, and grease may leak from maintenance equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations.

Industrial Safety Impacts

The operational workforce for the proposed utility corridors would be up to 20 employees. As with the proposed sequestration site, the majority of these workers would not be on permanent assignment and would be drawn from the plant pool. Based on these employment numbers, during operation and maintenance of utility corridors, the TRCs, LWDs, and fatalities presented in Table 7.17-10 would be expected. As shown in Table 7.17-10, the number of calculated fatalities for operation of this facility would be less than one

Table 7.17-10. Calculated Annual Occupational Injury and Fatality Cases for Utility Corridors Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Transportation Corridors

Facility personnel would not be involved in activities associated with these infrastructure operations. Rail and road transportation activities would be performed by non-facility employees and vendors. Hazards related to proposed transportation corridor operation would not be different from those posed by the normal transportation risks associated with product delivery.

7.17.3 AIR EMISSIONS

7.17.3.1 Air Quality – Normal Operations

Air quality impacts on human health were evaluated for HAPs potentially released during normal operation of the proposed Odessa Power Plant and proposed Sequestration Site. HAP emissions from the

FutureGen Project were estimated based on the Orlando Gasification Project. The methods used to analyze impacts are described in detail in Section 7.2.3 with supporting materials in Appendix E. Assessment of the potential toxic air pollutant emissions demonstrated that all ambient air quality impacts for air toxics would be below the relevant EPA recommended exposure criteria. This section of the report provides a summary of the results of potential air quality impacts.

As described in Section 7.2.3 regarding the modeling approach, estimated emissions of HAPs were based on data taken from the Orlando Gasification Project (DOE, 2007). Although the Orlando project is an IGCC power plant, there are differences from the proposed project. Consequently, the Orlando project data were scaled, based on relative emission rates of volatile organic compounds (VOCs) and particulate matter, to produce more appropriate estimates of stack emissions from the proposed project.

Airborne HAP concentrations were determined by modeling the impacts of 1 g/s emissions rate using AERMOD. Table 7.17-11 shows representative air quality impacts for several metallic and organic toxic air pollutants. Each of these airborne concentrations was evaluated using chronic exposure criteria (expressed as inhalation unit risk factors and reference concentrations) obtained from the EPA Integrated Risk Information System (IRIS) (EPA, 2006a). As appropriate, an inhalation unit risk factor was multiplied by the maximum annual average airborne concentration for each HAP to calculate a cancer risk. Hazard coefficients were calculated by dividing the maximum annual average airborne concentration for each HAP by the appropriate reference concentration taken from the EPA IRIS (EPA, 2006a). The cancer risks and hazard coefficients calculated for each HAP were then summed and compared to the EPA criteria for evaluating HAP exposures. The results of this analysis, as indicated in Table 7.17-11, show that predicted exposures are safely well below the EPA exposure criteria.

Normal Air Quality and Asthma

Asthma is a chronic respiratory disease characterized by attacks of difficulty breathing. It is a common chronic disease of childhood, affecting over 6.5 million children in the U.S. in 2005 and contributing to over 12.8 million missed school days annually (DHHS, 2006). In 2005, the prevalence of asthma among children in the U.S. was 8.9 percent. Asthma prevalence rates among children remain at historically high levels after a large increase from 1980 until the late 1990s.

Asthma-related hospitalizations followed a trend similar to those for asthma prevalence, rising from 1980 through the mid-1990s, remaining at historically high plateau levels. Asthma-related mortality rates in the U.S. have declined recently after a rising trend from 1980 through the mid-1990s (DHHS, 2006).

It remains unknown why some people get asthma and others do not (DHHS, 2006). Asthma symptoms are triggered by a variety of things such as allergens (e.g., pollen, dust mites, and animal dander), infections, exercise, changes in the weather, and exposure to airway irritants (e.g., tobacco smoke and outdoor pollutants). Although extensive evidence shows that ambient air pollution (based on measurements of NO_2, particulate matter, soot, and O_3) exacerbates existing asthma, a link with the development of asthma is less well established (Gilmour et al., 2006).

A 2006 workshop sponsored by the EPA and the National Institute of Health and Environmental Sciences (NIEHS) (Selgrade et al., 2006) found that there are a number of scientific questions that need to be answered in order to make appropriate regulatory decisions for ambient air, including which air pollutants are of greatest concern and at what concentrations. Nevertheless, IGCC power plants that are currently in operation have achieved the lowest levels of criteria air pollutant (SO_2, CO, O_3, NO_2, Pb, and respirable PM) emissions of any coal-fueled power plant technologies (DOE, 2002). Tables 7.2-1 and 7.2-2 show that the IGCC technology under evaluation for the proposed project would exceed the performance of technologies used at more conventional types of coal-fueled power plants of comparable size. Furthermore, based on evaluations conducted for this proposed site (as described in Section 7.2), the maximum predicted concentrations of the criteria air pollutants would not exceed the National Ambient Air Quality Standards and would not significantly contribute to existing background levels. Based on these determinations, it is unlikely that the proposed project would be a factor in asthma-related health effects.

Table 7.17-11. Summary Analysis Results — Hazardous Air Pollutants

Chemical Compound	CT/HRSG Emissions[1] (lb/hr)	CT/HRSG Emissions[1] (g/s)	Inhalation Unit Risk Factor[2] $(\mu g/m^3)^{-1}$	Reference Concentration[2] $(\mu g/m^3)^{-1}$	Cancer Risk[3]	Hazard Coefficient[4]
2-Methylnaphthalene	1.99E-04	2.51E-05	n/a	n/a	n/a	n/a
Acenaphthyalene	1.44E-05	1.81E-06	n/a	n/a	n/a	n/a
Acetaldehyde	9.99E-04	1.26E-04	2.20E-06	9.00E+00	3.74E-12	1.89E-07
Antimony	**5.59E-03**	**7.04E-04**	n/a	**2.00E-01**	n/a	**4.76E-05**
Arsenic	**2.94E-03**	**3.70E-04**	**4.30E-03**	**3.00E-02**	**2.15E-08**	**1.67E-04**
Benzaldehyde	1.61E-03	2.03E-04	n/a	n/a	n/a	n/a
Benzene	2.69E-03	3.39E-04	7.80E-06	3.00E+01	3.58E-11	1.53E-07
Benzo(a)anthracene	1.28E-06	1.61E-07	1.10E-04	n/a	2.39E-13	n/a
Benzo(e)pyrene	3.05E-06	3.84E-07	8.86E-04	n/a	4.59E-12	n/a
Benzo(g,h,i)perylene	5.26E-06	6.63E-07	n/a	n/a	n/a	n/a
Beryllium	**1.26E-04**	**1.59E-05**	**2.40E-03**	**2.00E-02**	**5.14E-10**	**1.07E-05**
Cadmium	**4.06E-03**	**5.12E-04**	**1.80E-03**	**2.00E-02**	**1.24E-08**	**3.45E-04**
Carbon Disulfide	2.49E-02	3.14E-03	n/a	7.00E+02	n/a	6.05E-08
Chromium[5]	**3.78E-03**	**4.76E-04**	**1.20E-02**	**1.00E-01**	**7.72E-08**	**6.43E-05**
Cobalt	**7.97E-04**	**1.00E-04**	n/a	**1.00E-01**	n/a	n/a
Formaldehyde	1.85E-02	2.33E-03	5.50E-09	9.80E+00	1.73E-13	n/a
Lead	**4.06E-03**	**5.12E-04**	n/a	**1.50E+00**	n/a	**4.61E-06**
Manganese	**4.34E-03**	**5.47E-04**	n/a	**5.00E-02**	n/a	**1.48E-04**
Mercury	**1.27E-03**	**1.60E-04**	n/a	**3.00E-01**	n/a	**7.22E-06**
Naphthalene	2.95E-04	3.72E-05	3.40E-05	3.00E+00	n/a	1.67E-07
Nickel	**5.45E-03**	**6.87E-04**	**2.40E-04**	**9.00E-02**	**2.23E-09**	**1.03E-04**
Selenium	**4.06E-03**	**5.12E-04**	n/a	**2.00E+01**	n/a	**3.45E-07**
Toluene	4.12E-04	5.19E-05	n/a	4.00E+02	n/a	1.75E-09
TOTAL					1.14E-07	8.98E-04
Risk Indicators					1.00E-06	1.00E+00
Percent of Indicator					11.4 percent	0.09 percent

[1] Emission rates scaled by the ratio of VOC or particulate emissions from Orlando EIS to FutureGen.
[2] Provided by EPA Integrated Risk Information System (IRIS).
[3] Unit risk factor multiplied by maximum annual average impact of 0.0135 $\mu g/m^3$ determined by AERMOD at a 1 g/s emission rate.
[4] Maximum AERMOD annual average impact divided by reference concentration.
Notes:
CT/HRSG = combustion turbine/heat recovery steam generator; lb/hr = pounds per hour; g/s = grams per second; $\mu g/m^3$ = micrograms per cubic meter; n/a = not available.
[5] Conservatively assumed all chromium to be hexavalent.
Compounds that are considered to be particulate matter in **bold** text.

7.17.3.2 Hazard Analysis

The “Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations” (referred hereafter as the Quest Study) was conducted to define creditable upperbound impacts from potential accidental releases of toxic and flammable gas from the proposed systems (Quest, 2006). Risks associated with gas releases include asphyxiation, exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions.

A particular concern associated with the release of gas is exposure to a toxic component within the dispersing gas cloud. Many of the process streams of the proposed power plant could contain one or more toxic components. The Quest Study evaluated the extent of exposure to gas clouds containing NH_3, CO, Cl_2, HCl, H_2S, and SO_2. Additional analyses were performed to define the extent of potential asphyxiation hazard associated with exposure to high concentrations of CO_2.

The hazard of interest for flash fires was direct exposure to flames. Flash fire hazard zones were determined by calculating the maximum size of the flammable gas cloud before ignition. The lower flammable limit (LFL) of the released hydrocarbon mixture was used as a boundary. The hazard of interest for the torch fires (ignition of a high velocity release of a flammable fluid, such as a hydrogen deflagration) was exposure to thermal radiation from the flame (Quest, 2006). For vapor clouds explosions, the hazard of interest was the overpressure created by the blast wave. For toxic components, potential impacts were determined by calculating the maximum distance at which health effects could occur.

Plant System Configurations

For the purposes of the analysis, the facility was assumed to be located in an area of reasonably flat terrain with limited vertical obstructions. This provided the bounding conditions that allow for the most conservative hazard impact analysis (Quest, 2006).

For the base case evaluation, the main process components for each of the proposed plant configurations were laid out in a rectangular area approximately 75 acres (30 hectares) in size. This area was surrounded by the rail line used to deliver the coal. The total area required for the project would consist of a minimum of 200 acres (81 hectares) (Quest, 2006).

Three other cases were also evaluated. Assuming the proposed facility is placed in the middle of a 200-, 400-, or 600-acre (81-, 162-, or 243-hectare) site, it was determined whether any explosion would extend beyond the boundaries of each site configuration.

Summary of Results

A full evaluation of the hazards associated with the preliminary designs of the four proposed gasifier systems for use in the proposed project was performed. This analysis was composed of the following three primary tasks:

- Task 1: Determine the maximum credible potential releases, for each process unit within each proposed system configuration for each candidate coal source.
- Task 2: For each release point identified in Task 1, determine the maximum downwind travel for harmful, but not fatal, consequences of the release under worst-case atmospheric conditions.
- Task 3: Using the results of Task 2 and the available general layout information for the proposed system configurations, develop a methodology to rank the potential impacts to the workers on site and the potential off-site public population.

Hazards Identification

In general, all four of the gasifier systems evaluated for the FutureGen Project are composed of similar equipment. All the gas processing equipment downstream of the gasifier is in common use in the petroleum industry and does not provide any unique hazards (Quest, 2006).

Upperbound-Case Consequence Analysis

The Quest Study evaluated the largest releases to determine the extent of possible flammable and toxic impacts under maximum (upperbound) release conditions. The analysis included a combination of four gasifiers and three types of coal (12 gasifier/coal combinations). The impacts were defined as those that could cause injury to workers or members of the public.

None of the flammable hazards were found to have impacts that extended beyond the proposed plant property. The largest flash fire impact zones extended less than 200 feet (61.0 meters) from the point of release. Areas within the process units in each of the four project system designs would have the potential to be impacted by flammable releases. This result is not unexpected for a facility handling similar materials (Quest, 2006).

The upperbound for toxic impacts associated with the 12 gasifier/candidate coal combinations evaluated would have the potential to extend past the proposed project property line. The toxic impacts would be dominated by releases of H_2S and SO_2 from the Claus process unit. The resulting plumes could extend from 0.3 to 1.4 miles (0.5 to 2.3 kilometers) from the point of release. However, there are no family residences or farm home sites within the 1.4-mile (2.3-kilometer) plume release radius.

The longest downwind toxic impact distance associated with any of the four gasifiers is due to the CO in the syngas process stream. These streams can produce toxic CO impacts extending from 0.4 to 0.6 mile (0.6 to 1.0 kilometer) from the point of release (Quest, 2006). There are no family residences, farm home sites or commercial properties within the 0.6-mile (1.0-kilometer) release footprint radius.

The potential health risks to these receptors are discussed in more detail in Section 7.17.5.

Hazard Ranking

Using the results from Tasks 1 and 2, a framework for ranking the flammable and toxic impacts associated with the upperbound release was designed as a function of the location of a worker or member of the public relative to the facility process units. Four zones were developed; two for the workers inside the property line and two for the public outside of the property lines (Quest, 2006).

Since none of the flammable hazards were found to have impacts that extended past the property line, there would be no off-site or public impacts due to flammable releases within the facility process units (Quest, 2006).

The upperbound for toxic impacts associated with all 12 gasifier/coal candidate combinations would have the potential to extend past the project property line. In 11 of the 12 gasifier/candidate coal combinations, toxic impacts associated with the Claus unit would be greater than the impacts from any other process unit (Quest, 2006).

In general, all 12 gasifier/candidate coal systems would have the potential to produce toxic impacts that could extend into a public area outside of the property line for the 200-acre (81-hectare) base case layout. By this measure, all four gasifier systems, regardless of candidate coal, have the potential to produce similar worst-case impacts and thus, are ranked equally. This conclusion is also true for a 400-acre (162-hectare) layout and is true for 11 of the 12 gasifier/candidate coal systems assuming a 600-acre (243-hectare) site (Quest, 2006).

Conclusions

The identification and evaluation of the largest potential releases associated with the four gasifier system designs for the proposed project results in the following findings:

- There are no flammable hazard impacts that extend off the project property.

- All four gasifier designs produce similar toxic hazards. No design demonstrates a clear advantage over others in this respect.
- The potential toxic impacts associated with the four gasifier system designs are dominated by releases of H_2S and SO_2 from the Claus unit that is included in each design.
- All three candidate coals, when used as feed to any of the four gasifier designs, have the potential to produce off-site toxic impacts. The PRB coal, used in any of the gasifiers, produces slightly smaller toxic impact distances strictly due to its lower sulfur content and thus, lower H_2S flow rates to the Claus unit (Quest, 2006).

7.17.4 RISK ASSESSMENT FOR CO_2 SEQUESTRATION

The "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement" (Tetra Tech, 2007) describes the results of the human health risk assessment conducted to support the proposed project. The risk assessment addresses the potential releases of captured gases at the proposed power plant, during transport via pipeline to the proposed geologic storage site, and during subsurface storage.

The approach to risk analysis for CO_2 sequestration in geologic formations is still evolving. However, a substantial amount of information exists on the risks associated with deep injection of hazardous waste and the injection of either gaseous or supercritical CO_2 in hydrocarbon reservoirs for enhanced oil recovery. There are also numerous projects underway at active CO_2 injection sites that are good analogs to determine the long-term fate of CO_2. The FutureGen Project assessment relies heavily on the findings from these previous and ongoing projects.

7.17.4.1 CO_2 Sequestration Risk Assessment Process

The human health risk assessment is presented in five sections: conceptual site models (CSMs); toxicity data and benchmark concentration effect levels; pre-injection risk assessment; the post-injection risk assessment; and the risk screening and performance assessment. The results of the risk screening of CO_2 sequestration activities are presented in Section 7.17.4.2.

Conceptual Site Models

A central task in the risk assessment was the development of the CSMs. Potential pathways of gas release during capture, transport and storage were identified for the pre- and post-injection periods. Site-specific elements of the proposed Odessa Site were described in detail based on information from the EIVs provided by the FutureGen Alliance (FG Alliance, 2006a - d). These data provided the basis for the CSM parameters and the analysis of likely human health exposure routes.

Toxicity Data and Benchmark Concentration Effect Levels

The health effect levels were summarized for the identified exposure pathways. The toxicity assessment provides information on likelihood of the chemicals of potential concern to cause adverse human-health effects. These data provided the basis for the comparison of estimated exposures and the assessment of potential risks.

Risk Screening and Performance Assessment

Pre-Injection Risk Assessment

This assessment evaluated the potential risks associated with the proposed plant and aboveground facilities for separating, compressing and transporting CO_2 to the proposed injection site. The risk assessment for the pre-injection components was based on qualitative estimates of fugitive releases of captured gases and quantitative estimates of gas releases from aboveground sources under different failure scenarios. Failure scenarios of the system included: pipeline rupture, pipeline leakage through a puncture (3-square-inch [19-square-centimeter] hole), and rupture of the wellhead injection equipment. The volumes of gas released for the pipeline scenarios were calculated using site-specific data for the four sites and the equations for gas emission rates from pipelines (Hanna and Drivas, 1987).

In general, the amount of gas released from a pipeline rupture or puncture was the amount contained between safety valves, assumed to be spaced at 5-mile (8.0-kilometer) intervals. The amount of gas released by a wellhead rupture was assumed to be the amount of gas contained within the well casing itself. The atmospheric transport of the released gas was simulated using the SLAB model (Ermak, 1990), with the gas initially in a supercritical[1] state (pressure ~2000 psi, temperature ~90°F [32.2°C]). The evaluation was conducted for the case with CO_2 at 95 percent and H_2S at 100 ppmv. The predicted concentrations in air were used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors.

Post-Injection Risk Assessment

The post-injection risk assessment describes the analysis of potential impacts from the release of CO_2 and H_2S after the injection into the subsurface CO_2 storage formation. A key aspect of the analysis was the compilation of an analog database that included the proposed site characteristics and results from studies performed at other CO_2 storage locations and from sites with natural CO_2 accumulations and releases. The analog database was used for characterizing the nature of potential risks associated with surface leakage due to cap-rock seal failures, faults, fractures, or wells. CO_2 leakage from the proposed project storage formation was estimated using a combination of relevant industry experience, natural analog studies, modeling, and expert judgment.

Qualitative risk screening of the proposed site was based upon a systems analysis of the site features and scenarios portrayed in the CSM. Risks were qualitatively weighted and prioritized using procedures identified in a health, safety, and environmental risk screening and ranking framework developed by Lawrence Berkeley National Laboratory for geologic CO_2 storage site selection (Oldenburg, 2005). In addition, further evaluation was conducted by estimating potential gas emission rates and durations using the analog database for a series of release scenarios. Three scenarios could potentially cause acute effects: upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells.

Six scenarios could potentially cause chronic effects: upward leakage through caprock and seals by gradual failure; release through existing faults due to effects of increased pressure; release through induced faults due to effects of increased pressure (local over-pressure); upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells. For the chronic-effects case for the latter three well scenarios, the gas emission rates were estimated to be at a lower rate for a longer duration. The predicted concentrations in air were then used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors. Other scenarios including catastrophic failure of the caprock and seals above the sequestration reservoir and fugitive emissions are discussed, but were not evaluated in a quantitative manner.

[1] A supercritical fluid occurs at temperatures and pressures where the liquid and gas phases are no longer distinct. The supercritical fluid has properties of both the gaseous and liquid states; normally its viscosity is considerably less than the liquid state, and its density is considerably greater than the gaseous state.

7.17.4.2 Consequence Analysis

Risk Screening Results for Pre-Sequestration Conditions (CO_2 Pipeline and Injection Wellheads)

As with all industrial operations, accidents can occur as part of the CO_2 transport and sequestration activities. Of particular concern is the release of CO_2 and H_2S. The CO_2 sequestration risk assessment (Tetra Tech, 2007) identified three types of accidents that could potentially release gases into the atmosphere before sequestration. Accidents included ruptures and punctures of the pipeline used to transport CO_2 to the injection sites and rupture of the wellhead equipment at these sites. The frequency of these types of accidents along the pipelines or at the wellheads is expected to be low. The amount of gas released depends on the severity and the location of the accident (i.e., pipeline or wellhead releases).

Health effects from inhalation of high concentrations of CO_2 gas can range from headache, dizziness, sweating, and vague feelings of discomfort, to breathing difficulties, increased heart rate, convulsions, coma, and possibly death. Exposure to H_2S can cause health effects similar to those for CO_2, but at much lower concentrations. In addition H_2S can cause eye irritation, abnormal tolerance to light, weakness or exhaustion, poor attention span, poor memory, and poor motor function.

Accident Categories and Frequency Ranges

Likely: Accidents estimated to occur one or more times in 100 years of facility operations (frequency ≥ 1×10^{-2}/yr).

Unlikely: Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from 1×10^{-2}/yr to 1×10^{-4}/yr).

Extremely Unlikely: Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency from 1×10^{-4}/yr to 1×10^{-6}/yr).

Incredible: Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1×10^{-6}/yr).

Impacts of CO_2 and H_2S gas releases on workers and the public depends on the location of the releases, the equipment involved, the meteorological conditions (including atmospheric stability and wind speed and direction), the directionality of any release from a puncture (e.g., upwards and to the side), and other factors. The effects to workers near a ruptured or punctured pipeline or wellhead are likely to be dominated by the physical forces from the accident itself, including the release of gases at high flow rates (3,000 kg/sec) and at very high speeds (e.g., ~500 miles per hour). Thus, workers involved at the location of an accidental release would be impacted, possibly due to a combination of effects, such as physical trauma, asphyxiation (displacement of O_2), toxic effects, or frostbite from the rapid expansion of CO_2 (2,200 psi to 15 psi). Workers near a release up to a distance of 380 feet (116 meters) could also be exposed to very high concentrations of CO_2 (e.g., 170,000 ppm) for short durations of one minute, which would be life-threatening.

For this evaluation, risks to workers were evaluated at two distances: involved workers at a distance of 66 feet (20.1 meters) of a release and other workers at a distance of 820 feet (249.9 meters). For all ruptures or punctures these individuals may experience adverse effects up to and including irreversible effects when concentrations predicted using the SLAB model (Ermak, 1990) exceed health criteria. The criteria used for this determination were the reference exposure levels established as occupational criteria for exposures to CO_2 and H_2S, consisting, respectively, of a short-term exposure limit (averaged over 15 minutes) for CO_2 and a ceiling concentration for H_2S that should not be exceeded at any time during a workday (NIOSH, 2007). Each of these criteria is listed in Table 7.17-4. Table 7.17-12 summarizes locations where pipeline and wellhead accidents create gas concentrations exceeding allowable levels for facility workers. Workers would be expected to be affected by CO_2 concentrations equal to or greater than 30,000 ppm from a pipeline rupture out to a distance of 397 feet (121 meters) and from a pipeline puncture out to a distance of 505 feet (154 meters), but not from a wellhead rupture. H_2S would exceed worker criteria for a pipeline rupture out to at least 1191 feet (363 meters), for a pipeline puncture to a distance of 554 feet (169 meters), or to a distance of 66 feet (20.1 meters) from a wellhead rupture. Concentrations of CO_2 would not exceed worker criteria at the proposed plant boundary, 820 feet (249.9 meters), but H_2S would for the pipeline rupture release.

Table 7.17-12. Exceedance of Occupational Health Criteria[1] for Workers

Release Scenario	Frequency Category[2]	Exposure Time	Gas	Area of Exceedance
Pipeline Rupture	U	Minutes	CO_2	Near pipeline only[3]
			H_2S	Within plant boundaries[4]
Pipeline Puncture[5]	U	Approximately 4 hours	CO_2	Near pipeline only[3]
			H_2S	Near pipeline only[3]
Wellhead Rupture	EU	Minutes	CO_2	None
			H_2S	Near wellhead only[3]

[1] Occupational health criteria used were the NIOSH REL ST and NIOSH REL C for CO_2 and H_2S, respectively. See Table 7.17-4.
[2] U (unlikely) =frequency of 1x 10^{-2}/yr to 1x 10^{-4}/yr; EU (extremely unlikely)=frequency of 1x10^{-4}/yr to 1x 10^{-6}/yr.
[3] Distances for CO_2 are: 397 feet (121 meters) for a pipeline rupture; 505 feet (154 meters) for e pipeline puncture. Distances for H_2S are: 1,191 feet (363 meters) for pipeline rupture, 554 feet (169 meters) for pipeline puncture, and 66 feet (20 meters) for a wellhead rupture.
[4] Plant boundary is at 850 feet (250 meters).
[5] 3-inch by 1-inch rectangular opening in pipe wall.

There is also interest in whether ruptures or punctures may affect non-involved workers. Non-involved workers are those workers on the plant site, but distant from the release point. The effects for non-involved workers were evaluated at a distance of 820 feet (249.9 meters) from the release point. The same occupational health criteria were used to determine the potential effects to the non-involved workers. Potential effects were determined by comparing SLAB model calculated concentrations with health criteria at the distances of concern. As shown in Table 7.17-12, no effects were estimated for non-involved worker exposures to CO_2 from any of the evaluated accidental releases. The criteria were exceeded for H_2S for the pipeline rupture release.

Accidental releases from the pipeline or wellhead, although expected to be infrequent, could potentially have greater consequences and affect the general public in the vicinity of a release. To determine the potential impacts to the public, the CO_2 sequestration risk assessment (Tetra Tech, 2007) evaluated potential effects to the public for accidental releases of gases from the pipelines and wellheads. The CO_2 pipeline failure frequency was calculated based on data contained in the on-line library of the Office of Pipeline Safety (OPS, 2007). Accident data from 1994 to 2006 indicated that 31 accidents occurred during this time period. DOE categorized the two accidents with the largest CO_2 releases (4,000 barrels and 7,408 barrels) as rupture type releases, and the next four highest releases (772 barrels to 3,600 barrels) as puncture type releases. For comparison, 5 miles (8.0 kilometers) of FutureGen pipeline contains about 6,500 barrels, depending on the pipeline diameter. Assuming the total length of pipeline involved was approximately 1,616 miles (2,600 kilometers) based on data in Gale and Davison (2004), the rupture and puncture failure frequencies were calculated to be 5.92 x 10^{-5}/(km-yr) and 1.18 x 10^{-4}/(km-yr), respectively. Puncture failure frequencies are reported in failure events per unit length and time based on data for a particular length of pipeline and period of time. The pipeline failure frequencies are only one component of the exposure frequency. The total exposure frequency also considered the percent of time the wind was blowing in the direction of the receptor, the percent of time the wind stability was the greatest, and the section of the pipeline that would have to fail to possibly allow the release to reach the exposed population.

The failure frequencies for pipeline ruptures and punctures are calculated as the product of the pipeline length at the site and the failure frequencies presented above (ruptures: 5.92 x 10^{-5}/km-yr; punctures: 1.18 x 10^{-4}/km-yr) (Gale and Davison, 2004). The failure rate of wellhead equipment during operation is estimated as 2.02 x 10^{-5} per well per year based on natural gas injection-well experience from an IEA GHG Study (Papanikolau et al., 2006). These failure frequencies provide the basis for the frequency categories presented in Tables 7.17-12 and Table 7.17-15.

The predicted releases, whether by rupture or puncture are classified as unlikely: the frequencies for ruptures is 5.9 x 10^{-3}, the frequency for punctures is 1.2 x 10^{-2}. The predicted releases from wellhead failures are classified as extremely unlikely; the frequency for a wellhead rupture 1 x 10^{-6} to 2 x 10^{-5}/year. The criteria used to examine potential health effects, including mild and temporary as well as permanent effects are defined in Tables 7.17-7 and 7.17-13. The CO_2 and H_2S exposure durations that could potentially occur for the three types of release scenarios are noted in Table 7.17-14.

Health Effects from Accidental Chemical Releases

The impacts from accidental chemical releases were estimated by determining the number of people who might experience adverse effects and irreversible adverse effects.

Adverse Effects: Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as headache or sweating (associated with lower chemical concentrations) to irreversible (permanent) effects, including death or impaired organ function (associated with higher concentrations).

Irreversible Adverse Effects: A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system damage), and other effects that impair everyday functions.

Life Threatening Effects: A subset of irreversible adverse effects where exposures to high concentrations may lead to death rather than other types of impairments.

Table 7.17-13. Description of Hazard Endpoints for Public Receptors

Hazard Endpoint	Description
RfC	An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
TEEL 1	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
TEEL 2	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
TEEL 3	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

RfC = Inhalation Reference Concetration.
TEEL = Temporary Emergency Exposure Limits.
Sources: EPA, 2006a,b and DOE, 2006.

Table 7.17-14. Hazard Endpoints for Public Receptors

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
Minutes (Pipelines)	CO_2	Adverse effects	30,000	TEEL 1
		Irreversible adverse effects	30,000	TEEL 2
		Life threatening	40,000	TEEL 3
	H_2S	Adverse effects	0.51	TEEL 1
		Irreversible adverse effects	27	TEEL 2
		Life threatening	50	TEEL 3
Minutes (Explosions[2])	H_2S	Irreversible adverse effects	41	AEGL 2 (10 minute)
		Life threatening	76	AEGL 3 (10 minute)
	SO_2	Irreversible adverse effects	0.75	AEGL 2 (10 minute)
		Life threatening	42	AEGL 3 (10 minute)[3]
Hours/Days	CO_2	Adverse effects	20,000	Headache, etc.[4,5]
		Life threatening	70,000	Headache, etc.[4,5,6]
	H_2S	Adverse effects	0.33	AEGL 1 (8 hour)
		Irreversible adverse effects	17	AEGL 2 (8 hour)
		Life threatening	31	AEGL 3 (8 hour)
Years	CO_2	Adverse effects	40,000	Headache, etc.[4,7]
		Life threatening	70,000	Headache, etc.[4,6,7]
	H_2S	Irreversible adverse effects	0.0014	RfC

[1] See Tables 7.17-7 and 7.17-13 for descriptions of the TEEL and AEGL endpoints.
[2] Used by Quest, 2006 to evaluate releases from explosions.
[3] Quest, 2006.
[4] EPA, 2000.
[5] Headache and dyspnea with mild exertion.
[6] Unconsciousness and near unconsciousness.
[7] Headache, dizziness, increased blood pressure, and uncomfortable dyspnea.
TEEL = Temporary Emergency Exposure Limits.
AEGL = Acute Exposure Guideline Level.
RfC = Inhalation Reference Concentration.

Simulation models were used to estimate the emission of CO_2 for the aboveground release scenarios when the gas is in a supercritical state. The SLAB model developed by the Lawrence Livermore National Laboratory and approved by U.S. EPA was used to simulate denser-than-air gas releases for both horizontal jet and vertically elevated jet scenarios. The model simulations were conducted for the case with CO_2 at 95 percent and H_2S at 100 parts per million by volume (ppmv). The state of the contained captured gas prior to release is important with respect to temperature, pressure, and the presence of other constituents. Release of CO_2 under pressure would likely cause rapid expansion and then reduction in temperature and pressure, which can result in formation of solid-phase CO_2, as explained in Appendix C-III of the risk assessment (Tetra Tech, 2007). The estimated quantity of solid-phase formed was 26 percent of the volume released; therefore 74 percent of the volume released from a pipeline rupture or puncture was used as input to the SLAB model for computing atmospheric releases of CO_2 and H_2S. Carbon dioxide is heavier than air and subsequent atmospheric transport and dispersion can be substantially affected by the temperature and density state of the initially released CO_2. The

meteorological conditions at the time of the release would also affect the behavior and potential hazard of such a release.

The potential effects of CO_2 and H_2S releases from pipeline ruptures and punctures were evaluated using an automated “pipeline-walk” analysis. The methodology (described briefly in Appendix D and in detail in Section 7.4.2 and Appendix C-IV of the risk assessment) estimates the maximum expected number of individuals from the general public potentially affected by pipeline ruptures or punctures at each site. The analysis takes into account the effects of variable meteorological conditions and the location of pipeline ruptures or punctures. For wellhead ruptures the potential impact zones corresponding to health-effects criterion values for H_2S and CO_2 were determined using the SLAB model and assuming meteorological conditions that resulted in the highest potential chemical exposures (i.e., assuming wind speeds of 2 meters per second and stable atmospheric conditions). The number of individuals potentially affected within the impact zone was determined from population data obtained from the 2000 U.S. Census.

This modeling approach to assess potential chemical exposures is based on the assumption that the population size and locations near the proposed project would not change during the time period assessed for this proposed project (i.e., 50 years for releases during the operation phase and 5,000 years for releases of sequestered gases).

Among the three types of accidental releases, none of the postulated accidents would result in exposure of the general populace to levels of CO_2 or H_2S expected to cause adverse health effects (including mild and temporary effects) (see Table 7.17-15). If this type of accident occurred near the proposed injection wells, it is estimated that less than one member of the general public might experience adverse effects, primarily from H_2S exposure (mild and temporary effects, such as headaches or exhaustion). Since the pipeline would extend approximately 61.5 miles (99 kilometers) from the proposed power plant to the injection wellheads, the public could be affected at other locations along the pipeline than near the proposed injection wells.

None of the postulated accidents would cause irreversible health effects or fatalities to the members of the public potentially exposed to the released gases (see Table 7.17-15).

Although the potential for releases from pipelines or wellheads may be low, any releases from the pipeline or wellheads could be high consequence events. For this reason, there are well-established measures for preventing or reducing impacts of accidental releases. These include design recommendations (e.g., increasing pipeline wall thickness, armoring pipelines in specific locations such as water body and road crossings); use of newer continuous pipeline monitors to detect corrosion and computer models to rapidly interpret changes in fluid densities, pressures, etc.; use of safety check valves at closer intervals (e.g., 1 to 3 miles [1.6 to 4.8 kilometers] instead of 5 miles [8 kilometers] in populated areas) that can quickly isolate damaged section of the pipeline; operational procedures (e.g., activating “bleed” valves to control location and direction of releases should a puncture occur); and emergency response procedures (e.g., notifying the public of events requiring evacuation). The pipeline could be buried at deeper depths or routed to maximize the distance to sensitive receptors or the nearest residence or business. In some cases it may be possible to further reduce the concentrations of effect-causing substances being transported (e.g., H_2S). These measures would be implemented, as appropriate.

Risk Screening Results for Post-sequestration Conditions

Under post-sequestration conditions, a slow continuous leak through a deep well was determined to be the only scenario that may cause adverse health effects to the general public (Tetra Tech, 2007). Since the deep wells within the vicinity of the proposed CO_2 injection wells would be properly sealed before initiation of CO_2 sequestration, and since the proposed CO_2 injection well(s) would also be properly sealed after their use, it is extremely unlikely that the proposed project would create a gas release of consequence from the subsurface (Table 7.17-16). However, if this type of release occurred at the proposed sequestration site, it is estimated that less than one member of the public might experience irreversible adverse effects from H_2S exposures (i.e., nasal lesions). This estimate is based on the assumption that the future population would be the same as current conditions, with the sequestration plume footprint remaining rangeland. Also, this evaluation is based on the EPA RfC criterion for chronic (i.e., long-term and low level) exposures that incorporates a safety factor of 300 to be protective of sensitive individuals. The RfC criterion value for H_2S is an extremely low concentration: 0.0014 ppm.

Table 7.17-16. Number of Individuals with Adverse Effects from Potential Exposure to Post-Sequestration H_2S Gas Releases

Release Scenario	Frequency Category[1]	Number Affected[2]
Upward slow leakage through CO_2 injection well	EU	0.3
Upward slow leakage through deep oil and gas wells	EU	0.3
Upward slow leakage through other existing wells	EU[3]	0.3

[1] EU (extremely unlikely) =frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[2] Potentially irreversible adverse effects could occur within 745 feet of the release point; instances presented here are converted from meters, which were used in the risk assessment (see Appendix D). Also, assumed future population density would remain the same as current conditions, with the property surrounding the sequestration plume footprint remaining as rangeland.
[3] Assumes that the other wells potentially within the sequestration plume footprint have been properly sealed before sequestration begins.

Since CO_2 sequestration is a relatively new technology, a series of mitigation and monitoring measures have been developed for these activities. In addition to plugging and properly abandoning wells, monitoring plans include use of remote sensing methods, atmospheric monitoring techniques, methods for monitoring gas concentrations in the subsurface and surface environments, and processes for monitoring subsurface phenomena associated with the injection reservoir and the caprock (FG Alliance, 2006a-d). A specific schedule for different types of monitoring has been proposed for the proposed Odessa Sequestration Site and surrounding areas that would occur before and during sequestration activities (FG Alliance, 2006d). Also, after the cessation of injection monitoring, activities would be used to identify any long-term, post-closure changes in land surface conformation, soil gas, and atmospheric fluxes of CO_2.

7.17.5 TERRORISM/SABOTAGE IMPACT

As with any U.S. energy infrastructure, the proposed power plant could potentially be the target of terrorist attacks or sabotage. In light of two recent decisions by the U.S. Ninth District Court of Appeals (*San Luis Obispo Mothers v. NRC, Ninth District Court of Appeals, June 2, 2006; Tri Valley Cares v. DOE, No. 04-17232, D.C. No. CV-03-03926-SBA, October 16, 2006),* DOE has examined potential environmental impacts from acts of terrorism or sabotage against the facilities being proposed in this EIS.

Although risks of sabotage or terrorism cannot be quantified because the probability of an attack is not known, the potential environmental effects of an attack can be estimated. Such effects may include localized impacts from releases from the proposed power plant and associated facilities, assuming that such releases would be similar to what would occur under an accident or natural disaster (such as a tornado). To evaluate the potential impacts of sabotage/terrorism, failure scenarios are analyzed without specifically identifying the cause of failure mechanism. For example, a truck running over a wellhead at the proposed sequestration site would result in a wellhead failure, regardless of whether this was done intentionally or through mishap. Therefore, the accident analysis evaluates the outcome of catastrophic events without determining the motivation behind the incident. The accident analyses evaluated potential releases from pipelines, wellheads, and major and minor system failures/accidents at the proposed power plant site. These accidents could also be representative of the impacts from a sabotage or terrorism event.

Various release scenarios were evaluated including: pipeline rupture, pipeline puncture, and wellhead equipment rupture. Gaseous emissions were assumed to be 95 percent CO_2 and 0.01 percent H_2S. Table 7.17-15 provides effects levels for individuals of the public that could potentially be exposed to releases. Of these release scenarios at the proposed Odessa Site, a pipeline puncture would result in impacts to the public over the largest distance. For a release of the CO_2 gas from a pipeline puncture, no impacts from CO_2 would occur beyond 0.1 mile (0.2 kilometer) of the release, while adverse effects from the H_2S in the gas stream could occur within 1 mile (1.7 kilometers) of the release, with no impacts beyond that distance. No irreversible effects or fatalities would occur to members of the public.

For short-term CO_2 and H_2S co-sequestration testing, the concentration of H_2S in the sequestered gas would be two percent (20,000 ppmv) or 200 times greater than the base case, which assumed the H_2S concentration would be 100 ppmv. Thus, impacts to the public (both mild and life-threatening effects) could extend to greater distances than shown for the base case in Table 7.17-15. Although short-term testing of co-sequestration (CO_2 with H_2S) is examined for two weeks during the DOE-sponsored phase of the project, no decision has been made yet to pursue co-sequestration over a longer period. However, co-sequestration cannot be ruled out as a possible operating scenario.

In general, ruptures or punctures of pipelines are rare events. Based on OPS nationwide statistics, 31 CO_2 pipeline accidents occurred between 1994 and 2006. None of these reported accidents were fatal nor caused injuries (OPS, 2006). Should a CO_2 pipeline rupture occur, it would be immediately detected by the pipeline monitoring system, alerting the pipeline operator. Once the flow of gas has stopped, the gas would dissipate and chemical concentrations at the source of the release would decline to non-hazardous levels in a matter of minutes for a pipeline rupture and several hours for a pipeline puncture. However, the released gas then migrates downwind, as described in the preceding sections.

The potential health effects from "upperbound" explosion and release scenarios at the proposed power plant (Section 7.17.3.2) can be contrasted with those associated with the pipeline. Hazardous events evaluated for the proposed power plant included: gas releases and exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions. Evaluations of these results indicate:

- Toxic releases from the Claus unit that could extend from 0.2 to 1.4 miles (0.3 to 2.3 kilometers) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are 3 residences within the maximum distance potentially impacted by releases from the Claus unit (i.e., 1.4 miles [2.3 kilometers] of the site) under current conditions. However, examination of population density estimates (see Section 7.17.4.2) suggests that such releases could potentially cause irreversible adverse effects in 12 individuals exposed to SO_2, with one exposed to potentially life threatening concentrations of H_2S (Table 7.17-17).
- Toxic releases from the gasifier could extend from 0.2 to 0.6 mile (0.3 to 1.0 kilometer) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are three residences within this release radius. However, examination of the population density estimates suggests that such a release could potentially cause irreversible adverse effects in two individuals exposed to CO, but no potentially life-threatening effects.
- Fire hazards at the plant site would not extend off site.
- Under all worst case scenarios, plant workers would be the most at-risk of injury or death.

Table 7.17-17. Effects to the Public from Explosions at the FutureGen Plant

Release Scenario	Gas	Effect[1]	Distance[2] (miles [kilometers])	Number Affected
Claus Unit failure (release duration = minutes)	H_2S	Irreversible adverse effects	0.5 (0.8)	2
		Life threatening	0.4 (0.6)	1
	SO_2	Irreversible adverse effects	1.4 (2.3)	12
		Life threatening	0.2 (0.3)	0
Gasifier release (release duration = minutes)	CO	Irreversible adverse effects	0.6 (1.0)	2
		Life threatening	0.2 (0.3)	0

[1] See Table 7.17-3 for an explanation of the effects.
[2] Distances taken from Quest, 2006.

As discussed, if an explosion occurred at the proposed plant site as the result of a terrorist attack, it is likely that hazardous gases would cause injury and death of workers within the proposed plant site and most likely the public located within 1.4 miles (2.3 kilometers) of the proposed plant site. This would exceed the distance that the public would be adversely affected by a pipeline puncture (approximately 1 mile [1.7 kilometers]).

7.18 COMMUNITY SERVICES

7.18.1 INTRODUCTION

This section identifies the community services most likely to be affected by the construction and operation of the proposed FutureGen Project at the Odessa Power Plant Site in Ector County, Texas. This section addresses law enforcement, fire protection, emergency response, health care services, and the school system. Additionally, the potential effects that the construction and operation of the proposed FutureGen Project could have on those services, as well as any proposed mitigation measures that could reduce any adverse effects, are discussed.

7.18.1.1 Region of Influence

The ROI for community services includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site and sequestration site. The proposed sequestration site is located approximately 58 miles (93.3 kilometers) northeast of the proposed plant site. As shown in Figure 7.18-1, the 50-mile (80.5-kilometer) radius for the sequestration site and the 50-mile (80.5-kilometer) radius for the power plant site largely overlap. The ROI for the proposed Odessa Power Plant Site and Sequestration Site includes all land area in Ector County and some land area in the counties of Andrews, Crane, Martin, Midland, Pecos, Upton, Ward and Winkler.

Community services data are reported county-wide because this format is most often used in public information. This includes counties that have only a relatively small portion of land lying within the 50-mile (80.5-kilometer) radius. Therefore, if only a minor portion of a county was touched by the 50-mile (80.5-kilometer) radius and two or fewer small communities fall within that minor portion of the county, then that county was excluded from the analysis as not materially affecting the aggregate community services in the ROI. Those counties with two or fewer small communities that were excluded from the ROI include Brewster, Crockett, Reeves and Terrell in Texas, and Lea County in New Mexico. Excluding these counties from the ROI makes the remaining data more meaningful for determining project effects.

Although the analysis in this section addresses the entire ROI, the affected environment and environmental consequences focus on the proposed power plant site in Ector County.

7.18.1.2 Method of Analysis

DOE evaluated the impacts to community services based on anticipated changes in demand for law enforcement, fire protection, emergency response, health care services, and schools using research provided in the Odessa EIV (FG Alliance, 2006d). In many cases, the change in demand is directly related to the increased population.

DOE assessed the potential for impacts based on the following criteria:

- Affect on law enforcement;
- Conflict with local or regional management plans for law enforcement;
- Affect on fire protection;
- Conflict with local or regional management plans for fire protection;
- Affect on emergency response;
- Conflict with local or regional management plans for emergency response;
- Affect on health care services;

- Conflict with local or regional management plans for health care services;
- Affect on local schools; and
- Conflict with local and regional management plans for local schools.

7.18.2 AFFECTED ENVIRONMENT

7.18.2.1 Law Enforcement

Ector County is served by 327 law enforcement officers and one municipal police department located in Odessa (UC, 2005 and FG Alliance, 2006d). Each county in Texas is also served by its own County Sheriff's Office (FG Alliance, 2006d; UC, 2005; and CD, 2002). Andrews, Crane, Martin, Midland, Pecos, Upton, Ward and Winkler counties in Texas are served by a total of eight police departments (UC, 2005).

The U.S. has an average of 2.3 police officers per thousand residents (Quinlivan, 2003). In Ector County, the ratio is approximately 2.6 officers per thousand residents based on the 2005 projected population and 327 full-time law enforcement officers. The ratio of officers is above the national average and crime in Ector County is extremely low. Index offenses, which include criminal sexual assault, robbery aggravated assault, burglary, theft, motor vehicle theft and arson, are a way of measuring and comparing crime statistics (TDPS, 2003). The State of Texas averaged 5,153 index offenses per 100,000 residents in 2003, whereas Ector County averaged 580 index offenses per 100,000 residents for the same year (TDPS, 2003).

7.18.2.2 Emergency and Disaster Response

In Texas, Councils of Government are organizations of local county governments working together to solve mutual community problems. Emergency response and fire protection are managed by the Councils of Government because Texas counties can be very rural and cover large land areas that can be more effectively served at a regional level. Ector County is a member of the Permian Basin Regional Planning Commission's organization of 911 public safety answering points. This organization oversees 911 emergency management and dispatches fire and rescue, ambulances and emergency medical personnel from the answering points located throughout its member counties. The ROI is served by 21 emergency medical and ambulance services and three air ambulance services (FG Alliance, 2006d).

7.18.2.3 Fire Protection

Ector County hosts a total of six fire departments with trained fire services personnel. The proposed Odessa Power Plant Site and Sequestration Site could be served by a total of 51 fire departments from within the Permian Basin Regional Planning Commission's Council of Government. As of May 2006, the State of Texas was in the process of developing a statewide mutual aid system (TFCA, 2006). This system, if implemented, would provide a mechanism for fire protection and emergency response assistance in case of a major emergency from organizations throughout the State of Texas.

7.18.2.4 Hazardous Materials Emergency Response

The proposed Odessa Power Plant Site and sequestration site would be served by five Hazardous Materials (HazMat) units located in Anderson, Ector, Midland and Ward counties. HazMat units respond and perform functions to handle and control actual or potential leaks or spills of hazardous substances (OSHA, 1994).

7.18.2.5 Health Care Service

A total of 21 hospitals and medical clinics serve the ROI (FG Alliance, 2006d). Ector County is served by five hospitals, which include Medical Center Hospital, Odessa Regional Hospital, Alliance Hospital Limited, Regency Hospital of Odessa, and Healthsouth Rehabilitation Hospital of Odessa. There are approximately 1,390 beds in the 21 hospitals in the ROI. Based on the 2005 total projected population, there are 4.5 beds per thousand people within the ROI.

7.18.2.6 Local School System

Ector County has 26 elementary schools, six junior high schools, three high schools, four specialty schools, and as many as four private schools (FG Alliance, 2006d and TEA, 2005). Table 7.18-1 shows the expenditure per pupil per school year and the student-teacher ratio for the State of Texas and the U.S in 2005.

Table 7.18-1. School Statistics for Texas and the U.S. in 2005

	Expenditure per Pupil per School Year ($)	Pupils per Teacher (Elementary/Secondary)
Texas	7,142	14.9/14.9
Nationwide	8,287	15.4/15.4

Source: CPA, 2006; USCB, 2006; and NCES, 2005.

7.18.3 IMPACTS

7.18.3.1 Construction Impacts

As discussed in Section 7.19, the need for construction workers would be limited in duration, but would likely cause an influx of temporary residents. Construction workers could be drawn from a large labor pool within the ROI; however, some temporary construction workers with specialized training and workers employed by contractors from outside the ROI would also likely be employed to construct the facilities. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period.

Law Enforcement

The temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. The increased temporary population could affect the working capacities of individual local police departments, depending on where the workers chose to reside. The affected locations would depend on the degree to which the construction workers would be dispersed throughout the communities within the ROI. As discussed in Section 7.19, temporary construction workers would likely reside in short-term housing. Ector County does not have enough hotel rooms, when occupancy rates are taken into account, to accommodate all of the temporary workers (FG Alliance, 2006d). Therefore, it is anticipated that the availability of local lodging would effectively disperse workers throughout communities within the ROI and law enforcement would not be affected.

The population in the ROI is expected to grow on average by 7.1 percent, or approximately 21,193 people, by 2010 (FG Alliance, 2006d). Additional police and other law enforcement services would be required to accommodate the growing population, especially in Martin and Upton counties, which have the highest projected growth rates. The number of law enforcement officers is above the U.S. average and county crime rates are extremely low, which is an indication that law enforcement is appropriately staffed (FG Alliance, 2006d; CD, 2002; and Quinlivan, 2003). The exact number of construction workers and their families who would temporarily relocate to the area for the proposed project is unknown, but any additional population would not be anticipated to create a permanent unsustainable increase in the demand for law enforcement.

Construction activities would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 7.17, construction of the proposed facility would involve the use of flammable and combustible materials that pose an overall increase in risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during construction of the proposed project is low. Incidents during construction of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Texas fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site and sequestration site. Currently, 51 fire departments are located within the Permian Basin Regional Planning Commission's Council of Governments. Any of these fire departments would be available to assist in a fire emergency if needed.

Emergency and Disaster Response

As discussed in Section 7.17, it is anticipated that construction of the proposed facilities would result in an average of 19.6 total recordable injury cases per year with a peak maximum of 39.2 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site and sequestration site would be adequately served in an emergency. Ector County and the entire ROI are served by 21 ambulance services and three air ambulance services. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond current available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

The 350 to 700 temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. Currently, the ROI has 4.5 hospital beds per thousand residents, whereas the U.S. average is 2.9 hospital beds per thousand residents. Even if all 700 temporary workers relocated within the ROI, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 4.5 and, therefore, no impacts are expected.

The **Hill-Burton Act of 1946** established the objective standard for the number of hospitals, beds, types of beds, and medical personnel needed for every 1,000 people, by county (Everett, 2004). It called for states to "afford the necessary physical facilities for furnishing adequate hospital, clinic, and similar services to all their people." The Hill-Burton standard is 4.5 beds per thousand residents (Everett, 2004). However, the U.S. average in 2001 was 2.9 beds per thousand residents, which is about 24 percent fewer beds per thousand residents than the current ratio within the ROI (Everett and Baker, 2004).

Local School System

Although some portion of the temporary construction workers may relocate to the ROI with their families, a large influx of school-aged children would not be anticipated. Because construction of the proposed facilities would create temporary work, it is unlikely that the construction workers would relocate with their families. It is more likely that temporary workers, who permanently reside outside of the ROI, would seek short-term housing for themselves during the work week. As a result, any influx of school-aged children would result in a minimal impact to local schools and their resources.

Project construction would not displace existing school facilities or conflict with school system plans.

7.18.3.2 Operational Impacts

As is discussed in Section 7.19, the operational phase of the proposed facilities would require approximately 200 permanent staff. Although the exact number of permanent staff who would relocate to the ROI is unknown, the increase in population would be very small, even if all 200 positions were filled by staff relocating to the ROI. Based on the 2005 projected population and the average family size within the ROI, the relocation of 200 workers would result in a population increase of 650 people, a 0.2 percent increase in population within the ROI.

Law Enforcement

Law enforcement in the ROI would be sufficient to handle the 0.2 percent increase in population during facility operation. A 0.5 percent increase in population in Ector County would result in an imperceptibly small decrease, less than 0.02, in the ratio of law enforcement officers per thousand residents. In addition, the average crime rate in Ector county, which is consistent with crime rates in rural communities in Texas, is well below the national average. This is an indication that law enforcement is appropriately staffed and would be sufficient to handle a minor increase in population.

Project operation would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 7.17, operation of the proposed power plant would involve the use of flammable and combustible materials that pose an overall increase in risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during operation of the proposed project is low. Incidents during the operational phase of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Texas fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site. There are currently 51 fire departments within the Permian Basin Regional Planning Commission’s Council of Government. Any of these fire departments could assist in a fire emergency if needed.

Emergency and Disaster Response

As indicated in Section 7.17, it is anticipated that the operational phase of the proposed facilities would result in an average of 6.6 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site and sequestration site would be adequately served in an emergency. Ector County and the entire ROI are served by 21 ambulance services and three air ambulance services. Emergencies during construction of the proposed facilities are not expected to increase the demand for emergency services beyond the available capacity of currently existing services. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

It is anticipated that the 200 permanent operations jobs created by FutureGen Project operations could cause an influx of permanent residents to the communities within the ROI. This influx would result in an increase in population of 0.2 percent, representing approximately 650 new residents. The ROI currently has a health care capacity that is greater than the national average, with 4.5 hospital beds per thousand residents. The U.S. average is 2.9 hospital beds per thousand residents. Although the proposed project would increase the number of residents requiring medical care, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 4.5 and, therefore, no impacts are expected.

Local School System

While the actual number of the 200 permanent staff who would relocate to the ROI with their families to work at the facility is unknown, based on the average family size and the percent of school-aged children in the population, it can be estimated that a maximum of 218 new school-aged children could relocate within the ROI (FG Alliance, 2006d). The 2005 public school enrollment for the counties within the ROI was 61,152 for kindergarten through 12th grade (FG Alliance, 2006d). An additional 218 new school-aged children would represent a 0.4 percent increase in the number of students who would share the current schools' resources.

Project operation would not displace existing school facilities or conflict with school system plans.

7.19 SOCIOECONOMICS

7.19.1 INTRODUCTION

This section addresses the region's socioeconomic resources most likely to be affected by the construction and operation of the proposed FutureGen Project. This section discusses the region's demographics, economy, sales and tax revenues, per capita and household incomes, sources of income, housing availability, and the potential effects that the construction and operation of the proposed project could have on socioeconomics.

7.19.1.1 Region of Influence

The ROI for socioeconomics includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors. As shown in Figure 7.18-1, the ROI for the proposed FutureGen Project includes all land area in Ector County and some land area in Andrews, Crane, Martin, Midland, Pecos, Upton, Ward, and Winkler counties. Therefore, this section focuses on the socioeconomic environment at the county level rather than by the proposed sites and utility and transportation corridors.

A few counties have a relatively small portion of land within the ROI and were, therefore, excluded from the analysis as not materially affecting the aggregate socioeconomics of the ROI. Brewster, Crockett, Reeves and Terrell counties in Texas, and Lea County in New Mexico contain no more than two small communities and were also excluded from the ROI. Although the analysis addresses the entire ROI, the affected environment and environmental consequences focus more on the proposed power plant site located in Ector County.

7.19.1.2 Method of Analysis

DOE reviewed U.S. Census data, the Alliance EIVs, and other information to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Displace existing population or demolish existing housing;
- Alter projected rates of population growth;
- Affect the housing market;
- Displace existing businesses;
- Affect local businesses and the economy;
- Displace existing jobs; and
- Affect local employment or the workforce.

7.19.2 AFFECTED ENVIRONMENT

7.19.2.1 Regional Demographics and Projected Growth

The regional demographics for the ROI are provided in Table 7.19-1. In 2000, the total population for the counties within the ROI was 297,173 (USCB, 2000a). The total population for the ROI is anticipated to increase by approximately 7.1 percent by 2010 to 318,366 (FG Alliance, 2006d).

The 2000 Texas population was 20,851,820 and is anticipated to increase by 9.4 percent by 2010 to 22,802,947 (USCB, 2005a). The 2000 U.S. population was 282,125,000 and is anticipated to increase approximately 9.5 percent by 2010 to 308,936,000 (USCB, 2000b). Thus, the ROI is anticipated to grow at a slower rate than the U.S. and Texas (FG Alliance, 2006d). The 2000 Ector County population was 121,123 (FG Alliance, 2006d). Within the ROI, Ector County had the largest population in 2000 and a growth rate greater than the ROI average growth rate. The median ages of residents in 2000 were 35.3 years for the U.S., 32.3 years for Texas, and 32.0 years in Ector County (USCB, 2000c and USCB, 2000d).

Table 7.19-1. Population Distribution and Projected Change for Counties Containing Land Area Within the ROI

County	Year 2000					2010 Projected Total Population	Projected Change 2000 to 2010 (percent)
	Total	Under 18	18-64	65 and over	Average Family Size		
Ector	121,123	41,024	66,861	13,238	3.3	131,364	10,241 (8.5)
Andrews	13,004	4,501	6,882	1,621	3.3	14,155	1,151 (8.9)
Crane	3,996	1,412	2,148	436	3.4	4,384	388 (9.7)
Martin	4,746	1,610	2,504	632	3.4	5,332	586 (12.3)
Midland	116,009	38,650	63,893	13,466	3.2	122,297	6,288 (5.4)
Pecos	16,809	5,413	9,575	1,821	3.3	17,675	866 (5.2)
Upton	3,404	1,119	1,803	482	3.2	3,774	370 (10.9)
Ward	10,909	3,677	5,674	1,558	3.2	11,701	792 (7.3)
Winkler	7,173	2,356	3,789	1,028	3.2	7,684	511 (7.1)
Total or Average	**297,173**	**99,762**	**163,129**	**34,282**	**3.3**	**318,366**	**21,193 (7.1)**
Texas	**20,851,820**					**22,802,947**	**1,951,127 (9.4)**
U.S.	**282,125,000**					**308,936,000**	**2,681,000 (9.5)**

Source: FG Alliance, 2006d and USCB, 2000a.

7.19.2.2 Regional Economy

Income and Unemployment

Table 7.19-2 provides information about the workforce, and per capita and median household incomes for the counties located within the ROI. In July 2006, approximately 8,280 persons were unemployed within the ROI and the average unemployment rate was 5.1 percent (FG Alliance, 2006d). In the same year, Ector County had a lower unemployment rate of 4.7 percent (FG Alliance, 2006d). In July 2006, the average unemployment rate in the U.S. was 4.8 percent and 5.2 percent for Texas (USBLS, 2006a and USBLS, 2006b). Thus, Ector County and the ROI have unemployment rates consistent with Texas and U.S. averages.

In 1999, the average median household income for the ROI was $25,935 and the average per capita income was $15,216 (FG Alliance, 2006d), while the median household income for the U.S. was $50,046 and the per capita income was $21,587 (USCB, 2000e and USCB, 2000f). In 1999, Texas had a median household income of $39,927 and a per capita income of $16,617 (USCB, 2000g). That same year, Ector County had an average median household income of $31,152 and a per capita income of $15,031 (FG Alliance, 2006d). Based on 2000 Census data, Ector County and the ROI have median household incomes and per capita incomes that are less than both the Texas and U.S. averages.

In 2004, Ector County collected $24 million in property tax and in 2005 collected $109 million in sales tax (FG Alliance, 2006d). The counties located within the ROI each collected an average of $5.8 million in sales tax in 2005 (FG Alliance, 2006d).

Table 7.19-2. Employment and Income for Counties Within the ROI

County	Employment		Income	
	Total Employed (2004)	2006 Unemployment Rate (percent)	1999 Per Capita Income	1999 Median Household
Ector	66,088	4.7	$15,031	$31,152
Andrews	6,388	4.6	$15,916	$34,036
Crane	1,922	5.7	$15,374	$32,194
Martin	2,583	5.1	$15,647	$31,836
Midland	83,176	4.0	$20,369	$39,082
Pecos	7,029	5.8	$12,212	$28,033
Upton	1,803	4.5	$14,274	$28,977
Ward	4,365	6.3	$14,393	$29,386
Winkler	3,125	5.3	$13,725	$30,591
ROI Total or Average	**176,479**	**5.1**	**$15,216**	**$25,935**
Texas	**9,968,309**	**5.2**	**$16,617**	**$39,927**
U.S.	**n/a**	**4.8**	**$21,587**	**$50,046**

n/a = not available.
Source: FG Alliance, 2006d; USCB, 2000a; and USCB, 2000h.

Table 7.19-3 provides 2003 average hourly wages for Ector County for trades that would be required for construction of the proposed project. The minimum and maximum wages for these trades were not available. Although actual wage costs would not be known until contractor selection, it is expected that wages for construction of the proposed FutureGen Project would be typical for construction trades in Ector County adjusted for inflation.

Table 7.19-3. Average Hourly Wage Rates in 2003 by Trade in Ector County, Texas

Trade	Average Wage Rate
Electrician	$12.66
Iron Worker	$10.94
Laborer	$5.50
Plumber	$10.00

Source: GPO, 2005.

Housing

Table 7.19-4 provides total housing units vacant units by county within the ROI. As of 2000, there were a total of 122,447 existing housing units within the ROI, with Ector County accounting for 49,500 of those units (FG Alliance, 2006d). Of the existing housing units within the ROI, 12.5 percent, or 15,314, were vacant (FG Alliance, 2006d). In 2005, Texas reported that 32.4 percent of vacant units were for rent and 10.9 percent of vacant units were for sale (USCB, 2005b). There were approximately 4,962 units for rent and 1,669 units for sale within the ROI, and 1,832 units for rent and 616 units for sale within Ector County (FG Alliance, 2006d). In addition, there were at least 4,580 short-term hotel and motel rooms with within the ROI (FG Alliance, 2006d).

There are no residences on or adjacent to the proposed power plant or sequestration sites.

Table 7.19-4. Total Housing Units Within the ROI in 2000

County	Total Housing Units	Vacant Units
Ector	49,500	5,654
Andrews	5,400	799
Crane	1,596	236
Martin	1,898	274
Midland	48,060	5,315
Pecos	6,338	1,185
Upton	1,609	353
Ward	4,832	868
Winkler	3,214	630
Total	**122,447**	**15,314**

Source: FG Alliance, 2006d.

7.19.2.3 Workforce Availability

Construction

In 2004, there were approximately 176,479 people within the ROI workforce (FG Alliance, 2006d). Because construction workers represented 8.6 percent of the workforce in Texas, there were approximately 15,000 construction workers within the ROI (USCB, 2005c and FG Alliance, 2006d). This indicates that there could be a large local workforce from which some or all of the construction workers could be drawn.

Operations

Utility workers made up 1.0 percent of the workforce in Texas in 2004, resulting in approximately 1,800 workers within the ROI (USCB, 2005c). Operations workers could be drawn from this workforce.

7.19.3 IMPACTS

7.19.3.1 Construction Impacts

Population

The need for construction workers would be limited to the estimated 44-month construction period, and a potential influx of temporary residents is not expected to cause an appreciable increase in the regional population. Monthly employment on the proposed power plant site would average 350 workers during construction, with a peak of 700 workers (FG Alliance, 2006e). Approximately 15,000 general construction workers residing within the ROI would provide a local workforce. Temporary construction workers with specialized training and workers employed by contractors from outside the ROI could also be employed to construct the proposed power plant. Some of these workers could be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period. Although it is not known how many workers would relocate, the required number of construction workers represents less than 0.3 percent of population within the ROI. Therefore, impacts on population growth within the ROI would be small.

Employment, Income, and Economy

Construction of the proposed facilities would result in 350 to 700 new jobs in Ector County. These new jobs would represent a 0.2 to 0.4 percent increase in the number of workers employed in the county (FG Alliance, 2006d). These workers would be paid consistent with wages in the area for similar trades. Wages for trades associated with power plant construction for 2003 are presented in Table 7.19-3, although it is likely that actual wages could be higher than those presented because of inflation. Therefore, a direct, but small, positive impact on employment rates and income could occur within the ROI during the construction period.

Texas and Ector County could benefit from temporarily increased sales tax revenue resulting from the project-related spending on payroll and construction materials. It is anticipated that construction workers would spend their wages on short-term housing, food, and other personal items in the ROI. Additional sales tax revenues would result from taxes embedded in the price of consumer items such as gasoline. Therefore, an indirect and positive impact could be expected for the local economy from increased spending and related sales tax revenue.

Texas and Ector County could also benefit from increased property tax revenue associated with properties acquired for the proposed FutureGen Project. Property taxes are applied to construction sites on the basis of an evaluation of work completed to date in each year. The amount paid would depend not only on levy rates at the time the construction is under way, but also on the construction schedule relative to the evaluation's timing. The facility's property tax would be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue could be in the millions of dollars each year. This increase would have a direct and positive impact to the total property tax revenue for Ector County and Texas. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance.

Housing

A potential influx of construction workers may increase local housing demand, which would have a beneficial short-term impact on the regional housing market. The ROI has approximately 4,962 vacant housing units for rent, with Ector County accounting for approximately 1,832 of these units. There are also at least 4,580 hotel rooms within the ROI, with Ector County accounting for approximately 1,570 of these rooms. In 2005, it is estimated that Texas experienced an average occupancy rate of 57.6 percent (HO, 2004). Therefore, depending upon the percentage of construction jobs that could be filled by existing residents, the influx of workers from outside the region could increase the occupancy rate within the ROI by as much as 15.2 percent. This increase would result in a hotel occupancy rate of 72.6 percent and a positive, direct impact for the hotel industry within the ROI.

Power Plant Site

There are no existing residences or buildings on the proposed power plant site; therefore, no existing population would be displaced.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site; therefore, no existing population would be displaced.

7.19.3.2 Operational Impacts

Population

Operation of the proposed power plant would likely result in a very small increase in population growth. It is anticipated power plant operation could require approximately 200 permanent workers. Based on the 2005 projected population and average family size within the ROI, the relocation of 200 workers could result in a population increase of 650 people. This would represent a 0.2 percent increase in population within the ROI and a 0.5 percent increase in the population of Ector County.

Employment, Income, and Economy

The operational phase of the proposed FutureGen Project could have a direct and positive impact on employment by creating 200 permanent jobs in Ector County. These new jobs could represent a 0.11 percent increase in the total number of workers employed in Ector County (FG Alliance, 2006d).

Each new direct operations job created by the proposed FutureGen Project could generate both indirect and induced jobs. An indirect job supplies goods and services directly to the plant site. An induced job results from the spending of additional income from indirect and direct employees. A job multiplier is used to determine the approximate number of indirect and induced that jobs that would result. An Economic Impact Analysis was issued for Ford Park in Beaumont, Texas, in 2004 and reported a job multiplier of 1.6 (IDS, 2004). A job multiplier of 1.6 means that, for every direct job, 0.6 indirect or induced jobs could result. Based on this multiplier, the proposed FutureGen Project could have an indirect impact on employment by creating approximately 113 indirect or induced jobs in and around the ROI.

The proposed FutureGen Project would also have annual operation and maintenance needs that could benefit Ector County. Local contractors could be hired to complete specialized maintenance activities that could not be undertaken by permanent staff, and items such as repair materials, water, and chemicals could be purchased within the ROI. The 200 employees who would fill new jobs created by the proposed FutureGen Project could generate tax revenues from sales and use taxes on plant materials and maintenance. The property tax from the proposed power plant could be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue would be in the millions of dollars each year. This increase would have a direct and positive impact on the total property tax revenue for Ector County and Texas. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance. Texas would likely benefit from a public utility tax it levies when power is produced by the proposed FutureGen Project.

Housing

During operation of the proposed power plant, relocating employees would likely be distributed between owned and rental accommodations. Although it is not known how many of the permanent staff would relocate within the ROI, if all 200 permanent employees relocated, the increased demand for housing would be small. In Texas, approximately 64.7 percent of housing units are owner-occupied (USCB, 2005d). Using this value, operation of the proposed power plant could result in a 7.8 percent decrease in residences for sale and a 3.9 percent decrease in residences for rent within the ROI.

Power Plant Site

There are no existing residences or buildings on the proposed power plant site; therefore, no existing population would be displaced.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site; therefore, no existing population would be displaced.

7.2 AIR QUALITY

7.2.1 INTRODUCTION

This section describes existing local and regional air quality and the potential impacts that may occur from constructing and operating the FutureGen Project at the Odessa Power Plant Site and sequestration site. The FutureGen Project would use integrated gasification combined-cycle (IGCC) technology and would capture and sequester carbon dioxide (CO_2) in deep underground formations. Chapter 2 provides a discussion of the advancements in IGCC technology associated with the FutureGen Project that would reduce emissions of air pollutants. Because of these technologies, emissions from the FutureGen Project would be lower than emissions from existing IGCC power plants and state-of-the-art (SOTA), conventional coal-fueled power plants.

7.2.1.1 Region of Influence

The ROI for air quality includes the area within 50 miles (80.5 kilometers) of the boundaries of the proposed Odessa Power Plant Site and within 50 miles (80.5 kilometers) of the boundaries of the proposed Odessa Sequestration Site. Sensitive receptors that have been identified within the ROI are discussed in Section 7.2.2.3.

7.2.1.2 Method of Analysis

DOE reviewed available public data and also studies performed by the Alliance to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Result in emissions of criteria pollutants and hazardous air pollutants (HAPs);
- Result in mercury (Hg) emissions and conflict with the Clean Air Mercury Rule (CAMR) as related to coal-fueled electric utilities;
- Cause a change in air quality related to the National Ambient Air Quality Standards (NAAQS);
- Result in consumption of Prevention of Significant Deterioration (PSD) increments as defined by the Clean Air Act (CAA), Title I, PSD rule;
- Affect visibility and cause regional haze in Class I areas;
- Result in nitrogen and sulfur deposition in Class I areas;
- Conflict with local or regional air quality management plans;
- Result in emissions of greenhouse gases (GHGs);
- Cause solar loss, fogging, icing, or salt deposition on nearby residences; and
- Discharge odors into the air.

> **Plant upset** is a serious malfunction of any part of the IGCC process train and usually results in a sudden shutdown of the combined-cycle unit's gas turbine and other plant components.

Based on the above criteria, DOE assessed potential air quality impacts from construction and operational activities related to the FutureGen Project at the proposed Odessa Power Plant Site and sequestration site. For impacts related to FutureGen Project operations, DOE conducted air dispersion modeling of criteria pollutants using EPA's refined air dispersion model, AERMOD (American Meteorological Society/EPA Regulatory Model). Details on the air modeling protocol are presented in Appendix E. To establish an upper bound for potential impacts, DOE used the FutureGen Project's estimate of maximum air emissions, which was developed by the Alliance and reviewed by DOE, for the air dispersion modeling based on 85 percent plant availability and unplanned restarts as a result of plant upset (also called unplanned outages) (see Table 7.2-1). The estimate of maximum air emissions was developed using the highest pollutant emission rates for various technology options being considered for the FutureGen Project (see Section 2.5.1.1). Surrogate data from similar existing or permitted units (e.g., the Orlando Gasification Project [Orlando Project]) were used for instances where engineering details and emission data were not available due to the early design stage of the FutureGen Project (DOE, 2007).

Table 7.2-1 presents expected emissions of air pollutants from the FutureGen Project during the 4-year research and development period and beyond. Emissions from the first year of proposed power plant operation, which are expected to be highest, represent the upper bound for potential air emissions and were modeled for this EIS. Emissions would be expected to decrease each year, as learning and experience over time would reduce the frequency and types of unplanned restart events from an estimated 29 in the first year to 3 in the fifth year and beyond (see Appendix E). Consequently, annual impacts would be expected to decrease progressively from the first year of operation to the fourth year of operation and beyond. Because emissions of some criteria pollutants are projected to exceed 100 tons per year (tpy) (90.7 metric tons per year [mtpr]) (even with less than 3 restarts per year), the FutureGen Project would be classified as a major source under Clean Air Act Regulations.

Table 7.2-1. Yearly Estimates of Maximum Air Emissions from the FutureGen Project[1] (tpy [mtpy])

Pollutant	Year 1	Year 2	Year 3	Year 4	Year 5 Onward[2]
Sulfur Oxides[3] (SO_x)	543 (492)	322 (292)	277 (251)	255 (231)	100 (90.7)
Nitrogen Oxides[4] (NO_X)	758 (687)	754 (684)	753 (683)	753 (683)	750 (680)
Particulate Matter[5] (PM_{10})	111 (100)	111 (100)	111 (100)	111 (100)	111 (100)
Carbon Monoxide[5] (CO)	611 (554)	611 (554)	611 (554)	611 (554)	611 (554)
Volatile Organic Compounds[5] (VOCs)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)
Mercury[5] (Hg)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)

[1] Because the FutureGen Project would be a research and development project, DOE assumes that the maximum facility annual availability would be 85 percent. Values are estimated based on maximum emissions rates for design Case 1, 2, or 3A, plus maximum emissions rates for design Case 3B and includes emissions from unplanned restarts (upset conditions).
[2] Year 1 to Year 4 calculated based on information provided by the Alliance. Year 5 estimated by DOE, not provided by the Alliance.
[3] SO_x emissions from coal combustion systems are predominantly in the form of sulfur dioxides (SO_2).
[4] NO_x emissions from coal combustion are primarily nitric oxide (NO); however, for the purpose of the air dispersion modeling, it was assumed that all NO_x emissions are nitrogen dioxides (NO_2). One of the technologies being considered for the FutureGen Project is post-combustion selective catalytic reduction (SCR), which would reduce the annual NO_X emissions to 252 tpy (228.6 mtpy).
[5] Values for PM_{10}, CO, VOCs, and Hg would remain constant between Year 1 through 5 because unplanned restarts would not affect these emissions. Conversely, SO_2 and NO_2 emissions would decrease each year due to expected decrease in restart events. See Appendix E, Tables E-2 and E-3.
tpy = tons per year; mtpy = metric tons per year.
Source: FG Alliance, 2007.

In addition to assessing impacts of criteria pollutant emissions, DOE assessed impacts of HAP emissions by estimating the annual quantities of HAPs that would be emitted from the proposed FutureGen Power Plant. These estimates were developed based on emissions predicted for the Orlando

Project, which would burn a carbon-rich syngas (DOE, 2007). The estimated HAPs may be overstated since the FutureGen Project would include new technologies that would produce syngas that would contain lower levels of carbon. The estimated emissions are presented in Section 7.2.3.2.

DOE also assessed the potential for impacts to local visibility from the vapor plume using qualitative measures because engineering specifications needed to conduct quantitative modeling for vapor plume sources (e.g., cooling towers) were not available. Class-I-related modeling, including pollutant dispersion and air-quality-related values (AQRV), were reviewed for their applicability. Potential effects to soil, vegetation, animals, human health, and economic development were also reviewed.

7.2.2 AFFECTED ENVIRONMENT

7.2.2.1 Existing Air Quality

The Texas Commission on Environmental Quality (TCEQ) Monitoring Operations Division has monitoring sites throughout the state, which monitor ambient air quality and designate areas or regions that either comply with all of the NAAQS or fail to meet the NAAQS for one or more criteria pollutants. The NAAQS specify the maximum allowable concentrations of six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and inhalable particles, which are also known as respirable particulate matter (PM). The PM_{10} standard covers particles with diameters of 10 micrometers or less and the $PM_{2.5}$ standard covers particles with diameters of 2.5 micrometers or less. Areas that meet the NAAQS for a criteria pollutant are designated as being in "attainment" for that pollutant, and areas where a criteria pollutant concentration exceeds the NAAQS are designated as "non-attainment" areas. Where insufficient data exist to determine an area's attainment status, the area is designated as unclassifiable. Maintenance areas are those non-attainment areas that have been redesignated as attainment areas and are under a 10-year monitoring plan to maintain their attainment status.

The proposed Odessa Power Plant Site and sequestration site have the cities of Midland to the north-northeast and Fort Stockton to the southwest. The proposed Odessa Power Plant Site is located in Ector County in Texas. Odessa forms part of the Midland-Odessa Metropolitan Planning Organization (MPO). The surface extent of the proposed sequestration site is located within Pecos County. Ector and Pecos counties are part of the Midland-Odessa-San Angelo Intrastate Air Quality Control Region (AQCR). This AQCR has no history of non-attainment for the six criteria pollutants.

There are currently two $PM_{2.5}$ monitors operating within the ROI of the proposed Odessa Power Plant Site that provide the nearest criteria air pollutant monitoring data that is representative of the proposed Odessa Power Plant Site. Ector County is considered in attainment for $PM_{2.5}$. No monitoring for other criteria pollutants has been conducted in or around Ector County in recent years (FG Alliance, 2006d). There are no monitors within the ROI of the proposed sequestration site. According to accepted EPA and TCEQ practices, counties not previously designated as either in attainment or in non-attainment based on monitoring are designated as "unclassifiable" for criteria pollutants. Therefore, Ector County is designated unclassifiable for other criteria pollutants and Pecos County is designated unclassifiable for all criteria pollutants.

While it is likely that the ROI for the proposed project is in attainment, most of the counties within the ROI are currently designated as unclassifiable (FG Alliance, 2006d). The nearest O_3 monitors are located in Hobbs, New Mexico, approximately 75 miles (120.7 kilometers) from the proposed Odessa Power Plant Site. These monitors may be considered generally representative of the West Texas area and have shown no violations of the O_3 NAAQS. The proposed power plant site is more than 215 miles (346.0 kilometers) away from the nearest border of a designated non-attainment area (El Paso County). The most recent available data from monitoring stations nearest to the project site are presented in Table

7.2-2. The Alliance may choose to conduct site-specific monitoring for criteria pollutants as appropriate for development of a detailed site characterization if the proposed Odessa Site is selected.

Table 7.2-2. Monitoring Stations and Ambient Air Quality Data

Monitoring Site Location	Distance from Proposed Site (miles [kilometers])	Pollutant and Averaging Time	Monitored Data[1]	Primary/ Secondary Standard[1]
Odessa Hays, TX Ector County Midland-Odessa-San Angelo AQCR	< 5 (8.0)	$PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	7.9 18.0	15 35
Odessa Gonzales, TX Ector County Midland-Odessa-San Angelo AQCR	< 5 (8.0)	$PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	8.28 13.75	15 35
Hobbs, NM Lea County Pecos-Permian Basin Intrastate AQCR	75 (120)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour) PM_{10} (Annual)[2] PM_{10} (24-hour) NO_2 (Annual)	0.083 0.079 6.8 16.0 22 72 0.007	0.12 0.08 15 35 -- 150 0.053
El Paso, TX El Paso County El Paso-Las Cruces-Alamogordo Interstate AQCR	245 (394)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour) PM_{10} (Annual)[2] PM_{10} (24-hour)[2] CO (1-hour) CO (8-hour) NO_2 (Annual) SO_2 (Annual) SO_2 (24-hour) SO_2 (3-hour) Pb (Quarterly)	0.110 0.092 9.6 33.0 42 402 2.8 1.9 0.014 0.001 0.003 0.010 0.01	0.12 0.08 15 35 - 150 35 9 0.053 - - 0.500 1.5

[1] Units for $PM_{2.5}$, PM_{10}, and Pb are in micrograms per cubic meter (μg/m^3); units for O_3 and NO_2 are in parts per million (ppm). To determine representative background data for both PM_{10} and $PM_{2.5}$ 24 hours and annual averaging periods, the monitored data are averaged over a period of three years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values each year for a period of three years (2003 to 2005) is used (see Appendix E).
[2] The standards for PM_{10}, annual averaging period, were revoked on December 17, 2006.
Source: FG Alliance, 2006d.

7.2.2.2 Existing Sources of Air Pollution

Emissions from the proposed FutureGen Project and potential environmental consequences must be considered in the context of both regional air quality and existing local sources of emissions. Existing sources of emissions outside and within the ROI are discussed. Additionally, local sources (i.e., within 1 mile [1.6 kilometers] of the proposed Odessa Power Plant Site and sequestration site) are discussed.

Outside the Region of Influence

Traffic-related pollution and pollution from existing industrial sources associated with large cities can contribute to air pollution in nearby rural areas. The nearest non-attainment area is in El Paso County, approximately 215 miles (346.0 kilometers) to the west. O_3 monitors located at Hobbs, New Mexico (located about 75 miles [120.7 kilometers] to the north-northwest of the Odessa Site) and at Big Bend National Park (located more than 170 miles [273.6 kilometers] to the south-southwest of the Odessa Site) show no violations of the standards, but these monitoring sites are not in prevalent downwind directions from El Paso. Outside the ROI, the nearest large city is Lubbock, Texas, approximately 100 miles (160.9 kilometers) to the north of Odessa. While it is unlikely that El Paso or Lubbock would cause any violations of the NAAQS at the proposed Odessa Site, the generally downwind location of these cities suggests that they would infrequently contribute to background concentrations of pollutants. Many of the largest cities in Texas are hundreds of miles to the east. Therefore, it is unlikely that these eastern urban and industrial sources are contributing significantly to background concentrations at the proposed Odessa Power Plant Site.

Inside the Region of Influence

The closest population areas to the proposed Odessa Power Plant Site are the cities of Odessa and Midland. The types and quantities of air pollutants emitted from existing sources located within 10 miles (16.1 kilometers) of the proposed power plant site may contribute to the background concentrations of pollutants within and surrounding the ROI. According to the EPA Envirofacts website (http://www.epa.gov/enviro) (EPA, 2006a), the largest emitters, also considered major sources, within a 10-mile (16.1-kilometer) radius but outside a 1-mile (1.6-kilometer) radius are Block 31 Gas Plant, Walton Compressor Station, Shell Western E and P Incorporated, and Sands Hills Plant (FG Alliance, 2006d). Along the low escarpment or ridge located between the proposed Odessa Power Plant Site and the City of Odessa, there are several active and abandoned limestone quarries, as well as the Odessa Cement Plant. Some of these active facilities are significant sources of dust and range in distance from less than 1 mile (1.6 kilometers) to about 2 miles (3.2 kilometers) to the east of the proposed plant site. These existing sources, which are also considered major sources, may contribute to concentrations of airborne contaminants and dust and, therefore, provide a context for understanding the potential emissions and associated air quality impacts from the proposed project.

> A **major source** is a unit that emits any one criteria pollutant in amounts equal to or greater than thresholds of 100 tpy (90.7 mtpy) or one HAP in amounts greater than or equal to 10 tpy (9.1 mtpy) or a combination of HAPs in amounts greater than or equal to 25 tpy (22.7 mtpy). Additionally, an electric generating unit is one of the 28 categories defined by the PSD rule. For sources that are not in one of the 28 categories, the threshold is 250 tpy (226.8 mtpy) of criteria pollutants (40 Code of Federal Regulations [CFR] 52.21, 2006).

Local

The vicinity of the proposed power plant site is mostly rural with a low to very low population density. Land use in the area is dominated by oil and gas production activities and ranching. A web of unpaved service roads connect the oil and gas wells surrounding the proposed project site, and the very light traffic on these roads would cause some fugitive dust. Fugitive emissions of hydrocarbons may occur from the oil and gas wells and related transmission and storage facilities. Duke Energy Field Services is the only existing large emissions source within 1 mile (1.6 kilometers) of the proposed Odessa Power Plant Site.

Most traffic within 1 mile (1.6 kilometers) of the proposed project site is on I-20, which is a major east-west trucking and traffic route across the southern U.S. There would be some vehicle exhaust and diesel exhaust emissions associated with I-20. Local paved roads carry light to very light traffic loads and are not likely to be significant sources of dust or vehicle exhaust emissions.

Land surrounding the proposed plant site consists of scrub rangeland that incurs significant wind and water erosion, and therefore, constitutes a source of dust. Scattered areas of windblown sand and small sand dunes to the south and west of the site indicate the very active nature of the wind erosion in the area and the potential for wind-blown particulates in the air.

The proposed sequestration site is on University of Texas land that is largely vacant with some leases for ranching and oil and gas extraction. I-10 crosses the proposed sequestration site. Some roads, especially ranch roads, are unpaved. Both the ranching and local traffic likely constitute a source of fugitive dust emissions.

7.2.2.3 Sensitive Receptors (Including Class I Areas)

Only a few occupied (and habitable) residences were noted within 1 mile (1.6 kilometers) of the power plant site in the Town of Penwell. These include two single-family residences along FM 1601 on the south side of I-20 and one on the north side of I-20 within the Town of Penwell. A ranch house was noted in the fields south of I-20 and southeast of the site, near the edge of the 1-mile (1.6-kilometer) ROI. There are no churches, schools, or hospitals within 1 mile (1.6 kilometers) of the proposed power plant site. There are also no sensitive receptors within 1 mile (1.6 kilometers) of the proposed sequestration site.

Within the 10-mile (16.1-kilometer) radius of the proposed Odessa Power Plant Site, there are two schools, one day care center, and one retirement center. There are no sensitive receptors within the 10-mile (16.1-kilometer) radius of the Odessa Sequestration Site (see Figure 7.2-1).

Class I Areas

For areas that are already in compliance with the NAAQS, the PSD requirements provide maximum allowable increases in concentrations of pollutants, which are expressed as increments. Allowable PSD increments currently exist for three pollutants: SO_2, NO_2, and PM_{10}. They apply to the three types of areas classified under the PSD regulations: Classes I, II, and III, where the smallest allowable increments correspond to Class I areas (Table 7.2-3).

Class I areas, which are those areas designated as pristine, require more rigorous safeguards to prevent deterioration of the air quality, and include many national parks and monuments, wilderness areas, and other areas as specified in 40 CFR Part 51.166(e). The closest Class I area is 110 miles (177.0 kilometers) from the proposed Odessa Power Plant Site and sequestration site (see Table 7.2-4), which is well beyond the 62-mile (99.8-kilometer) distance required to consider impacts to Class I areas under the PSD regulations. All other clean air regions are designated Class II areas with moderate pollution increases allowed (FWS, 2007). The proposed Odessa Power Plant Site and sequestration site are located in Class II areas.

Table 7.2-3. Allowable PSD Increments (µg/m^3)

Pollutant, averaging period		Class I Area	Class II Area	Class III Area
SO_2	3-Hour	25	512	700
	24-Hour	5	91	182
	Annual	2	20	40
NO_2	Annual	2.5	25	50
PM_{10}	24-Hour	8	30	60
	Annual	4	17	34

µg/m^3 = micrograms per cubic meter.
Source: EPA, 2005.

Table 7.2-4. Nearest Class I Areas to Proposed Odessa Power Plant Site

Class I Area/Location	Distance (miles)	Distance (kilometers)	Direction
Carlsbad Caverns National Park, New Mexico	110.0	177.0	NW
Guadalupe Mountains National Park, Texas	125.0	201.2	W

Source: FG Alliance, 2006d.

7.2.2.4 Air Quality Management Plans

The CAA requires states to develop federally approved regulatory programs, called State Implementation Plans (SIPs), for meeting the NAAQS throughout the state. These plans aim to limit emissions from sources as necessary to achieve and maintain compliance. In part, SIPs focus on new major stationary sources and modifications to existing major stationary sources. A state's New Source Review (NSR)/PSD review program is defined and codified in its SIP. The Texas SIP is available from the TCEQ.

The FutureGen Project would be required to undertake the NSR/PSD permit application process after a host site is selected. State and local governmental officials contacted during the development of this EIS and the supporting Environmental Information Volume (EIV) indicate that there are no local air quality management plans currently in existence for the ROI (FG Alliance, 2006d). Additionally, these officials have no knowledge of specific local needs or concerns for air quality management at the proposed Odessa Power Plant Site and sequestration site.

7.2.3 IMPACTS

7.2.3.1 Construction Impacts

Construction at the proposed power plant site, sequestration site, utility corridors, and transportation corridors would result in localized increases in ambient concentrations of SO_2, NO_X, CO, VOCs, and PM. These emissions would result from the use of construction equipment and vehicles including trucks, bulldozers, excavators, backhoes, loaders, dump trucks, forklifts, pumps, and generators. In addition, fugitive dust emissions (i.e., PM emissions) would occur from various construction-related activities, including earth moving and grading, material handling and storage, and vehicles traveling over dirt and gravel areas.

Given the size of the proposed site and the short duration of the construction period, potential impacts would be localized and temporary in nature. Construction impacts would be minimized through the use of best management practices (BMPs), such as wetting the soil surfaces, covering trucks and stored materials with tarps to reduce windborne dust, and using properly maintained equipment (see Section 3.4).

Power Plant Site

DOE assumed that up to 200 acres (81 hectares) of the proposed 600-acre (243-hectare) site would be directly affected for the purposes of the air impact analysis. DOE estimates that construction of the proposed Odessa Power Plant would take 44 months. PM concentrations would be localized because of the relatively rapid settling of larger dust particles and impacts to off-site receptors would be temporary. In addition, PM emissions would decrease with the total amount of land disturbed, as PM emissions were calculated on the basis of site acreage. Impacts of the SO_2, NO_X, CO, and VOC emissions from vehicular sources would be temporary in nature and could cause minor to moderate short-term degradation of local air quality. The air pollutant emissions would be minimized through the use of BMPs, such as limiting the amount of vehicle trips, wetting the soil surfaces, covering trucks, limiting vehicle idling, and properly maintaining equipment.

Sequestration Site

While the University of Texas land hosting the proposed sequestration site contains over 42,300 acres (17,119 hectares) (FG Alliance, 2006d), only a very small fraction (10 acres [4 hectares]) of the land area would be disturbed by either exploratory investigations (e.g., geophysical surveys) or construction of the sequestration facilities. Construction-related impacts on air quality at the proposed sequestration site would be limited to preparation of well drilling sites and the drilling of wells, as discussed in Chapter 2. Exploratory wells would be installed to sample and test the underground reservoir systems, and injection wells and monitoring wells would be installed to inject CO_2 and monitor its fate. Site preparation and construction activities would involve grading and surface preparation by earth-moving equipment that would result in localized fugitive dust air emissions during construction.

Utility Corridors

The proposed utility corridors could include a natural gas pipeline, process water pipeline, potable water pipeline, sanitary wastewater pipeline, and electric transmission line. Construction of the utility corridors would require less acreage, use less equipment, and take less time than the construction of the proposed power plant. The duration of utility corridor construction would range from one week for the process water pipeline to 45 weeks for the other pipelines. The emissions from construction would include SO_2, NO_X, PM, CO, and VOCs. Impacts from emissions of these pollutants would be localized and temporary in nature and could cause minor to moderate short-term degradation of air quality in the areas where construction is taking place.

Transportation Corridors

Access to the proposed Odessa Power Plant Site would primarily be via FM 1601 which borders the site. The site's southern border is less than 0.5 mile (0.8 kilometer) from I-20. Additionally, the Union Pacific Railroad line runs along the southern border of the proposed power plant site. Delivery to and from the proposed site could be accomplished either by railway or roadway, therefore construction of additional public roadways or railways would not be required, and no impact would be expected. Travel on existing roadways during construction of the proposed facility and associated corridors is discussed above.

7.2.3.2 Operational Impacts

Power Plant Site

Sources of Air Pollution

Primary sources of air emissions associated with the FutureGen Project would be the combustion turbine, flare, gasifier preheat, cooling towers, and sulfur recovery system (see Figure 2-18). DOE and the Alliance have estimated the maximum potential emissions that would be expected (see Table 7.2-1) using data from equipment typical of an IGCC power plant. However, because the FutureGen Project is in the early stages of design, specific engineering and technical information on the equipment that would ultimately be used is not available. Other sources of air emissions could include mobile sources such as plant vehicular traffic and personnel vehicles, which would be equipped with standard pollution-control devices to minimize emissions.

Local traffic within the proposed power plant site would be expected to emit small amounts of criteria pollutants. In addition, coal delivery trains (five trains per week) would emit a small amount of criteria pollutants from the train exhaust, and potentially PM during coal unloading and handling. However, coal handling emissions are not expected to appreciably change air quality because the emissions would be reduced by minimizing points of transfer of the material, enclosing conveyors and loading areas, and installing control devices such as baghouses and wetting systems.

Clean Air Act General Conformity Rule

Section 176(c)(1) of the Clean Air Act requires that federal actions conform to applicable SIPs for achieving and maintaining the NAAQS for the criteria air pollutants. In 1993, EPA promulgated a rule titled “Determining Conformity of General Federal Actions to State or Federal Implementation Plans,” codified at 40 CFR Parts 6, 51, and 93. The rule is intended to ensure that criteria air pollutant emissions and their precursors (e.g., VOCs and NO_X) are specifically identified and accounted for in the attainment or maintenance demonstration contained in a SIP. The conformity rule applies to proposed federal actions that would cause emissions of criteria air pollutants above certain levels in locations designated as non-attainment or maintenance areas for the emitted pollutants. Under the rule, an agency must engage in a conformity review process and, depending on the outcome of that review, conduct a conformity determination.

DOE conducted a conformity review to assess whether a conformity determination (40 CFR Part 93) is needed for the proposed FutureGen Project. As discussed in Section 7.2.2.1, Ector and Pecos counties are in attainment or unclassified with the NAAQS for all pollutants. Additionally, these counties are not designated as a maintenance area. Consequently, no conformity determination is needed (see Section 7.2.2.4).

Criteria Pollutant Emissions

DOE conducted refined modeling using AERMOD. Table 7.2-5 presents the results of the AERMOD modeling for the operational phase of the proposed Odessa Power Plant. Limited amounts of background air concentration data for the Odessa area were available for use in this EIS. With the exception of $PM_{2.5}$, for the pollutants, DOE used background data from monitors that were outside the ROI but within attainment areas to represent ambient concentrations for those pollutants. To determine representative background data for both PM_{10} and $PM_{2.5}$ 24-hour and annual averaging periods, DOE took the average of the second-highest monitored data over a period of 3 years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values of each year for the period of 3 years (2003 to 2005) was used (see Appendix E).

Table 7.2-5 shows that concentrations of pollutants during the operational phase combined with background concentrations would be below their respective NAAQS during normal plant operation and plant upset. Additionally, the proposed FutureGen Project would not exceed the Class II PSD allowable increments; however, short-term 3-hour and 24-hour SO_2 concentrations could approach Class II PSD increment limits during plant upset from emissions associated with unplanned restart events. These unplanned restart emissions of SO_2 would typically be higher than steady-state SO_2 emissions, because syngas would be directly flared without the benefit of the sulfur recovery unit (see Appendix E). The probability of the proposed power plant exceeding the three-hour SO_2 Class II PSD increment at the proposed Odessa Power Plant Site during periods of plant upset is 0.09 percent and zero percent during normal operating scenarios. The probability of the proposed power plant exceeding the 24-hour SO_2 Class II PSD increment at the proposed Odessa Power Plant Site is zero. Maximum concentrations of the pollutants would be limited to a radius of less than 1.6 miles (2.6 kilometers) from the center of the proposed Odessa Power Plant Site. Currently, two single-family residences and a ranch house are within 1 mile (1.6 kilometers) of the proposed site. These residences would be impacted.

Hazardous Air Pollutants

HAP emissions from the FutureGen Project were estimated based on the Orlando Project, a recent IGCC power plant that was determined to provide the best available surrogate data (DOE, 2007). DOE scaled the Orlando Project data based on relative emission rates of VOCs and PM to produce more appropriate estimates of emission rates for the FutureGen Project. However, only emissions from the gas turbine were considered to account for differences between the Orlando design and the FutureGen Project. These differences include the FutureGen Project's use of oxygen (O_2) in the gasifier instead of air, the use of a catalytic shift reactor to convert CO to CO_2, and CO_2 capture and sequestration features.

Predicted HAP emissions are presented in Table 7.2-6. This data indicates that the FutureGen Project would not emit an individual HAP above the 10-tpy (9.1-mtpy) major source threshold. Additionally, at 0.32 tpy (0.3 mtpy) of combined HAPs, the proposed FutureGen Project would not be a major source of HAPs as defined under the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Health hazards and risks associated with these HAP emissions and other air toxins are discussed in Section 7.17.

Mercury

The CAMR establishes standards of performance limiting Hg emissions from new and existing coal-fueled power plants that produce more than 25-MW equivalent output and that would sell at least a portion of the electricity. The CAMR also creates a cap-and-trade program.

New coal-fueled power plants (commencing after January 30, 2004) in Texas would need to meet the EPA New Source Performance Standards (NSPS) for Hg (which vary based on the type of coal utilized) and cannot contribute to an exceedance of the Texas Hg cap. Based on 2005 Hg emissions, Texas has exceeded its state Hg cap and will utilize a cap and trade strategy to bring existing and new sources under this limit (TCEQ, 2006). The FutureGen Project would emit Hg levels far below the NSPS for all coal types but may need to buy Hg credits to comply with the state cap mandate.

Table 7.2-5. Comparison of Maximum Concentration Increases with NAAQS and PSD Increments

Pollutant	Maximum Concentration FutureGen Project Alone[1] (μg/m³)	Maximum Concentration FutureGen Project + Background (μg/m³)	NAAQS (μg/m³)	Class II PSD Increments (μg/m³)	PSD Increment Consumed by FutureGen Project (percent)	Distance of Maximum Concentration (miles [kilometers])
SO_2 (normal operating scenario)[2]						
3-hour	0.54	52.89	1,300	512	0.11	0.71 (1.14)
24-hour	0.20	13.28	365	91	0.21	0.59 (0.95)
SO_2 (upset scenario)[3]						
3-hour	511.98	564.33	1,300	512	99.99	0.79 (1.3)
24-hour	73.00	86.09	365	91	80.22	0.79 (1.3)
SO_2 Annual[4]	0.25	5.49	80	20	1.24	0.71 (1.1)
NO_2[4, 5]						
Annual	0.35	15.40	100	25	1.38	0.71 (1.1)
PM/PM_{10}[4, 6]						
24-hour	0.38	51.71	150	30	1.25	0.59 (1.0)
Annual	0.05	18.05	50	17	0.30	0.71 (1.1)
$PM/PM_{2.5}$[4, 6]						
24-hour	0.38	20.71	35[2]	n/a	n/a	0.59 (1.0)
Annual	0.05	7.75	15	n/a	n/a	0.71 (1.1)
CO[7]						
1-hour	8.42	7,234.37	40,000	n/a	n/a	1.60 (2.6)
8-hour	4.85	3,906.86	10,000	n/a	n/a	0.53 (0.9)

[1] Value based on site-specific meteorological and terrain data. Except for the 3-hour SO_2 during the upset scenario, the highest maximum predicted concentrations are provided for all pollutants and corresponding averaging times, based on the worst-case emissions rates, meteorological data, and terrain data. For the 3-hour SO_2 averaging time during the upset scenario, the 33rd highest maximum predicted concentration is provided. Although the highest maximum three-hour SO_2 concentration could exceed the PSD increment during the upset scenario, the 3-hour increment would not be exceeded at least 99.91 percent of the time. The highest maximum predicted concentrations for the other pollutants and corresponding averaging times would not be expected to exceed the PSD Class II increment at any time.
[2] The normal operating scenario is based on steady-state emissions and is a period when the plant is operating without flaring, sudden restarts, or other upset conditions (see Appendix E).
[3] The upset scenario is based on unplanned restart emissions and is a period when a serious malfunction of any part of the IGCC process train usually results in a sudden shutdown of the combined-cycle units gas turbine and other plant components (see Appendix E).
[4] Annual impacts are based on maximum annual emissions (see Appendix E) over 7,446 hours per year.
[5] There are no short-term NAAQS for NO_2.
[6] There are no unplanned restart emissions of PM_{10} and $PM_{2.5}$ pollutants; therefore, short-term impacts (24-hour) are based on steady-state emissions.
[7] Although there are unplanned restart emissions of CO pollutants, the short-term impacts (1-hour and 8-hour) are based on steady-state emissions because steady-state CO emissions are larger than unplanned restart CO emissions.
n/a = not applicable; μg/m³ = micrograms per cubic meter.
Source: AERMOD modeling result (see Appendix E).

The maximum potential emissions of Hg from the FutureGen Project of 0.011 tpy (0.01 mtpy) would be well below the major source threshold for Hg of 10 tpy (9.1 mtpy) and significant emissions rate of 0.1 tpy (0.09 mtpy). The AERMOD analysis predicted that a negligible annual concentration of Hg (5.10×10^{-6} micrograms per cubic meter) would be deposited within 0.55 mile (0.9 kilometer) of the proposed power plant site.

Table 7.2-6. Annual Hazardous Air Pollutant Emissions[1]

Chemical Compound	Combustion Turbine Emissions	
	tpy	mtpy
2-Methylnaphthalene	7.41E-04	6.72E-04
Acenaphthyalene	5.36E-05	4.86E-05
Acetaldehyde	3.72E-03	3.37E-03
Antimony[2]	2.08E-02	1.89E-02
Arsenic[2]	1.09E-02	9.93E-03
Benzaldehyde	5.99E-03	5.44E-03
Benzene	1.00E-02	9.09E-03
Benzo(a)anthracene	4.77E-06	4.32E-06
Benzo(e)pyrene	1.14E-05	1.03E-05
Benzo(g,h,i)perylene	1.96E-05	1.78E-05
Beryllium[2]	4.69E-04	4.26E-04
Cadmium[2]	1.51E-02	1.37E-02
Carbon Disulfide	9.27E-02	8.41E-02
Chromium[2, 3]	1.41E-02	1.28E-02
Cobalt[2]	2.97E-03	2.69E-03
Formaldehyde	6.89E-02	6.25E-02
Lead[2]	1.51E-02	1.37E-02
Manganese[2]	1.62E-02	1.47E-02
Mercury[2]	4.73E-03	4.29E-03
Naphthalene	1.10E-03	9.96E-04
Nickel	2.03E-02	1.84E-02
Selenium	1.51E-02	1.37E-02
Toluene	1.53E-03	1.39E-03
TOTAL	3.21E-01	2.91E-01

[1] Emission rates scaled by the ratio of VOC or PM emissions from Orlando Gasification Project EIS to the FutureGen Project. Orlando Project's VOC emissions were multiplied by a factor of 0.2727, based on 30 tpy (27.2 mtpy) VOC for the FutureGen Project divided by 110 tpy (99.8 mtpy) VOC for the Orlando Project. The Orlando Project's PM emissions were multiplied by a factor of 0.6894, based on 111 tpy (100.7 mtpy) PM for the FutureGen Project divided by 161 tpy (146.1 mtpy) PM for the Orlando Project.
[2] Compounds which are considered to be PM are in bold text.
[3] Conservatively assumed all chromium to be hexavalent.
Source: DOE, 2007.

Greenhouse Gases

GHGs include water vapor, CO_2, methane, NO_X, O_3, and several chlorofluorocarbons. Water vapor is a naturally occurring GHG and accounts for the largest percentage of the greenhouse effect. Next to water vapor, CO_2 is the second-most abundant GHG. Uncontrolled CO_2 emissions from power plants are a function of the energy output of the plants, the feedstock consumed and the power plants' net efficiency at converting the energy in the feedstock into other forms of energy (e.g., electricity, useable heat, and hydrogen gas). Because CO_2 is relatively stable in the atmosphere and essentially uniformly mixed throughout the troposphere and stratosphere, the climatic impact of CO_2 emissions does not depend upon the CO_2 source location on the earth (DOE, 2006a). Although regulatory agencies are taking actions to address GHG effects, there are currently no Texas or federal standards or regulations limiting CO_2 emissions and concentrations in the ambient air.

The proposed FutureGen Project would produce electricity and hydrogen fuel while emitting CO_2. DOE estimates that up to 0.28 million tons (0.25 million metric tons [MMT]) per year of CO_2 would be released into the atmosphere. A goal of the FutureGen Project is to capture and permanently sequester at least 90 percent of the CO_2 generated by the proposed power plant at a rate of 1.1 to 2.8 million tons (1.0 to 2.5 MMT) per year. By sequestering the CO_2 in geologic formations, the FutureGen Project aims to prove one technological option that could virtually eliminate future CO_2 emissions from similar coal-based power plants.

DOE's Energy Information Administration (EIA) report (DOE, 2006a) indicates that U.S. CO_2 emissions have grown by an average of 1.2 percent annually since 1990 and energy-related CO_2 emissions constitute as much as 83 percent of the total annual CO_2 emissions. DOE reviewed EPA's Emissions and Generation Resource Integrated Database (eGRID) to gain an understanding of the scale of the estimated CO_2 emissions from the proposed FutureGen Project compared to existing coal-fueled plants (EPA, 2006b). eGRID provides information on the air quality indicators for almost all of the electric power generated in the U.S.

The most recent data that can be accessed electronically is for the year 2000. A review of the database yielded the following information:

- In 2000, CO_2 emissions from all coal-fueled plants in Texas equaled 152.7 million tons (138.6 MMT). The average emissions rate of these coal plants was 2,292 pounds (1,039 kilograms) per megawatt-hour.
- Based on the average CO_2 emissions rates of nine representative coal plants in the size range of 153 to 508 MW, a conventional 275-MW coal-fueled power plant would emit 2.17 million tons (2.0 MMT) per year at an 85 percent capacity factor. This is in the same range as the estimated amount of CO_2 (1.1 to 2.8 million tons [1.0 to 2.5 MMT] per year) that would be sequestered by the proposed FutureGen Project.

Carbon capture and sequestration, if employed widely throughout the U.S. in future power plants or retrofitted existing power plants, could help reduce and possibly reverse the growth in national annual CO_2 emissions.

Acid Rain Requirements

Acid rain or acid deposition can occur when acid precursors (such as SO_2 and NO_X) are released into the atmosphere, and they react with O_2 and water to form acids (EPA, 2007). Acid rain can cause soil degradation; increase acidity of surface water bodies; and reduce growth, injure, or even cause death of forests and aquatic habitats. The Acid Rain Program, established under Title IV of the CAA, requires electric generating units greater than 25 MW to obtain a Phase II Acid Rain Permit and meet the objectives of the program, which are achieved through a system of marketable allowances. The FutureGen Project would be required to obtain a Phase II Acid Rain Permit and would operate in a manner that is consistent with EPA's overall efforts to reduce emissions of acid precursors. Continuous emissions monitoring for SO_2, NO_X, and CO_2, as well as volumetric gas flow and opacity, is a part of the acid rain regulations, which include requirements for monitoring, recordkeeping, and reporting. Upon facility startup, the FutureGen Project would need to obtain SO_2 allowances each year in an amount equal to the actual SO_2 emissions from the facility.

Odors

Operation of the FutureGen Project may cause noticeable odors. The chemical components that could cause noticeable odors are hydrogen sulfide (H_2S) and ammonia (NH_3). H_2S is formed during the gasification of coal containing sulfur. The FutureGen Project would use an acid gas removal system which would potentially remove 99 percent of the sulfur in the syngas stream, thereby reducing the amount of H_2S emitted and reducing the impact from H_2S odors. For the FutureGen Project, the fuel stock would be blown into the gasifier using O_2; therefore, the NH_3 in the syngas would be formed from fuel bound nitrogen. Additionally, NH_3 would used in a Selective Catalytic Reduction (SCR) system, a potential component of the FutureGen Project, which controls NO_X emissions. While the current FutureGen Project design configurations include an SCR system, current research activities sponsored under the DOE Fossil Energy Turbine Program are investigating technologies that can achieve the NO_X emissions goals through combustion modifications only, thereby eliminating the need for post-combustion SCR (DOE, 2006b). The Alliance estimates that approximately 1,333 tons (1,209 metric tons) of NH_3 per year would be consumed in the FutureGen SCR process (FG Alliance, 2006e).

Both gases would normally only be emitted as small quantities of fugitive emissions (e.g., through valve or pump packing); however, if an accidental large release were to occur, such as a pipe rupture in the Claus Unit (the sulfur recovery unit) or from on-site NH_3 storage, a substantial volume of odor would be noticeable beyond the plant boundary. Other odors could be emitted from activities such as equipment maintenance, coal storage, and coal handling; however, these potential odors should be limited to the immediate site area and should not affect off-site areas. Texas regulates H_2S odors in the ambient air (i.e., beyond the fence line) under nuisance laws. There are no odor regulations for NH_3. Depending on the wind direction, even small volumes of H_2S and NH_3 odor could be a nuisance for the residences within 1 mile (1.6 kilometers) of the proposed Odessa Power Plant Site.

Local Plume Visibility, Shadowing, Fogging, and Water Deposition

The proposed Odessa Power Plant would have two main sources of water vapor plumes: the gas turbine exhaust stack and the cooling towers. The height of the cooling tower is typically less than the height of the gas turbine exhaust stack, which for the FutureGen Project is estimated to be 250 feet (76.2 meters) (FG Alliance, 2006e). Because of a reduced height, the cooling tower presents a greater concern than the gas turbine exhaust stack for impacts such as ground-level fogging, water deposition, and solids deposition (including precipitates). Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Potential deposition of solids would occur because the Odessa Site proposes to use very saline process water, which may contain total dissolved solids and other PM (see Section 7.6.2.1). Effects from vapor plumes and deposition would be most pronounced within 300 feet (91.4 meters) of the vapor source and would decrease rapidly with distance from the source. Both cooling towers and the gas turbine exhaust plume may cause some concern for shadowing and aesthetics. Plume shadowing is generally a concern only when considering its effect on agriculture, which, due to the attenuation of sunlight by the plume's shadow, may reduce yield.

At the proposed Odessa Power Plant Site, nearby residences or agriculture could be impacted by fogging, water deposition, icing, or solid deposition under rare meteorological events; however, the impacts would be minimal. The greatest concern would be for traffic hazards created on FM 1601, which borders the southwest side of the proposed power plant property and I-20 also south of the site. Because the proposed Odessa Site is 600 acres (243 hectares) and the FutureGen Project footprint requires 60 acres (24 hectares), it is unlikely that the boundary of the power plant would be located within 300 feet (91.4 meters) of either road. If the location of the cooling tower and stack are more than 300 feet (91.4 meters) from the road, fog from the plant would dissipate and deposition of solids on the roads would not occur. Overall, solar loss, fogging, icing, or salt deposition from the proposed Odessa Power Plant would not interfere with quality of life in the area.

Effects of Economic Growth

Any air quality impacts due to residential growth would be in the form of automobile and residential (fuel combustion) emissions that would be dispersed over a large area. Commercial growth would be expected to occur at a gradual rate in the future, and any significant new source of emissions would be required to undergo permitting by the TCEQ. Impacts of economic growth on ambient air quality and PSD increments are unknown at this time. As part of the PSD permitting process, a determination of existing background concentrations of pollutants and additional modeling work would be required to estimate the maximum air pollutant concentrations that would be associated with the proposed Odessa Power Plant as a result of future economic growth. Section 7.19 provides detailed discussions of the impacts of economic growth from the FutureGen Project on the local resources.

Effects on Vegetation and Soils

Section 165 of the Clean Air Act requires preconstruction review of major emitting facilities to provide for the prevention of significant deterioration and charges federal managers with an affirmative responsibility to protect the AQRVs of Class I areas. Implementing regulations require an analysis of the potential impairment to visibility, soils, and vegetation. Subsequently, EPA developed "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals," which specifies the air pollutant screening concentrations for which adverse effects may occur for various vegetation species and soils, depending on their sensitivity to pollutants (EPA, 1980). While the Odessa Power Plant Site is more than 62 miles (100 kilometers) from a Class I area, there may be sensitive vegetation that could be affected by the plant's air emissions. Therefore, DOE compared the power plant's predicted maximum air pollutant emissions with the EPA screening concentrations (Table 7.2-7). Based on this comparison, the power plant's emissions would be well below applicable screening concentrations. Emissions also would be well below the secondary NAAQS criteria, which are established to prevent unacceptable effects to crops and vegetation, buildings and property, and ecosystems.

Table 7.2-7. Screening Analysis for Effects on Vegetation and Soils

Pollutant	Averaging Period [1]	Maximum Total Concentration[1,2] ($\mu g/m^3$)	Screening Concentrations[3] ($\mu g/m^3$)	Secondary NAAQS ($\mu g/m^3$)
SO_2	3-hour	564.33	786	1,300
NO_X	Annual	15.40	94	100

[1] Maximum concentration for shortest averaging period available.
[2] Maximum concentration including background data (see Table 7.2-5).
[3] The most conservative values were utilized, based on the highest vegetation sensitivity category.
$\mu g/m^3$ = micrograms per cubic meter.
Source: EPA, 1980.

Effects on Animals

The secondary NAAQS were established to set limits to protect public welfare, including protection against harm to animals. The maximum predicted concentrations from the FutureGen Project estimated from the upper-bound emissions of the FutureGen Project's estimate of maximum air emissions, in addition to the ambient background concentration, are below the secondary NAAQS for all pollutants.

Sequestration Site

The proposed CO_2 sequestration reservoir would be within bedrock layers located several thousand feet beneath the ground surface, far below the soil zone, water table aquifer, and overlying unsaturated zone (see Section 7.5 and Chapter 2). Because co-sequestration of H_2S and CO_2 is being considered as part of research and development activities for the FutureGen Project, minor air emissions of H_2S and CO_2 would occur during routine operations over the lifetime of the proposed injection period, which DOE expects to be between 20 to 30 years, and possibly up to 50 years. Sources of emissions during sequestration site operations could include:

- Injection wells, monitoring wells, and other wells; and
- Aboveground valves, piping, and well heads that comprise the transmission system.

Injection Wells, Monitoring Wells, and Other Wells

Wells provide the greatest opportunity for the escape of sequestered fluids. The injection well would extend into a target injection zone, with steel pipe inserted its full length and cemented into the bore hole to prevent upward escape of sequestered fluid around the outside of the pipe. Within the steel casing, tubing is installed from the well head down to the top of the injection zone, with the annular space sealed against the casing with a packer. The annular space is filled with heavy liquid, such as brine, to help control any accidental leakage into the annular space. This tubing could be removed and replaced should it become corroded or damaged over time. The technology is standard for constructing a well of this type and no measurable fugitive emissions from the well would be expected. Monitoring wells would be constructed in a similar manner as the injection wells, so they would be secure and could also be monitored for leaks and be repaired as needed. There should be no contact by CO_2 with the soils. The sequestration reservoir would be tested for assurance that no leak paths exist prior to project operations. Pre-existing oils wells that are not related to the FutureGen Project present a greater risk of leakage. If Odessa is selected to host the FutureGen Project, DOE anticipates that some means of identifying the locations of pre-existing wells over the plume and monitoring these wells for leakage would be employed at levels commensurate with the risks posed by the pre-existing wells. Wells that provide leakage points would be repaired or plugged to prevent leakage and emissions. All exploratory wells would be properly plugged with concrete and abandoned before operation of the sequestration facility if they are not used as injection wells or monitoring wells, preventing potential fugitive emissions from the sequestered CO_2.

Aboveground Valves, Piping, and Well Heads

The supercritical CO_2 that would be piped from the plant to the injection wells would enter each well through a series of valves attached to the underground steel pipe to ensure proper direction and control of flow. These valves would be above ground and easily accessible to workers for controlling well operation and conducting well maintenance. There would typically be four valves with flanged fittings for each well. Fugitive emissions from each valve were estimated based on a California South Coast Air Quality Management District (SCAQMD, 2003) valve emission factor of 0.0013 pound (0.6 gram) per hour for non-methane organic compounds. In addition to the expected fugitive emissions typical of gate valves, periodic well inspections, testing, and maintenance would be another source of emissions. The well valves would be periodically manipulated to allow insertion of inspection or survey tools to test the integrity of the system or to repair or replace system components. During each of those instances, some amount of CO_2 gas would be vented to the atmosphere.

The annual emissions estimate is based on the 10 injection wells required, accounting for the tubing volume and the number of evacuations that would occur each time a valve is opened. DOE estimates annual emissions of approximately 58 tons (52.6 metric tons) of CO_2. A number of tracers would be used to track the fate and transport of the injected CO_2. Descriptions of these compounds are provided in Section 7.16. Fugitive emissions from valves, piping, and well heads may also contain very minute amounts of these tracers.

Utility Corridors

There are no planned operational activities along the proposed utility corridors that would cause air emissions impacts. Routine maintenance along the corridors would not result in fugitive emissions. However, if repairs were required and an underground line had to be excavated, there would be localized and temporary soil dust releases during the excavation process, which would be minimized through BMPs.

Transportation Corridors

During operation of the power plant, transportation-related air emissions would be produced from train and truck shipments to and from the plant and also from employee automobiles. Major pollutants emitted from automobiles, trucks, and trains include hydrocarbons (HC), NO_X, CO, PM, and CO_2. Trucks emit more HC and CO than trains on a brake horsepower per hour basis although they emit less NO_x and PM on the same basis. The higher values for HC and CO are caused by the differences in driving cycle—the truck driving cycle is much more dynamic than that of a train, which has more constant speed operations (Taylor, 2001). The FutureGen Project would aim to utilize train shipments for materials and waste to the greatest extent possible to increase transportation efficiency and reduce shipping costs but to also minimize related air pollution.

7.20 ENVIRONMENTAL JUSTICE

Specific populations identified under Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 *Federal Register* 7629), are examined here along with the potential of effects on these populations from construction and operation of the proposed FutureGen facility. In the context of this EIS, Environmental Justice refers specifically to the potential for minority and low-income populations to bear a disproportionate share of high and adverse environmental impacts from activities within the project area and the municipalities nearest to the proposed Odessa Power Plant Site, sequestration site, and related corridors.

The U.S. Department of Energy defines "**Environmental Justice**" as: The fair treatment and meaningful involvement of all people—regardless of race, ethnicity, and income or education level—in environmental decision making. Environmental Justice programs promote the protection of human health and the environment, empowerment via public participation, and the dissemination of relevant information to inform and educate affected communities. DOE Environmental Justice programs are designed to build and sustain community capacity for meaningful participation for all stakeholders in DOE host communities (DOE, 2006).

7.20.1 INTRODUCTION

Executive Order 12898 directs federal agencies to achieve Environmental Justice as part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations. Minorities are defined as individuals who are members of the following population groups: Native American or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. To classify as a minority population, an area must have a population of these groups that exceeds 50 percent of the total population, or the minority population percentage of the affected area should be meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis (59 *Federal Register* 7629).

The Council on Environmental Quality (CEQ) guidance recommends that low-income populations in an affected area be identified using data on income and poverty from the U.S. Census Bureau (CEQ, 1997). Low-income populations are groups with an annual income below the poverty threshold, which was $19,971 for a family of four for calendar year 2006.

7.20.1.1 Region of Influence

The ROI includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, reservoir, and utility and transportation corridors. The proposed sequestration site is located approximately 58 miles (93.3 kilometers) south of the proposed plant site. The ROI includes the counties of Andrews, Crane, Ector, Martin, Midland, Pecos, Upton, Ward and Winkler. Section 7.19.1.1 describes the rationale for including these counties in the ROI.

7.20.1.2 Method of Analysis

DOE collected demographic information from the U.S. Census Bureau 2000 census to characterize low-income and minority populations within 50 miles (80.5 kilometers) of the proposed Odessa Power Plant Site and Sequestration Site. Census data are compiled at various levels corresponding to geographic areas and include, in order of decreasing size, states, counties, census tracts, block groups, and blocks. In order to accurately characterize and locate minority and low-income populations, DOE followed CEQ Guidance (CEQ, 1997) to determine the minority and low-income characteristics using U.S., State of Texas, regional (defined by the 9-county ROI) and individual county data. The data presented in Table 7.20-1 show the overall composition and makeup of both minority and non-minority populations, and low-income populations within the ROI. Where available, DOE obtained U.S. Census data for local jurisdictions (i.e., towns and cities) to further identify the presence of minority or low-income populations. DOE used Census block group data (FG Alliance, 2006d) to examine the distribution of minority and low-income populations within the ROI.

DOE used potential environmental, socioeconomic, and health impacts identified in other sections of this EIS to assess potential impacts to Environmental Justice that could occur with the proposed construction and operation of the FutureGen Project.

DOE assessed the potential for impacts based on the following criteria:

- A significant and disproportionately high and adverse effect on a minority population; or
- A significant and disproportionately high and adverse effect on a low-income population.

Table 7.20-1. County, Regional and National Population and Low-income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-income (percent)
Counties Wholly Located Within the ROI								
Crane	3,996	73.7	2.9	1.0	0.4	0.0	43.9	13.4
Ector	121,123	73.7	4.6	0.8	0.6	<0.1	42.4	18.7
Andrews	13,004	77.1	1.6	0.9	0.7	<0.1	40.0	16.4
Winkler	7,173	74.8	1.9	0.4	0.2	0.0	44.0	18.7
Counties Partially Located Within the ROI								
Martin	4,746	79.0	1.6	0.8	0.2	0.0	40.6	18.7
Midland	116,009	77.3	7.0	0.6	0.9	<0.1	29.0	12.9
Pecos	16,809	75.8	4.4	0.4	0.5	<0.1	61.1	20.4
Upton	3,404	77.8	1.6	1.2	<0.1	0.1	42.6	19.9
Ward	10,909	79.8	4.6	0.7	0.3	<0.1	42.0	17.9
Regional and National Statistics								
9-County ROI	297,173	76.6	3.4	0.8	0.5	<0.1	42.8	17.4
Texas	20,851,820	71.0	11.5	0.6	2.7	0.1	32.0	15.4
U.S.	281,421,906	75.1	12.3	0.9	3.6	0.1	12.5	12.4

[1] Some of the minority population counted themselves as more than one ethnic background, thus the counts do not add up to 100 percent.
Source: USCB, 2006.

7.20.2 AFFECTED ENVIRONMENT

7.20.2.1 Minority Populations

Table 7.20-1 compares the minority percentage and low-income percentage of county populations within the ROI with those of Texas and the nation. The 2000 Census revealed a more diverse population in Texas compared to the 1990 Census, especially regarding the Hispanic population. In 2000, 14.9 percent of Texas residents identified themselves as non-white (excluding Hispanic), down from 15.9 percent in 1990. During that same period, however, the percentage of population identifying themselves as being of Hispanic origin increased from 28.6 percent to 32 percent. With the exception of populations of Hispanic origin, the Texas population is less diverse than that of the nation.

Populations within the ROI have non-minority populations (white) as the highest percentage (76.6 percent) compared to state (71.0 percent) and U.S. (75.1 percent) percentages; however, the ROI populations also have a greater percentage of individuals of Hispanic origin (42.8 percent regional versus 32.0 percent state and 12.5 percent for the nation). The overall population in the area surrounding the proposed Odessa Power Plant Site and associated utility and transportation corridors (located in Ector County) identifies themselves as 73.7 percent white with 42.4 percent of the population being of Hispanic or Latino origin of any race. The overall population in the area surrounding the proposed sequestration site and reservoir (located in Pecos County) identifies themselves as 75.8 percent white with 61.1 percent of the population being of Hispanic or Latino origin of any race.

The closest of these populations within the ROI of the proposed Odessa Power Plant Site occur approximately 10 miles (16 kilometers) to the east along the I-20 corridor and include the town of West Odessa (2 percent minority with an additional 48 percent of Hispanic origin) (USCB, 2006). Other areas of higher minority percentages include the community of Odessa (7.2 percent minority with an additional 48 percent of Hispanic origin), located approximately 15 miles (24 kilometers) to the northeast of the proposed power plant site.

Although the majority of the population within the ROI identify itself as white, those identifying themselves as being of Hispanic or Latino origin are at a percentage greater than the state and national averages, and in some instances the overall minority population (including other minority groups) is equal to or greater than 50 percent. Due to the high percentage of individuals being of Hispanic or Latino origin, a “minority population” as characterized by CEQ does exist within the ROI area of the proposed Odessa Power Plant and Sequestration Sites.

7.20.2.2 Low-Income Populations

Most of the by-county percentages of low-income populations for individuals exceed the state percentage (15.4 percent) and all of them exceed the national average (12.4 percent) (Table 7.20-1). The majority (82.6 percent) of the ROI is at or above the poverty rate (annual household income above $19,971).

7.20.3 IMPACTS

This section discusses the potential for disproportionately high and adverse impacts on minority and low-income populations associated with the proposed FutureGen Project. The CEQ’s December 1997 Environmental Justice Guidance (CEQ, 1997) provides guidelines regarding whether human health effects on minority populations are disproportionately high and adverse. CEQ advised agencies to consider the following three factors to the extent practicable:

- Whether the health effects, which may be measured in risks and rates, are significant (as defined by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.
- Whether the risk or rate of hazard exposure by a minority population, low-income population, or Native American tribe to an environmental hazard is significant (as defined by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority population, low-income population, or Native American tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Based on the definitions in Section 7.20.1, the criteria outlined above, and the findings regarding environmental and socioeconomic impacts throughout this EIS, the analysis for environmental justice in this EIS was performed in the following sequence:

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a minority population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 7.20.1, was determined.

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a low-income population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 7.20.1, was determined.

Using the impacts analyzed in Section 7.17, the potential for adverse health risks in a wider radius from project sites and corridors was compared with the potential adverse health risks that could affect a minority population or low-income population at a disproportionately high and adverse rate.

Using the impacts analyzed in Section 7.17, the potential for health effects in a minority population or low-income population affected by cumulative or multiple adverse exposures to environmental hazards was determined.

7.20.3.1 Construction Impacts

As discussed in Section 7.20.2.1, areas of minority and low income population percentages, are located within the ROI. The proposed power plant would be located within Ector County, which has 26.3 percent of the population identifying itself as minority (73.7 percent is white), and 42.4 percent of the population is of Hispanic or Latino origin of any race. Due to some of the minority population counting themselves as belonging to more than one ethnic background, DOE calculated the percentages by subtracting the white population Census numbers from 100 percent (e.g., 100 percent – 73.6 percent = 26.3 percent for Ector County). The proposed sequestration site would be located in Pecos County which has 24.2 percent of the population identifying itself as minority and 75.8 percent white. Sixty-one percent of the population reports being of Hispanic or Latino origin of any race. No disproportionately high and adverse impacts are anticipated to minority populations. Construction activities may cause temporary air quality, water quality, transportation and noise impacts to the general population (see Sections 7.2, 7.7, 7.13, and 7.14).

Ector County has a higher percentage of low-income populations (18.7 percent) in comparison to the state (15.4 percent) and national (12.4 percent) percentages. The proposed sequestration site would be located in Pecos County, which a low income population at 20.4 percent and it is also below the respective state and national percentages. All of these percentages, however, are far below the 50 percent threshold as defined in EO 12898. No disproportionately high and adverse impacts are anticipated to low-income populations. Construction activities may cause temporary air quality, water quality, transportation and noise impacts to the general population (see Sections 7.2, 7.7, 7.13, and 7.14). Short-term beneficial impacts may include an increase in employment opportunities and potentially higher wages, or supplemental income through jobs created during facility construction.

Low-income populations are located within the ROI. Both low-income populations and non low-income populations located immediately adjacent to the plant, the sequestration site, and utility and transportation corridors may encounter temporary air quality, water quality, transportation, and noise issues during the construction phase. Any impacts related to construction that would affect the health or environment of these areas of low-income populations would be temporary and are not considered disproportionately high and adverse with the general surrounding populations not identified as low-income.

7.20.3.2 Operational Impacts

Aesthetics and noise impacts (see Sections 7.12 and 7.14) resulting from operations were determined not to have a disproportionately high and adverse effect to minority or low-income populations. A potential risk to health was determined to be from a catastrophic accident, terrorism, or sabotage, which cannot be predicted (Section 7.17). This potential would be uniform across the general population, and therefore, no disproportionately high and adverse impacts are anticipated.

Long-term beneficial impacts would be anticipated due to an increase in employment opportunities and potentially higher wage jobs associated with facility operation.

INTENTIONALLY LEFT BLANK

7.21 REFERENCES

7.1 Chapter Overview

Energy Information Administration (EIA). 2000. ***Energy Policy Act Transportation Rate Study: Final Report on Coal Transportation.*** Accessed January 1, 2007 at ftp://ftp.eia.doe.gov/pub/pdf/coal.nuclear/059700.pdf

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Odessa FutureGen Site, Ector County, Texas." Austin, TX.

7.2 Air Quality

40 CFR 6. "Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 50. "National Primary and Secondary Ambient Air Quality Standards." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 52.21. "Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 93. "Determining Conformity of Federal Actions to State or Federal Implementation Plans." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FG Alliance. 2007. "Initial Conceptual Design Report."

South Coast Air Quality Management District (SCAQMD). 2003. *Guidelines for Fugitive Emissions Calculations*. Accessed January 3, 2007 at www.ecotek.com/aqmd/2006/forms_and_instructions_pdf/2003_fugitive_guidelines.pdf

Taylor, G. W. R. 2001. *Trucks and Air Emissions, Final Report*. Prepared for Transportation Systems Branch, Air Pollution Prevention, Environmental Protection Service, Environment Canada. March 2001. Accessed April 9, 2007 at http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/trucks/trucktoc.htm (last updated December 11, 2002).

Texas Commission on Environmental Quality (TCEQ). 2006. *Mercury in Texas: Background, Federal Rules, Control Technologies, and Fiscal Implications; Implementation of Section 2, HB 2481 (79^{th} Legislature)—A Report to the Texas Legislature*. Accessed April 3, 2007 at http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/sfr/085.pdf

U.S. Department of Energy (DOE). 2006a. "Emissions of Greenhouse Gases in the United States 2005." Washington, D.C.

DOE. 2006b. *The Turbines of Tomorrow*. Accessed January 5, 2007 at http://www.fe.doe.gov/programs/powersystems/turbines/index.html (last updated November 9, 2006).

DOE. 2007. *"Final Environmental Impact Statement for the Orlando Gasification Project, January 2007."* Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1980. "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals." Washington, DC.

EPA. 1990. "New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting." Draft, October 1990. Washington, DC.

EPA. 2005. "Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations." Washington, DC.

EPA. 2006a. *EnviroMapper for Envirofacts (Query Odessa, Texas)*. Accessed December 28, 2006 at http://www.epa.gov/enviro/emef (last updated March 30, 2006).

EPA. 2006b. *eGRID – Emissions and Generation Resource Integrated Database (eGRID)*. Accessed December 1, 2006 at http://www.epa.gov/cleanenergy/egrid/index.htm (last updated October 30, 2006).

EPA. 2007. *Acid Rain Program*. Accessed April 27, 2007 at http://www.epa.gov/airmarkets/progsregs/arp/index.html (last updated February 2, 2007).

U.S. Fish and Wildlife Service (FWS). 2007. *Permit Application, PSD Overview*. Accessed January 27, 2007 at http://www.fws.gov/refuges/AirQuality/permits.html (last updated August 14, 2006).

7.3 Climate and Meteorology

Blue Planet Biomes. 2006. *World Climates*. Accessed December 1, 2006 at http://www.blueplanetbiomes.org/climate.htm (last updated November 7, 2006).

Climate-Zone. Undated. *Climate-Zone Website*. Accessed March 13, 2007 at http://www.climate-zone.com/

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

National Oceanic and Atmospheric Administration (NOAA). 2006. *Storm Events*. Accessed December 2, 2006 at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms (updated daily).

Natural Resources Conservation Service (NRCS). 2006. *Soil Data Mart*. Accessed October 19, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

The Tornado Project. 1999. *The Fujita Scale*. Accessed December 1, 2006 at http://www.tornadoproject.com/fscale/fscale.htm

7.4 Geology

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Louie, J. 1996. *What is Richter Magnitude?* Accessed October 5, 2006 at http://www.seismo.unr.edu/ftp/pub/louie/class/100/magnitude.html (last updated October 9, 1996).

U.S. Geological Survey (USGS). 2006. *NEIC: Earthquake Search Results. U. S. Geological Survey Earthquake Database*. Accessed October 6, 2006 at http://eqint.cr.usgs.gov/neic/cgi-bin/epic/epic.cgi?SEARCHMETHOD=3&SLAT2=0.0&SLAT1=0.0&SLON2=0.0&SLON1=0.0&FILEFORMAT=4&SEARCHRANGE=HH&CLAT=39.737&CLON=-88.3&CRAD=193&SUBMIT=Submit+Search&SYEAR=&SMONTH=&SDAY=&EYEAR=&EMONTH=&EDAY=&LMAG=&UMAG=&NDEP1=&NDEP2=&IO1=&IO2=

University of Texas at Austin (UTA). 2006. *Introduction: Earthquakes in Texas*. Accessed December 5, 2006 at http://www.ig.utexas.edu/research/projects/eq/compendium/earthquakes.htm?PHPSESSID=def1b9#West%20Texas (last updated February 1, 2002).

7.5 Physiography and Soils

Damen, K., A. Faaij and W. Turkenburg. 2003. “Health, Safety and Environmental Risks of Underground CO_2 Sequestration.” Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

Horizon Environmental Services, Inc. 2006. “Phase I Environmental Site Assessment, Odessa FutureGen Site, Ector County, Texas.” Austin, TX.

University of Texas at Austin (UTA). 2006. *“Physiography of Texas.”* Accessed October 9, 2006 at http://www.lib.utexas.edu/geo/physiography.html (last updated July 24, 2006).

U.S. Geological Survey (USGS). 2006. *High Plains Regional Ground-Water Study*. Accessed October 10, 2006 at http://co.water.usgs.gov/nawqa/hpgw/factsheets/DENNEHYFS1.html (last updated July 19, 2006).

7.6 Groundwater

30 TAC 331. “Underground Injection Control.” *Texas Administrative Code*.

Caldwell, C. 2006. Personal communication. Email from Craig Caldwell, Texas Water Development Board, Austin, TX, to Lisa Guizar, R. W. Harden & Associates, Inc. Austin, TX. August 25, 2006.

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Texas Board of Water Engineers (TBWE). 1937. "Ector County, Texas; Records of Wells, Driller's Logs, and Water Analysis and Map Showing Location of Wells." Austin, TX.

TBWE. 1952. "Bulletin 5210: Ground-Water Resources of Ector County." Austin, TX.

Texas Commission on Environmental Quality (TCEQ). 2006. *Joint Groundwater Monitoring and Contamination Report*, 2005. *SFR 056/05*. Accessed December 17, 2006 at http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/sfr/056_05_index.html (last updated July 20, 2006).

Texas Water Development Board (TWDB). 1995. "Report 345: Aquifers of Texas." Austin, TX.

TWDB. 1997. *1997 State Water Plan*. Accessed January 23, 2007 at http://rio.twdb.state.tx.us/publications/reports/State_Water_Plan/1997/Ch_3.2_Regions.pdf

TWDB. 2001. "Report 356: Aquifers of West Texas." Austin, TX.

TWDB. 2003. "Report 359: The Groundwater Resources of the Dockum Aquifer in Texas." Austin, TX.

TWDB. 2006a. *Regional Water Plan Files*. Accessed September 4, 2006 at http://www.twdb.state.tx.us/RWPG/main-docs/regional-plans-index.htm

TWDB. 2006b. *2007 State Water Plan*. Accessed January 23, 2007 at http://rio.twdb.state.tx.us/publications/reports/State_Water_Plan/2007/2007StateWaterPlan/2007StateWaterPlan.htm

TWDB. 2006c. *Well Location Data and GIS Data Layers*. Accessed September 1 through October 11, 2006 at http://www.twdb.state.tx.us/ mapping/gisdata.asp

Tsang, C., S. M. Benson, B. Kobelski and R. Smith. 2001. *Scientific Considerations Related to Regulation. Development for CO_2 Sequestration in Brine Formations. First National Conference on Carbon Sequestration. Conference Proceedings 2001*. Accessed March 1, 2007 at www.netl.doe.gov/publications/proceedings/01/carbon_seq/p33.pdf

U.S. Environmental Protection Agency (EPA). 2006a. *Designated Sole Source Aquifers in EPA Region VI*. Accessed December 15, 2006 at http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg6.pdf

EPA. 2006b. *Underground Source of Drinking Water*. Accessed March 11, 2007 at http://www.epa.gov/safewater/uic/usdw.html (last updated February 28, 2006).

EPA 2007. *Using the Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects. UIC Program Guidance (UICP #83), Underground Injection Control Program, Geologic Sequestration of Carbon Dioxide*. Accessed March 20, 2007 at http://www.epa.gov/safewater/uic/index.html (last updated March 2, 2007).

7.7 Surface Water

Benson, S., R. Hepple, J. Apps, C. Tsang and M. Lippman. 2002. "Lessons Learned from Natural and Industrial Analogues for Storage of Carbon Dioxide in Deep Gas Formations." Earth Sciences Division, E.O. Lawrence Berkeley National Laboratory, Berkeley, CA.

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

Federal Emergency Management Agency (FEMA). 1977. "Flood Insurance Rate Map (FIRM) Panel Nos. 4812490004A and 4812490005A, Ector County, Texas." Jessup, MD.

FEMA. 1991. "Flood Insurance Rate Map (FIRM) Panel Nos. 48135C0015C, 48135C0020C, 48135C0050C, 48135C0055C, 48135C0090C, 48135C0125C, 48135C0150C, 48135C0180C, 48135C0185C, 48135C0190C, 48135C0215C, 48135C0225C, 48135C0230C, and 48135C0250C, Ector County, Texas." Jessup, MD.

FEMA. 1998. "Flood Insurance Rate Map (FIRM) Panel Nos. 48135C0160D and 48135C0195D, Ector County, Texas." Jessup, MD.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

Holloway, S. 1996. "The Underground Disposal of Carbon Dioxide." British Geological Survey, Keyworth, Nottingham, UK.

Natural Resources Conservation Service (NRCS). 2006. *Soil Data Mart*. Accessed October 19, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

Reichle, D., J. Houghton, B. Kane and J. Ekmann. 1999. "Carbon Sequestration Research and Development." U.S. Department of Energy, Office of Science, Office of Fossil Energy, Oak Ridge, TN.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

Texas Commission on Environmental Quality (TCEQ). 2006a. *Rio Grande Basin (23) and Portion of Bays and Estuaries (24)*. Accessed October 19, 2006 at http://www.tceq.state.tx.us/comm_exec/forms_pubs/pubs/gi/gi-316/basin23-RioGrande-PBE_234924.pdf (last updated May 8, 2006).

TCEQ. 2006b. *Texas Surface Water Quality Viewer 2002*. Accessed October 19, 2006 at http://www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/viewer/viewer.html (last updated May 19, 2006).

TCEQ. 2006c. *Class III Injection Wells Regulated By the TCEQ: Technical Guideline III: Fluid Handling*. Accessed January 24, 2007 at http://www.tceq.state.tx.us/permitting/waste_permits/uic_permits/UIC_Guidance_Class_3.html (last updated June 13, 2006).

7.8 Wetlands and Floodplains

10 CFR 1022. "Compliance with Floodplain and Wetland Environmental Review Requirements." U.S. Department of Energy, *Code of Federal Regulations*.

42 *Federal Register* 26951. "Executive Order 11988 – Floodplain Management." Federal Register. May 24, 1977.

42 *Federal Register* 26961. "Executive Order 11990 – Protection of Wetlands." Federal Register. May 24, 1977.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States." U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Emergency Management Agency (FEMA). 1977. "Flood Insurance Rate Map (FIRM) Panel Nos. 4812490004A and 4812490005A, Ector County, Texas." Jessup, MD.

FEMA. 1991. "Flood Insurance Rate Map (FIRM) Panel Nos. 48135C0015C, 48135C0020C, 48135C0050C, 48135C0055C, 48135C0090C, 48135C0125C, 48135C0150C, 48135C0180C, 48135C0185C, 48135C0190C, 48135C0215C, 48135C0225C, 48135C0230C, and 48135C0250C, Ector County, Texas." Jessup, MD.

FEMA. 1998. "Flood Insurance Rate Map (FIRM) Panel Nos. 48135C0160D and 48135C0195D, Ector County, Texas." Jessup, MD.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

Natural Resources Conservation Service (NRCS). 2006. *Soil Data Mart*. Accessed October 19, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

U.S. Fish and Wildlife Service (FWS). 1994. "National Wetlands Inventory Maps, for Amburgey Ranch, Andrew, China Ranch, Clabber Hill Ranch, Cowden Place, Douro, East Mesa, East Mesa SW, Florey, Goldsmith, Kermit, Kermit NW, Metz, Monohans, North Cowden, Panther Bluff, Penwell, Pyote East, Red Lakes, Saddle Butte, Seminole SE, Vesrue, and Wheeler Ranch, Texas, quadrangles." Washington, DC.

7.9 Biological Resources

Avian Power Line Interaction Committee (APLIC). Edison Electric Institute and Raptor Research Foundation. 1996. "Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996." Washington, DC.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srcc/index.htm (last updated January 16, 2006).

Texas Parks and Wildlife Department (TPWD). 2006. *Rare, Threatened, and Endangered Species of Texas by County*. Accessed August 28, 2006 at http://gis.tpwd.state.tx.us/ TpwEndangeredSpecies/DesktopDefault.aspx

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

7.10 Cultural Resources

16 USC 470. "National Historic Preservation Act of 1966 as amended through 1992." *United States Code*.

36 CFR 60. "National Register of Historic Places." U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 62. "National Natural Landmarks Program." U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 800. "Protection of Historic Properties." U.S. Department of the Interior, Advisory Council on Historic Preservation, *Code of Federal Regulations*.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

King, T. F. 1998. "Cultural Resource Laws and Practice." AltaMira Press, Walnut Creek, CA.

Mercado-Allinger, P. A., N. A. Kenmotsu and T. K. Perttula. 1996. "Archeology in the Central and Southern Planning Region, Texas: A Planning Document." Texas Historical Commission, Austin, TX.

Miller, M. and S. W. Yost. 2006. "Cultural Resource Overview of Proposed FutureGen Odessa, Ector County, Texas." El Paso, TX.

National Park Service (NPS). 2004. *National Natural Landmarks, NNL G*uide. Accessed December 2, 2006 at http://www.nature.nps.gov/nnl/Registry/USA_Map/index.cfm (last updated February 5, 2004).

NPS. 2006a. *National Register Information System*. Accessed December 3, 2006 at http://www.cr.nps.gov/nr/research/nris.htm (last updated August 18, 2006).

NPS. 2006b. *Native American Consultation Database*. Accessed December 6, 2006 at http://home.nps.gov/nacd/ (last updated March 31, 2006).

Patterson, P.E. 2001. "Native American Territorial Ranges in the Central Region of Texas: A Report Prepared to Support NAGPRA Consultation." Fort Worth, TX.

Texas Historical Commission (THC). 2006. *Texas Archaeological Sites Atlas*. Accessed December 2, 2006 at http://nueces.thc.state.tx.us/

The University of Texas at Austin (UTA). 1970. "Geologic Atlas of Texas, Waco Sheet." Austin, TX.

UTA. 1996. "Physiographic Map of Texas." Austin, TX.

7.11 Land Use

14 CFR 77. "Objects Affecting Navigable Airspace." Federal Aviation Administration, *Code of Federal Regulations*.

Andrews County. 2006. *Andrews County Chamber of Commerce Website*. Accessed December 2, 2006 at http://www.andrewstx.com (as retrieved from archives, November 6, 2006).

De Figueiredo, M. A., D. M. Reiner and H. J. Herzog. 2005. "Framing the Long-Term In Situ Liability Issue for Geologic Carbon Storage in the United States." *Mitigation and Adaptation Strategies for Global Change* 10 (4): 647-657.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

Haner, J. 2006. Personal communication. Discussions and On-Site Meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Gary Haner, P.E., Engineered Pipeline Systems, Inc., Odessa, Texas. November 29, 2006.

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Odessa FutureGen Site, Ector County, Texas." Austin, TX.

National Resources Conservation Service (NRCS). 2000. *National Resource Inventory*. *Illinois Highlights. 1997 National Resources Inventory*. Accessed October 16, 2006 at http://www.il.nrcs.usda.gov/technical/nri/highlights.html (last updated December, 2000).

NRCS. 2006. *Soil Data Mart*. Accessed August 24, 2006 at http://soildatamart.nrcs.usda.gov (last updated July 15, 2006).

Texas Groundwater Protection Council (TGPC). 2005. "Joint Groundwater Monitoring and Contamination Report – 2005." Austin, TX.

Vest, G. 2006. Personal communication. Discussions and On-Site meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Gary Vest, Director of Business Retention and Expansion, Odessa Chamber of Commerce, Odessa, Texas. November 29, 2006.

7.12 Aesthetics

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

Haner, G. 2006. Personal communication. Discussions and On-Site Meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Gary Haner, P.E., Engineered Pipeline Systems, Inc., Odessa, Texas. November 29, 2006.

Herrera, T. 2006. Personal communication. E-mail from Theresa Herrera, Bureau of Land Management, U.S. Department of the Interior, Santa Fe, NM, to Abby Peyton, Horizon Environmental Services, Inc., Austin, TX. September 6, 2006.

Horizon Environmental Services, Inc. 2006. "Phase I Environmental Site Assessment, Odessa FutureGen Site, Ector County, Texas." Austin, TX.

Smith, H. 2006. Personal communication. Telephone conversation between Hoxie Smith, Director of Midland College Petroleum Professional Development Center, Midland, Texas, and Marie J. Archambeault, Horizon Environmental Services, Inc., Austin, TX. September 6, 2006.

Texas Legislation Online (TLO). 2006. *Texas Statutes.* Accessed August 24, 2006 at http://tlo2.tlc.state.tx.us/statutes/statutes.html (last updated May 16, 2006).

Texas Parks and Wildlife Department (TPWD). 2006. *State Parks and Destinations*. Accessed August 24, 2006 at http://www.tpwd.state.tx.us/spdest/

Texas State Historical Association (TSHA). 2001. *The Handbook of Texas Online* **-** *Penwell, Texas*. Accessed September 6, 2006 at http://www.tsha.utexas.edu/handbook/online/articles/PP/hnp16.html (last updated June 6, 2001).

U.S. Department of Agriculture, Farm Service Agency, Aerial Photography Field Office (USDA-FSA-APFO). 2004. "Digital Aerial Photography: Ector county, Texas."

U.S. Department of Energy (DOE). 2006a. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

DOE. 2006b. *FutureGen* **-** *Tomorrow's Pollution-Free Power Plant*. Accessed December 28, 2006 at http://www.fossil.energy.gov/programs/powersystems/futuregen/ (last updated December 14, 2006).

7.13 Transportation and Traffic

American Association of State Highway and Transportation Officials (AASHTO). 2004. "A Policy on Geometric Design of Highways and Streets." Washington, DC.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

Haner, J. 2006. Personal communication. Discussions and On-Site Meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Gary Haner, P.E., Engineered Pipeline Systems, Inc., Odessa, Texas. November 29, 2006.

Texas Department of Transportation (TxDOT). 2005. *Texas Rail System Plan*. Accessed December 11, 2006 at http://www.txdot.gov/services/transportation_planning_and_programming/rail_plan.htm

TxDOT. 2006a. *TxDOT Transportation Studies*. Accessed November 17, 2006 at http://www.dot.state.tx.us/mis/mis.htm

TxDOT. 2006b. *Texas Highway Designation Files*. Accessed November 17, 2006 at http://www.dot.state.tx.us/tpp/search/query.htm

TxDOT. 2006c. *Roadway Design Manual*. Accessed May 1, 2007 at ftp://ftp.dot.state.tx.us/pub/txdot-info/gsd/manuals/rdw.pdf

Transportation Research Board (TRB). 2000. "Highway Capacity Manual." Washington, DC.

Vest, G. 2006. Personal communication. Discussions and On-Site meeting between Peter Sparhawk, The Louis Berger Group, Inc., and Gary Vest, Director of Business Retention and Expansion, Odessa Chamber of Commerce, Odessa, Texas. November 29, 2006.

Walden, S., 2006. Personal communication. Email from Steve Walden, Steve Walden Consulting, Austin, TX, to Lucy Schwartz, Battelle Memorial Institute, Aberdeen, MD. December 14, 2006.

7.14 Noise

Barksdale. 1991. "The Aggregate Handbook." National Stone Association. Washington, DC.

Bolt, Beranek, and Newman. 1971. "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances." Prepared for the U.S. Environmental Protection Agency, Washington, DC.

Bolt, Beranek, and Newman. 1973. "Fundamentals of Abatement and Highway." Federal Highway Administration.

Bolt, Beranek and Newman. 1984. "Electric Power Plant Environmental Noise Guide. Volume 1, 2nd edition." Prepared for Edison Electric Institute.

Cowan, J. P. 1994. "Handbook of Environmental Acoustics." John Wiley & Sons, Inc.

Federal Highway Administration (FHWA). 1992. ***Highway Traffic Noise***. Accessed December 27, 2006 at http://www.fhwa.dot.gov/environment/htnoise.htm (last updated December 14, 2006).

FHWA. 1998. "FHWA Traffic Noise Model, Technical Manual (TNM Lookup Table)." Washington, DC.

Federal Transit Administration (FTA). 2006. "Transit Noise and Vibration Impact Assessment." Harris Miller Miller and Hanson, Inc. Washington, DC.

FutureGen Alliance (FG Alliance). 2006d. "Odessa Site Environmental Information Volume."

New York State Department of Environmental Conservation (NYSDEC). 2000. "Assessing and Mitigating Noise Impacts." Albany, NY.

U.S. Department of Energy (DOE). 2006. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

VIBCO. Undated-a. "High Frequency Silent Models." Wyoming, RI.

VIBCO. Undated-b. "Silent Pneumatic CC Series." Wyoming, RI.

Walden, S., 2006. Personal communication. Email from Steve Walden, Steve Walden Consulting, Austin, TX, to Lucy Schwartz, Battelle Memorial Institute, Aberdeen, MD. December 14, 2006.

Western Safety Products. 2007. *Aldon Rail Safety Page 6.* Accessed April 3, 2007 at http://www.westernsafety.com/aldon/aldonpage6.html (last updated March 28, 2007).

7.15 Utility Systems

Electric Reliability Council of Texas (ERCOT). 2006a. “2005 Annual Report.” Austin, TX.

ERCOT. 2006b. “Future Generation Interconnection Security Screening Study, Leon and Ector County Locations.” Austin, TX.

Energy Information Administration (EIA). 2006. “Annual Energy Outlook 2006 with Projections to 2030.” Washington, DC.

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

FG Alliance. 2006e. “FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts.”

North American Electric Reliability Council (NERC). 2006. “2006 Long-Term Reliability Assessment: The Reliability of the Bulk Power Systems in North America.” Princeton, NJ.

7.16 Materials and Waste Management

30 TAC 330.3. “Definitions.” *Texas Administrative Code*.

30 TAC 330.5. “Classification of Municipal Solid Waste Facilities.” *Texas Administrative Code*.

30 TAC 330.173 “Operational Standards for Municipal Solid Waste Landfill Facilities.” *Texas Administrative Code*.

30 TAC 335.5 “Deed Recordation of Waste Disposal.” *Texas Administrative Code*.

30 TAC 335.6 “Notification Requirements.” *Texas Administrative Code*.

American Coal Ash Association (ACAA). 2006. *2005 Coal Combustion Product (CCP) Production and Use Survey*. Accessed November 4, 2006 at http://www.acaa-usa.org/PDF/2005_CCP_Production_and_Use_Figures_Released_by_ACAA.pdf

California Integrated Waste Management Board (CIWMB). 2006. *Estimated Solid Waste Generation Rates for Industrial Establishments*. Accessed November 9, 2006 at http://www.ciwmb.ca.gov/WasteChar/WasteGenRates/Industrial.htm (last updated December 7, 2004).

Ciba. 2006. *Water Treatment*. Accessed November 6, 2006 at http://www.cibasc.com/index/ind-index/ind-water_treatment.htm

Energy Information Administration (EIA). 2006. *U.S. Coal Consumption by End Use Sector, by Census Division and State*. Accessed December 7, 2006 at http://www.eia.doe.gov/cneaf/coal/page/acr/table26.html

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

FG Alliance. 2006e. “FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts.”

FG Alliance. 2007. “Initial Conceptual Design Report.”

FutureGen Site Proposal (Odessa, Texas). 2006. “Proposal for FutureGen Host Site.” Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

Horizon Environmental Services, Inc. 2006. “Phase I Environmental Site Assessment, Heart of Brazos FutureGen Site, Leon, Limestone, and Freestone Counties, Texas.” Austin, TX.

Martin. 2006. Letter from Dick Wilkinson, Vice President, Martin Sulphur, Kilgore, TX, to Jay P. Kipper, Bureau of Economic Geology, The University of Texas at Austin. April 28, 2006.

Morris, R. J. 2003. *Sulphur Surplus in the Making Impacts Refineries*. Accessed October 30, 2006 at http://www.sulphurinstitute.org/Morris.NPRApaper.pdf

Railroad Commission of Texas (RRC). 2004. *Coal Mining Locations. July*. Accessed December 15, 2006 at http://www.rrc.state.tx.us/divisions/sm/sm_info/forms/TXCoalOp.pdf

Texas Commission on Environmental Quality (TCEQ). 2006a. Letter from Dan Eden, Deputy Director, TCEQ, Austin, TX, to Scott W. Tinker, Director, Bureau of Economic Geology, The University of Texas at Austin, Austin, TX. April 27, 2006.

TCEQ. 2006b. *Municipal Solid Waste in Texas: A Year in Review. FY 2005 Data Summary and Analysis.* Accessed November 27, 2006 at http://www.tceq.state.tx.us/assets/public/comm_exec/pubs/as/187_06.pdf (last updated October 16, 2006).

TCEQ. 2006c. *Storm Water Permits.* Accessed October 15, 2006 at http://www.tceq.state.tx.us/nav/permits/sw_permits.html (last updated October 2, 2006).

The Innovation Group (TIG). 2002. *Chemical Profiles: Sulfur*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sulfur.htm

TIG. 2003. *Chemical Profiles: Sodium Hypochlorite*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sodium%20Hypochlorite.htm

U.S. Geological Survey (USGS). 2006a. *Mineral Commodity Summaries– Lime*. Accessed December 4, 2006 http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/lime_mcs06.pdf

USGS. 2006b. *Mineral Industry Surveys – Directory of Lime Plants in the United States in 2005*. Accessed December 4, 2006 http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/limedir05.pdf

7.17 Human Health, Safety and Accidents

American Industrial Hygiene Association (AIHA), 1997. “Odor Thresholds for Chemicals with Established Occupational Health Standards.” Fairfax, VA.

Department of Health and Human Services (DHHS). 2006. "The State of Childhood Asthma, United States, 1980–2005." National Center for Health Statistics. Advance Data from Vital and Health Statistics. Number 381. Revised December 29, 2006.

Ermak, D. L. 1990. "User's Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air Releases." Report UCRL-MA-105607, University of California, Lawrence Livermore National laboratory, Livermore, CA.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006d. "Odessa Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project EIS Project Description Data Needs Table Operational Parameters and Assumptions Unplanned Starts."

Gale, J. and J. Davison. 2004. "Transmission of CO_2 – Safety and Economic Considerations." *Energy* 29 (9-10): 1319–1328.

Gilmour, M I., M. S. Jaakkola, S. J. London, A. E. Nel and C. A. Rogers. 2006. "How Exposure to Environmental Tobacco Smoke, Outdoor Air Pollutants, and Increased Pollen Burdens Influences the Incidence of Asthma." *Environmental Health Perspectives* 114: 627-633.

Hanna, S. R. and P. J. Drivas. 1987. "Guidelines for Use of Vapor Cloud Dispersion Models." Center for Chemical Process Safety, American Institute of Chemical Engineers. NY.

Interstate Oil and Gas Compact Commission (IOGCC). 2005. "Carbon Capture and Storage: A Regulatory Framework for States - Summary of Recommendations." Oklahoma City, OK. January 24, 2005.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Mills, W. B., D. B. Porcella, M. J. Ungs, S. A. Gherini, K. V. Summers, L. Mok, G. L. Rupp, G. L. Bowie and D.A. Haith. 1985. "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water." Volume 1. EPA/600/6-85/002a. U.S. Environmental Protection Agency, Washington, DC.

National Institute of Environmental Health Sciences (NIEHS). 1999. "Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields." NIH Publication No. 99-4493.

National Institute of Occupational Health (NIOSH). 1983. *Comprehensive Safety Recommendations for Land-Based Oil and Gas Well Drilling*. Publication No. 83-127. Accessed April 5, 2007 at http://www.cdc.gov/niosh/83-127.html

NIOSH. 1987. "Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Material." NIOSH Publication No. 88-102.

NIOSH. 2007. *Pocket Guide to Chemical Hazards*. NIOSH Publication No. 2005-149. Accessed March 13, 2007 at http://www.cdc.gov/niosh/npg/npgsyn-a.html

Office of Pipeline Safety (OPS). 2006. *Hazardous Liquid Pipeline Accident Summary by Commodity*. 1/1/2006-12/05/2006. Accessed March 13, 2007 at http://ops.dot.gov/stats/LQ06_CM.HTM

OPS. 2007. *FOIA On-line Library*. Accessed March 12, 2007 at http://ops.dot.gov/stats/IA98.htm (last updated January 22, 2007).

Oldenburg, C. M. 2005. *Health, Safety, and Environmental Screening and Ranking Framework for Geologic CO_2 Storage Site Selection*. Accessed July 21, 2006 at http://repositories.cdlib.org/cgi/viewcontent.cgi?article=4279&context=lbnl

Papanikolau, N., B. M. L. Lau, W. A. Hobbs and J. Gale. 2006. "Safe Storage of CO_2: Experience from the Natural Gas Storage Industry." In *Proceedings of the 8th International Conference on Greenhouse Gas Control Technologies (GHGT-8)*, 19 - 22 June 2006. Trondheim, Norway.

Quest Consultants Inc. (Quest). 2006. "Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations." November 28, 2006. Norman, OK.

Scherer, G. W., M. A. Celia, J-H Prevost, S. Bachu, R. Bruant, A. Duguid, R. Fuller, S. E. Gasda, M. Radonijic and W. Vichit-Vadkan. 2005. "Leakage of CO_2 through Abandoned Wells: Role of Corrosion of Cement, in Carbon Dioxide Capture for Storage in Deep Geologic Formations." In *Carbon Dioxide Capture for Storage in Deep Geologic Formations – Results from the CO_2 Capture Project, Vol 2 – Geologic Storage of Carbon Dioxide with Monitoring and Verification*. Elsevier Science, London.

Selgrade, M. K., R. F. Lemanske Jr., M. I. Gilmour, L. M. Neas, M. D.W. Ward, P. K. Henneberger, D. N. Weissman, J. A. Hoppin, R. R. Dietert, P. D. Sly, A. M. Geller, P. L. Enright, G. S. Backus, P. A. Bromberg, D. R. Germolec and K. B. Yeatts. 2006. "Induction of Asthma and the Environment: What We Know and Need to Know." *Environmental Health Perspectives* 114: 615-619.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/osh/os/ostb1619.pdf

USBLS. 2006b. *Fatal Occupational Injuries to Private Sector Wage and Salary Workers, Government Workers, and Self-employed Workers by Industry. All United States, 2005*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/cfoi/cftb0207.pdf

U.S. Census Bureau. 2006. *Topologically Integrated Geographic Encoding and Referencing Database*. Accessed March 13, 2007 at: http://www.census.gov/geo/www/census2k.html

U.S. Department of Energy (DOE). 2002. “Major Environmental Aspects of Gasification-Based Power Generation Technologies.” Final Report. December, 2002. Washington, DC.

DOE. 2004. “ALOHA Computer Code Application Guidance for Documented Safety Analysis, Final Report.” Report DOE-EH-4.2.1.3-ALOHA Code Guidance, June 2004, Office of Environment, Safety and Health, Washington, DC.

DOE. 2006. *Temporary Emergency Exposure Limits (TEELs) [Revision 21 of AEGLs, ERPGs and TEELs for Chemicals of Concern]*. Accessed March 13, 2007 at http://www.eh.doe.gov/chem_safety//teel.html (last updated October 16, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007.* Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1995. “SCREEN3 Model User’s Guide.” EPA-454/B-95-004. Research Triangle Park, NC.

EPA. 2000. “Carbon Dioxide as a Fire Suppressant: Examining the Risks.” EPA430-R-00-002. February 2000.

EPA. 2006a. *IRIS Database for Risk Information*. Accessed March 13, 2007 at http://www.epa.gov/iris/

EPA. 2006b. *Acute Exposure Guideline Levels (AEGLs)*. Accessed March 12, 2007 at http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (last updated January 9, 2007).

EPA. 2007. *Acute Exposure Guideline Levels (AEGLs): Ammonia Results*. Accessed April 16, 2007 at http://www.epa.gov/oppt/aegl/pubs/results88.htm (last updated August 28, 2006).

7.18 Community Services

City Data (CD). 2002. *City Data*. Accessed December 1, 2006 at http://www.city-data.com/

Everett, L. 2004. *VA Losing the Ability to Care `For Him Who Has Borne the Battle’*. Accessed November 30, 2006 at http://www.larouchepub.com/other/2004/3118v_a_hosptls.html

Everett, L. and M. M. Baker. 2004. *LaRouche: Reverse the Policy that Created the Flu Crisis*. Accessed November 30, 2006 at http://www.larouchepub.com/eiw/public/2004/2004_40-49/2004-42/pdf/04-13_41_ecoflu.pdf

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

National Center for Educational Statistics (NCES). 2005. *Public and Private Elementary and Secondary Teachers, Enrollment, and Pupil/Teacher Ratios: Selected Years, Fall 1955 through Fall 2014*. Accessed December 3, 2006 at http://nces.ed.gov/programs/digest/d05/tables/dt05_063.asp

Occupational Safety and Health Administration (OSHA). 1994. *Members of a HAZMAT Team*. Accessed December 3, 2006 at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21384

Quinlivan, J. T. 2003. *Burden of Victory: The Painful Arithmetic of Stability Operations*. Accessed December 2, 2006 at http://www.rand.org/publications/randreview/issues/summer2003/burden.html (last updated August 2, 2006).

Texas Comptroller of Public Accounts (CPA). 2006. *Major Challenges Facing Texas Education Today*. Accessed December 3, 2006 at http://www.cpa.state.tx.us/comptrol/wwstand/wws0512ed/

Texas Department of Public Safety (TDPS). 2003. *Texas Crime by Jurisdiction: Texas Crime Summary*. Accessed December 3, 2003 at http://www.txdps.state.tx.us/administration/crime_records/docs/cr2003/cit03ch9.pdf

Texas Education Agency (TEA). 2005. *Texas Public Schools: District and School Directory for County*. Accessed December 3, 2006 at http://askted.tea.state.tx.us/org-bin/school/SCHOOL_RPT?Y::County::Directory

Texas Fire Chiefs Association (TFCA). 2006. *Texas Fire Chiefs Association: Letter dated May 18, 2006.* Accessed December 3, 2006 at http://www.dshs.state.tx.us/emstraumasystems/StakeholderLetter.pdf

U.S. Census Bureau (USCB). 2006. *National Spending per Student Rises to $8,287*. Accessed November 29, 2006 at http://www.census.gov/Press-Release/www/releases/archives/economic_surveys/006685.html

USACOPS (UC). 2005. *Texas Police Departments*. Accessed December 1, 2006 at http://www.usacops.com/tx/pollist.html

7.19 Socioeconomics

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

FG Alliance. 2006e. “FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts.”

Hotel-Online (HO). 2005. *Arlington Convention & Visitors Bureau Reports 2004. Increases in Hotel Occupancy and Average Daily Rate*. Accessed December 1, 2006 at http://www.hotel-online.com/News/PR2005_1st/Feb05_ArlingtonTX.html

Impact DataSource (IDS). 2004. *A Report of the Economic Impact of Ford Park in Beaumont, Texas*. Accessed December 2, 2006 at http://www.co.jefferson.tx.us/eco_dev/fordpark-economicimpactanalysis-full.pdf

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Unemployment Rate (National Unemployment Rates 1996 to 2006)*. Accessed December 3, 2006 at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=LNS14000000

USBLS. 2006b. *Regional and State Employment and Unemployment Summary*: *November 2006*. Accessed December 28, 2006 at http://www.bls.gov/news.release/laus.nr0.htm (last updated December 22, 2006).

U.S. Census Bureau (USCB). 2000a. *United States Census 2000. Demographic Profiles*. Accessed December 1, 2006 at http://censtats.census.gov/pub/Profiles.shtml (last updated September 2, 2004).

USCB. 2000b. *Projected Population of the United States, by Age and Sex: 2000 to 2050*. Accessed December 1, 2006 at http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf (last updated August 26, 2004).

USCB. 2000c. *Annual Estimates of the Population by Sex and Five-Year Age Groups for the United States: April 1, 2000 to July 1, 2005*. Accessed December 2, 2006 at http://www.census.gov/popest/national/asrh/NC-EST2005/NC-EST2005-01.xls (last updated June 8, 2006).

USCB. 2000d. *Median Age: 2000. Texas by County*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF1_U_M00022&-ds_name=DEC_2000_SF1_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=4001|zf=0.0|ms=thm_def|dw=10.50392852716582|dh=6.058983803831548|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-89.504051|cy=39.739275000000006|zl=8|pz=8|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=04000US17|ds=DEC_2000_SF1_U|sb=50|tud=false|db=050|mn=27.5|mx=42.1|cc=1|cm=1|cn=5|cb=|um=Years|pr=1|th=DEC_2000_SF1_U_M00022|sf=N|sg=

USCB. 2000e. *Per Capita Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000f. *Median Household Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00024&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000g. *Per Capita Income in 1999: 2000, Texas by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF3_U_M00270&-ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=1.9557697048764706E7|dh=1.4455689123E7|dt=gov.census.aff.domain.map.LSRMapExtent|if=gif|cx=-1159354.4733499996|cy=7122022.5|zl=10|pz=10|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=01000US|ds=DEC_2000_SF3_U|sb=50|tud=false|db=040|mn=8185|mx=28766|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00270|sf=N|sg=

USCB. 2000h. *Median Household Income in 1999: 2000, Texas by County*. Accessed December 24, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=04000US48&-tm_name=DEC_2000_SF3_U_M00024&-

ds_name=DEC_2000_SF3_U&-_MapEvent=displayBy&-_dBy=050&-redoLog=false&-tm_config=|b=50|l=en|t=403|zf=0.0|ms=thm_def|dw=27.393417839603167|dh=17.698715125323893|dt=gov.census.aff.domain.map.EnglishMapExtent|if=gif|cx=-100.0765285|cy=31.170218499999997|zl=9|pz=9|bo=|bl=|ft=350:349:335:389:388:332:331|fl=403:381:204:380:369:379:368|g=04000US48|ds=DEC_2000_SF3_U|sb=50|tud=false|db=050|mn=7069|mx=33345|cc=1|cm=1|cn=5|cb=|um=Dollars|pr=0|th=DEC_2000_SF3_U_M00270|sf=N|sg=

USCB. 2005a. *Population Pyramids of Texas*. Accessed December 1, 2006 at http://www.census.gov/population/projections/14PyrmdTX1.pdf (last updated April 20, 2005).

USCB. 2005b. *Texas: Physical Housing Characteristics for Vacant Housing Units*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=04000US48&-qr_name=ACS_2005_EST_G00_S2505&-ds_name=ACS_2005_EST_G00_&-redoLog=false

USCB. 2005c. *Texas: Industry by Sex and Median Earnings in the Past 12 Months (in 2005 Inflation-Adjusted Dollars) for the Civilian Employed Population 16 Years and Over*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=04000US48&-qr_name=ACS_2005_EST_G00_S2403&-ds_name=ACS_2005_EST_G00_&-redoLog=false

USCB. 2005d. *Percent of Occupied Housing Units that are Owner-Occupied: 2005. United States by State*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=01000US&-tm_name=ACS_2005_EST_G00_M00621&-ds_name=ACS_2005_EST_G00_&-_MapEvent=displayBy&-_dBy=040#?388,250

U.S. Government Printing Office (GPO). 2005. *General Decision: TX20030008 03/04/2005 TX8 (Average Wages for Trades in Ector County, Texas)*. Accessed December 1, 2006 at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=Davis-Bacon&docid=TX20030008

7.20 Environmental Justice

59 *Federal Register* 7629. “Executive Order Number 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.” February 11, 1994. *Federal Register* [Volume 59, No. 32].

Council on Environmental Quality (CEQ). 1997. “Environmental Justice Guidance under the National Environmental Policy Act.” Executive Office of the President. December 10, 1997. Washington, DC.

FutureGen Alliance (FG Alliance). 2006d. “Odessa Site Environmental Information Volume.”

U.S. Census Bureau (USCB). 2006. *American FactFinder*. Accessed November 12, 2006 at http://factfinder.census.gov

U.S. Department of Energy (DOE). 2006. *Environmental Justice Definition*. Accessed November 12, 2006 at http://www.lm.doe.gov/env_justice/definition.htm (last updated December 13, 2006).

7.3 CLIMATE AND METEOROLOGY

7.3.1 INTRODUCTION

This section addresses the region's climate and meteorology and the potential impacts on construction and operation of the proposed FutureGen Project.

7.3.1.1 Region of Influence

The ROI for climate and meteorology includes the proposed Odessa Power Plant Site, sequestration site, and the utility and transportation corridors.

7.3.1.2 Method of Analysis

DOE reviewed the Odessa EIV (FG Alliance, 2006d) report to assess the potential impacts of climate and meteorology on the proposed FutureGen Project. Factors identified in this section include normal and extreme temperatures, and severe weather events such as tornadoes and floods. There were no uncertainties identified in relation to climate and meteorology at the proposed Odessa Site.

DOE assessed the potential for impacts based on the following criteria:

- Potential for aspects of the project to fail or cause safety hazards due to temperature variations and extremes; and
- Potential for aspects of the project to fail or cause safety hazards due to a high probability for severe weather events.

7.3.2 AFFECTED ENVIRONMENT

This section describes the west-central Texas region's climate and provides information on climate, meteorology, and severe weather events for Ector and Pecos counties.

7.3.2.1 Local and Regional Climate

The **Köppen Climate Classification System** is the most widely used system to classify world climates. Categories are based on the annual and monthly averages of temperature and precipitation. The Köppen System recognizes five major climatic types, and each type is designated by a capital letter (A through E). Additional information about this classification system is available at http://www.blueplanetbiomes.org/climate.htm (Blue Planet Biomes, 2006).

The proposed Odessa Power Plant Site is located in Ector County about 15 miles (24 kilometers) southwest of the city of Odessa on the far eastern edge of the Trans-Pecos climate region of west Texas. The proposed sequestration site is located about 58 miles (93.3 kilometers) south of the power plant site in Pecos County. The climate of this region is most consistent with the Köppen Climate Classification "Bsh," with relatively mild temperatures and generally arid conditions. The Köppen Climate Classification System recognizes five major climate types based on annual and monthly temperature and precipitation averages. Each major type is designated by a capital letter A through E. The letter "B" refers to climates where the precipitation is less than the potential evapotranspiration. These climates are arid and semi-arid. Further subgroups are designated by a second, lowercase letter which distinguishes seasonal temperature and precipitation characteristics of temperature and precipitation. The letter "s" refers to places where precipitation is less than the threshold but more than half the threshold. To further denote climate variations, a third letter was added to the code. The letter “h” refers to an average temperature that is above 32°F (0°C) during the coldest month.

Maximum precipitation occurs in the summer, and minimum occurs in the winter. Average annual precipitation is about 5 inches (12.7 centimeters), and measurable precipitation occurs about 64 days per year. Average annual snowfall is 4.5 inches (11.4 centimeters).

Winters in the region are relatively mild, with average high and low January temperatures around 56.5°F (13.6°C) and 28.5°F (-1.9°C), respectively. On average, the temperature falls below 32°F (0°C) 64 days a year. In the summer, the maximum high temperature is 93.2°F (34.0°C) and the minimum low temperature is around 66.7°F (19.3°C). The average high temperature reaches 90°F (32.2°C) nearly 100 times each year. Table 7.3-1 summarizes representative temperature, precipitation, and wind speed data. Climate data for this table were collected from the Midland Airport weather station located 26 miles (41.8 kilometers) east of the proposed power plant site (FG Alliance, 2006d).

Table 7.3-1. Seasonal Weather Data

Weather Parameter	Spring	Summer	Fall	Winter
Average Daily Temperature, °F (°C)	76.4 (24.7)	79.9 (26.6)	56.9 (13.8)	47.2 (8.4)
Precipitation, inches (centimeters)	1.2 (3.0)	1.9 (4.8)	1.2 (3.0)	0.5 (1.3)
Average Wind Speed, miles per hour (kilometers per hour)	12.5 (20.1)	12.0 (19.3)	11.3 (18.2)	10.5 (16.9)

°F = degrees Fahrenheit; °C = degrees Celsius.
Source: FG Alliance, 2006d and Climate-Zone, undated.

A wind rose is a graph created to show the directional frequencies of wind. Representative wind rose data for 2005 are presented in Figure 7.3-1. The wind rose is representative of the percent of time that the wind blows at a particular speed and direction. The concentric circles on the wind rose represent percentage of time. The wind rose was based on climate data from the nearby Midland Airport weather station. As the wind rose indicates, the most common wind directions are from the south-southeast and the southeast, and to a lesser extent from the southwest.

The average annual wind speed is 10.4 mph (16.8 kmph). Average seasonal wind speeds generally vary from 12.5 mph (20.1 kmph) in the spring to a low of 10.5 mph (16.9 kmph) in the winter (FG Alliance, 2006d). For the proposed FutureGen Project, the primary use of wind rose data is for evaluating potential hazardous material releases to estimate plume transport times and determine potential population exposure.

The proposed power plant site and sequestration site are located in the western region of Texas that historically experiences a wide spectrum of weather phenomena, including cold and hot days, high winds, heavy rainfalls, thunderstorms, localized floods, and tornadoes. Based on historical norms, the 1,000-square-mile (2,600-square-kilometer) region around the proposed power plant site can expect one tornado of F2 or greater intensity every 200 years.

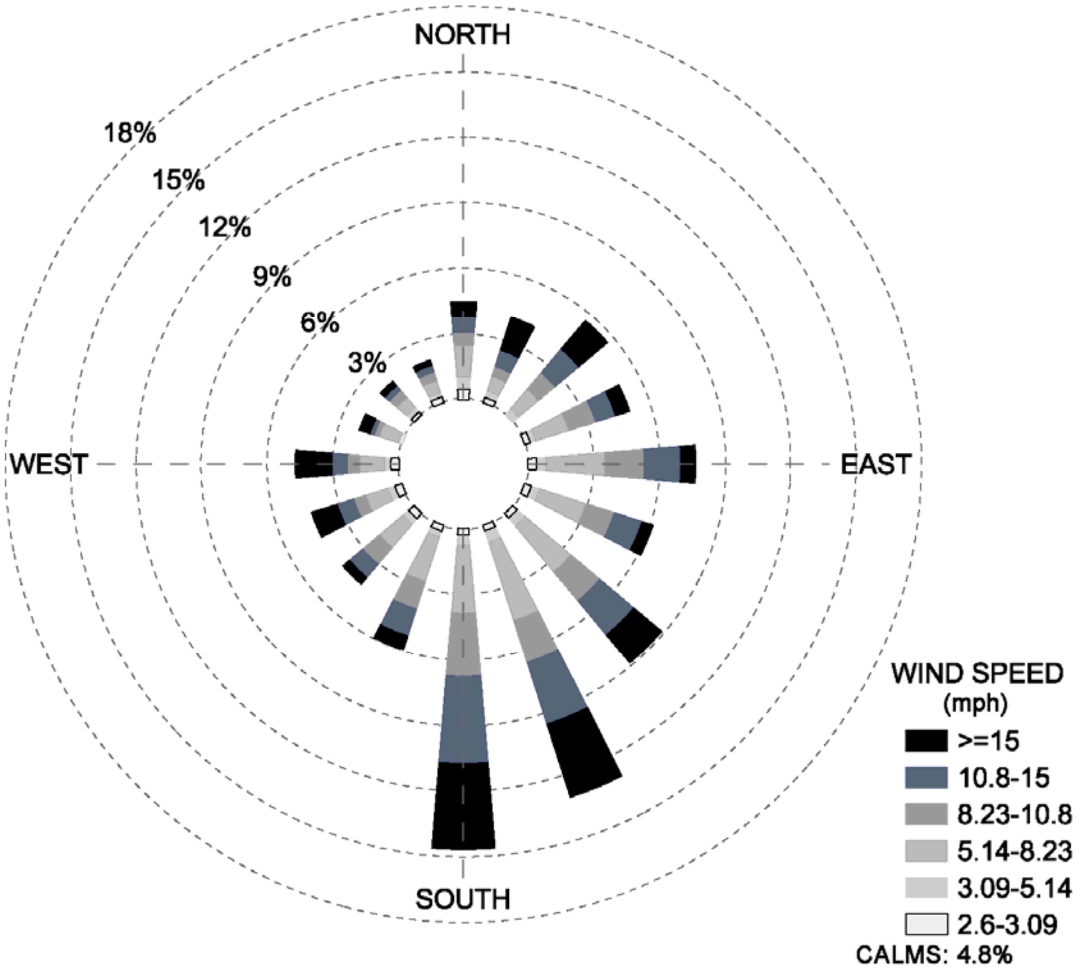


Figure 7.3-1. Wind Rose for the Odessa Region

7.3.2.2 Severe Weather Events

Relevant severe weather events for the ROI include tornadoes, floods, and drought. The proposed project site is located more than 300 miles (483 kilometers) inland (northwest) of the Gulf Coast. For this reason, coastal hurricanes do not occur within the region and have been excluded from discussion.

Tornadoes

The National Oceanic Atmospheric Administration (NOAA) documents tornado activity for each Texas county (NOAA, 2006). The Fujita Scale is a standard qualitative metric to characterize tornado intensity based on the damage caused. This scale ranges from F0 (weak) to F6 (violent). From 1950 to 2006, 37 tornadoes were reported in the 901 square miles (2,333 square kilometers) of Ector County, including 30 F0 tornadoes, three F1 tornadoes, and four F2 tornadoes. Odessa's tornado activity is slightly below the Texas state average and 22 percent lower than

> The most common metric for tornado strength is the **Fujita Scale**. There are six categories on this scale. F0 and F1 are considered weak, F2 and F3 are strong, and F4 through F6 are violent. Each category represents a qualitative level of damage and an estimated range of sustained wind speed delivered by the tornado. Additional information about the Fujita Scale is available at http://www.tornadoproject.com/fscale/fscale.htm (The Tornado Project, 1999).

the U.S. average. Only two strong tornadoes, an F3 in 1965 and an F2 in 1973, have been reported within 20 miles (32 kilometers) of the City of Odessa (FG Alliance, 2006d).

Floods

The entire proposed power plant site and transmission line corridor is located outside of the 500-year floodplain. Small portions of the proposed water supply corridors and CO_2 pipeline corridors would be within the 100-year floodplain. The NOAA database shows that, from 1993 to 2006, 60 floods have been reported in Ector County. Thirty-six of these floods caused no damage, 18 caused damage between $5,000 and $30,000, and three caused damage between $75,000 and $300,000. The most severe flood occurred in the early fall of 2004 with an estimated $2 million of damage. Total flood damage in Ector County since 1993 is $3.2 million.

Drought

Texas has suffered notable periods of drought since the 1930s with extended periods of severe to extreme drought in 1933 to 1935, 1950 to 1957, 1962 to 1967, 1988 to 1990, 1996, and 1998 to 2002. These droughts were more common and widespread in the Rio Grande Basin in the western part of the state. A statewide network of data collection sites, operated by state and federal agencies, has been established to monitor drought conditions. These sites provide real-time climate, steam flow, aquifer, and reservoir information to water management professionals to develop drought mitigation and response plans. Additional information on the State of Texas Drought Preparedness Plan can be found at http://www.txwin.net/DPC/State_Drought_Preparedness_Plan.pdf.

7.3.3 IMPACTS

7.3.3.1 Construction Impacts

Power Plant Site

Severe temperature or weather conditions may temporarily delay construction at the proposed power plant site. Some aspects of construction could not be performed in the rain or snow, or when temperatures are too low, so delays could arise due to unusually cold or wet weather conditions. These conditions could delay material deliveries to and from the construction site. However, it is anticipated that the impacts would be minimal and temporary, as the region’s climate is relatively mild. A strong thunderstorm, flood, or tornado could also cause construction delays; however, the probability that these adverse climate conditions would compromise construction schedules would be small. In addition, the statistical probability of a tornado greater than F1 intensity in the region is about once every 200 years. Because the proposed power plant site is less than 1 square mile (2.6 square kilometers), the probability that a strong tornado would impact the proposed site during construction would be low. The risks posed to construction safety by climate and severe weather would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements, with concern for the affects of ambient climate conditions in the region (FG Alliance, 2006d).

Severe or extreme drought conditions could increase the potential for wildfires in the area. Drought conditions would also increase the number of water trucks needed to reduce fugitive dust emissions and to support other construction activities. In dry, hot weather, construction workers may need to wear a dust mask and work for shorter time intervals between breaks.

Sequestration Site

Severe temperature or weather conditions may temporarily delay construction at the proposed sequestration site. The portion of the proposed sequestration site within Pecos County is currently unmapped regarding flood hazard areas. For this area, the NRCS soil flooding frequency data were reviewed. Sequestration site soils range from "none" and "rare" to "frequent" (NRCS, 2006). Because construction activities at the proposed sequestration site would be performed over a relatively short time, the potential impact of a flood on construction activities would be minimal.

It would also be possible that a strong tornado could affect construction activities at the sequestration site. However, because construction activities would occur over a relatively small area and for a limited time, and because the statistical probability of a tornado greater than F1 intensity is once every 200 years in the region around the proposed power plant site, it is unlikely that a strong tornado would have a direct or indirect impact on construction activities at the proposed sequestration site.

Utility Corridors

Severe temperature or weather conditions could temporarily delay construction at the proposed utility corridors. The electrical utility corridor would span about 1.8 miles (2.9 kilometers), and the process water, potable water, and sequestration corridors would span as much as 54 miles (87 kilometers). Portions of these corridors would be within the 100-year floodplain. Accordingly, construction activities along these corridors could be affected by flood conditions in the region. However, because only portions of the corridors would be within the 100-year floodplain, and given the limited duration of construction along any portion of the corridor, the probability that a flood would cause direct or indirect impacts on corridor construction activities would be low.

It would also be possible that a strong tornado could affect corridor construction activities. However, because construction activities would occur over a relatively small area and for a limited time, and the chance for a tornado greater than F1 intensity is once every 200 years in the region around the proposed power plant site, it is unlikely that a strong tornado would have a direct or indirect impact on utility corridor construction activities.

Transportation Corridors

There would be no direct or indirect impact of climate or severe weather on construction of transportation infrastructure corridors because new roads or rail lines would not be required.

7.3.3.2 Operational Impacts

Power Plant Site

It is unlikely that operations at the proposed power plant site would be affected directly or indirectly by temperature or snowfall extremes in the region. Historically, summer temperatures are generally very warm, winters are relatively mild, and significant snowfalls are rare. The proposed power plant site would be designed to operate under the expected range of temperature and snowfall conditions.

Topographic features around the proposed power plant emissions stack could potentially influence the effect of stack emissions downwash. In addition, water vaporization from cooling tower operation would potentially contribute to local fog conditions. Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Although this potential impact is referred to as fogging, cooling tower plume touchdown or fogging is usually a temporary event for only a few operational hours. Section 7.2 provides further discussion.

The possibility of a strong tornado in the region poses the potential for both direct and indirect impacts on power plant operations. A strong tornado could directly impact plant operations if sufficient damage were incurred at the plant site. Indirect impacts could occur if a strong tornado struck nearby communities and affected the ability of workers or supplies to reach the site. However, the probability of a tornado greater than F1 intensity in the region is once every 200 years. Because the proposed power plant site occupies less than 1 square mile (2.6 square kilometers), the probability that a strong tornado would impose significant direct and indirect impacts on operations would be low (FG Alliance, 2006d).

It is also very unlikely that a flood would cause a direct or indirect impact on operations at the proposed power plant site because it is located outside of the 500-year floodplain. The risks posed to operational safety would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements.

Severe or extreme drought conditions could increase the potential for wildfires in the area. Ready availability of water is crucial for both fire protection and daily power plant operations. Because severe to extreme drought conditions are likely over the planned life of the facility, contingency plans and design features must be established to address these conditions to ensure that the necessary water is always available.

Sequestration Site

Severe temperature or weather conditions may temporarily delay operations at the proposed sequestration site. Though the site is unmapped with regard to flood hazards, soil studies indicate that the potential for flood conditions range from “none” to “rare” to “frequent.” To mitigate potential impacts, injection equipment would be installed at topologically favorable locations (those outside of floodplain areas) within the proposed sequestration site.

It would also be possible that a strong tornado could impact operations at the proposed sequestration site. However, because the total area of the proposed sequestration site would be relatively small, and because the chance for a tornado greater than F1 intensity is once every 200 years in a 1,000-square-mile (2,600-square-kilometer) region around the proposed power plant site, it is unlikely that a strong tornado would have a direct or indirect impact on sequestration site operations.

Utility Corridors

Climate or severe weather would not impact operations of utilities that would be installed underground. However, severe weather would potentially impact operations for the utility corridor components installed aboveground (e.g., electrical transmission lines, pump stations). Portions of the utility corridors would be located within the 100-year floodplain, so there would be some potential for impact due to a flood. This could be mitigated through engineering design and placement of equipment in topologically favorable locations.

A strong tornado could sever transmission lines and support structures or damage other aboveground utility equipment. However, because the aboveground utilities cover a relatively small area, and because the chance for a tornado stronger than F1 intensity in a 1,000-square-mile (2,600-square-kilometer) region would be once every 200 years, the potential impact of a tornado on the utility corridors would be low.

Transportation Corridors

Severe temperature or weather conditions may temporarily affect operations on the proposed transportation corridors. Cold weather, snow, and icy conditions could interfere with the material deliveries to and from the site by road or rail. However, because the climate of the region is generally mild and snowfall is rare, the potential impact of these conditions would be low.

Because portions of the transportation corridors would be within the 100-year floodplain, road and rail travel could be interrupted by localized flood conditions; however, the effects would most likely be small and temporary. The probability that a tornado stronger than F1 intensity would strike the region would be once every 200 years. Because the transportation corridor would represent only a small fraction of this area, the statistical probability that a strong tornado would have a direct or indirect impact on operations would be low.

7.4 GEOLOGY

7.4.1 INTRODUCTION

The geologic resources of the proposed Odessa Power Plant Site, sequestration site, and related corridors are described in this section, followed by a discussion of the potential impacts to these resources.

7.4.1.1 Region of Influence

There are three ROIs for geologic resources. The first ROI includes the land area on the surface that could be directly affected by construction and operation of the FutureGen Project at the proposed Odessa Power Plant Site and sequestration site. The second ROI includes the subsurface geology related to the radius of the injected CO_2 plume. At the Odessa Sequestration Site, multiple injection wells would be necessary because of the permeability of the proposed reservoir. Plume size was modeled for each injection well (four injection wells are proposed to inject 1.1 million tons (1.0 MMT) of CO_2 per year). Numerical modeling indicates that the plume radius for each injection well associated with injecting 1.1 million tons (1.0 MMT) of CO_2 per year for 50 years would be 1.0 mile (1.6 kilometers), equal to an area of 2,136 acres (864 hectares) (FG Alliance, 2006d). The plume radius and land area above the CO_2 plume are shown in Figure 7.4-1. The third ROI is a wider area (100 miles [160.9 kilometers]) that was evaluated to include potential effects from seismic activity.

7.4.1.2 Method of Analysis

The geologic setting includes the near-surface geology of the entire project and all deeper strata that make up the proposed sequestration reservoir. DOE evaluated the potential effects of the construction and operation of the proposed project on specific geologic attributes. In addition, DOE assessed the potential for impacts on the project due to geologic forces (e.g., earthquakes). The potential for impacts was based on the following criteria:

- Occurrence of local seismic destabilization (induced seismicity) and damage to structures;
- Occurrence of geologic-related events (e.g., earthquake, landslides, sinkholes);
- Destruction of high-value mineral resources or unique geologic formations, or rendering them inaccessible;
- Alteration of geologic formations;
- Migration of sequestered CO_2 through faults, inadequate caprock or other pathways such as abandoned or unplugged wells;
- Human exposure to radon gas; and
- Noticeable ground heave or upward vertical displacement of the ground surface.

DOE based its evaluation on a review of reports from state geologic surveys and information provided in the Odessa EIV (FG Alliance, 2006d).

DOE identified uncertainties in relation to geological resources at the Odessa Site. These include the porosity and permeability of the target formation where CO_2 would be sequestered. Analog well data was analyzed; however, site-specific test well data was not collected. Detailed geologic mapping has been conducted at the proposed Odessa Sequestration Site, and it appears that faults in the area are confined to the “basement” rocks that lie below the proposed sequestration reservoir at approximately 1.3 miles (2.1 kilometers) below the ground surface. However, there is still some uncertainty concerning the presence of transmissive faults in the area. In this case, regional geologic maps and tectonic stress regimes were analyzed using best professional judgment to determine the likelihood of faults in the area.

7.4.2 AFFECTED ENVIRONMENT

7.4.2.1 Geology

The proposed Odessa Power Plant Site is 600 acres (243 hectares) in size. The entire site is essentially flat and has historically been used for ranching and oil and gas activities. The elevation of the site varies from a high of 2,969 feet (905 meters) above mean seal level (AMSL) to a low of 2,920 feet (890 meters) AMSL.

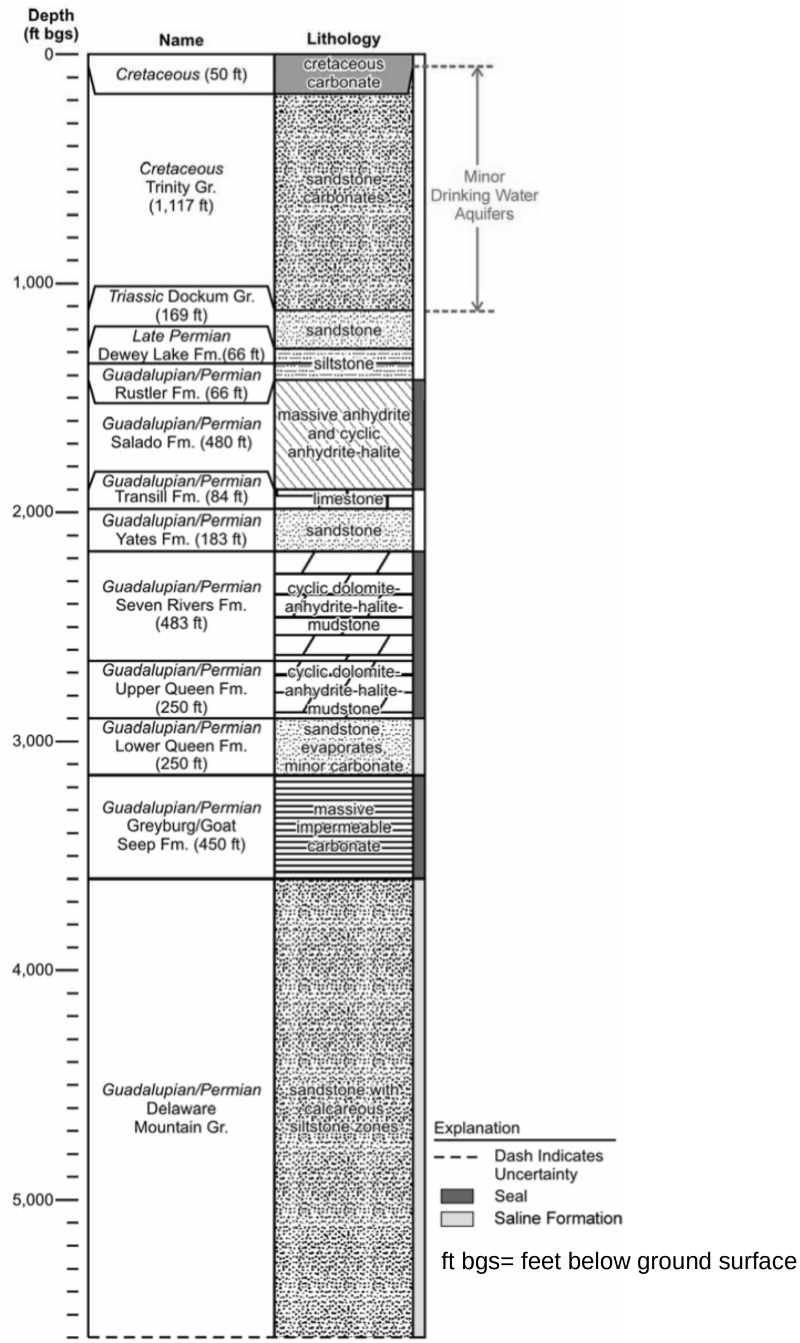
Early to middle Paleozoic rocks in Texas are typically carbonates deposited in ancient seas located inland of the continental margin. Permian-aged rocks are the most well-known of the Texas Paleozoic, likely because these strata are also oil-rich where buried in west Texas, such as in the Midland and Odessa region.

The surficial geology at the proposed plant and sequestration site, and other areas where construction would occur, varies. At the proposed power plant site, the surficial unit is Quaternary-aged deposits consisting of unconsolidated sand, silt, gravel, clay, and cobbles. The surficial geology of the proposed utility and transportation corridors is primarily carbonate rocks and sandstones, with areas of Quaternary sands, silts, and clays. The surficial geology at the proposed sequestration site is Cretaceous-aged carbonates and sandstone carbonates that are approximately 0.2 mile (0.3 kilometer) thick.

Figure 7.4-2 is a stratigraphic column of the geology beneath the proposed Odessa Sequestration Site**.** The surficial Cretaceous-aged deposits are underlain by a relatively thin Triassic age Dockum Group sandstone (169 feet [51.5 meters] thick) and a thin layer of siltstone (Dewey Lake formation) approximately 66 feet [20.1 meters]) thick. Below the Dewey Lake formation, which terminates at a depth of approximately 0.3 mile (0.5 kilometer) is the Guadalupian/Permian Salado formation. From this depth to approximately 0.7 mile (1.1 kilometers) are primarily sealing formations interbedded with two separate, more porous strata consisting of limestones and sandstones which are each approximately 200 feet (61 meters) thick.

From 0.3 to 0.7 mile (0.5 to 0.7 kilometer) below ground surface are three separate seal units: a 500.0-foot (152.4-meter) thick massive anhydrite and cyclic anhydrite-halite from 0.3 to 0.4 mile (0.5 to 0.6 kilometer) below ground surface, a 700.0-foot (213.4-meter) thick primary seal cyclic dolomite-anhydrite-halite –mudstone from 0.4 to 0.5 mile (0.6 to 0.8 kilometer) below ground surface, and a 450.0-foot (137.2-meter) thick massive impermeable carbonate from 0.6 to 0.7 mile (1 to 1.1 kilometers) below ground surface.

Below 0.7 mile (1.1 kilometers) is the thicker of two primary injection targets, the Guadalupian/Permian Delaware Mountain Group which is a sandstone with calcareous siltstone zones. There are two primary injection targets: the Lower Queen sandstones (0.5 to 0.6 mile [0.8 to 1 kilometer] below ground surface) and the Delaware sandstones (0.7 mile [1.1 kilometers] to at least 1.1 miles [1.8 kilometers]).



Source: FG Alliance, 2006d

Figure 7.4-2. Stratigraphy of the Odessa Injection Area

The Delaware Mountain Group consists of sandstone and siltstone deposits, separated by thin, low permeability carbonates. The Delaware sandstones are a succession of deep-water sandstones that increase in thickness from northeast to southwest across the sequestration area. This southwestward increase in thickness parallels the gentle structural dip of the unit. The Delaware Mountain Group was deposited as very well-sorted fine wind-blown sand. The basal part of the formation is dominated by coarse-grained sandstones. The middle and upper parts of the Group contain somewhat finer-grained sandstones and interbedded carbonates. The top of the Delaware sandstones is estimated to be about 0.7 mile (1.1 kilometers) below ground surface and is expected to be between 0.2 and 0.3 mile (0.3 and 0.5 kilometer) thick. These sandstones are separated from the Lower Queen sandstones by a thick 450-foot (137.2-meter) inter-reservoir seal of low permeability carbonates (FG Alliance, 2006d).

The sandstones of the Lower Queen formation, the upper sequestration target, differ from those of the Delaware Mountain Group in having been deposited in shallow water marine settings. These deposits include laminated-to-massive siltstone and well-sorted, very fine-grained sandstones interbedded with low permeability carbonates and evaporites. Based on regional mapping and well control through petroleum exploration activities, the top of the Lower Queen sandstone at the Odessa Site is estimated to be at a depth of 0.5 mile (0.8 kilometer) and to be between 250 and 500 feet (76.2 and 152.4 meters) thick.

The Odessa Site is located in a seismically stable area at the margin of the Central Basin Platform in the Permian Basin of West Texas-New Mexico. The principal tectonic features of the Odessa Site are the deep Delaware Basin and the uplifted Central Basin Platform. These geologic features originated during the Pennsylvanian, when northeastward directed tectonic compression folded and faulted the older rock layers and formed the southern edge of the Central Basin Platform. The area has since undergone minor east-west extension associated with Tertiary-age in New Mexico (the Rio Grande Rift).

There are no mapped faults or fracture zones within the sequestration ROI. Deep-seated faults are common throughout the region, associated with the formation of the Permian Basin and carbonate platform. Recent 3-D seismic data indicate that none of these faults have penetrated the Delaware Mountain Group, the Queen, or overlying stratigraphic units. The seismic datasets show that faults are restricted to the older stratigraphic horizons below the Delaware Mountain Group (FG Alliance, 2006d).

The current tectonic regime at the proposed Odessa Sequestration Site is tensional, mixed normal and strike-slip, with the vertical overburden stress magnitude close to horizontal principal stress magnitude, leading to a generally low differential stress condition. The principal stress direction is north-south, which indicates that any east-west fractures or faults in the area are not likely to be transmissive unless propped open by mineral in-filling. Any existing fractures oriented north-south are less likely to be sealed. Undetected faults are not likely to slip as a result of increased pore pressure related to injection activities, although further geomechanical characterization would be desirable (FG Alliance, 2006d).

Geological Resources in the Odessa Area

No mineral resources are located on the proposed power plant site or utility and transportation corridors, although limestone is a common resource found in the area. Three active oil wells, two active gas wells, two inactive/plugged oil wells, and a proposed (permitted) well exist on the proposed power plant site. Many active and inactive (abandoned/plugged) oil and gas wells are present within the proposed Odessa sequestration site and utility/ transportation corridors (FG Alliance, 2006d).

The project area should not be affected by subsidence (sinking or lowering of the ground surface), because most factors known to cause subsidence are not present in the project area. Such factors include undermining by coal or other mines, and withdrawal of large quantities of water from aquifers (discussed in Section 7.6).

7.4.2.2 Seismic Activity

The proposed Odessa Site is located roughly 800 miles (1,287 kilometers) southwest of an area of seismic activity known as the New Madrid Fault Zone, which is located in the general area of the common borders of southern Illinois, western Kentucky and Tennessee, and southeastern Missouri. This area has spawned the most powerful earthquakes recorded in the continental U.S (Richter magnitudes of 8.0). However, the proposed Odessa location is far enough away that earthquake damage from movement on these faults is not of concern.

A search of the U.S. Geological Survey (USGS) database of historic earthquakes shows that since 1974, 40 earthquakes have occurred within 120 miles (193.1 kilometers) of the approximate midway point between the proposed power plant and sequestration sites. The Richter magnitude of the earthquakes ranged from 2.3 to 5.7. The magnitude 5.7 earthquake was centered 80 miles (128.7 kilometers) from the approximate midway point between the proposed power plant and sequestration sites. The most recent seismic event, on April 8, 2006, was a 2.9 magnitude earthquake centered 84 miles (135.2 kilometers) from the midpoint between the power plant and sequestration site. The closest seismic event to the proposed power plant site was a magnitude 2.8 earthquake that occurred on June 23, 1993, approximately 8 miles (13 kilometers) from the plant-sequestration site midpoint (USGS, 2006).

There have been three historic earthquakes that were felt over all or a significant part of West Texas. The first, which occurred on August 16, 1931, was centered near Valentine (approximately 130 miles [209 kilometers] southwest of the midpoint between the proposed power plant and sequestration sites), had a magnitude of 6.0. Many buildings in Valentine were constructed of adobe and brick and sustained severe damage. The second, which occurred on January 2, 1992, approximately 100 miles (161 kilometers) northwest of the midpoint between the proposed power plant and sequestration sites along the Texas-New Mexico border near Andrews and Hobbs, had a magnitude of 4.6. The third is also the most recent, occurring on April 14, 1995, near Alpine (approximately 80 miles [129 kilometers] southwest of the midpoint between the proposed power plant and sequestration sites), and had a magnitude of 5.7. Both the 1931 and the 1995 earthquakes produced landslides in mountainous areas. The amount of injury and damage from the 1931 and 1995 earthquakes was relatively small, mostly because of the relatively low population density in West Texas (UTA, 2006). No information is available on the effects of these earthquakes in the project area.

7.4.2.3 Target Formation Properties

Characteristics

Depth

Based on regional mapping and well control through petroleum exploration activities, the Lower Queen sandstone at the proposed Odessa Site is estimated to be at a depth of 2,900 feet (884 meters), and is estimated to be between 250 and 500 feet (76.2 and 152.4 meters) thick. The top of the Delaware Mountain Group sandstones is estimated to be about 0.5 mile (0.8 kilometer) and is expected to be between 0.2 and 0.3 mile (0.3 and 0.5 kilometer) thick. The depth interval of the injection reservoir for the lower Queen formation is between approximately 0.5 to 1.0 mile (0.8 to 1.6 kilometers) for the Delaware Mountain Group.

A closer seismically active zone is the Rio Grande Rift system. Differential movement of the Earth's crust along the system of faults of this rift has produced the north-south trending valley of the Rio Grande River in New Mexico. The seismically active zone them turns southeast along the Rio Grande River between Texas and New Mexico. This system of faults generates small and moderate sized earthquakes. Near El Paso, Texas, the fault zone is about 210 miles (338 kilometers) from the Odessa Power Plant Site.

Injection Rate Capacity

Because of low reservoir permeabilities, the injection rate of each well is limited by the maximum pressure that can be safely used without causing reservoir fracturing. Numerical modeling results indicate that four wells would be required to support the proposed injection rate for the lower injection rate and ten wells for the higher rate (FG Alliance, 2006d).

Storage Capacity

The storage capacity of a reservoir depends on its porosity, permeability, thickness and lateral extent. Permeability is measured in units of millidarcy (md) and values of 0.001 md or less are almost impermeable, 0.1 md is "tight" or of very low permeability, 1 to about 50 md is low permeability, and higher values are permeable.

Porosities in the Guadalupe sandstones generally range from 5 percent to 15 percent, with permeabilities up to 50 md. Effective porosity (defined as greater than 14 percent porosity) occurs in thin 1- to 2-foot (0.3- to 0.6-meter) sandstones, separated by lower permeability rock. The total combined effective porosity in both zones is about 130 feet (40 meters). The closest well with porosity logs is within several miles of the proposed injection well field area (FG Alliance, 2006d).

The Odessa Site is characterized by large storage capacity, but low permeability. Because of low reservoir permeabilities, the injection rate of each well is limited by the maximum pressure that can be safely used without causing reservoir fracturing. Numerical modeling results indicate four wells would meet the proposed injection rate for the lower injection rate and 10 wells for the higher rate. The most dominant regional controls on capacity and injectivity are reservoir heterogeneity due to depositional environment, and associated abundance of calcite cement. The geology of the sequestration targets is well known because of petroleum exploration activities.

Seals, Penetrations, and Faults

Seals

The primary seal, the upper Queen-Seven Rivers formation, is composed of 400 to 650 feet (121.9 to 198.1 meters) of interbedded anhydrite, carbonate, and siliclastic mudstones with a permeability of less than 0.01 md. This zone serves as a top seal on 16 oil and gas reservoirs in the region, including some of the fields nearest to the proposed site (Yates, White-Baker, Taylor Link). The evaporites of the Salado formation form a 500-foot (152.4-meter) thick secondary seal.

Penetrations

Sixteen oil production wells penetrate the Delaware Mountain Group sandstone interval. These wells are outside the modeled maximum radius of the CO_2 plume.

Relation of Primary Seal to Active or Transmissive Faults

The primary seal is not intersected by any known historically active or transmissive faults, and there is a low-risk of fault-induced seal failure. Faults are mapped at depth greater than 1.3 miles (2.1 kilometers) beneath the proposed sequestration site; however, accepted regional geologic interpretation shows that the tectonic activity creating these faults became quiescent at the end of the early Permian.

7.4.2.4 Geologic Sequestration Studies, Characteristics and Risk Assessment

Currently, there are four CO_2 injection projects worldwide under detailed study. These are the Rangely, Weyburn, In Salah, and Sleipner projects. They are located in the US, Canada, Algeria, and Norway, respectively. Rangely and Weyburn involve enhanced oil recovery (EOR), In Salah involves enhanced gas recovery (EGR) and saline reservoir injection, and Sleipner is a storage project located off shore in the North Sea.

A database of these and other geologic storage facilities was created and used in conducting the human health risk assessment for this EIS (Section 7.17). These studies of natural and industrial analogs for geologic storage of CO_2 (i.e., sites in similar geologic and hydraulic settings with similar human influences) support the feasibility of geologic containment over the long-term and for characterizing the nature of potential risks from surface leakage, should it occur. A more detailed description of these studies, their characteristics, and the state of risk assessment for geologic sequestration of CO_2 is provided in Section 7.17 and Appendix D.

7.4.3 IMPACTS

7.4.3.1 Construction Impacts

Power Plant Site

The surficial geology of the power plant site is sand, gravel, and clay deposits. There are no geologic features present that would affect construction of the power plant infrastructure. Because there are no economically extractable geologic resources in the surface geology ROI, there would be no impact to the availability of such resources from construction of the power plant. However, aggregate and other geologic resources (e.g., sand) would be required to support construction activities; these resources are abundant near the proposed plant site and the quantities required for construction of the power plant would not have a noticeable effect on their availability. Additional discussion of the availability of construction materials is addressed in Section 7.16.

The relatively flat surface topography of the power plant site precludes any potential impacts from landslides or other slope failures during construction. Similarly, because the area is not seismically active and most of the earthquakes in west Texas have a Richter magnitude below 4.0, it is not expected that seismic activity would affect construction of the power plant.

Sequestration Site

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction at the sequestration site as discussed above for the power plant site. The injection wells would penetrate over 1.1 miles (1.8 kilometers) of bedrock. It is believed that mineral resources would not be impacted by the installation of the injection wells, or deep monitoring wells (these wells are discussed below).

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed transportation infrastructure corridors as discussed above for the power plant site.

7.4.3.2 Operational Impacts

Power Plant Site

During power plant operations, no additional impacts to geologic resources would be expected. The power plant site's relatively flat surface topography and lack of karst geology precludes any potential impacts from landslides, other slope failures, or sinkhole development during operation. Similarly, because the area is not seismically active, it is not expected that seismic activity would affect operation of the power plant.

Sequestration Site

The potential impacts to geologic resources and impacts to the sequestration site from geologic processes during operation are discussed below.

When CO_2 is injected into a deep brine-saturated (saline) permeable formation in a liquid-like (i.e., supercritical) dense phase, it is immiscible in, and less dense than, water. This would be the case at the Odessa Sequestration Site. The CO_2 would displace some of the brine fluid. In addition to displacement of brine, CO_2 may dissolve in or mix with the brine thereby causing a slight acidification of the water, react with the mineral grains, or be trapped in the pore spaces by capillary forces. Some combination of these processes is likely, depending on the specific conditions encountered in the reservoir (see Section 7.6).

Geochemical modeling of the potential pH changes was conducted for this EIS. The modeling showed that the pH of the brine in the Lower Queen and Delaware Mountain Group formations would be expected to drop from about 6.8 to 4.6 over many years, creating acidic brine. However, the Lower Queen formation and Delaware Mountain Group are made up primarily of quartz-rich sedimentary rocks (primarily sandstone) that are extremely resistant to chemical changes. Although more active geochemical reactions would be expected in the interbedded carbonates and evaporates over very long periods of time (hundreds to thousands of years), this acidification of the brine solution would not be expected to substantially alter the Lower Queen formation or Delaware Mountain Group.

CO_2 emitted from the power plant would include some H_2S. Because of the significant expense required to separate these two elements, it is possible that the Alliance may conduct tests where greater concentrations of H_2S are included in the gas stream to be sequestered. Therefore, geochemical modeling of the potential changes that could occur to the Upper Queen/Seven Rivers (caprock) from the introduction of H_2S into the reservoir formation was conducted. It was concluded that the most significant effect is that the H_2S concentration in the sequestered gas-mixture would be reduced with only very small (less than 1 percent) decrease in the porosity of the Upper Queen/Seven Rivers seal, due to precipitation of minerals contacting H_2S that would reduce the porosity of the formation.

Increases in pore pressure associated with the injection of CO_2 can decrease friction on existing faults, and may cause them to become transmissive or to slip. Injection-induced seismicity at the Odessa Site is, however, unlikely for the following reasons:

- Four injection wells at the lower injection rate or ten for the higher rate would be used so that the FutureGen CO_2 storage goals could be reached. Having a greater number of injection wells allows for a lesser injection pressure and consequently less pressure buildup.
- The low differential stress regime of the Odessa Site, coupled with seismic data showing a lack of intersecting faults and faults at depths well below the proposed injection reservoir, suggests that induced seismicity is unlikely. The risk assessment also estimates a very low probability of induced seismicity (1E-4 over 5,000 years).

Although injection-induced seismicity is unlikely, monitoring methods discussed below in Section 7.4.4 would further reduce the possibility of accidentally inducing seismicity on a scale larger than micro-scale (measuring -4 to 0 on the Richter scale).

The injection pressures that would cause new or existing fractures to open in the target reservoir and caprock are not known and would need to be determined as part of the permitting process. Requiring injection pressures to be substantially below the fracture opening and fracture closure pressures would greatly lower the risk of accidental overpressure and induced fracturing of the formation, the seal, or cements in wellbores, as well as lowering the risk of opening existing fractures. Site-specific injection pressure limits may be established as part of the permitting process.

Numerical modeling was conducted to estimate the potential CO_2 plume migration if an undetected transmissive fracture zone or fault was present that through-cuts the seals. Two cases were modeled for Odessa. The first case had only the 400-foot (121.9-meter) Goat Seep carbonate above the Delaware Mountain Group injection zone breached and had CO_2 injected into the Delaware Mountain Group which migrated through the Lower Queen sandstone and contacted the bottom of the Upper Queen/Seven Rivers primary seal. In the second scenario, both the Goat Seep and the entire Upper Queen/Seven Rivers seals are fractured and CO_2 escapes into the interbedded sandstones and anhydrites of the Yates formation. The fracture zone or transmissive fault likely had permeabilities in excess of the permeability of the carbonate/anhydrite seals (four cases were modeled with permeabilities ranging from 0.01 to 1000 md). Only narrow faults were evaluated because fracture/ fault zones larger than 33 feet (10.1 meters) wide could be detected through geophysical methods and investigated before initiation of an injection program. Injection wells would be relocated, if necessary, to avoid such faults.

The results of the numerical modeling of fault leakage scenario number one for the Odessa Site indicate that, for permeabilities of 1 md and higher, the amount of CO_2 leakage through the fault is relatively large, as measured by the CO_2 flux rates, extent of the plume, and CO_2 gas pressure at the base of the overlying Upper Queen/Seven Rivers formation. The maximum plume extent occurred for the higher permeability faults and was 1.3 miles (2.1 kilometers) after 100 years. The plume extent for the 0.01 md case was essentially zero. Significant permeation of the Goat Seep formation is clearly unlikely to occur at permeabilities less than 0.01 md (FG Alliance, 2006d).

The scenario number two results indicate that no leakage occurs across the Goat Seep Fracture during the simulation, which is attributed to the gas-phase hydrostatic pressure balance in the well also being observed in the formations. Diffusive migration of dissolved CO_2 into the Goat Seep Fracture from the formations above and below the fracture is noted, but there is no net migration of CO_2 across the Goat Seep Fracture. There is a vertical gradient caused primarily by buoyancy forces across the Queen/Seven Rivers Fracture toward the Yates formation, but no leakage occurs across this fracture because the fracture drains into a very low permeability (0.05 md) unit at the bottom of the Yates formation that inhibits flow.

The potential for leakage of CO_2 from the sequestration reservoir by means other than faults would also be a potential impact of concern. The injection wells themselves would be one of the likely paths for CO_2 migration from the reservoir, as by their nature they perforate all the seals present. Unknown wells and improperly plugged existing well bores within the ROI could potentially leak CO_2. The Odessa Site subsurface ROI is surrounded by operating and abandoned petroleum exploration and production wells; there are 16 petroleum exploration wells identified that penetrate the Delaware Mountain Group sandstones (lower injection interval) in the injection area. Through strategic placement of the injection wells at the Odessa Site, the CO_2 plumes would not intersect these existing wells. In addition to these known wells, there may be other undocumented wells located within the subsurface ROI that may or may not be properly abandoned. However, as part of the site-specific assessment to be conducted on the selected site, geophysical surveys will be conducted to locate existing wells, and if found to be improperly abandoned, such wells could be properly sealed and abandoned to meet state regulations and prevent leakage. The risk assessment estimates the probability of leakage from such wells (Appendix D).

An earthquake has the potential to affect the injection wells. If a fault was penetrated by the well bore, the injection well's casing could be sheared if movement occurred on that fault during a seismic event. However, vibrations from an earthquake would not likely cause faulting or affect the integrity of the well. Minor earthquakes do occur in west Texas, but the project area is not seismically active. The Odessa Site lies in a stable continental area where there is little risk of new faulting. In addition, earthquake epicenters in continental areas are typically deeper than the sedimentary strata penetrated by the well. Earthquakes with shallow epicenters have historically been of low Richter magnitude (<4) within an approximate 120-mile (193.1-kilometer) radius around the Odessa area.

There are several sequestration features that indicate that CO_2 would be retained in the proposed injection formation, the Delaware Mountain Group and Lower Queen sandstones, including:

- The target intervals likely have up to 260 feet (79.2 meters) of permeable sandstone and extend laterally for hundreds of miles; therefore, more than adequate storage capacity exists in the proposed sequestration reservoir.
- Permeable sandstones are interlayered with less permeable rock that should act as multiple barriers to the upward migration of CO_2.
- The primary seal lithologies of the upper Queen and Seven Rivers units are dolomites, limestones and anhydrites with low permeabilities and high capillary entry pressures. The upper Queen and Seven Rivers are seals to hydrocarbon accumulations across several counties. These rocks display very little porosity (typically less than 1 percent) and extremely low permeabilities (less than 0.01 md). In addition, the 500-foot (152.4-meter) thick Salado formation consisting of anhydrites provides an excellent secondary seal.

There are many variables that affect the potential to increase pore pressure enough to cause vertical displacement. Collection of site-specific data including porosity, permeability and mean effective stress would allow for future modeling of the predicted pressure increases and subsequent potential for ground heave at the Odessa Sequestration Site and surrounding area. If a potential problem is identified, injection pressures could be maintained below the levels that would cause heaving.

The U.S. EPA has mapped most of Texas, including the Odessa area, as an area with a low potential for radon to exceed the recommended upper limit for air concentrations within buildings. Thus, if CO_2 were to escape the sequestration reservoir and increase pore pressures in the vadose zone (near surface unsaturated soils above the water table), there is low potential to displace radon, forcing it into buildings. As discussed above, several sequestration features indicate that CO_2 should be retained in the sequestration reservoir. If CO_2 were to leak, however, radon transport induced by CO_2 leakage would be highly localized over the point of CO_2 leakage. The risk assessment conducted for this EIS addressed the potential for adverse impacts from radon displacement (Appendix D). Data concerning potential existing radon levels from state and local sources were used as the baseline. Using conservative assumptions on increases of radon via displacement by CO_2, it was concluded that the situation with respect to radon would remain unchanged as to whether EPA-established action levels would be exceeded. This indicates that there would be no incremental risks above background from radon at the Odessa Site.

The University of Texas, which controls the surface rights on land above the proposed sequestration site, has historically provided access for subsurface activities on these lands through easements. Complete title searches for subsurface rights at the injection sites would be conducted. The University has indicated, however, that it would grant a 50-year lease for all sequestration reservoir activities (FG Alliance, 2006d). All mineral rights needed to conduct sequestration would be acquired. Conflicts with commercial accessibility to high-value mineral resources or unique geologic formations would be dealt with as part of the acquisition of mineral rights.

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed transportation infrastructure corridors as discussed above for the power plant site.

7.4.3.3 Fate and Transport of Injected/Sequestered CO_2

As previously mentioned, in saline formations, supercritical CO_2 is less dense than water which creates strong buoyancy forces that drive CO_2 upwards. After reaching the top of the reservoir formation, CO_2 would continue to migrate as a separate phase until it is trapped as residual CO_2 saturation or in local structural or stratigraphic traps within the sealing formation. In the longer term, significant quantities of CO_2 (up to 30 percent) would dissolve in the formation water and then migrate with the groundwater. Reservoir studies and simulations for the Sleipner Project have shown that CO_2 saturated brine would eventually become denser and sink, thereby eliminating the potential for long-term leakage. These reactions, however, may take hundreds to thousands of years (IPCC, 2005).

It would be unlikely that CO_2 would migrate vertically for any significant distance. However, if a large transmissive fracture was present in the subsurface ROI, CO_2 could migrate along its path. Horizontal open fractures within the Guadalupian sandstones would cause the CO_2 to migrate farther laterally than the numerical modeling predicts. Vertical open fractures are more likely at depth than horizontal ones, and fractures or faults trending roughly east-west, if present, may be transmissive. Thus, if such fractures are present in the cap rock within the ROI, they could promote vertical migration of CO_2. In order for the CO_2 to reach shallow potable groundwater or the biosphere, however, such fractures would need to penetrate and be open through, or connect in networks through, over 0.6 mile (1.0 kilometer) of various types of rock. It is unlikely that such fractures exist in the project area; however, site-specific geologic investigations would be necessary to verify this before initiating injection of CO_2. See Section 7.17 for a detailed discussion of CO_2 transport assumptions and potential associated risks.

7.5 PHYSIOGRAPHY AND SOILS

7.5.1 INTRODUCTION

This section describes the physiography and soils associated with the proposed Odessa Power Plant Site, sequestration site, and related corridors.

7.5.1.1 Region of Influence

The ROI for physiography and soils is defined as a 1-mile (1.6-kilometer) radius surrounding the proposed power plant site, sequestration site, reservoir, and utility corridors.

7.5.1.2 Method of Analysis

DOE reviewed reports from the U.S. Department of Agriculture (USDA) and information provided in the Odessa EIV (FG Alliance, 2006d) and other available public data to assess the potential impacts of the proposed FutureGen Project on physiographic and soil resources. DOE assessed the potential for impacts based on the following criteria:

- Potential for permanent and temporary soil removal;
- Potential for soil erosion and compaction;
- Soil contamination due to spills of hazardous materials; and
- Potential to change soil characteristics and composition.

Some uncertainties were identified in relation to soil resources at the proposed Odessa Site such as the porosity and permeability of the various soils where the project infrastructure would be located. Uncertainties, based on the absence of site-specific data, are discussed as appropriate in the following analysis. Prime farmland is discussed in Section 7.11.

7.5.2 AFFECTED ENVIRONMENT

7.5.2.1 Physiography

The proposed Odessa Power Plant Site is located in the Great Plains Physiographic Province, which lies between the Rocky Mountains on the west and the Central Lowlands on the east. Elevations range from 7,800 feet (2,377 meters) on the west to 1,100 feet (335 meters) on the east. This area is a remnant of a vast plain formed by sediments that were deposited by streams flowing eastward from the ancestral Rocky Mountains. The High Plains province is characterized by gently sloping, smooth plains, which makes it ideal for agricultural use; however, the climate is dry. The mean annual precipitation ranges from about 16 inches (41 centimeters) in the west to about 28 inches (71 centimeters) in the east (USGS, 2006).

The High Plains of Texas form a nearly flat plateau with an average elevation of approximately 3,000 feet (914 meters). Extensive stream-laid sand and gravel deposits, which contain the Ogallala aquifer, underlie the plains. Windblown sands and silts form thick, rich soils and caliche locally. Havard shin oak mesquite brush dominates the silty soils, whereas sandsage Havard shin oak brush occupies the sand sheets. Numerous playa lakes are scattered randomly over the treeless plains. The eastern boundary is a westward-retreating escarpment capped by a hard caliche. Headwaters of major rivers deeply notch the caprock, as exemplified by Palo Duro Canyon and Caprock Canyons State Parks (UTA, 2006).

On the High Plains, widespread small, intermittent streams dominate the drainage. The Canadian River cuts across the province, creating the Canadian Breaks and separating the Central High Plains from the Southern High Plains. Pecos River drainage erodes the west-facing escarpment of the Southern High Plains, which terminates against the Edwards Plateau on the south (UTA, 2006).

7.5.2.2 Soils

The following section describes the different predominant soils at the power plant site, sequestration site, and utility and transportation corridors. Descriptions of the soil type characteristics and uses are presented in Table 7.5-1.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Blakeney And Conger Soils, Gently Undulating (BcB)	• Found along drainageways and around playas. Slopes range from 0 to 3 percent. • Soil-blowing hazard is moderate.	• Most of the acreage is used for rangeland. Better suited to irrigated farming than dryland farming.
Blakeney Fine Sandy Loam, 0- To 2-Percent Slopes (BfA)	• Shallow, nearly level to gently sloping soil. Located mainly along drainageways and around playas. Surface runoff and internal drainage are medium while permeability varies through the soil column. Soil-blowing and water-erosion hazards are moderate. Plant rooting zone is restricted by shallow depth over rock and available water capacity is low. • Depth to strongly cemented caliche is about 16 inches (41 centimeters).	• Used mainly for rangeland. Medium potential for growing a mixture of short and mid grasses. Low potential for most urban uses due to the shallow depth to indurated caliche. Medium potential for recreational uses because the soil is dusty.
Blakeney-Conger Complex, Gently Undulating (BCB)	• Very shallow and shallow soils located on broad upland ridges and divides. They are formed in calcareous loamy materials and have slopes ranging from 1 to 5 percent. Blakeney • Well drained soils, available water capacity is very low, permeability is moderately rapid in the upper part and very slow in the indurated layer. Medium to high runoff rate. Root zone is shallow to very shallow and water and wind erosion hazard is severe. Conger • Well drained soils, very low water capacity, moderately permeable in the upper part and very slowly permeable in the indurated layer. Runoff is medium to high and water and wind erosion is severe. Root zone is very shallow to shallow. • Surface layer: 0 to 4 inches (0 to 10 centimeters) is a brown sandy clay loam. Subsoil: 4 to 18 inches (10 to 46 centimeters) is a brown sandy clay loam. Underlying material: 18 to 24 inches (46 to 61 centimeters) is a white, indurated calcium carbonate with a 0.3-inch (0.8-centimeter) thick laminar cap. From 24 to 80 inches (61 to 203 centimeters), the material is white carbonatic soil that is 30 percent strongly cemented fragments of calcium carbonate.	• Used as rangeland. Produces a moderate amount of native plant forage with shallow and very shallow rooting depth, very low available water capacity, and limited rainfall as limitations affecting forage production. Poorly suited to most urban and recreational uses. Very shallow and shallow depth to the indurated layer is the main limitation.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Conger Loam, 0 to 2 Percent Slopes (CnA)	• Shallow, nearly level to gently sloping soil. Found along drainageways, ridges, and playas. Surface runoff and internal drainage are medium. Permeability moderate in the upper 16 inches (41 centimeters) and moderately slow or slow below 16 inches (41 centimeters). Soil-blowing (erosion) hazard and water erosion hazard are moderate. Shallow rooting zone and available water capacity is very low. • Indurated caliche is below a depth of 16 inches (41 centimeters). • Included in mapping are small areas of Blakeney, Kimbrough, Ratliff, Tencee, and Reagan soils. Included soils make up less than 20 percent of any one mapped area.	• Used mainly for range, low potential for growing a mixture of short and mid grasses. Low rainfall, very low available water capacity, and a shallow rooting zone limit the production of forage. Low potential for most urban uses. The shallow depth to indurated caliche is the limiting feature. Medium potential for recreational uses because the soil is dusty.
Dune Land (DUB)	• Very deep, hummocky, eolian sand deposits on uplands. Available water capacity is low, permeability is rapid, and runoff is negligible. Soils are excessively drained with slight water erosion potential and severe wind erosion potential. Slopes generally range from 1 to 3 percent, and 2 to 35 percent on side slopes of sand dunes. Sand dunes are generally larger and more active on the northeastern side of the mapped areas and becoming more stabilized on the southwestern side. • Included in this map unit are small, concave blowout areas. These areas receive more runoff water than the rest of the unit and remain moist for longer periods. Also included are small areas of Elgee and Penwell soils. Penwell soils are sand dunes that have become stabilized and are producing vegetation.	• Used mainly as rangeland, but it provides very little forage for livestock. Not suitable for cultivation and poorly suited for urban and recreational uses because of soil-blowing hazard.
Ector-Rock Outcrop Association, Steep	• Very shallow stony soils on limestone hills and mountains. Well drained soil, surface runoff is rapid, permeability is moderate, and available water capacity is very low. Water-erosion hazard is moderate, and soil-blowing hazard is slight. Slope range is 20 to 45 percent. Scattered areas of rock outcrop as ledges and escarpments on the sides and on eroded tops. • Included in mapping are small areas of Dev, Hodgins, Reagan, Sanderson, and Upton soils.	• Not suited to irrigated crops, hay, pasture, or orchards because of very shallow root zone, very low available water capacity, high volume of stones and gravel, and steep slopes. Used mainly for rangeland. Medium potential for native range plant and wildlife habitat due to low rainfall, low available water capacity, and rapid runoff. Low potential for openland wildlife habitat. Low potential for most urban and recreational uses due to steep slopes, depth to limestone bed rock, and large amount of gravel and stones.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Ector-Upton Association, Gently Undulating	• Soils are shallow and very shallow over bedrock or a cemented pan. Located on limestone plateaus and mesa tops. Well drained soils, surface runoff is medium to rapid, permeability is moderate, and available water capacity is very low. Water-erosion hazard is moderate, and soil-blowing hazard is slight. Slope range is 1 to 4 percent. • Included in the mapping are small areas of Lozier, Iraan, and Dalby soils. Ector • This layer rests on top fractured limestone bedrock. Upton • From 18 to 24 inches (46 to 61 centimeters) the soil is indurated caliche. From 24 to 40 inches (61 to 102 centimeters) the soil is weakly cemented caliche.	• Mainly used as rangeland. Not suited to irrigate crops due to very low available water capacity, shallow root zone, and high content of coarse fragments. Low potential for native plant growth as well due to low rainfall, very low available water capacity, and lack of runoff from other areas. Low potential for openland and rangeland wildlife habitat. Low potential for most urban uses due to shallowness over indurated caliche or limestone bedrock and high content of small stones. Large amount of small stones on the surface, steep slopes, and depth to bedrock or indurated caliche make potential for recreational uses medium.
Elgee-Penwell Complex, Gently Undulating (EPB)	• These deep, sandy soils formed in eolian deposits, are found on upland plains and ridges. They have slopes that are generally convex and range from 1 to 5 percent, but can be as much as 30 percent on the side slopes of some dunes. • Included in this mapped area are small areas of active sand dunes and areas of Pyote and Wickett soils. The active sand dunes are hummocky areas that are devoid of vegetation because of shifting sands. Elgee • Nearly level to gently undulating and stabilized against wind erosion. Available water capacity is low, permeability is moderately rapid, and runoff is negligible to very low. Soils are well drained with a very deep root zone, slight water erosion hazard and severe wind erosion hazard. Penwell • Hummocky and intermixed with and adjacent to active sand dunes. Available water capacity is very low, permeability is rapid, and runoff is negligible to very low. These excessively drained soils have a very deep root zone, slight water erosion hazard, and severe wind erosion hazard.	• Elgee and Penwell soils are used mainly as rangeland as they produce a large amount of native forage. The vegetation on these soils responds well to summer showers. Well suited to most building site development. The main limitation affecting shallow excavations is instability of sidewalls. Soils are poorly suited as sites for most sanitary facilities because of seepage, poor filtering capacity, and sandy texture of the surface layer. Poorly suited for recreational uses due to the sandy surface layer.
Faskin and Douro Soils, Gently Undulating (FdB)	• Occupy the broad uplands. Slopes are convex and range from 0.5 to 3.0 percent. Soil profiles described as representative of the Faskin and Douro series. Soil-blowing hazard is moderate. Large amounts of fertilized crop residue need to be kept on the surface to maintain soil tilth, control soil blowing and water erosion. • Blakeney, Lipan, Slaughter, Stegall, and other soils similar to Douro soils are included as well.	• Most of the acreage used for rangeland, but a few areas are used for cotton and grain sorghum.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Faskin-Douro Association, Nearly Level (FDA)	• Located on uplands. Slopes range from 0 to 3 percent. Local shifting of soil by wind is evident in some places. • Included in mapping are small areas of Triomas soils, a soil similar to Faskin soils. Faskin • Available water capacity is medium. Surface runoff is slow to medium, internal drainage is medium, and permeability is moderate in these soils. Soil-blowing and water-erosion hazards are moderate. Rooting zone is deep and easily penetrated by plant roots. It ranges from 20 to 30 percent, by volume, calcium carbonate. Douro • Available water capacity is low. Surface runoff is slow, internal drainage is medium, and permeability is moderate. Soil-blowing and water-erosion hazards are moderate. Rooting zone is moderately deep, and plant roots easily penetrate to the cemented layer.	• Used mainly as rangeland. High potential for growing a mixture of short and mid grasses. Careful management, proper stocking, controlled grazing, and brush management needed to minimize soil blowing. Douro soils have low potential for urban uses due to indurated caliche. Faskin soils have high potential for urban uses. Low strength limits their use for local roads and streets but can be overcome by careful design and installation. Both soils have high potential for recreational uses.
Holloman-Monahans Complex, Gently Undulating (HMB)	• Very shallow and very deep soils, located on upland plains, knolls, and basins. Formed in alluvium containing significant amounts of calcium carbonate and gypsum. Slopes are linear to convex and range from 0 to 5 percent. Holloman and Monahans soils are underlain by gypsum that dissolves when wet, forming sink holes or solution caverns. • Included in this complex are small areas of Pajarito, Reeves, and Wink soils. Pajarito and Wink soils are not underlain by gypsum. Holloman • Very low water capacity, moderate upper permeability and slow underlying material permeability. Well drained soils with negligible to very low runoff and very shallow to shallow root zone. Water and wind erosion hazard is severe. Monahans • Moderate water capacity, moderate permeability, and a very deep root zone. Runoff in negligible to very slow, wind erosion is severe and water erosion is moderate. • Surface layer is 0 to 8 inches (0 to 20 centimeters) and is a brown fine sandy loam. Subsoil (8 to 30 inches [20 to 76 centimeters]) is a pale brown fine sandy loam. Underlying material from 30 to 60 inches (76 to 152 centimeters) is a white, gypsiferous sandy clay loam with visible calcium carbonate and gypsum crystals.	• Holloman and Monahans soils are used as rangeland. Holloman soil produces a small amount of forage limited by very low available water capacity and very shallow rooting depth. Monahans soil produces a moderate amount of forage limited by rainfall and moderate available water capacity. Maintaining an adequate vegetative cover is essential for minimizing wind erosion. Holloman soil is poorly suited to most urban uses because of the depth to gypsum bedrock, excess salt, excess gypsum, and the hazard of soil subsidence. Monahans soil is moderately suited to most urban uses. Excess salt and excess gypsum are the main limitations affecting urban uses. Holloman soil is poorly suited to most recreational uses due to the depth to gypsum bedrock and excess gypsum Monahans soil is well suited to most recreational uses.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Holloman-Reeves Association, Nearly Level (Ector) (HRA)	• Located on uplands with slopes that range from 0 to 3 percent. • Minor soils included in mapping are Kinco, Ima, Reakor, and Reagan soils and a soil similar to Reeves soils. Holloman • Medium surface runoff and internal drainage, and moderate permeability. Soil-blowing and water-erosion hazards are moderate. Very shallow plant rooting zone. Available water capacity is very low. Reeves • Surface runoff and internal drainage that are medium, and permeability is moderate. Soil-blowing and water-erosion hazards are moderate, with moderately deep rooting zone. Available water capacity is medium. This horizon ranges from 25 to 50 percent, by volume, calcium sulfate and calcium carbonate.	• Used mainly as rangeland. Low potential for growing a mixture of short and mid grasses. Holloman soils have low potential for most urban uses due to the depth to gypsum layer, low strength, and corrosivity. Reeves soils have a medium potential for urban uses. Shrink-swell, low strength, and corrosivity to uncoated steel are the limiting features. Both soils have medium potential for recreational uses because they are dusty.
Holloman-Reeves Complex, Nearly Level (Winkler) (HRA)	• Very shallow to very deep, located on upland plains, knolls, and basins. They formed in alluvial sediments and materials weathered from gypsum. Slopes are linear to convex and range from 0 to 3 percent. Both soils are underlain by gypsum that dissolves when wet, forming sink holes or solution caverns. • Included in this complex are small areas of Mentone, Monahans, Toyah, and Turney soils. Holloman • These well drained soils have a very low water capacity, moderate to moderately slow permeability, and negligible to very slow runoff. Root zone is very shallow to shallow and the potential for water and wind erosion is severe. Reeves • These well drained soils have a low water capacity, moderate permeability and negligible to very low runoff. Root zone is moderately deep, and water and wind erosion hazard is moderate.	• Holloman and Reeves soils are used as rangeland and for wildlife habitat. Holloman soil produces a small amount of forage due to very low available water capacity and very shallow and shallow rooting depth. Reeves soil produces a moderate amount of forage because of limited rainfall and low available water capacity. Holloman and Reeves soils are poorly suited to most urban uses because of the depth to gypsum bedrock, excess salt, excess gypsum, and the hazard of soil subsidence. Holloman soil is poorly suited to most recreational uses because of the very shallow depth to gypsum bedrock, excess salt, and the hazard of erosion. Reeves soil is moderately suited to most recreational uses due to excess salt, dusty surface conditions, and the hazard of erosion.
Ima Loamy Fine Sand, 0 to 3 Percent Slopes (ImB)	• Nearly level to gently sloping soil, occurs on uplands. Soil-blowing hazard is severe. Large amounts of crop residue need to be kept on the surface to help control soil blowing and water erosion and to help maintain soil tilth. • Included in mapping are small areas of Blakeney, Jalmar, and Triomas soils.	• Most of the acreage used for rangeland. Soil not suited to dryland farming, but suited to irrigated farming. A few areas are used for cotton and grain sorghum.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Irann Silty Clay Loam, Occasion-ally Flooded	• Deep soil located in draws and drainageways that drain limestone hills and mountains. Slopes range is 0 to 1 percent. Flooding of very brief duration occurs about once in two years, usually in July through October due to excess runoff from limestone hills and mountains during heavy rains. Well drained soil, medium surface runoff, moderate permeability is moderate, and available water capacity is high. Water-erosion hazard is moderate, and soil-blowing hazard is slight. • Included in this map unit are small areas of Hodgins and Reagan soils.	• Most of the acreage is irrigated cropland, pastureland, hayland, or pecan (***Carya illinoensis***) orchards. Because of occasional flooding, diversions are needed to avoid flood damage to crops. Some areas are idle cropland, and some have returned to native rangeland. High potential for rangeland and medium for open land and rangeland wildlife habitats. Low potential for most urban uses due to the flooding hazard. Medium potential for most recreation uses. The most limiting factor is the flood hazard. Soil is also slippery and sticky when wet, and slow to dry.
Jalmar-Penwell Association, Undulating (JPC)	• Located on uplands. Slopes range from 1 to 8 percent. Local shifting of soil by wind is evident in some places. • Included in mapping are small areas of Dune land and Pyote soils. Jalmar • Available water capacity is low, surface runoff is slow, permeability is moderate and internal drainage is medium in Jalmar soils. Soil-blowing hazard is severe, and water-erosion hazard is slight. Rooting zone is deep and easily penetrated by plant roots. The underlying layer is a reddish yellow, calcareous sandy clay loam that contains 35 percent, by volume, calcium carbonate. Penwell • Surface runoff is slow, internal drainage and permeability is rapid, and available water capacity is low. Soil-blowing hazard is severe, and water-erosion hazard is slight. Rooting zone is deep and easily penetrated by plant roots.	• Used mainly as rangeland. Medium potential for growing a mixture of tall and mid grasses. Careful management needed to minimize soil blowing. Proper stocking, controlled grazing, and brush management needed. High potential for urban uses. Low potential for recreational uses because soils are too sandy.
Kermit-Dune Land Association, Hummocky (KD)	• Gently undulating to hummocky areas. Located in broad areas on uplands. • Included in this mapping unit are areas of Pyote soils, 20 to 40 acres (8 to 16 hectares) in size that occupy slightly concave, irregularly shaped interdune areas.	• Used mostly for rangeland and recreation.
Kimbrough Association, Nearly Level (KUA)	• Located on uplands. Slopes are weakly convex to slightly concave and range from 0 to 3 percent. Surface runoff is slow to medium, internal drainage is medium, and permeability is moderate. Soil-blowing hazard is moderate, and water-erosion hazard is slight. Rooting zone is very shallow to shallow and available water capacity is very low. • Included in mapping are small areas of Slaughter, Conger, and Lipan soils and a soil similar to Blakeney soils, which have a layer of clay accumulation over indurated caliche.	• Used mainly for rangeland. Low potential for a mixture of short and mid grasses. Low potential for most urban uses due to depth to indurated caliche and corrosivity to uncoated steel. High potential for most recreational uses. • Main hazards are soil-blowing and soil subsidence. Potential for corrosivity to uncoated steel is another factor.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Kimbrough Soils, Gently Undulating (KmB)	• Slopes are weakly convex to slightly concave and range from 0 to 3 percent. One of these soils has the profile described as representative for the Kimbrough series, but in places the surface layer is clay loam rather than loam. • Included in mapping are small areas of Conger, Lipan, and Slaughter soils.	• Most of the acreage is used for rangeland, recreational areas, and wildlife habitat.
Kimbrough-Stegall Association, Nearly Level (KSA)	• Located on uplands and slopes range from 0 to 3 percent. • Included in mapping are areas of Conger, Slaughter, and Lipan soils and a soil similar to Stegall soils that lack indurated caliche. Kimbrough • Available water capacity is very low, surface runoff is slow to medium, internal drainage is medium, and permeability is moderate. Soil-blowing hazard is moderate, and water-erosion hazard is slight. Plant rooting zone is very shallow to shallow. The underlying layer is strongly cemented caliche in the upper part and weakly cemented caliche in the lower part. Stegall • Located in rounded, nearly level, slight depressions. Available water capacity is low, surface runoff is slow, internal drainage is medium, and permeability is moderately slow. Water-erosion hazard is moderate and soil-blowing hazard is slight. Rooting zone is moderately deep and easily penetrated by plant roots.	• Used mainly as rangeland. Kimbrough soils have low potential for growing short and mid grasses. Very shallow to shallow depth to caliche and very low available water capacity are the main limiting features. Stegall soils are deeper and have a higher available water capacity than Kimbrough soils, so they can produce more forage. Low potential for most urban uses. Depth to indurated caliche, which is the main limiting feature for this use, can be overcome by careful design and installation. Potential for most recreational uses is high.
Kinco-Blakeney Complex, Nearly Level (KBA)	• Very shallow and very deep soils, located on upland plains and knolls. Formed in calcareous loamy materials of eolian and alluvial origin. Slopes are linear to convex and range from 0 to 3 percent. • Included in this complex are small areas of Conger and Sharvana soils. Kinco • Well drained and have a moderate available water capacity with moderate permeability and negligible runoff. Root zone is very deep, water erosion hazard is slight and wind erosion hazard is severe. Blakeney • Well drained with very low water capacity with moderately rapid permeability in the upper layers and very slow in the indurated layer. Runoff is low to negligible, root zone ranges from shallow to very shallow, and water and wind erosion potential is severe.	• Kinco and Blakeney soils are used as rangeland and for wildlife habitat. Kinco soil produces a large amount of native range forage, while Blakeney soil produces a moderate amount, which is limited by very shallow and shallow rooting depth and very low available water capacity. Kinco soil is well suited to most urban uses. Seepage is a limitation affecting sewage lagoons in areas though. Blakeney soil is poorly suited to most urban uses because of very shallow and shallow depth to indurated calcium carbonate and excessive seepage. Kinco soil is well suited to most recreational uses while Blakeney soil is poorly suited to these uses due to very shallow and shallow depth to indurated calcium carbonate as well as dusty surface conditions.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Kinco-Ima Association, Gently Undulating (KWB)	• Located on uplands with slopes ranging from 1 to 5 percent. Local shifting of soils by wind is evident in some places. • Included in the mapping unit are small areas of a soil similar to the Reeves soil, which has a loamy fine sand surface layer and a gypsum lower layer. Kinco • Surface runoff on Kinco soils is slow, internal drainage is medium, available water capacity is medium and permeability is moderately rapid. Soil-blowing hazard is severe, water-erosion hazard is slight, and rooting zone is deep. Ima • Surface runoff on Ima soils is slow, internal drainage is medium, and permeability is moderately rapid. Soil-blowing hazard is severe, and water-erosion hazard is slight. Rooting zone is deep and available water capacity is medium.	• Used mainly for rangeland. Low potential for growing a mixture of short and mid grasses. Management concerns include proper stocking, controlled grazing, and brush management. High potential for urban uses. Medium potential for most recreational uses due to the sandy surface.
Lipan Clay, Depression-al (Lc)	• Nearly level soil in slightly concave playas. Slopes range from 0 to 1 percent. Surface runoff is very slow to ponded. water enters the cracked soil rapidly, but after the cracks are closed, water movement into the soil is very slow. In wet years water stands on the surface until it evaporates in the spring or fall. Soil-blowing hazard is moderate, and water-erosion hazard is slight. Rooting zone is deep and available water capacity is high.	• Used mainly as rangeland. High potential for growing short and mid grasses, but occasional flooding can affect forage production. Low potential for most urban uses. Low potential for most recreational uses because of flooding and the clayey surface texture. • Limitations: flooding, very high shrink-swell, low strength, and corrosivity to uncoated steel.
Lozier Association, Hilly	• Very shallow to shallow stony and gravelly soils on limestone hills. Slope ranges from 10 to 25 percent. Soils are well drained, surface runoff is medium to rapid, permeability is moderate, and available water capacity is very low. Water-erosion hazard is moderate and soil-blowing hazard is slight. • Included in mapping are small areas of Delnorte, Hodgins, Reakor, and Upton soils and spot of Lozier soils that have slopes of 10 to 20 percent.	• Used as rangeland. Not suited to irrigated crops, hay, pasture, or orchards. Low potential for native range plants because very low rainfall and very low available water capacity limit the amount of forage. Low potential for openland and rangeland wildlife habitat. Low potential for most urban and recreation uses. Slope, shallowness to bedrock, and large amount of small stones are the most limiting factors.
Lozier-Rock Outcrop Association, Steep	• Slope range is 20 to 45 percent. Very shallow stony soils on limestone hills and mountains. Found on the crests and sideslopes. Limestone crops out along the sharp breaks and escarpments. Well drained, medium to rapid surface runoff, moderate permeability and very low available water capacity. Water-erosion hazard is moderate, and soil-blowing hazard is slight. • Included in some places are areas of Hodgins, Reakor, and Upton soils and soils that are similar to Lozier soil.	• Same use as that for Lozier Association, hilly.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
McCarran Soils, Nearly Level, Nearly Level (MC)	• Located on uplands. Slopes are 0 to 1 percent. • Included with these soils in mapping are small areas of Delnorte soils, 2 to 10 acres (0.8 to 4.0 hectares) in size, on knobs or hilltops, and small areas of Monahans soils, 1 to 5 acres (0.5 to 2.0 hectares) in size, in circular, slightly concave areas. A few areas of McCarran soils that have slopes up to 3 percent are also included.	• Most of these soils are native rangeland and because rooting depth is shallow, are not suitable for cultivation.
Monahans Fine Sandy Loam, 0- to 2-Percent Slopes (MO)	• Soil-blowing hazard is moderate. • Included with this soil are small, circular areas of McCarran soils, and Kinco soils.	• Suitable for cultivation where sufficient irrigation water is available. Management is needed to maintain soil tilth and control soil blowing. Crops that produce cover and large amounts of residue should be planted.
Patricia Fine Sand (Bs)	• Found on plains. These soils are sandy eolian deposits from blackwater draw formations of the Pleistocene age. They have slopes of 0 to 3 percent. Well drained soils with available water capacity that is moderate.	
Penwell-Dune Land Association, Rolling (PDD)	• Located on uplands. Most areas have a duned topography, but some are smooth. Slopes range from 5 to 16 percent. Local shifting of soil by wind is evident in some places. Internal drainage and permeability are rapid and surface runoff is slow. Soil blowing hazard is severe and water-erosion hazard is moderate. Soils are deep and easily penetrated by plant roots and available water capacity is very low. • Included in mapping are small areas of Jalmar and Pyote soils and a soil that is similar to Reeves soils, but has a fine sand surface layer over gypsum. Penwell • Surface soils have a brown, noncalcareous, fine sand surface layer about 13 inches (33 centimeters) thick. The underlying layer, to a depth of 80 inches (203 centimeters), is noncalcareous fine sand that is light brown in the upper part and pink in the lower part. Dune land • Surface consists of light colored, eolian sands that show little evidence of soil development. Dunes are active and are constantly shifted by the wind. They are especially unstable on the east and north sides. During years of low to normal rainfall these dunes have little vegetation except for shinnery and tall grasses on the outer edges and between the dunes. During consecutive years of above-average rainfall these dunes support sparse tall grasses and annuals.	• Used mainly as rangeland. Medium potential for growing a mixture of tall and mid grasses. Management to minimize soil blowing include proper stocking, controlled grazing, and brush management. Medium potential for most urban uses. Seepage, a sandy surface layer, and soil blowing are the main limiting features. The potential for most recreational uses is low because the surface is too sandy. Soil-blowing and soil subsidence are the major hazards affecting the area.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Penwell-Dune Land Complex, Hummocky (PND)	• Deep soil and sandy eolian deposits on upland plains. Slopes are generally convex ranging from 1 to 3 percent, but can be as much as 30 percent on the side slopes of some dunes. • Included in this complex are small areas of Elgee and Pyote soils. Penwell • Available water capacity is very low, permeability is rapid and runoff is negligible. These excessively drained soils have a very deep root zone, slight water erosion hazard, and severe wind erosion hazard. Dune land • (See Dune land description above.)	• Used as rangeland. Penwell soil produces a large amount of native forage, but the Dune land is devoid of vegetation due to shifting sands. It is moderately suited to most urban uses. Droughty conditions and the instability of sidewalls are the main limitations affecting building site development. Seepage, poor filtering capacity, and sandy textures are the main limitations affecting sanitary facilities. This complex is poorly suited to recreational uses because of the sandy texture and droughty conditions.
Portales Clay Loam (Po)	• Occupies floodplains of intermittent streams and draws. Its areas are narrow and several miles long. Receives excess runoff water from surrounding areas and occasionally subject to flooding. Soil-blowing hazard is slight. Slopes range from 0 to 1 percent. • Included in mapping are areas of Ratliff soils, and areas of soil similar to this Portales soil.	• Most of the acreage is used for rangeland, although soil is suitable for cultivation if protected from flooding. Large amounts of fertilized crop residue need to be kept on the surface to maintain soil tilth and control soil blowing and water erosion.
Potter Soils, Sloping (PtC)	• Found on the sides of Mustang and Seminole Draws. Water-erosion hazard is moderate, and soil-blowing hazard is slight. Slopes are convex and range from 5 to 8 percent. • Surface layer is mainly loam but, in some areas, is gravelly loam. • Included in mapping are small areas of Blakeney and Ima soils, and some of Potter soils that have slopes of 3 to 5 percent and 8 to 12 percent.	• Most of the acreage is used for rangeland. Erosion can be controlled by maintaining a good cover of grasses.
Pyote Fine Sand, Gently Undulating (POB)	• Very deep, gently undulating, hummocky soil, found on upland plains. Formed in sandy sediments of eolian or alluvial origin. Available water capacity is low, permeability is moderately rapid, and soils are well drained. Runoff is negligible to very low and root zone is very deep. Water erosion hazard is slight while wind erosion hazard is severe. Slopes are generally convex and range from 0 to 5 percent. • Included with this soil in mapping are Elgee, Penwell, Sharvana, and Wickett soils and small areas of active sand dunes.	• Used as rangeland. Produces a large amount of middle height and tall native grasses. Maintaining a vegetative cover helps to minimize wind erosion. Moderately suited to most urban uses. Seepage, poor filtering capacity, and the sandy texture are the main limitations affecting sanitary facilities. Instability of sidewalls is the main limitation affecting shallow excavations. Poorly suited to recreational uses because of the sandy surface.
Pyote Soils, Undulating (PY)	• These severely susceptible to soil-blowing soils occupy broad upland plains. Slopes are 1 to 4 percent. • Included in this soil in mapping is a similar soil that has a lower layer of sandy clay loam with a smooth surface. Also included are oblong areas of Wickett and Sharvana soils.	• Most areas are used for rangeland, and a few small areas are used for housing and commercial development as well as irrigated crops.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Pyote-Penwell Complex, Gently Undulating (PPB)	• Deep, well drained soils located on upland plains and formed in eolian sands. Slopes are linear to convex and generally range from 1 to 5 percent but are as much as 30 percent on the side slopes of some dunes. • Included in this complex are small areas of Elgee soils and active sand dunes. Pyote • Available water capacity is low, permeability is moderately rapid, and runoff is negligible to very low. Soils are well drained with a very deep root zone, slight water erosion hazard and severe wind erosion hazard. Penwell • Available water capacity is very low, permeability is rapid and runoff is negligible to very low. These excessively drained soils have a very deep root zone, slight water erosion hazard, and severe wind erosion hazard.	• Pyote and Penwell soils are used as rangeland and for wildlife habitat, as they produce a large amount of native forage. Moderately suited to most urban uses. Because of the sandy texture and rapid and moderately rapid permeability, soils may not adequately filter effluent, making seepage a limitation for most sanitary facilities. Walls of shallow excavations may be unstable and slough. Poorly suited to most recreational uses because of the sandy surface layer. These soils are droughty, and the wind-erosion hazard is severe if soils are disturbed.
Ratliff Association, Nearly Level (RFA)	• Found on uplands. Slopes are concave and range from 0 to 3 percent. Surface runoff and internal drainage are medium, and permeability is moderate. Soil blowing hazard and water erosion hazard are moderate. Deep and easily penetrated by plant roots. Available water capacity is medium. • Included in mapping are small areas of Kinco, Conger, Reeves, Reagan, and Lipan soils.	• Used mainly as range, high potential for growing a mixture of short and mid grasses. Proper stocking, controlled grazing, and brush management needed. High potential for urban uses. Moderate corrosivity to uncoated steel and low strength for local roads and streets. But these limitations can be overcome with careful design and installation. High potential for most recreational uses.
Reagan-Hodgins Association, Nearly Level	• Deep soils in valleys and plains. Well drained soils, surface runoff is slow, permeability is moderate, and available water capacity is medium for Reagan soil and high for Hodgins soil. Water-erosion hazard is moderate, and soil-blowing hazard is slight. Slopes range from 0 to 1 percent. Included are small areas of Dalby, Iraan, and Upton soils. Regan • Surface typically is friable, moderately alkaline, brown silty clay loam about 8 inches (20 centimeters) thick. The next layer from 8 to 32 inches (20 to 81 centimeters) is a moderately alkaline, yellowish brown silty clay loam soil. Between 32 and 60 inches (81 and 152 centimeters) the soil is very pale brown silty clay loam that is moderately alkaline and about 35 percent by volume soft masses of calcium carbonate. Hodgins • Surface typically is very friable, moderately alkaline silty clay loam about 24 inches (61 centimeters) thick. This layer is light brownish gray in the upper part and light brown in the lower part. The next layer from 24 to 44 inches (61 to 112 centimeters) is moderately alkaline, pink silty clay loam.	• Used as rangeland. High potential for some irrigated crops if a sufficient quantity of good quality irrigation water is available. High potential for native range plants. Low rainfall, high dry winds, and brush infestation limit the amount of forage produced making the potential low for openland wildlife habitat and medium for rangeland habitat. Medium potential for most urban and recreation use. Major limiting factors include high shrink-swell potential and slippery and sticky conditions when wet. They are also slow to dry and have a dusty surface.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Sanderson Association, Gently Undulating	• Deep gravelly soils on uplands. Well drained soils, surface runoff is medium, permeability is moderate, and available water capacity is low. Water-erosion and soil-blowing hazards are slight. Slope ranges from 1 to 5 percent. • About 75 percent of this map unit is Sanderson soil and 25 percent is other soils. Included in this mapping are small areas of Delnorte, Hodgins, Reagan, Reakor, and Upton soils.	• Used for rangeland. Low potential for irrigated crops because of low available water capacity, high content of limestone fragments, and slope. Low potential for native range plants because of low rainfall and low available water capacity. Low potential for openland wildlife habitat and medium for rangeland habitat. High potential for most urban uses and medium for most recreational uses due to the amount of small stones on the surface.
Sharvana Soils, Nearly Level (SH)	• Located in broad areas on uplands. Surface is smooth with a moderate soil-blowing hazard. Soil material has been blown around individual grass and mesquite plants in small mounds. Slopes are convex ranging from 0 to 1 percent. • A few areas of Sharvana soils that have slopes of up to 4 percent are also included.	• Most areas of these soils are used for rangeland, and are not suitable for cultivation because of shallow depth. The caliche under these soils is used as a source of road-building material.
Stegall-Slaughter Association, Nearly Level (SSA)	• Found on uplands. Slightly concave slopes, range from 0 to 1 percent. • Included in mapping are small areas of Kimbrough and Conger soils and a soil that is similar to Stegall soils but lacks indurated caliche. These inclusions make up less than 20 percent of any one mapped area. Stegall • Surface runoff is slow, internal drainage is medium, and permeability is moderately slow. Water-erosion hazard is moderate and soil-blowing hazard is slight. Moderately deep root zone. Soils easily penetrated by plant roots. Available water capacity is low. Slaughter • Slow surface runoff, medium internal drainage, and moderately slow permeability. Water-erosion hazard is moderate, and soil-blowing hazard is slight. Shallow plant root zone. Available water capacity is very low.	• Used mainly as rangeland. Medium potential for growing a mixture of short and mid grasses. Management includes proper stocking, controlled grazing, and brush management. Low potential for most urban uses because of shallow or moderately deep cemented layer. Medium potential for most recreational uses. The main hazards are soil-blowing and flooding and soil subsidence. Potential for corrosivity to uncoated steel is another factor.
Triomas and Wickett Soils, Gently Undulating (TwB)	• Located on uplands. Soil-blowing hazard is severe and slopes range from 0 to 5 percent. Profiles of these soils are similar to the Triomas and Wickett series.	• Most of the acreage is used for rangeland. Not suited to dryland farming but suited to irrigated farming. Large amounts of crop residue need to be kept on the soil surface to help control soil blowing and maintain soil tilth.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Triomas Loamy Fine Sand, 0- to 3-Percent Slopes (TrB)	• Nearly level to gently sloping soil located on uplands with slopes that are convex. Surface runoff is slow to very slow, internal drainage is medium, available water capacity is medium, and permeability is moderate. Soil-blowing hazard is severe, and water-erosion hazard is slight. The soil is deep and easily penetrated by plant roots. Local shifting of soil by wind is evident in some places. • Included in mapping are small areas of Faskin, Jalmar, Douro, and Wickett soils.	• Used mainly for rangeland with medium potential for growing a mixture of tall grasses. Management concerns include proper stocking, controlled grazing, and brush management to reduce soil-blowing. High potential for most urban uses with low strength as the main limitation in constructing local roads and streets. Medium potential for most recreational uses because the soil is sandy.
Upton Association, Gently Sloping	• Gravelly soils on uplands. Soils are very shallow to shallow over a cemented pan. Well drained soils, surface runoff is medium, and permeability is moderate. Available water capacity is very low due to the shallowness and gravel content. Water erosion hazard is moderate, and soil-blowing hazard is slight. Slope range is 1 to 3 percent. • Included in mapping are small areas of Hodgins, Reagan, and Sanderson soils and areas of a shallow to very shallow soil where the surface layer is less than 15 percent gravel.	• Used for rangeland. Not suited to irrigated crops because of shallowness over indurated caliche, high gravel content, and lack of a supply of irrigation water. Low potential for native range plants because of low rainfall and very low available water capacity. Low potential for most urban uses. The most limiting feature is shallowness over indurated caliche. Medium potential for most recreation use due to dusty surface and large amount of small stones on the surface.
Upton-Reagan Association, Gently Undulating (URB)	• Upton soils are found on convex knolls on uplands and Reagan soils are found in concave areas on uplands. Slopes range from 1 to 5 percent. • Included in mapping are areas of Conger, Blakeney, Tencee, and Lipan soils and a soil that is similar to Reagan soils. Upton • Surface runoff and internal drainage are medium, and permeability is moderate. Soil blowing hazard is slight, and water erosion hazard is moderate. Plant rooting zone is very shallow to shallow over indurated caliche. Available water capacity is very low. Reagan • Surface runoff is slow, internal drainage is medium, and permeability is moderate in Reagan soils. Soil-blowing hazard and water erosion hazard are moderate. Rooting zone is deep, and soils are easily penetrated by plant roots. Available water capacity is high.	• Used mainly as rangeland • Upton soils have low potential for growing a mixture of short and mid grasses. The very shallow to shallow depth to indurated caliche is their main limiting feature. Upton soils have low potential for most urban uses. High corrosivity to uncoated steel and very shallow to shallow depth to indurated caliche are the main limiting features. • Reagan soils are deeper and have a higher water holding capacity and, therefore, a medium potential for range production. Reagan soils have medium potential for most urban uses. Low strength and moderate shrink-swell properties are their main limiting features. • Potential for recreational uses is medium because soils are dusty, and Upton soils have small stones.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Wickett and Sharvana Fine Sandy Loams, Gently Sloping (WT)	• These soils have 1 to 2 percent slopes. • Included with these soils in the mapping area are long or oval areas of Pyote soils. Wickett • Reddish-brown, noncalcareous fine sandy loam surface layer about 8 inches (20 centimeters) thick. A layer of indurated caliche is at a depth of 36 inches (91 centimeters). Sharvana • Reddish-brown, noncalcareous, sandy loam surface layer about 6 inches (15 centimeters) thick. The next layer is reddish-brown, friable, noncalcareous fine sandy loam about 16 inches (25 centimeters) thick. A layer of pink, strongly cemented caliche is at a depth of 16 inches (41 centimeters).	• Most areas are used for rangeland, but a few small areas are used for irrigated crops.
Wickett and Sharvana Soils, Gently Undulating (WS)	• Slopes range from 1 to 3 percent. Soil-blowing hazard is severe. • Included with these soils in mapping are small oval areas of Sharvana fine sandy, as well as circular Pyote soils. Wickett • Surface layer is reddish-brown, noncalcareous loamy fine sand about 14 inches (36 centimeters) thick. The next layer is yellowish-red, noncalcareous fine sandy loam about 16 inches (41 centimeters) thick. The underlying material is weakly cemented to indurated caliche that extends to a depth of 38 inches (97 centimeters). Sharvana • Reddish-brown loamy fine sand surface layer about 4 inches (10 centimeters) thick. The next layer is reddish-brown, very friable, noncalcareous fine sandy loan about 9 inches (23 centimeters) thick. Below this is about 3 inches (8 centimeters) of pinkish-white caliche fragments, with brown fine sandy loam between the fragments. The next layer, at a depth of 16 inches (41 centimeters), is made up of pink caliche plates.	• Most areas are used for rangeland, but a few small areas are used for irrigated crops. The caliche under these soils is used as a source of road-building material.
Wickett Association, Gently Undulating (WAB)	• Found on uplands with slopes that are convex and range from 1 to 5 percent. Surface runoff is very slow, internal drainage is medium, available water capacity is very low, and permeability is moderately rapid. Soil-blowing hazard is severe, and water-erosion hazard is slight. Soils are moderately deep and easily penetrated by plant roots. • Surface layer is made up of loamy fine sand and fine sandy loam. Typically, it is a reddish brown, noncalcareous loamy fine sand about 12 inches (31 centimeters) thick. The next layer is yellowish red, noncalcareous fine sandy loam about 16 inches (41 centimeters) thick. Indurated platy caliche is located 28 inches (71 centimeters) deep. • Soils included in mapping are Triomas, Jalmar, Kinco, and Pyote soils and two soils that are similar to Wickett soils.	• Used mainly as rangeland. Medium potential for growing a mixture of mid and tall grasses. Management concerns include proper stocking, controlled grazing, and brush management. Medium potential for most urban uses with indurated caliche as the main limiting feature. Medium potential for most recreational uses due to the sandy soils. Soil-blowing is the major hazard.

Table 7.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Wickett-Pyote Complex, Gently Undulating (WCB)	• Moderately deep to very deep soils, formed on upland plains in loamy and sandy materials deposited by wind and water. Slopes are convex and range from 1 to 5 percent. • Included in mapping are small areas of Elgee, Kinco, and Sharvana soils. Wickett • Well drained soils, low available water capacity, moderate to slow permeability and low runoff. Root zone is moderately deep. Water erosion hazard is moderate while wind erosion hazard is severe. Pyote • Well drained soils with a very deep root zone. Water capacity is low, permeability is moderate to slow, and runoff is negligible to very slow. Water erosion hazard is slight while wind erosion hazard is severe.	• Used mainly as rangeland and for wildlife habitat. Produce a large amount of native range forage. The relationship between soils, plants, and water is favorable in this complex, and soils make efficient use of summer showers to produce forage. Wickett soil is poorly suited to most urban uses due to depth to indurated caliche and seepage. Pyote soil is moderately suited to most building site development and is poorly suited to most sanitary facilities. Sandy texture, seepage, poor filtering capacity, and instability of sidewalls are the main limitations. Wickett soil is well suited to most recreational uses, and Pyote soil is poorly suited to most recreational uses due to the sandy texture of the surface layer. Main hazards are soil-blowing and soil subsidence.

Source: FG Alliance, 2006d.

Power Plant Site

Predominant soil types within the proposed power plant site include Conger loam (CnA); Ratliff association (RFA); and Upton-Reagan association (URB). Additional soil types present on the proposed power plant site, but with lesser distribution, include Faskin-Douro association (FDA); Wickett association (WAB); Kinco-Ima association (KWB); Blakeney fine sandy loam (BfA); and Reagan silty clay loam (RgA) (see Table 7.5-1).

Sequestration Site

The Lozier-Rock association is the predominant soil type at the proposed sequestration site (see Table 7.5-1).

Utility Corridors

CO_2 Corridor East of the Proposed Power Plant Site

Predominant soils found along the proposed CO_2 corridor east of the proposed power plant site include Ratliff association (RFA); Upton-Reagan association (URB); and Reagan silty clay (RgA) (see Table 7.5-1).

CO_2 Corridor West of the Proposed Sequestration Site

Predominant soils in the CO_2 pipeline corridor west of the site include Irann silty clay loam, occasionally flooded; Lozier association, hilly; Lozier-Rock outcrop association, steep; Reagan-Hodgins association, nearly level; and Upton association, gently sloping (see Table 7.5.-1).

CO_2 Corridor East of the Proposed Sequestration Site

Predominant soils in the CO_2 pipeline corridor east of the proposed sequestration site include Ector-Rock outcrop association, steep; Ector-Upton association, gently undulating; Lozier-Rock outcrop association, steep; Reagan-Hodgins association; Sanderson association; and the Upton association (see Table 7.5.-1).

Transmission Corridors

The Predominant soils found in both transmission corridors, north and south of proposed plant site, include the Ratliff association (RFA) and the Upton-Reagan association (URB) (see Table 7.5-1).

Crane County Water Injection System

The predominant soils in the proposed Crane County Water Injection System (CCWIS) water supply pipeline include Kermit-Dune land association, hummocky (KD); McCarran soils, nearly level, (MC); Monahans fine sandy loam, 0 to 2 percent slopes (Mo); Pyote soils, undulating (PY); Sharvana soils, nearly level (SH); Wickett and Sharvana soils, gently undulating (WS); Wickett and Sharvana fine sandy loams, gently sloping (WT); Dune land (DUB); Elgee-Penwell complex, gently undulating (EPB); Pyote-Penwell complex, gently undulating (PPB); Penwell-Dune land complex, hummocky (PND); Blakeney fine sandy loam, 0 to 2 percent slopes (BfA); Conger loam, 0 to 2 percent slopes (CnA); Faskin-Douro association, nearly level (FDA); Holloman-Reeves association, nearly level (HRA-Ector); Jalmar-Penwell association, undulating (JPC); Kinco-Ima association, gently undulating (KWB); Ratliff association, nearly level (RFA); Triomas loamy fine sand, 0 to 3 percent slopes (TrB); and Wickett association, gently undulating (WAB) (see Table 7.5-1).

Smith Water Supply Corridor

The predominant soils found in the proposed Smith water supply corridor include Elgee-Penwell complex, gently undulating (EPB); Pyote-Penwell complex, gently undulating (PPB); Penwell-Dune land complex, hummocky (PND); Holloman-Monahans complex, gently undulating (HMB); Holloman-Reeves association, nearly level (HRA-Winkler); Kinco-Blakeney complex, nearly level (KBA); Pyote fine sand, gently undulating (POB); Blakeney fine sandy loam, 0 to 2 percent slopes (BfA); Ratliff association, nearly level (RFA); Conger loam, 0 to 2 percent slopes (CnA); Faskin-Douro association, nearly level (FDA); Holloman-Reeves association, nearly level (HRA-Ector); Jalmar-Penwell association, undulating (JPC); Kinco-Ima association, gently undulating (KWB); Wickett association, gently undulating (WAB); and Penwell-Dune land association, rolling (PDD) (see Table 7.5-1).

WTWSS Water Supply Corridor

The predominant soils found within the West Texas Water Supply System (WTWSS) water supply corridor include Dune land (DUB); Elgee-Penwell complex, gently undulating (EPB); Pyote-Penwell complex, gently undulating (PPB); Penwell-Dune land complex, hummocky (PND); Holloman-Monahans complex, gently undulating (HMB-Winkler); Pyote fine sand, gently undulating (POB); Blakeney-Conger complex, gently undulating (BCB); Wickett-Pyote complex, gently undulating (WCB); Blakeney fine sandy loam, 0 to 2 percent slopes (BfA); Conger loam, 0 to 2 percent slopes (CnA); Faskin-Douro association, nearly level (FDA); Holloman-Reeves association, nearly level (HRA-Ector); Jalmar-Penwell association, undulating (JPC); Kinco-Ima association, gently undulating (KWB); Ratliff association (RFA); Triomas loamy fine sand, 0 to 3percent slopes (TrB); Wickett association, gently undulating (WAB); Upton-Reagan association, gently undulating (URB); and Penwell-Dune land association, rolling (PDD) (see Table 7.5-1).

Jackson Water Supply Corridor

The predominant soils found within the Jackson water supply corridor include Patricia fine sand (Bs); Blakeney and Conger soils, gently undulating (BcB); Jalmar-Penwell association, undulating (JPC); Portales clay loam (Po); Potter soils, sloping (PtC); Ratliff soils, gently undulating (RaB); Triomas and Wickett soils, gently undulating (TwB); Conger loam, 0 to 2 percent slopes (CnA); Faskin-Douro association, nearly level (FDA); Kimbrough-Stegall association, nearly level (KSA); Kimbrough association, nearly level (KUA); and Reagan silty clay loam, 0 to 1 percent slopes (RgA) (see Table 7.5-1).

Texland Water Supply Corridor

The predominant soils found within the Texland water supply corridor include Blakeney and Conger soils, gently undulating, (BcB); Faskin and Douro soils, gently undulating (FdB); Ima loamy fine sand, 0 to 3 percent slopes (ImB); Jalmar-Penwell association, undulating (JPC); Kimbrough soils, gently undulating (KmB); Ratliff soils, gently undulating (RaB); Triomas and Wickett soils, gently undulating (TwB); Blakeney fine sandy loam, 0 to 2 percent slopes (BfA); Conger loam, 0 to 2 percent slopes (CnA); Faskin-Douro association, nearly level (FDA); Jalmar-Penwell association, undulating (JPC); Kimbrough-Stegall association, nearly level (KSA); Ratliff association (RFA); Reagan silty clay loam, 0 to 1 percent slopes (RgA); Triomas loamy fine sand, 0 to 3 percent slopes (TrB); Upton-Reagan association, gently undulating (URB); Stegall-Slaughter association, nearly level (SSA); and Lipan clay, depressional (Lc) (see Table 7.5-1).

Whatley

The predominant soils found within the mapping area include Blakeney fine sandy loam, 0 to 2 percent slopes (BfA); Conger loam, 0 to 2 percent slopes (CnA); Faskin-Douro association, nearly level (FDA); Ratliff association (RFA); Upton-Reagan association, gently undulating (URB); Stegall-Slaughter association, nearly level (SSA); Lipan clay, depressional (Lc); Kimbrough-Stegall association, nearly level (KSA); Kimbrough association, nearly level (KUA); and Reagan silty clay loam, 0 to 1 percent slopes (RgA) (see Table 7.5-1).

A Phase I Environmental Site Assessment was performed on the proposed power plant site by Horizon Environmental Services (Horizon Environmental Services, 2006) in April of 2006. The results of that investigation do not indicate any significant recorded or observed soil contamination on the proposed power plant site.

7.5.3 IMPACTS

7.5.3.1 Construction Impacts

Direct impacts that could be caused during construction of the proposed power plant and associated infrastructure include removal of soil, soil-blowing and erosion due to wind and motion of equipment, soil compaction, and change in soil composition. Soil removal disturbs soil properties such as permeability and horizon structure, and disturbs vegetation. Soil-blowing could cause the movement of soil, making it unstable as well as unsuitable for vegetation growth. Soil compaction could cause changes in soil characteristics such as permeability, water capacity, surface runoff, root penetration, and water capacity. Indirectly, impacts to soils could result in soil erosion due to runoff and wind, potential decline in nearby surface water quality due to increased sedimentation, potential soil contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. BMPs would be used to minimize impacts (see Section 3.1.5).

Groundwater contamination is unlikely to occur due to the depth to the water table estimated to be between 200 and 800 feet (61 and 244 meters) deep.

Power Plant Site

Construction at the proposed power plant site would impact up to 200 acres (81 hectares) of soil. Soil impacts would result from construction of the proposed power plant, storage areas, associated processing facilities, research facilities, parking areas, access roads, and the on-site railroad loop. During construction, soil would be removed from areas where the foundations of the structures would be sited. This soil would be placed on a temporary storage site protected from erosion and runoff for reuse as topsoil replacement or as fill. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 200-acre (81-hectare) power plant footprint. Soils impacts would be permanent for areas converted into impervious surface areas (e.g., structure, pads and parking). Temporary soil compaction would occur in areas of temporary road construction and heavy equipment storage, soil-blowing and localized erosion would be likely during construction from equipment movement. Construction-related impacts to soils in areas not converted to impervious surfaces would be temporary and these areas would be restored after construction is completed.

Chemical spills could potentially affect on-site soil. Chemicals commonly used during construction include oils, paints, solvents, lubricants and cement. The quantities of these chemicals expected on site during construction are small. The use of segregation, storage, labeling, and adequate handling, as well as secondary containment and other spill prevention techniques, could minimize the potential for a spill to occur. Should a spill occur, it would be contained and would not be expected to permanently impact soil characteristics such as pH, porosity, humidity, and texture.

Soils present at the site are abundant throughout the region; therefore, overall impacts would not be adverse. The potential for impacts to prime farmland soil is discussed in Section 7.11.

Sequestration Site

The construction of the injection wells at the proposed sequestration site would result in the removal of up to 10 acres (4 hectares) of soil. Direct impacts would include the removal of soil, soil-blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sedimentation, groundwater contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. These impacts would be temporary. After completion of drilling, soil could be replaced using BMPs, or would be disposed of offsite. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 10-acre (4-hectare) footprint.

Utility Corridors

Potable and process water would be piped from wells to the proposed site. The proposed water pipeline corridor is expected to be 50 feet (15 meters) wide and up to 54 miles (87 kilometers) long. This would impact up to 327 acres (132 hectares) of soil. The proposed CO_2 pipelines would extend up to approximately 14 miles (22.5 kilometers) along a 50-foot (15-meter) corridor which would affect approximately 83 acres (33.6 hectares) of soil. Two 138-kV transmissions lines are within 2 miles (3.2 kilometers) of the proposed site, therefore, minimal construction would be needed for the short 70-foot (21-meter) wide transmission line. The amount of soil disrupted would depend on the interval of the towers to be constructed. In total, up to 341 acres (138 hectares) of disturbed land could be susceptible to removal, erosion, or compaction of soils due construction of the utility corridors.

Construction and upgrades for all utility corridors would cause minimal impacts due to soil removal and general construction activities. Direct impacts would include removal of soil, soil-blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sediment, groundwater contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. Soil could be replaced using BMPs to minimize impacts of removal. Impacts would be temporary (during construction).

Transportation Corridors

Existing roads are within 0.5 miles (0.8 kilometers) of the proposed power plant site; therefore minimal construction would be needed. The site is also accessible by rail and no new rail construction would be needed. The construction of the transportation corridors would disrupt approximately 1.8 acres (0.7 hectares) of soil on the proposed power plant site. Gravel access roads would be constructed on the proposed site and would therefore, not disturb any additional soil beyond the 200 acres (81 hectares) as described above for the proposed power plant site. Impacts related to any roadway improvements would include direct impacts such as the removal of soil, soil-blowing, and compaction. Indirect impacts would include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sediment, groundwater contamination due to spills, and a decrease in biodiversity due to changing soil characteristics.

7.5.3.2 Operational Impacts

Direct impacts that could occur from operations include soil contamination from spills, increased CO_2 concentration in soils due to CO_2 pipeline failures, and soil erosion due to wind. Indirect impacts would include a disruption in plant growth and subsurface organisms. Impacts to groundwater from spills would depend on the permeability and depth of the water table. The water table near the proposed Odessa Power Plant Site is estimated to be between 200 and 800 feet (61 and 244 meters) deep. The permeability of the soils on the proposed sites range from low to moderate and have varying water table depth that is higher during the spring and winter due to increased precipitation (FG Alliance, 2006d). Higher permeability soils with higher water tables would be affected to a greater extent than less permeable soils with lower water tables. Due to the depth of the water table (200 to 800 feet [70 to 244 meters]), groundwater contamination would be unlikely. It is expected that the impacts during operations would remain at a minimum due to the limited extent and current ecological status of the proposed site.

Power Plant Site

No additional soil disturbance is anticipated. Revegetation of disturbed areas during operations would minimize potential for erosion. During operation of the proposed plant and associated facilities, depending on amount and duration, storage of hazardous materials, as well as ash and coal piles, could cause soil contamination if in direct contact with the soil. Utilization of BMPs and construction of proper storage areas (impervious surfaces) would minimize the potential for adverse impacts.

Sequestration Site

During operations at the proposed sequestration site, the soil would not be disturbed; therefore, there would be no impacts to soils. Potential impacts due to a pipeline, surface equipment, or well failure are to be minimal, as risk abatement and safety procedures would be in place. Though it is highly unlikely, an increase of CO_2 concentration in the soil due to leaks could lower pH which could in turn cause a disruption in plant growth and occurrence of subsurface organisms (Damen et al., 2003) (e.g., microbes occurring approximately 0.9 mile (1.4 kilometers) underground; see Section 7.9). Some levels of ground subsidence and heave have been known to be caused by petroleum production/injection operations, disposal well operations, and natural gas storage operations. Since the CO_2 injection at the proposed Odessa Site would be at great depth and into very well consolidated rocks, the risks of any significant ground movement are small. Furthermore, since differential heave occurs most commonly when the underlying strata are tilted, faulted, or discontinuous, and the underlying strata at the proposed Odessa Site is horizontal, un-faulted, and continuous, there is a very low potential for differential settlement. Thus, the impacts of a small amount of ground heave are very likely to be negligible.

Utility Corridors

During operations the soil would not be disturbed around the utility corridors, therefore there would be no environmental impacts associated with operations or maintenance of vegetation around the utilities. Access within the utility corridors would occur through existing access roads or through access points constructed and maintained for any potential new corridors.

Transportation Corridors

During operations there would be little or no impacts to the soil due to transportation infrastructure corridor use and maintenance. Impacts could include soil-blowing, soil compaction, and soil removal.

7.6 GROUNDWATER

7.6.1 INTRODUCTION

This section addresses groundwater resources that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Odessa Power Plant Site, sequestration site, and related corridors.

7.6.1.1 Region of Influence

The ROI for groundwater resources includes aquifers that underlie the proposed power plant site, sequestration site, and aquifers that may be used to obtain water for construction and operations support. The horizontal extent varies, depending on the particular aspects of the groundwater resource, as follows:

- A distance of 1 mile (1.6 kilometers) from the proposed power plant site defines the general vicinity that could be affected by changes in groundwater quantity or quality due to the power plant footprint.
- A larger distance could be impacted by pumping from groundwater to supply the water needed for the facility. The ROI for these wells depends on specific aquifer properties of the formations being used and well design. The specific aquifers to be used and the locations of the wells have not been selected from the six candidate aquifers.
- A distance of 1 mile (1.6 kilometers) from each sequestration injection well defines the area that could be affected by potential leaks of CO_2 from the target reservoir to overlying aquifers. This distance is based on modeling that indicates that CO_2 could migrate up to 1 mile (1.6 kilometers) from the site of each injection well.
- The facility footprint (including utility and transportation corridors) defines where construction or other land disturbances could take place. These areas could be susceptible to changes in groundwater infiltration, discharge, or quality. Damage to, or loss of use of, an existing well (including the potential need for well abandonment) could also occur within the facility footprint.

7.6.1.2 Method of Analysis

DOE reviewed reports from state water authorities and information in the Odessa EIV (FG Alliance, 2006d) to assess the potential impacts of the proposed FutureGen Project on groundwater resources.

Uncertainties identified in relation to groundwater resources at the Odessa Site include the porosity, brine saturation, and permeability of the target formation where CO_2 would be sequestered. Analog well data was analyzed; however, site-specific test well data was not collected. Uncertainty also exists concerning the presence of transmissive faults or improperly abandoned wells in the area.

Because neither the specific aquifer to be used for the water supply nor well locations have yet been selected, the analysis addresses a number of aquifers that could be used.

DOE assessed the potential for impacts based on the following criteria:

- Depletion of groundwater supplies on a scale that would affect available capacity of a groundwater source for use by existing water rights holders, interference with groundwater recharge, or reductions in discharge rate to existing springs or seeps;
- Relationship to established water rights, allotments, or regulations protecting groundwater for future beneficial uses;

- Potential to contaminate a public water supply aquifer through acidification of the aquifer due to migration of CO_2; toxic metal dissolution and mobilization; displacement of groundwater with brine due to CO_2 injection; and contamination of aquifers due to chemical spills, well drilling, or well completion failures; and
- Conformance with regional or local aquifer management plans or goals of governmental water authorities.

7.6.2 AFFECTED ENVIRONMENT

This section describes groundwater resources present in the project area. In general, this description applies to all project areas, although site-specific data are presented where available and applicable.

7.6.2.1 Groundwater Quality

The Dockum and Rustler aquifers, designated minor aquifers by the State of Texas, lie beneath the proposed power plant site at depths up to 1,500 feet (457 meters) (TWDB, 1995). These aquifers would be potential sources for process water at the proposed power plant. No sole source aquifers have been designated around the proposed project area (EPA, 2006a).

The Dockum aquifer is composed of a variety of sediments of Triassic age and consists predominantly of a series of alternating sandstones and shales with an approximate thickness beneath the proposed power plant site of 0.2 mile (0.3 kilometer) (TWDB, 2003). The Santa Rosa formation is the basal portion of the Dockum and is typically the most productive and can be up to 130 feet (40 meters) thick (TWDB, 2003). The depth to groundwater in the Dockum was measured at 205.6 feet (62.7 meters) in 1947 in a well located immediately to the south of the proposed power plant site (TWDB, 2006a). However, it is estimated that the depth to groundwater is now approximately 320 feet (98 meters).

The Rustler formation of Permian age lies below the Dockum aquifer; however, it is too saline to be designated as an aquifer in this area, and therefore, is not discussed further.

Other than the Dockum and the Rustler aquifers, the following water sources are being considered for the proposed power plant. These water sources are:

- The Pecos Valley aquifer, which is categorized as a major aquifer in Texas. It is composed of sediments which include alluvial and wind-blown deposits in the Pecos River Valley. Thickness of the alluvial fill reaches 0.3 mile (0.5 kilometer), and freshwater-saturated thickness averages about 250 feet (76 meters). The water quality is highly variable, typically hard, and generally better in the Monument Draw Trough where total dissolved solids (TDS) are less than 1,000 milligrams per liter than in the Pecos Trough. High levels of chloride and sulfate in the aquifer, resulting from previous oil field activities, exceed secondary drinking water standards. In addition, naturally-occurring arsenic and radionuclides exceed primary standards. More than 80 percent of groundwater pumped from the aquifer is used for irrigation, and the rest is withdrawn for municipal supplies, industrial use, and power generation. Localized water level declines in south central Reeves and northwest Pecos counties have moderated since the late 1970s as irrigation pumping has decreased. However, water levels continue to decline in central Ward County due to increased municipal and industrial pumping. The projected water availability is 200,690 acre-feet (2.5 million cubic meters) per year from 2010 to 2060 (TWDB, 2006b).
- The Ogallala aquifer, which is the largest aquifer in the United States and is a major aquifer in Texas, underlying much of the High Plains region. This 800-foot (243.8-meter) thick aquifer consists of sand, gravel, clay, and silt. Freshwater-saturated thickness averages 95 feet (29.0 meters). Water to the north of the Canadian River is generally fresh, with TDS typically

less than 400 milligrams per liter. Naturally-occurring high levels of arsenic, radionuclides, and fluoride exceed the primary drinking water standards. The Ogallala aquifer provides significantly more water than any other aquifer in the state, primarily for irrigation. Although water level declines in excess of 300 feet (91.4 meters) have occurred in several areas over the last 50 to 60 years, the rate of decline has slowed, and water levels have risen in a few areas. Projected water availability from the Ogallala aquifer is estimated at 5,968,260 acre-feet ($7.4x10^9$ cubic meters) per year in 2010 to 3,534,124 acre-feet ($4.4x10^9$ cubic meters) per year 2060 (TWDB, 2006b).

- The Capitan Reef aquifer, which is an ancient reef consisting of 2,360 feet (720 meters) of dolomite and limestone. Overall, the aquifer contains low-quality water, yielding small to large quantities of slightly saline to saline groundwater with concentrations of 1,000 to greater than 5,000 milligrams per liter of TDS. High-quality water, with TDS between 300 and 1,000 milligrams per liter, is located in the west near areas of recharge where the reef rock is exposed in several mountain ranges. Although most of the groundwater pumped from the aquifer in Texas is used for oil reservoir flooding in Ward and Winkler counties, a small amount is used to irrigate salt-tolerant crops in Pecos, Culberson, and Hudspeth counties. Over the last 70 years, water levels have declined in some areas as a result of localized production. Projected water availability is 52,150 acre-feet (64.3 million cubic meters) per year from 2010 to 2060 (TWDB, 2006b).
- The Edwards-Trinity Plateau aquifer, which is a major aquifer extending across much of the southwestern part of Texas. The water-bearing units are composed predominantly of limestone and dolomite of the Edwards Group and sands of the Trinity Group. Although maximum saturated thickness of the aquifer is greater than 800 feet (244 meters), freshwater-saturated thickness averages 433 feet (132.0 meters). Water quality ranges from fresh to slightly saline, with TDS ranging from 100 to 3,000 milligrams per liter, and is characterized as hard within the Edwards Group. Salinity typically increases to the west within the Trinity Group. Elevated levels of fluoride in excess of primary drinking water standards occur within Glasscock and Irion counties. Springs occur along the northern, eastern, and southern margins of the aquifer, primarily near the bases of the Edwards and Trinity groups where exposed at the surface. San Felipe Springs is the largest along the southern margin. More than two-thirds of groundwater pumped from this aquifer is used for irrigation, with the remainder used for municipal and livestock supplies. Water levels have remained relatively stable because recharge has generally kept pace with the relatively low amounts of pumping over the extent of the aquifer. This aquifer is present beneath the proposed Odessa Sequestration Site. In this area, the water table is approximately 200 feet (61.0 meters) below the ground surface. The base of the drinking water aquifer is at approximately 1,500 feet (457.2 meters) below the ground surface. Projected water availability from the aquifer is 572,515 acre-feet ($7.1x10^8$ cubic meters) per year in 2010 and 572,517 acre-feet ($7.1x10^8$ cubic meters) per year 2060 (TWDB, 2006b).

7.6.2.2 Dockum Aquifer Properties

The Dockum aquifer properties presented in Table 7.6-1 represent data from Winkler County, which is adjacent to Ector County to the west, since no such data exist from Ector County.

The Texas Water Development Board (TWDB) estimated that the Dockum aquifer contains approximately 1.07 $x10^{12}$ gallons ($4.1x10^{12}$ liters) of water in Ector County (TWDB, 2003); but it also states that only a small portion of this water is economically and technically recoverable.

There are no large well yields in Ector County and even though large well yields (2,500 gallons [9,464 liters] per minute) are reported from the Dockum aquifer in adjoining counties, lower well yields are anticipated due to the unsaturated nature of the aquifer beneath the proposed power plant site.

Table 7.6-1. Dockum Aquifer Properties

Parameter	Range in Values	Mean
Well Yield, gpm (m^3/day)	26 – 103 (141.73 – 561.45)	70 (381.57)
Specific Capacity, gpm/ft (m^3/day/m)	0.13 – 17 (2.32 – 304.04)	5.3 (94.79)
Transmissivity gpd/ft (L/day/meter)	12,000 – 37,000 (149,032 – 459,515)	20,667 (256,670)
Storage Coefficient (dimensionless)	2.4×10^{-4} – 2.5×10^{-4}	2.45×10^{-4}

Note: gpm = gallons per minute; gpd = gallons per day; ft = feet; m^3 = cubic meters; L = liters.
Source: TWDB, 2003.

The Dockum aquifer is recharged principally by precipitation and stream flow in outcrop areas, and also where permeable portions of the Dockum are overlain by other water-bearing units such as the Pecos Valley and by upward leakage of water from the underlying Permian rocks.

7.6.2.3 Dockum Aquifer Water Quality

In Ector County, the Dockum aquifer water quality is typically fresh to brackish with TDS generally less than 5,000 milligrams per liter (TWDB, 2003). Water quality in the Dockum aquifer typically decreases in quality due to higher mineralization with depth (FG Alliance, 2006d).

Only two water quality analyses for the groundwater within the ROI of the proposed power plant site (FG Alliance, 2006d) were found and these date to before 1950 (see Table 7.6-2).

Table 7.6-2. Groundwater Quality

Constituents	Well 45-20-101	Well 45-20-102
Sample Date	9/27/48	4/30/37
Aquifer	Dockum	Pecos Valley
Well Depth, feet (meters)	552 (168.25)	77 (23.47)
Bicarbonate (mg/L as HCO_3)	640	110
Hardness, Total (mg/L as $CaCO_3$)	102	No analysis
Calcium, Dissolved (mg/L as Ca)	18	No analysis
Magnesium, Dissolved (mg/L as Mg)	14	No analysis
Sodium Plus Potassium (mg/L)	678	No analysis
Chloride, Dissolved (mg/L)	240	80
Sulfate, Dissolved (mg/L as SO_4)	614	1,180
Silica, Dissolved (mg/L as SlO_2)	10	No analysis
Total Dissolved Solids (mg/L)	1,940	1,890
Nitrate Nitrogen, Dissolved (mg/L as NO_3)	1.2	No analysis

Note: mg/L = milligrams per liter; HCO_3 = bicarbonate; $CaCO_3$ = calcium carbonate; Ca = calcium; Mg = magnesium; SO_4 = sulfate; SlO_2 = silica; NO_3 = nitrate.
Sources: TBWE, 1937 and 1952.

A review of state records indicated no groundwater contamination on or within 1 mile (1.6 kilometers) of the proposed power plant site (FG Alliance, 2006d).

7.6.2.4 Groundwater Use

Table 7.6-3 provides groundwater production by use and aquifer in Ector County. The pumpage data is from 2003, the most recent year for which data are available. Groundwater use in Ector County totals 9,998 acre-feet (12.3 million cubic meters) per year. Over half of that water is used for mining purposes. The second and third largest groundwater uses are for municipal and industrial purposes, respectively (FG Alliance, 2006d).

Table 7.6-3. Groundwater Production and Use in Ector County

Aquifer	Municipal	Industrial	Power	Mining	Irrigation	Livestock
	acre-feet per year (cubic meters per year)					
Pecos Valley	25 ($3.1x10^4$)	0	0	0	0	11 ($1.4x10^4$)
Edwards Trinity Plateau	534 ($6.6x10^5$)	1,192 ($1.5x10^6$)	0	3,625 ($4.5x10^6$)	116 ($1.4x10^5$)	87 ($1.1x10^5$)
Ogallala	0	0	0	0	913 ($1.1x10^6$)	4 ($4.9x10^3$)
Dockum	0	11 ($1.4x10^4$)	0	384 ($4.7x10^5$)	0	8 ($9.87x10^3$)
Total County	559 ($6.9x10^5$)	1,203 ($1.5x10^6$)	0	4,009 ($5.0x10^6$)	1,029 ($1.3x10^6$)	110 ($1.4x10^5$)

Source: FG Alliance, 2006d.

The majority of the groundwater pumped in Ector County is from the Edwards-Trinity Plateau aquifer. A survey of the records kept by the TCEQ has shown no cases of contaminated groundwater in the vicinity of the proposed site (TCEQ, 2006).

The injection target would be at a depth of 0.4 to 1 mile (0.6 to 1.6 kilometers) in the Lower Queen formation and Delaware Mountain Group. These two formations are not known to have groundwater that has commercial, industrial, or other uses.

The proposed injection wells at the Odessa Site would penetrate the Dockum aquifer. This aquifer could be classified as an Underground Source of Drinking Water (USDW) according to EPA's definition (EPA, 2006b) of an USDW, which includes any aquifer or part of an aquifer that:

- Supplies any public water system, or contains a sufficient quantity of groundwater to supply a public water system and currently supplies drinking water for human consumption or contains fewer than 10,000 milligrams per liter of TDS; and
- Is not an exempted aquifer.

Since the aforementioned aquifers could be classified as USDW according to EPA (40 CFR 144.3), any injection well construction must consider the protection of the resource. Section 7.6.2.3 addresses the water quality of these aquifers and Section 7.6.2.4 identifies the different uses of the resource by the local counties.

In March 2007, EPA published a Guidance (UICPG #83) determining that wells used for testing underground CO_2 sequestration technologies should be classified as Class V experimental technology wells (EPA, 2007). These wells would be subject to permitting from the State and EPA regions and this Guidance present factors that might be considered in this permitting process. These factors include the physical appropriateness of the injection sites, which include characteristics such as thickness, porosity, permeability, trapping mechanism, and confining systems. The Guidance also recommends considering the area of review based on the CO_2 plume extent and migration pathways. It also suggests that the area of review should take into account the probable pressure buildup predictions based on injection volume, depth of injection, duration of injection, and boundary conditions.

EPA also presents considerations for the construction, operation, monitoring, and closure of the wells, with the overall intent of protecting the human health and the quality of any USDW intersected or affected by the injection wells.

The State of Texas also regulates the construction, operation, monitoring, and closure of Class V wells under the Texas Administrative Code, Title 30 Part 1 Chapter 331 subchapters H and K (TAC, 2007). Under these regulations, Class V injection wells would require state permits and would be monitored as well.

7.6.3 IMPACTS

7.6.3.1 Construction Impacts

Power Plant Site

Construction activities would not be expected to disturb the groundwater resources beneath the plant or other facilities. While construction of impervious areas would hinder aquifer recharge in the immediate vicinity, this effect would be minimal as the size of the aquifer recharge area is much larger than the area of impervious surface that would be created. There would not be a noticeable effect in aquifer recharge. Construction activities would not use groundwater, thus would not affect the quantity of available groundwater in the aquifer. Water for construction activities and dust control would be trucked to the site, so groundwater withdrawals would be unnecessary.

There would be no on-site discharge of wastewater to the subsurface. Appropriate Spill Prevention, Control, and Countermeasure (SPCC) plans would be employed to minimize the chance of petroleum, oils, lubricants, and other materials used during construction being released to the surface or subsurface and to ensure that waste materials are properly disposed of. In the event of a spill, it is unlikely that these materials would be able to reach groundwater sources before cleanup due to the depth of the groundwater table (estimated to be 320 feet [98 meters]). Section 7.5 provides further detail regarding soil properties, including permeability.

Sequestration Site

The above discussion for the power plant site also applies to the sequestration site, although considerably less impervious cover would be associated with CO_2 injection wells and equipment. The injection wells would be drilled through the Trinity Group where the aquifer system is located and continue to a greater depth (0.6 mile [1.0 kilometer]) where drilling would reach the sequestration reservoir (Lower Queen formation and the Delaware Mountain Group). The aquifer system would be isolated by conductor casing during drilling of the injection wells and thus no impacts to the aquifer would be expected.

Utility and Transportation Corridors

Potential construction impacts would be similar to those discussed for construction of the proposed power plant, with the exception that considerably less impervious area would be created in the corridors.

7.6.3.2 Operational Impacts

Power Plant Site

During operation of the power plant, petroleum, oils, lubricants, and other hazardous materials could be spilled onto the ground surface and potentially impact groundwater resources. However, appropriate SPCC plans would be employed to minimize the potential for such materials used during operation to be released to the surface or subsurface, and to ensure that waste materials are properly disposed of. The probability of these hypothetical spills reaching the water table underneath the proposed power plant site is low due to the depth of the aquifer. Section 7.5 provides further detail regarding soil properties, including permeability.

The cities of Midland, Odessa, San Angelo, and Big Springs receive water from the Colorado River Municipal Water District (CRMWD) from a combination of groundwater and surface water sources. According to the TWDB (TWDB, 1997), the supply of water for public and private use would be satisfied by the current sources until year 2050. Later, further models were performed and it was estimated that even though the water demand would increase by 14 percent from 2010 to 2060 (see Table 7.6-4), the water supply would be sufficient if the water management strategies for the region are followed. These water management strategies include a mixed supply of groundwater from different aquifers with surface water and a considerable investment in infrastructure and conservation policies.

Table 7.6-4. Projected Water Demand[1] for 2010-2060 (Groundwater and Surface Water Combined)

Category	2010 acre-feet (cubic meters)	2060 acre-feet (cubic meters)
Municipal	122,593 (1.5×10^8)	135,597 (1.7×10^8)
County-other	19,372 (2.4×10^7)	22,035(2.7×10^7)
Manufacturing	9,757 (1.2×10^7)	13,313 (1.6×10^7)
Mining	31,850 (3.9×10^7)	35,794 (4.4×10^7)
Irrigation	578,606 (7.1×10^8)	551,774 (6.8×10^8)
Steam-electric	22,215 (2.7×10^7)	23,060 (2.8×10^7)
Livestock	23,215 (2.7×10^7)	23,060(2.8×10^7)
FutureGen Power Plant	4,114 (5.1×10^6)	4,114 (5.1×10^6)

[1] Refers to Region F that includes Ector County.
Source: TWDB, 2006c.

As shown in Table 7.6-4, the water demand for the FutureGen Project would represent a small fraction of the total water demand for Ector County and the general area, representing less than 1 percent of the total demand from 2010 to 2060.

The process water demand expected for the FutureGen Project would be 3,000 gallons (11,356 liters) per minute. This amount could be satisfied by the abundant groundwater resources in the region without endangering the future supply of groundwater for other users. The TWDB estimated that the Dockum aquifer (one of the possible sources) has a water excess of 5.5×10^9 gallons (2.5×10^7 cubic meters) per year that could supply the annual requirement of 1.1×10^9 gallons (4.9×10^6 cubic meters) for the FutureGen Project (TWDB, 2006b). As shown in Table 7.6-5, the Dockum aquifer, other adjacent aquifers (Ogallala, Edwards Trinity Plateau, Pecos Valley, and Captain Reef), or a combination thereof, could provide the amount of water needed for the proposed power plant (Caldwell, 2006 and TWDB, 2006b). The total water demand derived from the FutureGen Project is one order of magnitude smaller that the current water excess from any of the aquifers listed on Table 7.6-5. Therefore, the FutureGen Project would have minimal impacts on groundwater availability in the region. Severe drought conditions are regional events that could affect the overall water supply for users in the area, but, since these events are foreseeable, their impact would be minimized through planning. Depending on the final design of the power plant, water from these sources may need to be pre-treated to meet process specifications.

Table 7.6-5. Groundwater Availability vs. FutureGen Project Demand

Aquifer	Counties	Availability, acre-feet (cubic meters)	Production, acre-feet (cubic meters)	Groundwater Excess, acre-feet (cubic meters)	FutureGen Water Demand, acre-feet (cubic meters)
Ogallala	Andrews Ector Gaines	466,239 ($5.8x10^8$)	442,870 ($5.5x10^8$)	23,369 ($2.9x10^7$)	4,000 ($4.9 x10^6$)
Edwards Trinity Plateau	Andrews Ector	15,964 ($2.0 x10^7$)	5,577 ($6.9x10^6$)	10,387 ($1.3x10^7$)	
Pecos Valley	Ector Winkler Ward	72,186 ($8.9x10^7$)	13,803 ($1.7x10^7$)	58,383 ($7.2x10^7$)	
Dockum	Andrews Ector Winkler Ward	25,185 ($3.1x10^7$)	4,788 ($5.91x10^6$)	20,397 ($2.5x10^7$)	
Capitan Reef	Winkler Ward	27,000 ($3.3x10^7$)	351 ($4.3x10^5$)	26,649 ($3.3x10^7$)	

Source: Caldwell, 2006; TWDB, 2006a; FG Alliance, 2006d.

Sequestration Site

The potential impacts associated with CO_2 sequestration in geologic formations are largely associated with the possibility of leakage. The potential for leaks to occur would depend upon caprock integrity and the reliability of well-capping methods and, in the longer term, the degree to which the CO_2 eventually dissolves or by reacts with formation minerals to form carbonates. The mechanisms that could allow leakage of the injected CO_2 into shallower aquifers are:

- CO_2 exceeds capillary pressure and passes through the caprock;
- CO_2 leaks into the upper aquifer via a transmissive fault;
- CO_2 escapes through a fracture or more permeable zone in the caprock into a shallower aquifer;
- Injected CO_2 migrates up dip, and increases reservoir pressure and permeability of an existing fault; or
- CO_2 escapes via improperly abandoned or unknown wells.

The CO_2 would be injected into the upper interval of the Lower Queen formation and the lower interval of the Delaware Mountain Group at a depth of 0.4 to 1 mile (0.6 to 1.6 kilometers) below the ground surface. It would then begin to mix with the saline groundwater in the formation. Because CO_2 is less dense than the surrounding groundwater, its buoyancy would cause it to move vertically into lower pressure zones until it reached less permeable strata, which would act as a seal (e.g., caprock layer). Over time, the CO_2 would dissolve in the formation water and begin to move laterally, unless it found a more permeable conduit, such as a transmissive fault or an improperly abandoned well.

However, vertical migration of CO_2 to near-surface freshwater aquifers would be considered to be highly unlikely due to:

- The depth of the injection zone in the Lower Queen formation and Delaware Mountain Group;
- The substantial primary seal provided by the Seven Rivers formation (700 feet [213.4 meters] thick);
- The presence of at least one secondary seal (Salado formation); and
- Another 328 feet (100 meters) of various low-permeability sandstones and siltstones.

Each series of less permeable and more permeable sedimentary layers within these more than 1,300 feet (396 meters) of strata would be a barrier to upward migration of CO_2. Pressure would force the CO_2 through each layer with lower permeability and then dissipate due to lateral flow of CO_2 in each layer with higher permeability. There are likely dozens of these series and as a result, extensive vertical movement to potable aquifers would not be likely.

Improperly abandoned wells provide one of the primary flow paths for CO_2 to reach the surface or the shallower aquifers, serving as an escape route for the over-pressured gases injected into the reservoir. These flow paths are of consideration when they cut through the primary seal above the reservoir. There are approximately 16 wells that penetrate the primary reservoir seal for the Odessa Sequestration Site. Through strategic placement of the injection wells at the Odessa Sequestration Site, the CO_2 plumes should not intersect these existing wells. Although it is stated that some of these wells need work to be considered properly abandoned, the condition of these two wells has not been identified (FG Alliance, 2006d).

In the hypothetical event that CO_2 and brine would reach the Dockum aquifer (an USDW), the impact would only be felt on the industrial, mining and livestock users, since no water from the Dockum aquifer is being used for human consumption.

The probability of CO_2 escaping through fractures or faults in the rocks is very low since the primary seal, the upper Queen-Seven Rivers formation, is not intersected by any known historically active or hydraulically transmissive faults. Furthermore, faulting is not known in the Delaware Mountain Group or any younger units within or above the Guadalupian sandstone sequestration reservoir.

Reservoir modeling shows that, at the maximum injection amount, the CO_2 plume would migrate 1 mile (1.6 kilometers) from the injection point in every direction, although differences in formation properties can result in fingering of the actual CO_2 plume. Brine in these formations would be displaced horizontally and to a lesser extent vertically for an unknown lateral distance. However, the displaced brines would have to move vertically more than 3,000 feet (915 meters) to reach the Dockum aquifer. As these brines move at a rate of a few centimeters a year, it is not expected that the Dockum aquifer or other sources of potable water could be affected.

In addition to displacing brine, CO_2 would also dissolve into the brine over time. In formations like the Lower Queen and the Delaware Mountain Group with slowly flowing water, reservoir-scale modeling for other similar projects shows that, over tens of years, up to 30 percent of the CO_2 would dissolve (IPCC, 2005). Once CO_2 dissolves in the brine groundwater, it could be transported out of the injection site by regional scale circulation or upward migration, but the time scales of such transport are millions of years and are thus not considered an impact for this assessment (IPCC, 2005).

Reactions between the CO_2 and brine would produce carbonic acid, a weak acid that would react with the formation rock. The target formations are quartz-rich and react with minerals very slowly, taking hundreds to thousands of years (IPCC, 2005). Toxic metal displacement and dissolution could be a concern in those areas where injected CO_2 reacts with brine, but there is a lack of mineral deposits in the area that indicate the presence of heavy metals. In the sequestration site ROI, there are no known anomalous concentrations of metals that could pose a risk to the aquifer.

Acidification of the aquifer due to dissolution of CO_2 into water would slightly lower the pH of the groundwater. At the Odessa Site, acidification of shallower groundwater sources would be very unlikely due to the hundreds of feet of separation between the injection target formation and these aquifers, as well as the limited pathways for CO_2 to travel upward and mix with groundwater. Similarly, it would be unlikely that the CO_2 injection would contaminate overlying aquifers by displacing brine, because this would require pathways, such as faults or deep wells that penetrate the primary seal, that are not present at the proposed site. However, monitoring methods could help detect CO_2 leaks before they migrated into an aquifer, and mitigation measures could minimize such impacts should they occur.

Utility Corridors

The above discussion for the power plant site also applies to the proposed utility corridors, but to a lesser extent as hazardous materials would not be expected to be on site in the utility corridors unless maintenance activities were occurring.

Transportation Corridors

Traffic accidents could result in hazardous materials spills. The spill response measures discussed for the proposed power plant site would be executed to ensure rapid control and cleanup of any hazardous material spill from a traffic accident.

7.7 SURFACE WATER

7.7.1 INTRODUCTION

Ready access to an abundant supply of water is an important consideration in siting power plants, as water is necessary for steam generation and process water. Drinking water would also be required for the employees at the proposed power plant and sanitary wastewater would be generated by restrooms, sinks, and shower facilities. The proposed FutureGen Power Plant would not discharge any industrial wastewater, as all process wastewater would be treated by the ZLD system and recycled back to the power plant. The following analysis examined short-term impacts from construction and long-term impacts from operations to surface water resources from the proposed FutureGen Project.

7.7.1.1 Region of Influence

The ROI consists of the proposed power plant site, sequestration site, areas within 1 mile (1.6 kilometers) of all related areas of new construction, and any surface water body above the sequestration reservoir.

The greatest potential for impacts to surface water resources is limited in most cases to the proposed power plant and sequestration site and related corridors. Because of the types of land disturbing activities that would occur during construction of the proposed power plant, injection wells, and supporting utilities and infrastructure, the disturbed areas would be susceptible to erosion and changes in surface water flow patterns. The area could also be affected by spills associated with construction or operations.

The ROI for surface water extends beyond the proposed construction sites. Construction and operation activities would affect a larger area in cases when flow patterns were modified or if contamination could be carried downstream by surface water drainages.

7.7.1.2 Method of Analysis

DOE reviewed public data, research, and studies compiled in the Odessa EIV (FG Alliance, 2006d) to characterize the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Alter stormwater discharges, which could affect drainage patterns, flooding, and erosion and sedimentation;
- Alter infiltration rates, which could affect (substantially increase or decrease) the volume of surface water that flows downstream;
- Conflict with applicable stormwater management plans or ordinances;
- Contaminate public water supplies and other surface waters exceeding water quality criteria or standards established in accordance with the Clean Water Act (CWA), state regulations, or permits;
- Conflict with regional water quality management plans or goals;
- Affect capacity of available surface water resources;
- Conflict with established water rights or regulations protecting surface water resources for future beneficial uses;
- Alter floodway or floodplain or otherwise impede or redirect flows such that human health, the environment or personal property is impacted; or
- Conflict with applicable flood management plans or ordinances.

DOE reviewed reports from USGS, U.S. EPA, and TCEQ, and reviewed information provided in the Odessa EIV (FG Alliance, 2006d) to assess the potential impacts of the proposed FutureGen Project on surface water resources. Surface water data analysis was limited to locations that had the potential for permanent impacts (i.e., power plant and sequestration site); however, site-specific surface water data for these areas were not collected. Data were evaluated from area discharge points and sample locations monitored by the agencies mentioned above. Best professional judgment was applied to determine the likelihood of surface water impairments in the area. Uncertainties and unavailable data are discussed as appropriate in the following analysis.

To avoid or limit adverse impacts, emphasis is placed on adhering to applicable laws, regulations, policies, standards, directives, and BMPs. Most importantly, careful pre-planning of construction and operational activities would allow potential impacts to be minimized before they occur.

7.7.2 AFFECTED ENVIRONMENT

Power Plant Site

The proposed plant site consists of approximately 600 acres (243 hectares) located 15 miles (24 kilometers) southwest of the City of Odessa, Texas. Figure 7.7-1 shows the proposed plant site, sequestration site, proposed utility corridors, and surface water resources in the area.

The proposed power plant site is located outside the 500-year floodplain; however, an unnamed 100-year flood zone is located in the southwestern corner of the ROI (FEMA, 1991) (See Section 7.8). Penwell, Texas, receives 14.7 inches (37.3 centimeters) rainfall annually. Local storms have been known to produce significant flows and localized flash floods. No significant surface water bodies are located on the proposed power plant site or within the ROI (Figure 7.7-1). The closest significant water body is the Upper Pecos River, more than 30 miles (48.3 kilometers) south of the site. The site is located in the Upper Pecos River Sub-basin of the Rio Grande Basin, which drains surface waters that eventually flow into the Gulf of Mexico (TCEQ, 2006a).

Sequestration Site

The floodplain and rainfall characteristics for the sequestration site are similar to the proposed power plant site discussed above. Land within the ROI is arid and contains some ephemeral or intermittent streams nearby (FG Alliance, 2006d). The corridor west of the proposed sequestration site is approximately 5 miles (8.0 kilometers) long and crosses several small unnamed ephemeral draws (FG Alliance, 2006d). Soils within isolated portions of this corridor suggest that occasional flooding may occur (NRCS, 2006). The corridor to the east of the proposed sequestration site is almost 7 miles (11.3 kilometers) long and also crosses several unnamed ephemeral draws that lead to the intermittent Tunas Creek to the north (FG Alliance, 2006d).

Utility Corridors

No surface water bodies or ephemeral draws exist within the proposed transmission line corridors (FG Alliance, 2006d). No major surface water bodies are located within any of the proposed water supply corridors (FG Alliance, 2006d). However, two named drainage features near the water supply corridors are Monument Draw and Monahans Draw (Figure 7.7-1). Monument Draw is located just south of the Gaines/Andrews County line, and intersects both the Jackson and Texland corridors (FG Alliance, 2006d). Monahans Draw is located 4 miles (6.4 kilometers) north of the proposed power plant site and intersects the Jackson, Texland, and Whatley corridors (FG Alliance, 2006d). No perennial surface water bodies exist within any of the proposed CO_2 pipeline corridors; however, Tunas Creek crosses the eastern edge of the projected sequestration plume (FG Alliance, 2006d). The planned pipeline corridor from the power plant site to the sequestration site crosses the Pecos River and several other intermittent streams; however, existing CO_2 pipelines are proposed to be used with the addition of new connections, as discussed in Section 7.7.3.1.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected surface waters. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained rights of way (ROWs).

7.7.2.1 Surface Water Quality

No known existing contamination has been identified in water bodies within the ROI of the proposed power plant site and sequestration site (TCEQ, 2006b). No stormwater collection, retention, or conveyance facilities currently exist within the ROI of the proposed power plant site or sequestration site.

7.7.2.2 Process Water Supply and Quality

No surface water would be used for the process water supply for the proposed power plant site. Process water would be provided by groundwater wells, as discussed in Section 7.6.

7.7.3 IMPACTS

7.7.3.1 Construction Impacts

Water would be required during construction for dust suppression and equipment washdown, and would most likely be trucked to areas where needed; no water would be withdrawn from surface waters. BMPs would be used to contain water used for dust suppression and equipment washdown, and would have little to no impact to surface water quality. This activity would be addressed in the National Pollutant Discharge Elimination System (NPDES) Permit. Proposed grades in paved areas and for building first floor elevations would be close to existing grade as feasible to minimize side slopes, limiting potential erosion. All temporarily disturbed areas would be seeded to re-establish vegetative cover.

Since there would be over 1 acre (0.4 hectare) of disturbance, the construction contractor would need to apply for a general NPDES Permit No. TXR150000 from the TCEQ, which also requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP).

> A **Storm Water Pollution Prevention Plan** consists of a series of phases and activities to characterize the site and then select and carry out actions to prevent pollution of surface water drainages.

Part III of the general NPDES permit includes erosion control and pollution prevention requirements and refers to specific construction standards, material specifications, planning principles and procedures. The plans are required to include site specific BMPs. Operating storm water pollution prevention restrictions and BMPs will be dictated by the NPDES permit. The relevant operating permit for the plant's operations is 40 CFR 122, Subpart B and Texas Water Code, Section 26.040.

Impacts due to construction activities would likely include erosion due to equipment moving, surfacing and leveling activities, and alteration of surface structures resulting in effects on local (i.e., at the point of disturbance) hydrology. In addition, Section 404 of the Clean Water Act (hereafter referred to as Section 404) permits are required for jurisdictional waterbody (wetland) crossings and would be issued before construction. Section 404 permits require the use of BMPs during and after construction and oftentimes include mitigation measures for unavoidable impacts.

Power Plant Site

There are currently no surface water reservoirs, lakes, or ponds within the ROI for the proposed power plant site (FG Alliance, 2006d). Presently, area soils have low to moderate surface water runoff due to soil permeability and slopes (FG Alliance, 2006d). Implementation of BMPs to address, mitigate, and control stormwater runoff would reduce potential impacts to downstream surface water resources.

Sequestration Site

The sequestration site is located 58 miles (93.3 kilometers) south of the proposed power plant site (Figure 7.7-1). The construction of injection wells would disturb minor amounts of land, which could cause temporary indirect impacts to adjacent surface waters (several intermittent and ephemeral draws) such as sedimentation and surface water turbidity from runoff; however, the lack of these resources in the area and the use of BMPs would make this impact highly unlikely.

Utility Corridors

The construction of new utility lines would potentially create temporary impacts to surface waters. The probability of these impacts to occur would increase the closer construction activities are located to surface water resources. The maximum extent of impacts would occur when the utilities cross one of these surface water resources. Temporary impacts to surface waters for utility line crossings using trenching methods would include stream diversion/piping flows around the crossing, increased turbidity and sedimentation during construction, streambed disturbance, and removal of streambank vegetation. Directional drilling under surface waters would avoid these impacts. Construction conducted near surface water resources could indirectly create sedimentation from runoff and could increase water turbidity. BMPs required under Section 404 permitting both during and after construction would be implemented and would help reduce temporary impacts by controlling sedimentation and turbidity, restoring stream crossings to their original grade, and stabilizing streambanks after construction. Potential surface water resources which may be affected by these activities are discussed below.

The construction of new pipelines in utility corridors would require hydrostatic testing of the lines to certify the material integrity of the pipeline before use. These tests consist of pressurizing the pipeline with water and checking for pressure losses from pipeline leakage. Hydrostatic testing would be performed in accordance with U.S. Department of Transportation pipeline safety regulations. The source and quantity of water for hydrostatic testing is further discussed in Section 7.6. Water used for hydrostatic testing is required to be contained in approved fluid holding or disposal facilities. Hydrostatic pipe and well testing waters may not be discharged to the surface (TCEQ, 2006c). No chemical additives would be introduced to the water used to hydrostatically test the new pipeline, and no chemicals would be used to dry the pipeline after the hydrostatic testing. Hydrostatic testing would be conducted in accordance with applicable permits.

Process Water Supply

Six locations have been identified as potential sources for the process water supply:

- Jackson in the High Plains aquifer, located to the north of the proposed power plant site approximately 54 miles (86.9 kilometers);
- Texland in the High Plains and Dockum aquifers, located to the north approximately 49 miles (78.9 kilometers);
- Whatley in the High Plains and Dockum aquifers, located to the north approximately 24 miles (38.6 kilometers);
- WTWSS located to the west through Ector and Winkler counties approximately 37 miles (59.5 kilometers);
- Smith in the Pecos Valley and Dockum aquifers, located to the west-northwest approximately 26 miles (41.8 kilometers); and
- CCWIS in the Capitan Reed aquifer, located in the west-southwest approximately 28 miles (45.1 kilometers).

No major waterbodies are located within any of the six proposed process water supply corridors. Seasonal runoff would occur in a number of drainage features or draws along all of these construction corridors. All of the proposed water supply corridors contain isolated depressions and small unnamed creek beds that either have been determined to be within the 100-year floodplain (FEMA, 1977, 1991, and 1998) or have soils that suggest rare flooding may occur (a 1 to 5 percent chance in any year) (NRCS, 2006). Several small, unnamed ponds also occur along each of these corridors, but are either intermittent or artificially maintained by groundwater wells (FG Alliance, 2006d). Water supply pipeline construction corridors are expected to be approximately 50 feet (15.2 meters) wide with a permanent width of 20 to 30 feet (6 to 9 meters).

Power Transmission Corridor

No surface water bodies or ephemeral draws exist within either of the proposed 138-kilovolt (kV) transmission lines corridors.

CO_2 Pipeline

The proposed power plant site is approximately 58 miles (93.3 kilometers) from the proposed sequestration reservoir. Within the surrounding area, there are numerous existing CO_2 pipelines used for secondary oil recovery in the region. These lines could be tapped into to facilitate the transport of CO_2 from the proposed power plant to the proposed sequestration site. Three corridors have been identified (FG Alliance, 2006d):

- Construction of approximately 2 miles (3.2 kilometers) of pipeline to the east of the proposed power plant site to connect with the Kinder Morgan CO_2 Company, L.P. Central Basin Pipeline System. One, short, ephemeral, unnamed draw, crosses this corridor near the junction with the existing pipeline.
- Construction of approximately 5.1 miles (8.2 kilometers) of new pipeline to the west of the proposed sequestration reservoir to connect to the existing $PSCO_2$ pipeline. This corridor crosses several small, unnamed ephemeral draws. Soils within isolated portions of this corridor suggest that occasional flooding (a 5 to 50 percent change in any year) may occur (NRCS, 2006).

- Construction of approximately 7 miles (11.3 kilometers) of pipeline east of the proposed sequestration reservoir to connect to the existing Val Verde pipeline. This corridor crosses several unnamed ephemeral draws that lead to the intermittent Tunas Creek to the north (FG Alliance, 2006d).

The construction corridors for these pipelines are expected to be approximately 50 feet (15 meters) wide with a permanent width of 20 to 30 feet (6 to 9 meters). A short (2-mile [3.2-kilometer]) length of new CO_2 pipeline would connect the proposed power plant site to the existing pipeline, and approximately 4 miles (6.5 kilometers) of new pipeline would connect the existing CO_2 pipeline to the proposed injection sites.

7.7.3.2 Operational Impacts

Operational impacts would consist largely of surface water runoff from the proposed power plant site and potential spills (i.e., fuel, chemicals, grease, etc.). Mitigation of runoff, recycling of materials, and pollution prevention measures would reduce or eliminate the potential for operational impacts to surface water. A pollution prevention program would be implemented to reduce the incidence of site spills (i.e., fuel, paint, chemicals, etc.). Adherence to applicable laws, regulations, policies, standards, directives and BMPs would avoid or limit potential adverse operational impacts to surface waters.

Stormwater runoff from the proposed plant site would be expected to have minimal impact on surface water resources. Stormwater could be collected and recycled into the process water to support the operations of the proposed power plant. Possible indirect impacts of sedimentation due to soil and wind erosion could occur, but impacts to surface waters are considered to be negligible.

Power Plant Site

No impacts to surface water from water usage by the proposed facility would be expected because groundwater would be the primary source of the process and potable water supply. Potentially, the site could discharge sanitary sewer waste to the surface, reinject the water to groundwater, or recycle it back into the process water to support the operations of the proposed power plant. The method of on-site waste systems has not been determined (see discussion in Section 7.15). Appropriate permits would be secured before any discharges. Discharge frequency, quantity, and quality would be subject to permit requirements.

During operations, slag and coal piles would be stored on site. Although, the actual configuration has yet to be determined, for the purposes of this analysis, it is presumed that these storage areas would be stored in open air, lined areas. Implementation of BMPs and a stormwater management system would capture the runoff from the coal piles, and direct it to the zero liquid discharge (ZLD) system for on-site treatment. Further mitigation could include covering the slag and coal pile areas to prevent contact with precipitation and eliminate stormwater runoff. Minimal effects to downstream surface water resources would be anticipated because the proposed power plant would be a zero emissions facility.

Increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation. Runoff from the site due to industrial activities would require implementing a stormwater management program to reduce or eliminate any potential surface water quality impacts. The general NPDES permit would include erosion control and pollution prevention requirements. Operating stormwater pollution prevention restrictions and BMPs would be dictated by the NPDES permit.

Sequestration Site

The operation of the proposed sequestration site is not expected to impact surface water resources within the ROI. The sequestration reservoir would occur far below these surface water resources and any connected aquifers, preventing any point of contact. Tunas Creek crosses the projected plume on the eastern edge. Monitoring for CO_2 leaks in the pipeline and caprock would enable the application of BMPs should a leak be detected.

In surface waters lacking buffering capacity, such as freshwater and stably stratified waterbodies, the pH could be significantly altered by increases in CO_2 (Benson et al., 2002). The persistence and amount of CO_2 being leaked are primary factors which determine the severity of the impacts from increased CO_2 in the soil and surface water (Damen et al., 2003). The risk of a CO_2 leak from the sequestration reservoir is dependent upon the reservoir and other site specific variables, such as the integrity of the well and cap rock and the CO_2 trapping mechanism (Reichle et al., 1999). CO_2 sequestration is maintained via a sealed caprock, which can be compromised via, rapid release of CO_2 through natural events or area wells, or slow leak of CO_2 through rock fractures and fissures. These are influenced by the characteristics (e.g., porosity) of the caprock material. As discussed in Section 7.4, the potential for CO_2 leakage from the proposed Odessa Sequestration Reservoir is small, but it could occur. A risk analysis was completed to assess the likelihood of such failures occurring, as discussed in Section 7.17 (Tetra Tech, 2007).

Although the risk of a CO_2 leak would be minimal, a leak from the pipeline transporting the CO_2 to the injection site could increase concentrations of CO_2 in the soil, which would lower the pH and negatively affect the mineral resources in the affected soil (Holloway, 1996). This, in turn, would lower the pH of the surface waters in the affected area, potentially resulting in calcium dissolution and altering the concentration of trace elements in the surface water (Damen et al., 2003; Benson et al., 2002; Holloway, 1996). The degree to which the pH of the surface waters would decrease depends on a variety of factors, including stratification and salinity of the waterbody (Benson et al., 2002). In surface waters lacking buffering capacity, such as freshwater and stably stratified waterbodies, the pH could be significantly altered by increases in CO_2 (Benson et al., 2002). Seepage of sequestered CO_2 from the reservoir would not impact surface water because the solubility of the CO_2 in water would keep the concentration of sequestered gases less than 0.2 percent (Tetra Tech, 2007).

Utility Corridors

Normal operations of the power transmission corridors and pipelines for the proposed site would not affect surface water resources. Occasional maintenance may require access to buried portions of the utilities; however, BMPs would be used to avoid any indirect impacts (e.g., sedimentation and turbidity) to adjacent surface waters.

The proposed pipeline route to the injection wells would cross the Pecos River. While the existing pipeline that could be used to transport CO_2 does cross the Pecos River, no new utility corridors would be established. If released gas reaches surface water, the predicted H_2S concentration in the surface water due to its solubility is less than the freshwater criteria of 0.002 milligrams per liter. Seepage of sequestered gases from the reservoir into flowing surface water is not considered to be a concern for either H_2S or CO_2 based on their solubility in water (Tetra Tech, 2007).

Transportation Corridors

Operation of the power plant would use existing transportation corridors, and therefore, would have no impact on surface water resources. Any upgrades to existing corridors would require a separate analysis.

INTENTIONALLY LEFT BLANK

7.8 WETLANDS AND FLOODPLAINS

7.8.1 INTRODUCTION

This section discusses wetlands and floodplains identified in the affected environment that may be affected by the construction and operation of the proposed FutureGen Project at the Odessa Power Plant Site, sequestration site, and related corridors. This section also provides the required floodplain and wetland assessment for compliance with 10 CFR Part 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements," and Executive Orders 11988, "Floodplain Management," and 11990, "Protection of Wetlands (May 24, 1977)."

7.8.1.1 Region of Influence

The ROI for wetlands and floodplains for the proposed Odessa Power Plant includes the proposed power plant site and the area within 1 mile (1.6 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors.

7.8.1.2 Method of Analysis

DOE reviewed research and studies in the Odessa EIV (FG Alliance, 2006d) to characterize the affected environment. DOE also conducted site visits in August and November 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause construction of facilities in, or otherwise impede or redirect flood flows in, a 100- or 500-year floodplain or other flood hazard areas;
- Conflict with applicable flood management plans or ordinances; and
- Cause filling of wetlands or otherwise alter drainage patterns that would affect wetlands.

7.8.2 AFFECTED ENVIRONMENT

7.8.2.1 Wetlands

All tributaries to Waters of the U.S., as well as wetlands contiguous to and adjacent to those tributaries, are subject to federal jurisdiction and potential permitting requirements under Section 404. These resources are referred to as jurisdictional, or regulated by federal and state agencies. To be contiguous or a tributary, a continuous surface water connection must be present between the Waters of the U.S. and the adjacent surface waterbody. This surface water connection can be either visible surface water flowing at regular intervals of time, or a continuum of wetlands between the two areas. Open water features (e.g., upland stock ponds) within the Federal Emergency Management Agency (FEMA) designated 100-year floodplain that have associated emergent vegetation fringe are also jurisdictional Waters of the U.S. Isolated wetlands are not jurisdictional unless protected under a local bylaw.

The local U.S. Army Corps of Engineers (USACE) Regulatory Branch makes jurisdictional determinations. Activities such as mechanized land clearing, grading, leveling, ditching, and redistribution of material require a permit from the USACE to discharge dredged or fill material into wetlands. Permit applicants must demonstrate that they have avoided wetlands and have minimized the adverse effects of the project to the extent practicable. Compensation is generally required to mitigate most impacts that are not avoided or minimized.

Horizon Environmental Services identified wetlands potentially subject to Section 404 jurisdiction in 2006. A field reconnaissance was conducted to verify the jurisdictional status of wetlands occurring within the ROI. Figure 7.8-1 shows the general location of mapped wetlands identified using the Cowardin et al. classification scheme (Cowardin et al., 1979).

Power Plant Site

No jurisdictional wetlands or Waters of the U.S. are located within the proposed power plant site. However, several wetland areas potentially subject to Section 404 jurisdiction exist within the proposed Odessa Power Plant ROI. These include two small (less than 0.01 acre [0.004 hectare] combined) non-jurisdictional wetlands within the ROI: a palustrine, unconsolidated shore, seasonally and artificially flooded, excavated wetland; and a palustrine, unconsolidated shore, temporarily flooded, excavated feature (FWS, 1994) (Figure 7.8-1). The first wetland, determined through field investigations, is an overflow area for a livestock watering trough, and the second is associated with an excavated gravel pit. A jurisdictional determination would need to be filed with the USACE for concurrence.

Sequestration Site

National Wetland Inventory (NWI) mapping indicates Sixshooter Draw, Monument Draw, Tunas Creek, and several in-channel impoundments (ponds) as areas potentially subject to Section 404 jurisdiction (also see Section 7.7). Field verification (wetland delineation) would be required to confirm the NWI mapping and to determine the value of these resources.

Utility Corridors

The related areas of new construction associated with the proposed power plant include two proposed transmission line corridors, six proposed water supply pipeline corridors, and three proposed CO_2 pipeline corridors. NWI maps indicate no areas potentially subject to Section 404 jurisdiction within the proposed transmission line corridor to the north or south of the proposed Odessa Power Plant Site. Field verification would be required to confirm the NWI mapping and determine the value of these resources.

Several areas potentially subject to Section 404 jurisdiction are located within the six proposed water supply pipeline corridors. NWI maps indicate three total aqueduct channels are within the CCWIS, WTWSS, and Jackson corridors. Nine unnamed tributaries are crossed within the Smith, WTWSS, Jackson, Texland, and Whatley corridors. Monument Draw and Monahans Draw are within the Jackson and Texland corridors. The Jackson corridor crosses two on-channel impoundments. Northwest Lake and Monahans Draw are within the Whatley corridor. Field verification would be required to confirm NWI mapping and determine the value of these resources.

No areas potentially subject to Section 404 jurisdiction are located within the CO_2 pipeline corridor east or west of the proposed power plant site. A tributary of Tunas Creek and a palustrine, unconsolidated bottom, artificial, temporary, diked/impoundment (PUSKAh) were identified as areas potentially subject to Section 404 jurisdiction within the corridor east of the proposed sequestration reservoir. Field verification would be required to confirm NWI mapping and identify any additional wetlands not included in said mapping.

Transportation Corridors

Because no new transportation corridors are proposed outside of the proposed power plant site, this EIS does not provide further description of wetlands. Any upgrades to existing transportation corridors are anticipated. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen upgrades or new transportation corridors would require a separate analysis.

7.8.2.2 Floodplains

FEMA flood insurance rate maps prepared for Ector County and dated March 4, 1991, show that the entire proposed Odessa Power Plant Site and ROI are located outside the 100- and 500-year floodplain boundaries (FEMA, 1991) (Figure 7.8-2). Both proposed transmission line corridors (north and south of the proposed power plant site) are also located outside of the 100- and 500-year floodplain boundaries.

Power Plant Site

Related areas of new construction associated with the proposed power plant include two proposed transmission line corridors, six proposed water supply pipeline corridors, and three proposed CO_2 pipeline corridors. FEMA flood hazard maps prepared for Ector County (FEMA, 1991 and 1998) and Ward County (FEMA, 1977) were reviewed. The portions of the proposed construction corridors located within Gaines, Andrews, Winkler, and Pecos counties are currently unmapped by FEMA regarding flood hazard areas. For those areas, the Natural Resources Conservation Service (NRCS) soil flooding frequency data were reviewed.

Sequestration Site

The portion of Pecos County within the proposed sequestration site is currently unmapped regarding flood hazard areas. For this area, the NRCS soil flooding frequency data were reviewed. Sequestration site soils range from “none” and “rare” to “frequent” (NRCS, 2006).

Utility Corridors

Several depressions within the CCWIS, Jackson, Texland, and Whatley water supply corridors are within the 100-year floodplain. One unnamed creek crosses the Smith and Texland corridor, and two unnamed creeks that are within the 100-year floodplain cross the WTWSS corridor. Portions of the water supply corridors that lie within Winkler, Gaines, and Andrews counties are currently unmapped regarding flood hazard areas. Soil surveys identified these areas as having a flooding frequency class of “none,” which means a zero percent chance of flooding in any given year, or less than one time in 500 years (NRCS, 2006).

One unnamed creek and associated 100-year floodplain crosses the corridor east of the proposed power plant site. The portion of Pecos County within the corridor west of the proposed sequestration site is currently unmapped regarding flood hazard areas. Soil surveys identify these areas as having a flooding frequency class of “occasional,” which means that flooding occurs infrequently under normal weather conditions (NRCS, 2006). The portion of Pecos County within the corridor east of the proposed sequestration site is currently unmapped regarding flood hazard areas. All soils within the corridor have a flooding frequency class of “none” (NRCS, 2006).

Transportation Corridors

Because no new transportation corridors are proposed outside of the proposed power plant site, this EIS does not provide further description of floodplains. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

7.8.3 IMPACTS

7.8.3.1 Construction Impacts

Direct impacts to wetland habitats would be related to heavy equipment and construction activities, and could include soil disturbance and compaction, dust, vegetation disturbance and removal, root damage, erosion, and introduction and spread of non-native species. The addition of silt, resuspension of sediment, or introduction of pollutants (e.g., fuels and lubricants) related to, and in the immediate vicinity of, construction activities could degrade the quality of native wetlands.

The proposed FutureGen Project could result in localized, direct, and adverse construction impacts to wetlands. Filling or modifying portions of wetlands, if avoidance is not feasible, would permanently alter hydrologic function and wetland vegetation, and result in direct habitat loss. Potential habitat degradation of wetlands and waters downstream could also occur if flow into adjacent areas is reduced. Construction impacts would be mitigated by minimizing the areas disturbed and preventing runoff from entering wetlands during construction. Section 404 jurisdiction would also be required for permit approval.

The amount of mitigation required for the proposed power plant site and other project components (e.g., utility corridors) is not known at this time. Ratios have been established by the USACE regarding mitigation. For example, a 1:2 ratio would require 2 acres (0.8 hectare) of wetland creation for every acre (0.4 hectare) of wetland loss. Typical mitigation ratios for unavoidable impacts to wetlands would be 1:1 for open water and emergent wetlands, 1:5 for shrub wetlands, and up to 2:1 for forested wetlands. The appropriate type and ratio of mitigation would be determined through the Section 404 permitting process.

Power Plant Site

Two small wetlands (less than 0.01 acre [0.004 hectare] combined) occur within the ROI in the southern portion of the proposed Odessa Power Plant Site. The first wetland is an overflow area for a livestock watering trough and the second is associated with an excavated gravel pit. Both wetlands were determined through field investigations to be non-jurisdictional. Any habitat loss would be due to clearing, filling, or modification of vegetation in wetlands associated with the ROW maintenance of the associated corridors. A more detailed discussion of habitat loss due to construction can be found in Section 7.9.

The proposed Odessa Power Plant Site would be constructed entirely outside FEMA's 100- and 500-year floodplain boundaries.

Sequestration Site

There are no jurisdictional wetlands within the proposed sequestration site.

Utility Corridors

There are no jurisdictional wetlands within the proposed water supply and CO_2 corridors.

Construction would only occur within the 100-year floodplain boundary in the areas located along the water supply and CO_2 pipeline corridors. Construction would require heavy and light equipment and small vehicles and implements. Temporarily adding or excavating fill during construction within the floodplain would have no permanent impact on the lateral extent, depth, or duration of flooding in the floodplain areas traversed. Construction within floodplain areas would not result in increases of the 100-year flood elevation by any measurable amount because the floodway is unconstrained and there are no barriers to floodflow passage.

Mitigation and protection measures to minimize direct impacts would include standard stormwater controls such as interceptor swales, erosion control compost, waddles, sod, diversion dikes, rock berms, silt fences, hay bales, or other erosion controls as necessary and as required by USACE permits.

Depending upon final site design and construction activities, other federal, state, and local authorities may have jurisdiction over dredging, filling, grading, paving, excavating, or drilling in the floodplain that would require permits. The USACE has authority to regulate the discharge of dredged or fill materials into waterways and adjacent wetlands through Section 404. Concurrent with its review of the proposed FutureGen Project to determine appropriate National Environmental Policy Act (NEPA) requirements, DOE would also determine the applicability of the floodplain management and wetlands protection requirements contained within 10 CFR Part 1022.

Transportation Corridors

Operations at the proposed power plant would use existing transportation corridors, and therefore, would have no impact on floodplains. Any upgrades to existing corridors would require a separate analysis.

7.8.3.2 Operational Impacts

Power Plant Site

Operations at the proposed power plant would have no impact on wetlands or floodplains. All activities associated with the proposed power plant would occur on previously disturbed surfaces outside of wetland and floodplain areas.

Sequestration Site

Operations at the proposed sequestration site would have no impact on wetlands or floodplains. All activities would occur outside of wetland and floodplain areas.

Utility Corridors

Corridors would be maintained without trees to provide maintenance access and safety. Conversion of some forested wetlands to scrub-shrub wetlands may occur. During the permitting process, an acceptable wetland functional assessment methodology would be used to determine the loss of function resulting from the proposed impacts. The resulting vegetation communities on the proposed site and associated corridors would be similar to those on other ROWs in the vicinity. Maintenance is likely to be conducted using mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in proximity to streams and wetlands could constitute a damaging indirect effect on vegetation and aquatic resources. Following approved herbicide usage instructions, however, would likely reduce this concern. The proposed utility corridors would have no impacts on floodplains.

Transportation Corridors

Operation of the proposed power plant would use existing transportation corridors, and therefore, would have no impact on floodplains. Any upgrades to existing corridors would require a separate analysis.

7.9 BIOLOGICAL RESOURCES

7.9.1 INTRODUCTION

This section discusses both aquatic and terrestrial vegetation and habitats, as well as threatened, endangered, and protected species identified in the affected environment that may be impacted by the construction and operation of the proposed FutureGen Project.

7.9.1.1 Region of Influence

The ROI for biological resources is defined as 5 miles (8 kilometers) surrounding the proposed power plant site, sequestration site, and utility corridors.

7.9.1.2 Method of Analysis

DOE reviewed the results of research and studies compiled in the Odessa EIV (FG Alliance, 2006d) to characterize the affected environment. This information included data on wetland, aquatic, and threatened and endangered species. DOE also conducted site visits in August and November 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause displacement of terrestrial communities or loss of habitat;
- Diminish the value of habitat for wildlife or plants;
- Cause a decline in native wildlife populations;
- Interfere with the movement of native resident or migratory wildlife species;
- Conflict with applicable management plans for wildlife and habitat;
- Cause the introduction of noxious or invasive plant species;
- Alter drainage patterns causing the displacement of fish species;
- Diminish the value of habitat for fish species;
- Cause a decline in native fish populations;
- Interfere with the movement of native resident or migratory fish species;
- Conflict with applicable management plans for aquatic biota and habitat;
- Cause loss of a wetland habitat;
- Cause the introduction of non-native wetland plant species;
- Affect or displace special status species; and
- Cause encroachment on or affect designated critical habitat.

7.9.2 AFFECTED ENVIRONMENT

7.9.2.1 Vegetation

Aquatic

Power Plant Site

There are no permanent surface waters within the proposed power plant site boundaries or its ROI. Within the ROI, man-made stock ponds and ephemeral streams serve as drainage during periods of heavy rainfall. As such, no aquatic plants are supported within the ROI and proposed power plant site.

Sequestration Site

The proposed Odessa sequestration site contains numerous intermittent and ephemeral channels with some ponded areas. Six Shooter Draw and its tributaries comprise the majority of the drainage swales in the area. Six Shooter Draw drains from west to east and carries water off site in roughly 70 to 80 percent of the ROI. Monument Draw drains the remaining area, located at the eastern end of the sequestration site. Both Six Shooter and Monument draws are largely intermittent to ephemeral in nature. However, both appear to have ponded portions at various locations in their primary channels. None of their feeder tributaries have such ponded areas. Throughout the approximate 19 miles (30.6 kilometers) of main channel areas, Six Shooter Draw has approximately eight ponds on the channel and another 13 small ponds scattered in upland areas of the watershed. Approximately five ponded areas exist along the 7-mile (11.3-kilometer) length of Monument Draw. A single pond is also located off channel within the watershed. Although the intermittent channels are not expected to contain much aquatic vegetation, the ponded portions could contain common species such as rush (*Juncus* sp.), spikerush (*Eleocharis* sp.), and common pondweed (*Stuckenia* sp.).

Utility Corridors

Two transmission line corridors and one CO_2 pipeline corridor are associated with the proposed power plant site. All are located in Ector County and contain no aquatic habitat. No intermittent ephemeral stream channels or ponds are located in the transmission line corridors. One unnamed ephemeral draw crosses the CO_2 pipeline corridor. This draw begins and ends within 0.5 mile (0.8 kilometer) of either side of the proposed CO_2 pipeline corridor.

There are six potential water supply pipeline corridors that would have a total of two intermittent stream crossings, seven temporary ponds, and multiple ephemeral stream crossings. Other than a limited potential for fast-growing macrophytes that grow from dormant roots, no aquatic vegetation is contained in any of these corridors. The CCWIS corridor originates in Ward County and extends northeastward to the proposed power plant site in Ector County. This corridor is crossed by an aqueduct in Ward County and by a single unnamed ephemeral channel approximately 3 miles (4.8 kilometers) west of the proposed power plant site.

The Smith and WTWSS water supply pipeline corridors originate in Winkler County west-northwest of the proposed power plant site. Neither corridor crosses any channels in Winkler County nor contains any aquatic habitat. Three unnamed ephemeral channels cross the WTWSS corridor in Ector County. Two such channels in the same reach cross the Smith corridor. These are minor channels and range from 2 to 7 miles (3.2 to 11.3 kilometers) in total length. They do not connect to an organized drainage system.

Three alternate water supply pipeline corridors are proposed to serve the power plant site from the north. The proposed Jackson corridor originates just inside Gaines County and contains no aquatic habitat in that county. The Jackson and Texland water supply pipeline corridors traverse Andrews County. The intermittent Monument Draw channel crosses both corridors. Neither corridor has any other defined drainages or ponds within it in Andrews County. The Whatley corridor joins the Jackson and Texland corridors in Ector County. All three corridors are traversed by the upstream extension of Monahans Draw, which is ephemeral in this reach. Each of the three corridors contains one additional unnamed ephemeral crossing. The Jackson and Texland corridors each have three small temporary ponds located along them, while the Whatley corridor contains four such ponds.

The remaining two proposed CO_2 pipeline corridors are associated with the proposed sequestration site in Pecos County. The corridor proposed to the west of the sequestration site contains three ephemeral draws, two of which are direct tributaries to Six Shooter Draw. All three constitute the upstream end of these draws and are approximately 1 to 1.5 miles (1.6 to 2.4 kilometers) long. The CO_2 pipeline corridor proposed to the east of the sequestration site contains four tributary crossings to Six Shooter Draw. These ephemeral draws and Six Shooter Draw in this area contain no aquatic habitat.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

Power Plant Site

The proposed power plant site is located in Ector County, Texas, and is situated within the High Plains and the Trans-Pecos Mountains and Basins vegetational areas of Texas (FG Alliance, 2006d). The vegetation is variously classified as mixed-prairie, short-grass prairie, and in some locations as tall-grass prairie. The most abundant native grasses are buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*). The High Plains region characteristically is free from brush, but mesquite and yucca have invaded some of the area. Sand sage (*Artemisia filifolia)* and shinnery oak (*Quercus havardii*) are common on the sandylands, and junipers (*Juniperus* sp.) have spread out of some of the breaks onto the Plains proper. Forbs are common, but not in the abundance or in the complicated patterns found in other regions of Texas.

The Trans-Pecos Mountains and Basins Vegetational Area is a region of diverse habitats and vegetation, varying from desert valleys and plateaus to wooded mountain slopes. Because of the wide range of ecological sites, many vegetation types exist. The most common are creosote-tarbush desert shrub, grama grass land, yucca and juniper savannahs, pinion pine and oak forest, and a limited amount of ponderosa pine forest (FG Alliance, 2006d).

The dominant vegetation types on the proposed power plant site include Mesquite-Lotebush Brush, Mesquite-Juniper Brush, Mesquite Shrub, and Havard Shin Oak-Mesquite Brush (FG Alliance, 2006d).

Dominant species of the Mesquite-Lotebush Brush community include mesquite (*Prosopis* sp.), lotebush (*Condalia obtusifolia*), and creosotebush (*Larrea divaricata*). Commonly associated plants include skunkbush sumac (*Rhus aromatica*), yucca (*Yucca* sp.), agarito (*Berberis* sp.), juniper, elbowbush (*Forestiera pubescens*), tasajillo (*Opuntia leptocaulis*), silver bluestem (*Bothriochloa saccharoides*), sand dropseed (*Sporobolus cryptandrus*), little bluestem (*Schizacharium scoparium*), cane bluestem (*Bothriochloa barbinodis*), Texas grama (*Bouteloua rigidiseta*), hairy grama (*Bouteloua hirsuta*), sideoats grama (*Bouteloua curtipendula*), red grama (*Bouteloua trifida*), buffalograss, tobosa (*Hilaria mutica*), purple three-awn (*Aristida purpurea*), Roemer three-awn (*Aristida roemeriana*), Texas wintergrass (*Stipa leucotricha*), Engelmann daisy (*Engelmannia pinnatifida*), broom snakeweed (*Xanthcephalum* sp.), and bitterweed (*Hymenoxys* sp.) (FG Alliance, 2006d).

The Mesquite-Juniper Brush community includes a component of juniper mixed with mesquite. Commonly associated species include lotebush, skunkbush sumac, Texas pricklypear (*Opuntia lindheimeri*), tasajillo, kidneywood (*Eysenhardtia texana*), agarito, yucca, sotol (*Dasylirion* sp.), sideoats grama, three-awn, Texas grama, hairy grama, curly mesquite (*Hilaria belangeri*), buffalograss, and hairy tridens (*Erioneuron pilosum*) (FG Alliance, 2006d).

The Mesquite Shrub community occurs in the northeasterly extents of the ROI, and is heavily dominated by mesquite. Common additional species include grassland pricklypear (*Opuntia machorhiza*), juniper, narrow-leaf yucca (*Yucca angustifolia*), sideoats grama, purple three-awn, Roemer three-awn, Texas grama, hairy grama, red lovegrass (*Eragrostis secundiflora*), gummy lovegrass (*Eragrostis curtipedicellata*), sand dropseed, western ragweed (*Ambrosia psilostachya*), wild buckwheat (*Eriogonum* sp.), and scurfpea (*Psoralea* sp.) (FG Alliance, 2006d).

The Havard Shin Oak-Mesquite Brush community occurs in the westerly extents of the ROI on predominantly sandy soils. The Havard shin oak (*Quercus havardii*) grows in mottes interspersed with mesquite. Other common plants include yucca, catclaw (*Acacia greggii*), sand dropseed, giant dropseed (*Sporobolus giganteus*), indiangrass (*Sorghastrum nutans*), silver bluestem, little bluestem, sand bluestem, feather plume (*Liatris* sp.), fox glove (*Penstemon cobaea*), yellow evening primrose (*Oenothera serrulata*), and Illinois bundleflower (*Desmanthus illinoensis*) (FG Alliance, 2006d).

Sequestration Site

The predominant vegetation type found on the sequestration site is the previously described Mesquite-Juniper Brush community.

Utility Corridors

Both proposed transmission line corridors lie wholly within Ector County, within the previously described High Plains and Trans-Pecos Mountains and Basins vegetational areas of Texas. The primary vegetation types within the proposed transmission line corridor north of the proposed power plant site are the Mesquite-Lotebush Brush and Mesquite-Juniper Brush communities, which are described above. The primary vegetation type within the transmission line corridor proposed south of the proposed power plant site is the previously described Mesquite-Lotebush Brush community.

There are six proposed water supply pipeline corridors. The primary vegetation types within the CCWIS corridor are Havard Shin Oak Brush and the previously described Mesquite-Lotebush Brush and Havard Shin Oak-Mesquite Brush communities. The Havard Shin Oak Brush vegetation type occurs primarily on the sandy soils of Andrews, Crane, Ward, and Winkler counties. The dominant species of this community is the Havard shin oak. Commonly associated species include catclaw, bush morningglory (*Ipomea leptophylla*), southwest rabbitbrush (*Chrysothamnus pulchellus*), sandsage (*Artemisia filifolia*), mesquite, hooded windmill grass (*Chloris culculatta*), sand bluestem (*Andropogon hallii*), big sandreed (*Calamovilfa gigantea*), false buffalograss (*Minroa squarrosa*), spike dropseed (*Sporobolus contractus*), giant dropseed, mesa dropseed (*S. flexuosos*), narrowleaf verbena (*Abronia augsutifolia*), sweet sandverbena (*A. fragrans*), bull nettle (*Cnidoscolus texanus*), sand dune spurge (*Euphorbia carunculata*), prairie spurge (*E. missurica*), firewheel (*Gaillardia* spp.), and plains sunflower (*Helianthus petiolarus*) (FG Alliance, 2006d).

The primary vegetation types within the proposed Smith corridor are the previously described Mesquite-Lotebush Brush, Havard Shin Oak-Mesquite Brush, and Havard Shin Oak Brush communities.

The primary vegetation types within the WTWSS corridor are Creosotebush-Mesquite Shrub and the previously described Havard Shin Oak Brush, Mesquite-Lotebush Brush, and Havard Shin Oak-Mesquite Brush communities. The Creosotebush-Mesquite Shrub vegetation type occurs primarily east of the Delaware Mountains in Culberson County in the Trans-Pecos region. The dominant species of this community are the creosote bush and mesquite. Commonly associated species include the soltol, lechuguilla (*Agave lechequilla*), catclaw, cholla (*Opuntia imbricate* var. *imbricate*), Plains pricklypear (*Opunita lindheimeri*), mormon tea (*Ephedra* spp.) range ratany (*Krameria glandulosa*), desert sumac (*Rhus microphylla*), plains bristlegrass (*Setaria macrostachya*), bush muhly (*Muhlenbergia poteri*), black grama (*Bouteloua eriopoda*), chino gramma (*B. ramosa*), fluffgrass (*Erioneuron pulchellum*), burrograss (*Scleropogon brevifolius*), mesa dropseed, purple three-awn, rough menodora (*Menodora scabra*), coldenia (*Coldenia* spp.), mariola (*Parthenium incanum*), grassland croton (*Croton dioicus*), and sickle-pod rushpea (*Hoffmanseggia drepanocarpa*) (FG Alliance, 2006d).

The primary vegetation types within the Jackson corridor are Mesquite Shrub/Grassland, Mesquite-Juniper Shrub, and the previously described Mesquite-Lotebush Brush, Havard Shin Oak-Mesquite Brush, and Havard Shin Oak Brush communities. The Mesquite Shrub/Grassland communities occur primarily on the High Plains, Rolling Plains, and Northwestern Edwards Plateau. Dominant species are mesquite and various grasses (non-woody plants). Associated plants include narrow-leaf yucca, tasajillo, juniper, grassland pricklypear (*Opuntia macrorhiza*), cholla (*Opuntia imbricate* var. *imbricate*), blue grama (*Bouteloua gracilis*), hairy grama, purple three-awn, Roemer three-awn, buffalograss, little bluestem, western wheatgrass (*Agropyron smithii*), indiangrass, switchgrass (*Panicum virgatum*), James rushpea (*Caesalpinia jamesii*), scurfpea (*Psorlea* spp.), lemon scurfpea (*P. lanceolata*), sandlily (*Mentzelia nuda*), plains beebalm (*Monarda pectinata*), scarlet guara (*Gaura coccinea*), yellow evening primrose (*Oenothera serrulata*), wild buckwheat (*Eriogonum* sp.), and sandsage (*Artemisia filifolia*) (FG Alliance, 2006d).

The Mesquite-Juniper Brush communities generally occupy the mesas and hillsides of the western Edwards Plateau. The predominant plant species are mesquite and juniper. The commonly associated plants are generally the same as those found in the previously described Mesquite-Juniper Brush community. The primary difference between two vegetation communities is occurrence of woody plants generally less than 9 feet (2.7 meters) tall. In “shrub” vegetation, such plants tend to be sparse and scattered, whereas in “brush” vegetation they form clusters and closed canopy.

The Texland corridor lies within Andrews and Ector counties. The primary vegetation types within the Texland corridor are the previously described Mesquite-Lotebush Brush, Havard Shin Oak-Mesquite Brush, Mesquite Shrub/Grassland, and Mesquite-Juniper Brush communities.

The primary vegetation types within the Whately corridor are the previously described Mesquite-Lotebush Brush, Mesquite Shrub/Grassland, and Mesquite-Juniper Brush communities.

There are three proposed sections of CO_2 pipeline. The predominant vegetation type found in the proposed CO_2 pipeline corridors east of the proposed power plant site and west of the proposed sequestration site is the previously described Mesquite-Juniper Brush Community. The predominant vegetation types within the proposed CO_2 pipeline corridor east of the proposed sequestration site are the previously described Mesquite-Juniper Brush and Mesquite-Lotebush Brush communities.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected terrestrial environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

7.9.2.2 Habitats

Aquatic

Power Plant Site

Because there are no permanent aquatic habitats within the proposed power plant site, the proposed utility corridors, and the ROI, there are no fish and limited aquatic invertebrates. Winged adult insects with rapid life-cycles lay eggs in temporary waters when available. These include flies (Diptera), mosquitoes (Culicidae), biting midges (Ceratopogonidae), and some beetles (Coleoptera). The eggs of many midges (Chironomidae) and mayflies (Ephemeroptera) "oversummer" in low-lying areas where water collects during the wet season. Similarly, immature microcrustaceans such as Ostracoda, Cyclopoida, and Amphipoda are able to survive for months in the top layer of a dry stream bed (FG Alliance, 2006d). Insects commonly found in stock ponds include dragonflies and damselflies (Odonata), a variety of flies, some beetles, and water "bugs" (Hemiptera). Additionally, oligochaete worms (Annelida) and burrowing crayfish (Cambaridae) are often found in such ponds. No formalized aquatic federal, state, or local jurisdiction management plans are present for any of the proposed areas of construction.

Sequestration Site

Several small ponds that may contain fish depending upon the land-owner stocking preferences are located on the sequestration site. Some of the forage species present could include red shiner (*Cyprinella lutrensis*), fathead minnow (*Pimephales promelas*), Mexican tetra (*Astyanax mexicanus*), rainwater killifish (*Lucania parva*), and western mosquitofish (*Gambusia affinis*). Additionally, species such as largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), green sunfish (*Lepomis cyanellus*), orangespotted sunfish (*Lepomis humillis*), bluegill (*Lepomis macrochirus*), and longear sunfish (*Lepomis megalotis*) are likely candidates to have been stocked in some of the more permanent ponded areas.

Utility Corridors

Because no permanent aquatic habitat exists within the proposed utility corridors this section does not include a description of affected aquatic habitats.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

Power Plant Site

The proposed power plant site, transmission lines, water supply pipeline corridors, CO_2 pipeline corridor east of the proposed power plant site, and ROI lie within the southern portion of the Kansan Biotic Province described by Blair (FG Alliance, 2006d). More specifically, they are situated within the Mesquite Plains District of the Kansan Province near its border with the Chihuahuan Province of western Texas. In Texas, the Mesquite Plains District is restricted to the Permian Basin area.

The Kansan Province supports at least 59 species of mammals, 14 species of lizards, 31 species of snakes, 14 species of frogs, and one species of turtle (FG Alliance, 2006d). Common species of the Kansan Province include the western spotted skunk (*Spilogale gracilis*), striped skunk (*Mephitis mephitis*), American badger (*Taxidea taxus*), coyote (*Canus latrans*), black-tailed prairie dog (*Cynomys ludovicianus*), jack rabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*), white-throated woodrat (*Neotoma albigula*), northern earless lizard (*Holbrookia maculata maculata*), eastern fence lizard (*Scleroporus undulatus*), six-lined racerunner (*Cnemidophorus sexlinatus*), dusky hog-nosed snake (*Heterodon nasicus gloydi*), western diamond-backed rattlesnake (*Crotalis atrox*), western rattlesnake (*Crotalis viridis*), checkered garter snake (*Thamnophis marcianus marcianus*), Couch's spadefoot (*Scaphiophus couchii*), green toad (*Bufo debilis*), Woodhouse's toad (*Bufo woodhousii*), Blanchard's cricket frog (*Acris crepitans blanchardi*), and northern leopard frog (*Rana pipiens*) (FG Alliance, 2006d). Within the ROI, common wildlife species would include scaled quail (*Callipepla squamata*), mourning dove (*Zenaidura macroura*), western meadowlark (*Sturnella neglecta*), field sparrow (*Spizella pusilla*), cottontail, jackrabbit, coyote, and white-tailed deer (*Odocoileus virginianus*) (FG Alliance, 2006d).

No formalized terrestrial federal, state, or local jurisdiction management plans are present for any of the proposed areas of construction.

Utility Corridors

The proposed CO_2 pipeline corridors located west and east of the proposed sequestration site are located within the Chihuahuan Biotic Province described by Blair (FG Alliance, 2006d). The mammalian fauna of the Chihuahuan Province is richer than that in any other region in Texas, with at least 83 species identified. These include the hooded skunk (*Mephistis macroura*), coyote, ringtail (*Bassariscus astutus*), collared peccary (*Tayassu tajacu*), and swift fox (*Vulpes velox*). Merriam's kangaroo rat (*Dipodomys spectabilis*), the desert shrew (*Notiosorex crawfordi*), Mexican ground squirrel (*Spermophilus mexicanus*), Nelson's pocket mouse (*Chaetodipus nelsoni*), and desert cottontail (*Sylvilagus audubonii*) are small herbivores native to the region. Bats are represented by yuma myotis (*Myotis yumanenis*) and the western mastiff (*Eumops perotis*). At least 22 species of lizards are known from this region, including the Texas banded gecko (*Coleonyx brevis*), crevice spiny lizard (*Scelopours pionsetti pionsetti*), canyon lizard (*S. merriami*), gray checkered whiptail (*Cnemidophorus tesselatus*), and plateau spotted whiptail (*C. septemvittatus*). Other reptiles include 38 species of snakes, including the Texas-Pecos rat snake (*Bogertophis subocularis*), Big Bend black-headed snake (*Salvadora deserticola*), rock rattlesnake (*Crotalus lepidus*), and black-tailed rattlesnake (*C. molossus molossus*). Amphibians in the Chihuahuan Province include the Rio Grande leopard frog (*Rana berlandieri*), Couche's spadefoot toad, spotted chirping frog (*Syrrhophus guttilatus*), red-spotted toad (*Bufo punctatus*), and Great Plains toad (*B.cognatus*). The desert box turtle (*Terrapene ornate*) is widely distributed. Birds of the grasslands include the bronzed cowbird (*Molothrus aeneus*), Baird's sparrow (*Ammodramus bairdii*), black-capped vireo (*Vireo atricapillus*), scaled quail (*Callipepla squamata*), Harris' hawk (*Parabuteo unicintus*), Inca dove (*Columbina inca*), and golden-fronted woodpecker (*Melannerpes aurifrons*) (FG Alliance, 2006d).

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected terrestrial environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

7.9.2.3 Federally Listed Threatened and Endangered Species

Based on review of threatened and endangered species databases generated by the Texas Parks and Wildlife Department (TPWD) and the U.S. Fish and Wildlife Service (FWS), and confirmed by a field reconnaissance that Horizon Environmental Services conducted on behalf of the site proponent in April 2006, there are no protected aquatic or terrestrial species within the proposed power plant site or surrounding area. Although there are no known occurrences of federally listed species within any of the proposed project construction areas, the federally listed threatened bald eagle (*Halieetus leucocephalus*) and federally listed endangered whooping crane (*Grus americana*) could occur within the proposed power plant site, associated areas of new construction, and the sequestration site as transients during migration; however, the proposed sites do not contain any suitable nesting habitat. As such, any sightings would be temporary and short-term. Coordination letters with the FWS are located in Appendix A. No designated critical habitat occurs at any of the areas to be affected by construction of the proposed project.

Federally listed bird species that occur in the same counties as the proposed utility corridors and the sequestration site include the interior least tern (*Sterna antillarum athalassos*), which is federally protected in Pecos and Ward counties. These birds nest on sand and gravel beds in braided steams. Appropriate habitat for this species does not exist in the proposed construction corridors. The black-capped vireo (*Vireo atricapilla*) is also federally listed for Pecos County. This avian species relies on oak-juniper woodlands with ample broad-leaved shrubs for nesting and feeding. This vegetation type does not occur in the proposed construction corridors in Pecos County.

Two mammalian species currently protected at both the state and federal level that were previously known in the same counties as the proposed utility corridors and the sequestration site are the black-footed ferret (*Mustela nigripes*) and gray wolf (*Canis lupus*). Although both are listed as endangered by the FWS, they are generally considered extirpated from their historical range in Texas (TPWD, 2006).

7.9.2.4 Other Protected Species

Aquatic Species

Based on review of threatened and endangered species databases generated by the TPWD, and confirmed by a field reconnaissance that Horizon Environmental Services conducted on behalf of the site proponent in April 2006, there are no protected aquatic species within the proposed power plant site or the ROI. Additionally, there is no suitable habitat for any rare aquatic species within any of the proposed utility corridors or on the sequestration site.

Terrestrial Species

Despite potential habitat, there are no known occurrences of any state-listed rare, threatened, or endangered species within any of the proposed project construction areas. One state-listed plant and one state-listed animal have the potential to occur within 10 miles (16.1 kilometers) of the site and its ROI. The neglected sunflower (*Helianthus neglectus*) was reported in the 1980s approximately 10 miles (16.1 kilometers) southwest of the proposed site; however, suitable habitat does not exist within the project area, so the sunflower would not be expected to occur. The proposed power plant site, utility corridors, sequestration site and ROI contain potential habitat for the state-listed threatened Texas horned lizard (*Phrynosoma cornumtum*). However, this species could potentially occur almost anywhere within the western two-thirds of the state.

The state-listed protected peregrine falcon (*Falco peregrinus*) and two associated sub-species, the Arctic peregrine falcon (*F. peregrinus tundrius*) and American peregrine falcon (*F. peregrinus anatum*), have the potential to migrate through these areas, but suitable nesting habitat (bluffs and cliffs) is not found in the proposed construction corridors.

The reddish egret (*Egretta rufescens*) and zone-tailed hawk (*Buteo albonotatus*) are also state-listed in Pecos County. The reddish egret is generally found in coastal areas of brackish ponds and tidal flats. The zone-tailed hawk occupies a variety of habitats, but generally nests in wooded areas. Suitable habitat for these two species is not found in the proposed utility corridors in Pecos County.

The Pecos or puzzle sunflower (*Helianthus paradoxus*) is a state-listed protected plant found within the six counties containing the proposed construction corridors and the sequestration site. It occurs in Pecos County in alkaline soils surrounding desert springs. Suitable habitat does not occur within the proposed utility corridors or the sequestration site.

7.9.3 IMPACTS

7.9.3.1 Construction Impacts

Power Plant Site

There are no permanent streams or ponds on the proposed power plant site. Therefore, no direct impacts to streams or ponds are expected. Standard stormwater management practices for construction activities (e.g., placement of silt fencing around disturbed areas) would prevent indirect impacts, such as sedimentation to off-site surface waters.

Project construction would require the removal of up to 200 acres (81 hectares) of terrestrial habitat. This would predominantly consist of mesquite lotebush-brush and mesquite juniper brush, neither of which is rare in the greater project area. The wildlife species found within the site are common to the area. Some small, less mobile species, such as reptiles and small mammals, would be displaced during project construction; however, this would not affect the overall populations of these species due to their commonality and plentiful alternative habitat adjacent to the site. Larger, more mobile species would likely disperse from the project site due to noise, disturbance, and habitat loss. Because adjacent suitable habitat is plentiful, this would not likely affect population health. Additionally, construction at the proposed power plant site is unlikely to cause a proliferation of noxious weeds because the disturbed area would become an industrial facility with little vegetation.

Project construction would not affect any federally or state-listed rare, threatened, or endangered species because the proposed project location does not contain any known occurrences or designated critical habitat. If the state-listed Texas horned lizard is found at the proposed power plant site, some loss of individuals could occur as a result of project construction in the absence of enforced protection measures. The potential loss of Texas horned lizard habitat is unlikely to affect the entire population because potential habitat occurs throughout the western two-thirds of the state. Surveys for the Texas horned lizard before commencement of any ground-disturbing activities on the proposed power plant site would confirm its presence or absence. If the species is found in proximity to any construction or disturbance area, consultation between the site proponent, the FWS, and the TPWD to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Sequestration Site

The sequestration site contains numerous intermittent and ephemeral channels with some ponded areas. Placement of the injection wells would likely avoid channels and ponded areas to avoid impacts. Construction of the injection wells would result in the loss of up to 10 acres (4 hectares) of Mesquite-Juniper Brush, which is not rare in the greater project area. However, this loss should not affect the overall extent and availability of habitat dispersed throughout the site. After construction, disturbed areas not used for injection wells would be revegetated with native species, limiting the proliferation of noxious weeds. Temporary impacts to vegetation would result from truck access occur during the required seismic surveys of the sequestration site, before injection well construction.

No federally or state-listed rare, threatened, or endangered species are known to occur at the sequestration site. If the state-listed Texas horned lizard is found at the proposed injection well locations, injection well locations could potentially be sited to avoid loss of individuals. The potential loss of Texas horned lizard habitat is unlikely to affect the entire population because potential habitat occurs throughout the western two-thirds of the state. Surveys for the Texas horned lizard before commencement of any ground-disturbing activities on the sequestration site, would confirm its presence or absence. If the species is found in proximity to any construction or disturbance area, consultation between the site proponent, the FWS, and the TPWD to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss. Similar to the power plant site, some species such as reptiles and small mammals could be displaced during project construction to similar habitat adjacent to the site.

Utility Corridors

The two proposed transmission line corridors and one proposed CO_2 pipeline corridor do not contain any aquatic habitat. There are six potential water supply pipeline corridors containing two intermittent stream crossings, seven temporary ponds, and multiple ephemeral stream crossings, some of which contain permanently ponded areas. These streams and ponds provide little to no aquatic habitat. If these utilities are not directionally drilled beneath these features, temporary and minor impacts to aquatic habitat could result from trenching of stream and pond beds during construction to accommodate the pipeline. Flow, if present during construction, would be temporarily diverted around the area of installation. Traditional pipeline construction methods, along with appropriate protection and mitigation measures such as time of year construction restrictions, silt fencing, hay bales, and other sediment and erosion control mechanisms, would minimize these effects.

Several miles of proposed transmission lines, process water supply pipeline, and CO_2 pipeline would need to be constructed. The project would potentially require either 0.7 mile (1.1 kilometers) or 1.8 miles (2.9 kilometers) of transmission lines, 24 to 54 miles (38.6 to 86.9 kilometers) of water supply pipeline depending upon the water supply that would be used, and 2 to 58 miles (3 to 93.3 kilometers) of CO_2 pipeline, totaling up to 113.8 miles (183.1 kilometers) of utility corridors. Using existing ROWs for portions of the corridors would minimize disturbance of mesquite-lotebush brush and mesquite-juniper brush habitat. The proposed transmission lines could use 0.7 mile (1.1 kilometer) of existing ROW. It is likely that up to 14 miles (22.5 kilometers) of CO_2 pipeline would need to be built. The corridors do not contain any designated critical habitat for federally or state-listed rare, threatened, or endangered species and similar habitat is plentiful in the project vicinity. Additionally, after construction, the land above the pipelines would be revegetated with native species, maintaining wildlife habitat similar to current conditions and limiting the proliferation of noxious weeds. Wildlife species found along the proposed utility corridors, like those at the proposed power plant site, are common species that could be temporarily displaced during construction.

As with the proposed power plant site, construction of the proposed utility corridors would not affect any federally or state-listed rare, threatened, or endangered species because the proposed locations do not contain any known occurrences or designated critical habitat. If the state-listed Texas horned lizard is found at the selected utility corridor locations, project construction could result in some loss of individuals in the absence of enforced protection measures. The potential loss of Texas horned lizard habitat is unlikely to affect the entire population because potential habitat occurs throughout the western two-thirds of the state. Surveys for the Texas horned lizard before commencement of any ground-disturbing activities on the utility corridors would confirm its presence or absence from the proposed sites. If the species is found in proximity to any construction or disturbance area, consultation between the site proponent, the FWS, and the TPWD to develop and implement species protection plans would avoid direct or indirect impacts, such as casualty or habitat loss.

Transportation Corridors

No new transportation corridors are proposed outside of the proposed power plant site or sequestration site. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

7.9.3.2 Operational Impacts

Power Plant Site

Operating the proposed power plant would have a minimal effect on biological resources. Noise during proposed project facility operations would be slightly elevated in the absence of mitigation (see Section 7.14), however, wildlife species that are found near the proposed power plant site would either adapt to the noise or disperse in the plentiful adjacent habitat. Air emissions due to routine operation would result in small increases in ground-level pollutant concentrations (see Section 7.2 for description) that should be below levels known to be harmful to wildlife and vegetation or affect ecosystems through bio-uptake and biomagnification in the food chain. The potential for effects of emissions on humans was assessed by comparing air quality impact levels against state and federal standards (see Section 7.2). Because there are no high-quality or sensitive aquatic or wildlife receptors near the proposed power plant site, air emissions would not impact biological communities.

Sequestration Site

A limited number of site characterization seismic surveys would be required during operation of the sequestration site, resulting in temporary impacts to vegetation due to truck access within the survey plots.

Microbes occurring approximately 0.9 mile (1.4 kilometers) under ground within the sequestration reservoir could be affected by sequestration. Microbes are likely to exist in almost every environment, including the proposed sequestration reservoir, unless conditions prevent their presence. CO_2 sequestration has the potential to destroy these localized microbial communities by altering the pH of the underground environment. However, it is also possible that CO_2 sequestration would not harm microbial communities (IPCC, 2005). The potential loss of localized microbial populations within the sequestration reservoir would not constitute an appreciable difference to the world's total microbial population.

No additional impacts are anticipated during normal operations. Should released gas from the sequestration reservoir reach surface water, impacts to aquatic biota would be unlikely because the concentration of CO_2 in the surface water would be less than the 2 percent level at which effects to aquatic biota could occur (see Section 7.17). Plants are not predicted to be impacted by gradual CO_2 releases from the sequestration reservoir, although effects to plants in the immediate vicinity of the injection wells could result from a rapid CO_2 release (see Section 7.17).

Utility Corridors

The proposed transmission line, process water supply pipeline, and CO_2 pipeline corridors would be maintained without trees due to safety concerns. Corridor maintenance would likely use both mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in proximity to streams and wetlands could be potentially damaging. Following approved herbicide usage instructions would eliminate this concern (DOE, 2007). If a leak or rupture in the CO_2 pipeline occurred, the respiratory effects to biota due to atmospheric CO_2 concentrations would be limited to the immediate vicinity along the pipeline where the rupture or leak occurred. While the heat generated from the supercritical fluid in the CO_2 pipeline could potentially affect surface vegetation, this is not expected to occur due to pipeline construction techniques which would contain the heat. Soil gas concentrations vary depending on soil type, therefore, effects on soil invertebrates or plant roots could occur close to the segment of pipeline that ruptured or leaked (see Section 7.17).

The proposed transmission lines could potentially affect raptors and waterfowl located near the lines due to collision or electrocution. Designing the line in accordance with current guidelines (APLIC et al., 1996) would minimize the potential for these effects.

Transportation Corridors

Other than a potential minimal increase in road kill, there would be no impact to biological resources due to increased traffic on existing roads and the new transportation spurs located at the proposed power plant site.

Table 4.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Ammonia (NH_3)	**NIOSH REL**: TWA 25 ppm, ST 35 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 300 ppm	Inhalation, ingestion (solution), skin and eye contact (solution/liquid)	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite
Carbon Dioxide (CO_2)	**NIOSH REL**: TWA 5,000 ppm ST 30,000 ppm **OSHA PEL**: TWA 5,000 ppm **IDLH**: 40,000 ppm	Inhalation, skin and eye contact (liquid/solid)	Respiratory and cardiovascular systems	Headache, dizziness, restlessness, paresthesia; dyspnea (breathing difficulty); sweating, malaise (vague feeling of discomfort); increased heart rate, cardiac output, blood pressure; coma; asphyxia; convulsions; liquid: frostbite
Carbon Monoxide (CO)	**NIOSH REL**: TWA 35 ppm; C 200 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 1200 ppm	Inhalation, skin and eye contact (liquid)	Cardiovascular system, lungs, blood, central nervous system	Headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope
Chlorine (Cl_2)	**NIOSH REL**: C 0.5 ppm [15-minute] **OSHA PEL**: C 1 ppm **IDLH**: 10 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Burning of eyes, nose, mouth; lacrimation (discharge of tears), rhinorrhea (discharge of thin mucus); cough, choking, substernal (occurring beneath the sternum) pain; nausea, vomiting; headache, dizziness; syncope; pulmonary edema; pneumonitis; hypoxemia (reduced oxygen in the blood); dermatitis; liquid: frostbite
Hydrogen Chloride (HCl)	**NIOSH REL**: C 5 ppm **OSHA PEL**: C 5 ppm **IDLH**: 50 ppm	Inhalation, ingestion (solution), skin and eye contact	Eyes, skin, respiratory system	Irritation in nose, throat, larynx; cough, choking; dermatitis; solution: eye, skin burns; liquid: frostbite; in animals: laryngeal spasm; pulmonary edema

Table 4.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Hydrogen Sulfide (H_2S)	**NIOSH REL**: C 10 ppm [10-minute] **OSHA PEL**: C 20 ppm 50 ppm [10-minute maximum peak] **IDLH:** 100 ppm	Inhalation, skin and eye contact	Eyes, respiratory system, central nervous system	Irritation in eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite
Sulfur Dioxide (SO_2)	**NIOSH REL**: TWA 2 ppm ST 5 ppm **OSHA PEL**: TWA 5 ppm **IDLH**: 100 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; rhinorrhea (discharge of thin mucus); choking, cough; reflex bronchoconstriction; liquid: frostbite

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.
Source: NIOSH, 2007.

Table 4.7-1. Water Resources Within ROI Listed on State of Illinois 2006 303(d) List

Segment Name	Assessment Unit ID	Cat.	Segment Length (Miles [Kilometers])	Cause of Impairment	Source(s) of Impairment
Upper Kaskaskia Watershed					
Whitley Creek[1]	IL_OZZS-01	2	13.4 (21.5)	n/a	n/a
Kaskaskia River	IL_O-02	5	13.2 (21.2)	PCBs[2], Fecal Coliform	Unknown
	IL_O-15	5	11.6 (18.7)	PCBs, Fecal Coliform	Unknown
	IL_O-13	5	8.8 (14.2)	PCBs	Unknown
	IL_O-17	5	10.96 (17.6)	Impairment Unknown	Unknown
	IL_O-31	5	5.2 (8.4)	PCBs	Unknown
	IL_O-35	5	15.1 (24.3)	PCBs	Unknown
	IL_O-37	5	7.8 (12.6)	PCBs	Unknown
Embarras Watershed					
Cassell Creek	IL_BENC-01	4C	8.2 (13.1)	Fish Kills	Other Spill Related Impacts
Kickapoo Creek	IL_BEN-01	5	1.3 (2.1)	Nitrogen (total), pH	Urban Runoff/Storm Sewers, Crop Production
	IL_BEN_02	2	13.5 (21.8)	n/a	n/a
Riley Creek	IL_BENA-01	5	1.3 (2.1)	Nitrogen (total), pH	Other Spill Related Impacts, Urban Runoff/Storm Sewers, Crop Production
	IL_BENA-02	5	8.1 (13.0)	Nitrogen (total)	Urban Runoff/Storm Sewers, Crop Production
Little Wabash Watershed					
Little Wabash	IL_C-12	5	9.4 (15.1)	Total Suspended Solids, Sedimentation/ Siltation	Crop Production
	IL_C-21	5	31.1 (50.1)	Fecal Coliform, Manganese	Unknown
Lake Paradise	IL_RCG	5	176 (283.2)	Phosphorus (Total), Nitrogen (Total), Sedimentation/ Siltation	Crop Production, Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland, Municipal Point Source Discharges, Unknown, Hydrostructure Flow Regulation/ Modification
Lake Mattoon	IL_RCF	5	765 (1,231)	Phosphorus (Total), Total Suspended Solids	Crop Production, Other Recreational Pollution Sources, Runoff from Forest/Grassland/Parkland, Littoral/ Shore Area Modifications (Non-riverine)

[1] Whitley Creek is not impaired. All other water resource segments exhibit some level of impairment.
[2] PCBs = polychlorinated biphenyls.
Source: IEPA, 2006.

Table 4.8-1. Summary of Delineated Wetlands Within the Proposed Mattoon Power Plant Project ROI

Wetland Areas	Size (acres [hectares])	Class/Cover Type	Vegetation Community Quality[1]	Description	Location
1	0.01 (0.004)	PFO1B	Low	Drainage ditch	Primary process water corridor
2	0.01 (0.004)	PEMA	Low	Drainage channel	Primary process water corridor
3	0.01 (0.004)	PSS1A	Low	Drainage channel	Primary process water corridor
4	0.2 (0.08)	PFO1A	Moderate	Forested floodplain	Primary process water corridor
5	0.01 (0.004)	PFO1F	Moderate	Forested drainageway	Primary process water corridor
6	Less than 0.01 (0.004)	PEMA	Low	Drainage channel	Primary process water corridor
7	0.05 (0.02)	PUB_X	Low	Farm pond	Power plant site
8	0.07 (0.03)	PFO1A	Low	Forested branch of Copperas Creek	Transmission line corridor
9	0.1 (0.04)	PFO1A	Low	Forested branch of Copperas Creek	Transmission line corridor
10	0.1 (0.04)	PFO1A	Low	Main channel of Copperas Creek	Transmission line corridor
11	0.03 (0.01)	PFO1A	Low	Forested periphery of Lake Mattoon	Transmission line corridor
12	4.7 (1.9)	PFO1A	Moderate	Forested floodplain	Transmission line corridor
13	1.8 (0.7)	PFO1A	Moderate	Forested floodplain	Transmission line corridor
14	0.07 (0.03)	PEME	Low	Unnamed tributary to the Little Wabash River	Transmission line corridor
15	0.02 (0.008)	PSSA-PFO1A	Low	Unnamed branch of the Little Wabash	Transmission line corridor
16	22.0 (8.9)	PFO1A	Moderate	Forested floodplain	Transmission line corridor
17	0.06 (0.02)	PSSA-PFO1F	Low	Little Wabash River crossing	Transmission line corridor
18	25 (10)	PFO1A	Moderate	Forested wetland associated with unnamed tributary of Whitley Creek; not within the ROI	Adjacent to power plant and sequestration site

[1] Wetlands quality descriptors have been assigned based on the NWI using the vegetation communities present.
PFO1B = Palustrine Forested, Broad-leaved Deciduous, Saturated; PEMA = Palustrine Emergent, Temporarily Flooded.
PSS1A = Palustrine Scrub-Shrub, Broad-leaved Deciduous, Temporarily Flooded; PFO1A = Palustrine Forested, Broad-leaved Deciduous, Temporarily Flooded; PFO1F = Palustrine Forested, Broad-leaved Deciduous, Semipermanently Flooded.
PUBx = Palustrine Unconsolidated Bottom, Man-made; PEME = Palustrine Emergent, Seasonally Flooded/Saturated.
PSSA = Palustrine Scrub-Shrub, Temporarily Flooded.
Source: FG Alliance, 2006a.

Table 5.1-1. Tuscola Site Features

Feature	Description
Power Plant Site	The proposed Tuscola Site consists of approximately 345 acres (140 hectares) located in east-central Illinois, 1.5 miles (2.4 kilometers) west of the City of Tuscola within Douglas County. TR 86 (750E) runs along the west border of the proposed plant site and TR 47 (1050N) runs along its northern border. The Site Proponent is a group consisting of the State of Illinois (through the Illinois Department of Commerce and Economic Opportunity), the City of Tuscola, Douglas County, and Tuscola Economic Development, Inc. The proposed site is currently privately owned, but the Site Proponent has an option to purchase the site title, which would be conveyed to the Alliance. The proposed site is located on flat farmland near an industrial complex, which is immediately west of the proposed site. The areas to the immediate north, east, and south are rural with a very low population density.
Sequestration Site Characteristics and Predicted Plume Radius	The proposed sequestration site is located in a rural area, approximately 2 miles (3.2 kilometers) south-southwest of the small town of Arcola in Douglas County in east-central Illinois. The proposed site is located 11 miles (17.7 kilometers) south of the proposed power plant site and is 3 miles (4.8 kilometers) west of I-57. The proposed sequestration site would be located on a land trust, where the trustee is the First National Bank of Arcola. The trustee has been authorized by the beneficiaries of the trust to sell the property. The proposed site is a 10-acre (4-hectare) portion of a larger parcel of 80 acres (32.4 hectares). The proposed sequestration site is located in Arcola Township, Douglas County, approximately 0.25 mile (0.4 kilometer) east of CR 750E along 000N, the Douglas-Coles County line. The site consists primarily of agricultural land with row crops. Injection would occur within the Mt. Simon saline-bearing sandstone, at a depth of between 1.3 to 1.5 miles (2.1 to 2.4 kilometers). The Mt. Simon formation is overlain by a thick (500- to 700-foot [152- to 213-meter]) regional seal of low permeability siltstones and shales of the Eau Claire Formation and is underlain by Precambrian granitic rock. The St. Peter sandstone is proposed as an optional target reservoir. It occurs at a depth of 0.9 mile (1.4 kilometers), which is about 0.4 mile (0.6 kilometer) above the Mt. Simon formation. The St. Peter reservoir is estimated to be over 100 feet (30.5 meters) thick with state-wide lateral continuity. Both the Mt. Simon and St. Peter reservoirs have been successfully used for natural gas storage in other parts of Illinois. To estimate the size of the plume of injected CO_2, the Alliance used numerical modeling to predict the plume radius from the injection well. This modeling estimated that the plume radius at the proposed Tuscola injection site could be as large as 1.1 miles (1.8 kilometers) after injecting 1.1 million tons (1 MMT) of CO_2 annually for 50 years. The dispersal and movement of the injected CO_2 would be influenced by the geologic properties of the reservoir, and it is unlikely the plume would radiate in all directions from the injection point in the form of a perfect circle. However, for reference purposes, this modeled radius corresponds to a circular area equal to 2,432 acres (984 hectares). A recent 2D seismic line across the proposed injection site indicated that the continuity of seismic reflectors on this seismic line suggest that there is no significant faulting cutting the plane of the seismic line within 1 mile (1.6 kilometers) to the west and 2.5 miles (4.0 kilometers) to the east of the Tuscola Sequestration Site (Patrick Engineering, 2006).
Utility Corridors	
Potable Water	Potable water would be supplied to the proposed power plant by tapping an existing 8-inch (20.3-centimeter) water line operated by the Illinois American Water Company. This line runs along the southern boundary of the property along the CSX Railroad. Tapping into the existing water line would require less than 1 mile (1.6 kilometers) of new construction.

Table 5.1-1. Tuscola Site Features

Feature	Description
Process Water	The proposed power plant would receive its process water from an existing 150 million-gallon (568 million-liter) water holding pond at the Lyondell-Equistar Chemical Company located west of the proposed site. This pond contains raw water pumped from the adjacent Kaskaskia River. A 1.5-mile (2.4-kilometer) force main would be constructed to pump water from the pond to the plant, crossing property owned by Lyondell-Equistar Chemical Company and Cabot Corporation, as well as an existing township ROW.
Sanitary Wastewater	Option 1: Under Option 1, an on-site WWTP would be constructed at the proposed plant site. The treated effluent from this facility could then be discharged into an on-site reservoir (if constructed) and then reused as process water. Option 2: Under Option 2, a 0.9-mile (1.4-kilometer) sanitary force-main would be constructed to the existing wastewater treatment system at the Lyondell-Equistar Chemical Company. Once treated, this effluent could potentially be discharged into the existing 150-million-gallon (568-million-liter) reservoir to be reused as process water for the proposed power plant. There is an abandoned 8-inch (20.3-centimeter) potable water pipeline at the property that could potentially be used as a sanitary force-main to the Lyondell-Equistar WWTP. This line would require hydraulic testing before it could be put into service.
Electric Transmission Lines	Option 1: The nearest electric transmission line to the proposed power plant site is a 138-kV line located 0.5 mile (0.8 kilometer) north of the proposed site. This line is owned and operated by Ameren Corporation. The connection to this line would require additional ROW. Under Option 1, the proposed plant would tie into this existing 138-kV line. Option 2: If the interconnection of the proposed plant to the electric grid required use of a 345-kV line, a new 345-kV line that would parallel or replace the existing 138-kV line would be constructed for approximately 17 miles (27.4 kilometers) and connect to a substation where the line currently joins the 345-kV Sidney-Kansas line. Approximately 3 miles (4.8 kilometers) of new ROW would be required. An interconnection study has been requested and would dictate the ultimate line requirements.
Natural Gas	Natural gas would be delivered to the proposed plant from an existing natural gas mainline that runs through the proposed power plant site. Because the pipeline is a high-pressure line, a new tap and delivery station would be required.
CO_2 Pipeline	A new 11-mile (17.7-kilometer) pipeline would be constructed to transport CO_2 to the proposed sequestration site 10 miles (16.1 kilometers) due south of the proposed plant site. The pipeline would be constructed across existing State of Illinois, Douglas County, and Township ROWs and would occupy new ROWs where needed. The pipeline corridor would run parallel to CR 750E and 700E to the injection location.
Transportation Corridors	There are four railroads nearby: CSX Transportation (borders site), Union Pacific (1.5 miles [2.4 kilometers]), Canadian National (1.5 miles [2.4 kilometers]),, and Norfolk Southern (approximately 30 miles [48 kilometers]). The proposed site is bordered by TR 86 and TR 47. Illinois is located within the East North Central Demand Region for coal, which also includes Ohio, Indiana, Wisconsin, and Michigan. According to the Energy Information Administration (EIA, 2000), the East North Central Demand Region is ideally situated for access to coal, which it receives from each of the major U.S. supply regions. In 1997, the average distance that a coal shipment traveled to reach a destination in this region was about 830 miles (1,336 kilometers) (EIA, 2000). In terms of a straight line distance, Tuscola is approximately 300 miles (483 kilometers) from the Pittsburgh Coalbed (near south-central Ohio in the northern Appalachian Basin), 900 miles (1,448 kilometers) from the PRB (eastern Wyoming), and within 35 miles (56.3 kilometers) of the nearest active coal mines in the Illinois Basin (Vermillion County, Illinois).

Source: FG Alliance, 2006b (unless otherwise noted).

Table 5.17-15. Effects to the Public from Pre-Sequestration Releases

Release Scenario	Frequency Category[2]	Gas	Effect[3]	Distance ft (m)	Number Affected
Pipeline Rupture[1] (release duration = minutes)	U	CO_2	Adverse Effects	459 (140)	0
			Irreversible Adverse	459 (140)	0
			Life Threatening	315 (96)	0
		H_2S	Adverse Effects	16,312 (4,972)	7
			Irreversible Adverse	1,384 (422)	<1
			Life Threatening	873 (266)	<1
Pipeline Puncture[1] (release duration = approximately 4 hours)	U	CO_2	Adverse Effects	623 (190)	0
			Life Threatening	118 (36)	0
		H_2S	Adverse Effects	5,692 (1,735)	1
			Irreversible Adverse	551 (168)	0
			Life Threatening	381 (116)	0
Wellhead Equipment Rupture (Main) (release duration = minutes)	EU	CO_2	Adverse Effects	16 (4.9)	0
			Irreversible Adverse	16 (4.9)	0
			Life Threatening	10 (3.0)	0
		H_2S	Adverse Effects	2,034 (620)	<1
			Irreversible Adverse	230 (70)	0
			Life Threatening	164 (50)	0

[1] Rupture/puncture assumed to occur about 7.4 miles from the injection site.
[2] U (unlikely) = frequency of $1x10^{-4}$/yr /y to$1x10^{-2}$/yr r; EU (extremely unlikely) = frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[3] See Section 5.17.4.2 for an explanation of the effects categories.

Table 5.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Ammonia (NH_3)	**NIOSH REL**: TWA 25 ppm, ST 35 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 300 ppm	Inhalation, ingestion (solution), skin and eye contact (solution/liquid)	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite
Carbon Dioxide CO_2	**NIOSH REL**: TWA 5,000 ppm ST 30,000 ppm **OSHA PEL**: TWA 5,000 ppm **IDLH**: 40,000 ppm	Inhalation, skin and eye contact (liquid/solid)	Respiratory and cardiovascular systems	Headache, dizziness, restlessness, paresthesia; dyspnea (breathing difficulty); sweating, malaise (vague feeling of discomfort); increased heart rate, cardiac output, blood pressure; coma; asphyxia; convulsions; liquid: frostbite
Carbon Monoxide CO	**NIOSH REL**: TWA 35 ppm; C 200 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 1200 ppm	Inhalation, skin and eye contact (liquid)	Cardiovascular system, lungs, blood, central nervous system	Headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope
Chlorine (Cl_2)	**NIOSH REL**: C 0.5 ppm [15-minute] **OSHA PEL**: C 1 ppm **IDLH**: 10 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Burning of eyes, nose, mouth; lacrimation (discharge of tears), rhinorrhea (discharge of thin mucus); cough, choking, substernal (occurring beneath the sternum) pain; nausea, vomiting; headache, dizziness; syncope; pulmonary edema; pneumonitis; hypoxemia (reduced oxygen in the blood); dermatitis; liquid: frostbite
Hydrogen Chloride (HCl)	**NIOSH REL**: C 5 ppm **OSHA PEL**: C 5 ppm **IDLH:** 50 ppm	Inhalation, ingestion (solution), skin and eye contact	Eyes, skin, respiratory system	Irritation in nose, throat, larynx; cough, choking; dermatitis; solution: eye, skin burns; liquid: frostbite; in animals: laryngeal spasm; pulmonary edema

Table 5.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
H_2S	**NIOSH REL**: C 10 ppm [10-minute] **OSHA PEL**: C 20 ppm 50 ppm [10-minute maximum peak] **IDLH** 100 ppm	Inhalation, skin and eye contact	Eyes, respiratory system, central nervous system	Irritation in eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite
SO_2	**NIOSH REL**: TWA 2 ppm ST 5 ppm **OSHA PEL**: TWA 5 ppm **IDLH**:100 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; rhinorrhea (discharge of thin mucus); choking, cough; reflex bronchoconstriction; liquid: frostbite

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.
Source: NIOSH, 2007.

Table 5.19-1. Population Distribution and Projected Change for Counties Containing Land Area Within the ROI

County	Year 2000					2010 Projected Total Population	Projected Change 2000 to 2010 (percent)
	Total	Under 18	18-64	65 and over	Average Family Size		
Counties Located Completely Within the ROI							
Douglas	19,922	5,388	11,354	3,180	2.6	21,032	1,110 (5)
Champaign	179,669	37,819	124,380	17,470	2.3	186,883	7,214 (4)
Coles	53,196	10,477	35,652	7,067	2.3	54,178	982 (2)
Cumberland	11,253	2,976	6,495	1,782	2.6	11,511	258 (2)
Edgar	19,704	4,701	11,509	3,494	2.4	19,901	197 (0.1)
Macon	114,706	28,171	69,054	17,481	2.4	115,199	493 (0.4)
Moultrie	14,287	3,670	8,093	2,524	2.6	14,928	641 (4)
Piatt	16,365	4,115	9,721	2,529	2.5	16,815	450 (3.0)
Subtotal	**429,102**	**97,317**	**276,258**	**55,527**	**2.5**	**440,447**	**11,345 (2.6)**
Counties Located Partially Within the ROI							
Christian	35,372	8,521	20,757	6,094	2.4	37,212	1,840 (5.0)
Clark	17,008	4,233	9,714	3,061	2.4	17,734	726 (4.0)
Crawford	20,452	4,664	12,391	3,397	2.4	20,978	526 (3.0)
De Witt	16,798	4,126	10,006	2,666	2.4	19,084	2,286 (3.0)
Effingham	34,264	9,784	19,713	4,767	2.6	36,558	2,294 (7.0)
Fayette	21,802	5,188	13,150	3,464	2.5	21,860	58 (0.2)
Ford	14,241	3,671	7,806	2,764	2.5	14,607	366 (3.0)
Jasper	10,117	2,620	5,830	1,667	2.6	10,174	57 (0.5)
Logan	31,183	6,824	19,668	4,691	2.4	31,310	127 (0.4)
McLean	150,433	35,292	100,520	14,621	2.5	159,339	8,906 (6.0)
Sangamon	188,951	47,147	116,280	25,524	2.4	190,721	1,770 (0.9)
Shelby	22,893	5,728	13,088	4,077	2.5	23,087	194 (0.8)
Vermilion, IL	83,919	20,972	49,522	13,425	2.4	84,471	552 (3.0)
Vermillion, IN	16,788	4,447	8,939	3,402	2.4	17,125	337 (2.0)
Vigo, IN	105,848	24,216	66,584	15,048	2.4	110,441	4,593 (4.0)
Subtotal or Average	**770,069**	**187,433**	**473,968**	**108,668**	**2.5**	**794,701**	**24,632 (3.2)**
Total	**1,199,171**	**284,750**	**750,226**	**164,195**	**2.5**	**1,235,148**	**35,977 (3.0)**
Illinois	**12,419,293**					**12,916,894**	**497,601 (1.0)**
U.S.	**282,125,000**					**308,936,000**	**2,681,100 (9.5)**

Source: FG Alliance, 2006b and USCB, 2000a.

Table 5.8-1. Summary of Delineated Wetlands Within the Proposed Tuscola Power Plant Project ROI

Wetland Areas	Size (acres [hectares])	Class/Cover Type	Vegetation Community Quality[1]	Description	Location
1	0.09 (0.04)	PEMIx	Low	Constructed drainage swale	Transmission line corridor
2	0.2 (0.08)	PEMIx	Low	Drainage swale	Transmission line corridor
3	0.4 (0.16) (0.3 [0.1] within corridor)	PUBGx	Low	Excavated pond	Transmission line corridor
4	0.9 (0.4) (0.7 [0.3] within corridor)	PUBGH	Low - Moderate	Bermed pond	Transmission line corridor
5	0.8 (0.3)	PFO1C R2OWH	Low - Moderate	Embarras River with floodplain terrace/wet meadow	Transmission line corridor
6	0.5 (0.2) (0.02 [0.008] within corridor)	PUBGH	Low	Bermed farm pond	Transmission line corridor
7	0.11 (0.04)	PEMU	Low	Eroded drainage swale	Transmission line corridor
8	0.4 (0.2) (0.36 [0.15] within corridor)	PUBGx	Low - Moderate	Bermed pond	Transmission line corridor
9	0.4 (0.16)	PEMC PFO1C R2OWH	Low - Moderate	Hackett Branch of Embarras River with floodplain/wet meadow	Transmission line corridor
10	Not included in corridor	PUBGH	Low	Excavated pond	Transmission line corridor
11	0.2 (0.09)	PEMHx	Low	Drainage swale and Hayes Branch of Embarras River	Transmission line corridor
12	0.2 (0.09)	PEMHx	Low - Moderate	Excavated pond	Transmission line corridor
13	Acreage dependent on future corridor construction	PUBKx, PUBGx PUBKH, L1UBHx	Low	Industrial excavated ponds, drainage swales and reservoirs	Lyondell-Equistar facility
14	Acreage dependent on future corridor construction	PEMFx R2UBH	Moderate	Constructed waterways and Kaskaskia River	Intake and outfall channels
15	0.1 (0.04)	PUBGX	Low	Eroded drainage swale	CO_2 corridor
16	0.09 (0.03)	PEMAF	Low	Drainage swale	Sequestration site
17	1.6 (0.7)	R2UBH PEMAF	Moderate	Kaskaskia River, floodplain/terrace, intermittent creeks	Sequestration site
18	2.7 (1.1)	PFO1AF	Low	Drainage swale	Sequestration site
19	0.5 (0.2)	POWx	Low	Excavated pond	Sequestration site

PFO = Palustrine Forested; PEM = Palustrine Emergent; PUB = Palustrine Unconsolidated Bottom; PSS = Palustrine Scrub-Shrub; L1 = Lacustrine Limnetic; R2 = Riverine Lower Perennial.
[1] Wetlands quality descriptors have been assigned based on the NWI using the vegetation communities present.
Source: FG Alliance, 2006b.

Table 6.1-1. Jewett Site Features

Feature	Description
Power Plant Site	The proposed Jewett Site is located in east-central Texas on approximately 400 acres (162 hectares) of land northwest of the Town of Jewett. The proposed site is located at the intersection of Leon, Limestone, and Freestone counties on FM 39 near US 79. The area is characterized by very gently rolling reclaimed mine lands immediately adjacent to an operating lignite mine and the nominal 1800-MW NRG Limestone Generating Station (power plant). The Site Proponent is the State of Texas. The proposed power plant site is currently held by one property owner – NRG Texas.
Sequestration Site Characteristics and Predicted Plume Radius	The proposed Jewett Sequestration Site is located in a rural area about 33 miles (53.1 kilometers) northeast of the proposed power plant site. It is located about 16 miles (25.7 kilometers) east of the Town of Fairfield in Freestone County, 65 miles (105 kilometers) north of the Bryan/College Station area, and 60 miles (96.6 kilometers) east of Waco. The land use at the proposed sequestration site is primarily agricultural, with few residences located over the projected plume. Injection would occur on a private ranch (Hill Ranch) and on adjoining state property managed by the Texas Department of Criminal Justice (TDCJ). Two injection wells are proposed for injection into the Woodbine formation. In addition, one more injection well is proposed for injection into the deeper Travis Peak formation at a much lower injection rate than the primary Woodbine wells to take advantage of CO_2 sequestration research opportunities on low permeability reservoirs. The Travis Peak well would not be required in addition to the Woodbine injection wells to accommodate the output of the proposed power plant. One of the Woodbine injection wells and the Travis Peak well would be located on the Hill Ranch property. The other Woodbine injection well would be located on TDCJ property. Under the proposed injection plan, each of the Woodbine wells would be used to inject 45 percent of the total CO_2 output with the remaining 10 percent injected into the Travis Peak well. Both the Woodbine and Travis Peak formations lie beneath a primary seal, the Eagle Ford Shale, which has a thickness of 400 feet (122 meters). The primary injection zone, the Woodbine sandstone, is directly beneath the Eagle Ford. There are also over 0.4 mile (0.6 kilometer) of low permeability carbonates and shales above the Eagle Ford that create additional protection for shallow drinking water aquifers. The injection depth within the Woodbine formation would be 1 to 1.1 miles (1.6 to 1.8 kilometers). Injection into the Travis Peak formation would occur between 1.7 to 2.1 miles (2.7 to 3.4 kilometers) below the ground surface. To estimate the size of the plume of injected CO_2, the Alliance used numerical modeling to predict the plume radius from the injection wells. This modeling estimated that the plume radius at the proposed Jewett injection site could be as large as 1.7 miles (2.7 kilometers) per Woodbine injection well, 50 years after injecting 2.8 million tons (2.5 MMT) of CO_2 annually for the first 20 years, followed by 30 years of gradual plume spreading. The dispersal and movement of the injected CO_2 would be influenced by the geologic properties of the reservoir, and it is unlikely that the plume would radiate in all directions from the injection point in the form of a perfect circle. However, for reference purposes, this modeled radius corresponds to a circular area equal to 5,484 acres (2,219 hectares). A total of 10,968 acres (4,439 hectares) is estimated for all three wells.
Utility Corridors	
Potable Water	Potable water would be supplied in the same manner as the proposed plant's process water, by installing new wells either on the property or off site. This would require 1 mile (1.6 kilometers) of new construction.
Process Water	Process water would be provided by installing wells on the proposed site or possibly off site into the Carrizo-Wilcox Aquifer. Because the wells would be located on or close to the proposed plant site, only a small length of distribution pipeline, less than 1 mile (1.6 kilometers), would be required to deliver water to the proposed plant.

Table 6.1-1. Jewett Site Features

Feature	Description
Sanitary Wastewater	Sanitary wastewater would be treated and disposed of through construction and operation of an on-site sanitary WWTP. Effluent from the WWTP would be treated and disposed of in accordance with local and state regulations or recycled back into the power plant for process water.
Electric Transmission Lines	Option 1: The proposed power plant would connect to a 345-kV transmission line bordering the plant site. Option 2: The proposed power plant would connect to a 138-kV line approximately 2 miles (3.2 kilometers) from the site on a new ROW.
Natural Gas	Natural gas would be delivered through an existing natural gas pipeline located at the northwestern corner of the proposed power plant site. This pipeline is owned and operated by Energy Transfer Corporation.
CO_2 Pipeline	A new CO_2 pipeline would be required to connect the proposed power plant site to the proposed sequestration site. The pipeline would be up to 59 miles (95.0 kilometers) in length and the ROW would be approximately 20 to 30 feet (6.1 to 9.1 meters) wide. The proposed CO_2 pipeline has been divided into the following common segments, except for segments A-C and B-C, which are alternatives between the proposed plant site and the beginning of segment C: • Segment A-C would begin on the northeastern side of the proposed plant site and follow 2 miles (3.2 kilometers) of existing ROW owned by the Burlington Northern – Santa Fe Railroad. It would continue approximately 3 miles (4.8 kilometers) along a new ROW until it intersects a section of a natural gas pipeline ROW. The corridor would then follow this pipeline another 3 miles (4.8 kilometers) east until it joins a larger trunk of a natural gas pipeline. • Segment B-C would begin along the southern boundary of the proposed plant site and extend southeast approximately 2.5 miles (4.0 kilometers) along FM 39. It then would turn northeast and follow the existing ROW of a natural gas pipeline for another 4 miles (6.4 kilometers) until it joins a ROW for a larger trunk of a natural gas pipeline that extends northwest for approximately 8 miles (12.9 kilometers). • Segment C-D would follow an existing natural gas line ROW northward for approximately 15 miles (24.1 kilometers). • Segment D-E is no longer being evaluated for this project; therefore, it is not addressed in this EIS. • Segment D-F would continue northward along the existing natural gas line ROW for another 9 miles (14.5 kilometers). • Segment F-G would extend in a straight line east along a new ROW approximately 6 miles (9.7 kilometers) to the proposed sequestration wells on the Hill Ranch. • Segment F-H would continue northward along the existing natural gas line corridor for almost 2 miles (3.2 kilometers) where it would cross the Trinity River to the north side. It then would intersect another leg of a natural gas pipeline ROW and continue east for approximately 6 miles (9.7 kilometers). The line would then continue in a generally eastward direction along a county highway (CH) ROW and TDCJ land for approximately another 6 miles (9.7 kilometers) to the proposed injection well site on TDCJ land.

Table 6.1-1. Jewett Site Features

Feature	Description
Transportation Corridors	The proposed Jewett Site is bordered by FM 39, which intersects US 79 and State Highway (SH) 164 within 10 miles (16.1 kilometers) of the site boundary. The Burlington Northern – Santa Fe Railroad also runs along the northeastern border of the proposed power plant site. Texas is located in the West South Central Demand Region for coal, which also includes Louisiana, Arkansas, and Oklahoma. According to the Energy Information Administration (EIA, 2000), the West South Central Demand Region receives the majority of its coal resources from the PRB and the Rockies. In 1997, the average distance that a coal shipment traveled to reach a destination in this region was about 1,300 miles (2,092 kilometers) (EIA, 2000). In terms of a straight line distance, Jewett is approximately 950 miles (1,529 kilometers) from the Pittsburgh Coalbed (south-central Ohio in the northern Appalachian Basin), 650 miles (1,046 kilometers) from the Illinois Basin coals (southern Illinois), and 1,000 miles (1,609 kilometers) from the PRB coal supplies (eastern Wyoming). In addition, Texas lignite is available from the on-site Westmoreland Coal Company mine and perhaps other regional mines.

Source: FG Alliance, 2006c (unless otherwise noted).

Table 6.17-15. Effects to the Public from Pre-Sequestration Releases

Release Scenario	Frequency Category[2]	Gas	Effect[3]	Distance (ft [meter])	Number Affected
Pipeline Rupture[1] (release duration = minutes)	U	CO_2	Adverse Effects	663 (202)	0
			Irreversible Adverse	663 (202)	0
			Life Threatening	216 (66)	0
		H_2S	Adverse Effects	22,588 (6,885)	52
			Irreversible Adverse	1,945 (593)	1
			Life Threatening	1,224 (373)	1
Pipeline Puncture (release duration = approximately 4 hours)	L-U	CO_2	Adverse Effects	551 (168)	<1
			Life Threatening	115 (35)	<1
		H_2S	Adverse Effects	5,712 (1,741)	6
			Irreversible Adverse	551 (168)	0
			Life Threatening	377 (115)	0
Wellhead Equipment Rupture (Travis Peak) (release duration = minutes)	EU	CO_2	Adverse Effects	26 (7.9)	0
			Irreversible Adverse	26 (7.9)	0
			Life Threatening	20 (6.1)	0
		H_2S	Adverse Effects	2,585 (787.9)	0
			Irreversible Adverse	269 (82.0)	0
			Life Threatening	174 (53.0)	0
Wellhead Equipment Rupture (Woodbine) (release duration = minutes)	EU	CO_2	Adverse Effects	10 (3.0)	0
			Irreversible Adverse	10 (3.0)	0
			Life Threatening	7 (2.1)	0
		H_2S	Adverse Effects	1,752 (534.0)	0
			Irreversible Adverse	161 (49.1)	0
			Life Threatening	98 (29.9)	0
Wellhead Equipment Rupture (TDCJ) (release duration = minutes)	EU	CO_2	Adverse Effects	10 (3.0)	0
			Irreversible Adverse	10 (3.0)	0
			Life Threatening	7 (2.1)	0
		H_2S	Adverse Effects	1,752 (534.0)	4
			Irreversible Adverse	161 (49.1)	0
			Life Threatening	98 (29.9)	0

[1] Rupture assumed to occur at the juncture of pipeline segments C&D, west of Buffalo, Texas.
[2] U(unlikely)=frequency of 1x 10^{-2}/yr to 1x 10^{-4}/yr; L (likely) = frequency of > or equal to 1x 10^{-2}/yr; EU(extremely unlikely)=frequency of 1x10^{-4}/yr to 1x10^{-6}/yr.
[3] See Section 6.17.4.2 for an explanation of the effects categories.

Table 6.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Ammonia (NH_3)	**NIOSH REL**: TWA 25 ppm, ST 35 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 300 ppm	Inhalation, ingestion (solution), skin and eye contact (solution/liquid)	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite
Carbon Dioxide (CO_2)	**NIOSH REL**: TWA 5,000 ppm ST 30,000 ppm **OSHA PEL**: TWA 5,000 ppm **IDLH**: 40,000 ppm	Inhalation, skin and eye contact (liquid/solid)	Respiratory and cardiovascular systems	Headache, dizziness, restlessness, paresthesia; dyspnea (breathing difficulty); sweating, malaise (vague feeling of discomfort); increased heart rate, cardiac output, blood pressure; coma; asphyxia; convulsions; liquid: frostbite
Carbon Monoxide (CO)	**NIOSH REL**: TWA 35 ppm; C 200 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 1200 ppm	Inhalation, skin and eye contact (liquid)	Cardiovascular system, lungs, blood, central nervous system	Headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope
Chlorine (Cl_2)	**NIOSH REL**: C 0.5 ppm [15-minute] **OSHA PEL**: C 1 ppm **IDLH**: 10 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Burning of eyes, nose, mouth; lacrimation (discharge of tears), rhinorrhea (discharge of thin mucus); cough, choking, substernal (occurring beneath the sternum) pain; nausea, vomiting; headache, dizziness; syncope; pulmonary edema; pneumonitis; hypoxemia (reduced oxygen in the blood); dermatitis; liquid: frostbite
Hydrogen Chloride (HCl)	**NIOSH REL**: C 5 ppm **OSHA PEL**: C 5 ppm **IDLH**: 50 ppm	Inhalation, ingestion (solution), skin and eye contact	Eyes, skin, respiratory system	Irritation in nose, throat, larynx; cough, choking; dermatitis; solution: eye, skin burns; liquid: frostbite; in animals: laryngeal spasm; pulmonary edema

Table 6.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Hydrogen Sulfide (H_2S)	**NIOSH REL**: C 10 ppm [10-minute] **OSHA PEL**: C 20 ppm 50 ppm [10-minute maximum peak] **IDLH** 100 ppm	Inhalation, skin and eye contact	Eyes, respiratory system, central nervous system	Irritation in eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite
Sulfur Dioxide (SO_2)	**NIOSH REL**: TWA 2 ppm ST 5 ppm **OSHA PEL**: TWA 5 ppm **IDLH**:100 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; rhinorrhea (discharge of thin mucus); choking, cough; reflex bronchoconstriction; liquid: frostbite

Source: NIOSH, 2007.
NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.

Table 7.1-1. Odessa Site Features

Feature	Description
Power Plant Site	The proposed Odessa Site is located on about 600 acres (243 hectares) approximately 15 miles (24.1 kilometers) southwest of the City of Odessa in Ector County, Texas. The proposed site consists of flat land near I-20 and across the Union Pacific Railroad from the Town of Penwell. The Site Proponent is the State of Texas. Both the proposed site and surrounding land to the east, west, and north are rural areas where land use has been dominated historically by ranching and oil and gas activities (Horizon Environmental Services, 2006). Unimproved roads and structures related to oil and gas well activities are found on and around the proposed site, with most oil production activities historically occurring immediately west of the proposed site. Several pipelines also traverse the proposed site boundaries. The entire property within the proposed power plant site boundary is owned by a single owner.
Sequestration Site Characteristics and Predicted Plume Radius	The proposed sequestration site is located in a semi-arid, sparsely populated area adjacent to I-10 in Pecos County, Texas. The proposed site, owned by the University of Texas, is located 58 miles (93.3 kilometers) south of the proposed power plant near Odessa, Texas, is 3 miles (4.8 kilometers) east of Fort Stockton, and is about 60 miles (96.6 kilometers) south of the Midland-Odessa International Airport. Proposed injection targets for this site are a lower interval of the Delaware Mountain Group sandstones and an upper interval of the Queen formation sandstones. The injection target would be at a depth of between 0.4 mile to 1 mile (0.6 to 1.6 kilometers). These sandstone intervals are separated by an intermediate seal that consists primarily of non-porous and impermeable carbonates of the Goat Seep Limestone. The upper injection horizon is overlain by a 700-foot (213-meter) thick primary seal, the Queen-Seven Rivers formation. To estimate the size of the plume of injected CO_2, the Alliance used numerical modeling to predict the plume radius from the proposed injection wells. This modeling estimated that the plume radius at the proposed Odessa injection site could be as large as 1 mile (1.6 kilometers) per well after injecting 1.1 million tons (1 MMT) of CO_2 annually for 50 years. The dispersal and movement of the injected CO_2 would be influenced by the geologic properties of the reservoir and it is unlikely the plume would radiate in all directions from the injection point in the form of a perfect circle. However, for reference purposes, this modeled radius corresponds to a circular area equal to 2,136 acres (864 hectares). A minimum of three wells would be required to support a constant 1.1 million tons (1 MMT) per year injection rate. A minimum of eight wells would be needed to support a 2.8-million-ton (2.5-MMT) per year injection rate. Assuming a total of 55 million tons (50 MMT) of CO_2 is injected, the total plume area would be 6,980 acres (2,825 hectares) assuming eight wells would be required to inject 2.8 million tons (2.5 MMT) per year for the first 20 years of a 50-year time period. A slightly smaller area (6,073 acres [2,458 hectares]) would be required if only three wells were needed to inject 1.1 million tons (1 MMT) per year for each year in a 50-year time period.
Utility Corridors	
Potable Water	Potable water would potentially be obtained through the same sources identified for process water.
Process Water	Process water could be acquired by developing new well fields or from several existing well fields that draw water from the Ogallala, Pecos Valley, Edwards-Trinity Plateau, Dockum, or Capitan Reef aquifers. Six existing well fields have been identified that could deliver water to the site, ranging from 24 to 54 miles (38.6 to 86.9 kilometers) from the proposed power plant site (straight-line distance). Any of these six potential sources would require pipeline construction along new ROWs.
Sanitary Wastewater	Sanitary wastewater would be treated and disposed of through construction and operation of a new on-site sanitary WWTP. Effluent from the WWTP would be treated and disposed of in accordance with local and state regulations or recycled back into the proposed power plant for use as process water.

Table 7.1-1. Odessa Site Features

Feature	Description
Electric Transmission Lines	The proposed power plant would connect with one of two 138-kV transmission lines, one approximately 0.7 mile (1.1 kilometers) on new ROW and the second approximately 1.8 miles (2.9 kilometers) on existing ROW from the proposed site. In either case, the interconnection would only require the construction of a substation and a short transmission line to tie into these lines. The southern corridor would follow an existing ROW along FM 1601, which borders the proposed site, while a new ROW would be required for the northern route option.
Natural Gas	The proposed power plant would tap an existing natural gas pipeline that traverses the proposed plant site and that is owned and operated by ATMOS Energy.
CO_2 Pipeline	The proposed injection wells would be located on 42,300 acres (17,118 hectares) of University of Texas lands, 58 miles (93.3 kilometers) south of the proposed Odessa Power Plant Site. CO_2 would be transported in (and co-mingled in) an existing regional 16-inch (40.6-centimeter) diameter CO_2 pipeline just east of the plant site operated by Kinder Morgan CO_2 Company. Two miles (3.2 kilometers) of new CO_2 pipeline would connect the proposed power plant site to the existing pipeline, and approximately 7 to 14 miles (11.3 to 22.5 kilometers) of new pipeline would connect the existing CO_2 pipeline to the proposed injection sites. Because multiple injection wells would be used, intra-well piping would be required to connect the wells to the pipeline.
Transportation Corridors	The southern border of the proposed plant site is less than 0.5 mile (0.8 kilometer) from I-20, with an improved roadway that borders the property. A Union Pacific Railroad line runs along the southern border of the site. Deliveries to or from the proposed site could be accomplished by either rail or truck. Texas is located in the West South Central Demand Region for coal, which also includes Louisiana, Arkansas, and Oklahoma. According to the Energy Information Administration (EIA, 2000), the West South Central Demand Region receives the majority of its coal resources from the PRB and the Rockies. In 1997, the average distance that a coal shipment traveled to reach a destination in this region was about 1,300 miles (2,092 kilometers) (EIA, 2000). In terms of a straight-line distance, Odessa is approximately 1,250 miles (2,012 kilometers) from the Pittsburgh Coalbed (south-central Ohio in the northern Appalachian Basin), 900 miles (1,448 kilometers) from the Illinois Basin (southern Illinois), and 800 miles (1,287 kilometers) from the PRB (eastern Wyoming). While no sources of coal or lignite are available near the proposed plant site, Texas does have several coal mines in the eastern and southern portions of the state. The closest operating Texas coal mine is the Eagle Pass Mine, approximately 250 miles (402 kilometers) to the southwest of Odessa.

Source: FG Alliance, 2006d (unless otherwise noted).

Table 7.17-15. Effects to the Public from Pre-Sequestration Releases

Release Scenario	Frequency Category[2]	Gas	Effect[3]	Distance (ft [m])	Number Affected
Pipeline Rupture[1] (release duration = minutes)	U	CO_2	Adverse Effects	397 (121)	0
			Irreversible adverse effects	397 (121)	0
			Life Threatening	269 (82)	0
		H_2S	Adverse Effects	14,025 (4,275)	0
			Irreversible adverse effects	1,191 (363)	0
			Life Threatening	751 (229)	0
Pipeline Puncture[1] (release duration = approximately 4 hours)	U	CO_2	Adverse Effects	627 (191)	0
			Life Threatening	118 (36)	0
		H_2S	Adverse Effects	5,692 (1,735)	0
			Irreversible adverse effects	554 (169)	0
			Life Threatening	380 (116)	0
Wellhead Equipment Rupture (release duration = minutes)	EU	CO_2	Adverse Effects	6.6 (2.0)	0
			Irreversible adverse effects	6.6 (2.0)	0
			Life Threatening	<3 (<1)	0
		H_2S	Adverse Effects	951 (290)	0
			Irreversible adverse effects	66 (20)	0
			Life Threatening	56 (17)	0

[1] Rupture/puncture assumed to occur near the proposed power plant site.
[2] U (unlikely) =frequency of $1x10^{-4}$/yr to $1x10^{-2}$/yr ; EU (extremely unlikely) =frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[3] See Section 7.17.4.2 for an explanation of the effects categories.

Table 7.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Ammonia (NH_3)	**NIOSH REL**: TWA 25 ppm, ST 35 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 300 ppm	Inhalation, ingestion (solution), skin and eye contact (solution/liquid)	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; dyspnea (breathing difficulty), wheezing, chest pain; pulmonary edema; pink frothy sputum; skin burns, vesiculation; liquid: frostbite
Carbon Dioxide (CO_2)	**NIOSH REL**: TWA 5,000 ppm ST 30,000 ppm **OSHA PEL**: TWA 5,000 ppm **IDLH**: 40,000 ppm	Inhalation, skin and eye contact (liquid/solid)	Respiratory and cardiovascular systems	Headache, dizziness, restlessness, paresthesia; dyspnea (breathing difficulty); sweating, malaise (vague feeling of discomfort); increased heart rate, cardiac output, blood pressure; coma; asphyxia; convulsions; liquid: frostbite
Carbon Monoxide (CO)	**NIOSH REL**: TWA 35 ppm; C 200 ppm **OSHA PEL**: TWA 50 ppm **IDLH**: 1200 ppm	Inhalation, skin and eye contact (liquid)	Cardiovascular system, lungs, blood, central nervous system	Headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope
Chlorine (Cl_2)	**NIOSH REL**: C 0.5 ppm [15-minute] **OSHA PEL**: C 1 ppm **IDLH**: 10 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Burning of eyes, nose, mouth; lacrimation (discharge of tears), rhinorrhea (discharge of thin mucus); cough, choking, substernal (occurring beneath the sternum) pain; nausea, vomiting; headache, dizziness; syncope; pulmonary edema; pneumonitis; hypoxemia (reduced oxygen in the blood); dermatitis; liquid: frostbite
Hydrogen Chloride (HCl)	**NIOSH REL**: C 5 ppm **OSHA PEL:** C 5 ppm **IDLH:** 50 ppm	Inhalation, ingestion (solution), skin and eye contact	Eyes, skin, respiratory system	Irritation in nose, throat, larynx; cough, choking; dermatitis; solution: eye, skin burns; liquid: frostbite; in animals: laryngeal spasm; pulmonary edema
Hydrogen Sulfide (H_2S)	**NIOSH REL**: C 10 ppm [10-minute] **OSHA PEL**: C 20 ppm 50 ppm [10-minute maximum peak] **IDLH** 100 ppm	Inhalation, skin and eye contact	Eyes, respiratory system, central nervous system	Irritation in eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite

Table 7.17-4. Properties and Hazards Associated with Chemicals of Concern

Chemical	Exposure Limits	Exposure Routes	Target Organs	Symptoms
Sulfur Dioxide (SO_2)	**NIOSH REL**: TWA 2 ppm ST 5 ppm **OSHA PEL**: TWA 5 ppm **IDLH**:100 ppm	Inhalation, skin and eye contact	Eyes, skin, respiratory system	Irritation in eyes, nose, throat; rhinorrhea (discharge of thin mucus); choking, cough; reflex bronchoconstriction; liquid: frostbite

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.
Source: NIOSH, 2007.

5. TUSCOLA SITE

5.1 CHAPTER OVERVIEW

This chapter provides information regarding the affected environment and the potential for impacts on each resource area in relation to construction and operation of the FutureGen Project at the proposed Tuscola Site. To aid the reader and to properly address the complexity of the FutureGen Project, as well as the need to evaluate four sites (two in Illinois and two in Texas), this Environmental Impact Statement (EIS) was prepared as two separate volumes. Volume I of the EIS includes the purpose and need for the agency action, a description of the Proposed Action and Alternatives, and a summary of the potential environmental consequences. Volume II addresses the affected environment and potential impacts for each of the four proposed alternative sites. Presenting the affected environment immediately followed by the potential impacts on each resource area allows the reader to more easily understand the relationship between current site conditions and potential project impacts on a particular resource.

Volume II is organized by separate chapters for each proposed site: Chapter 4-Mattoon, Illinois; Chapter 5-Tuscola, Illinois; Chapter 6-Jewett, Texas; and Chapter 7-Odessa, Texas.

This chapter is organized by resource area as follows:

- 5.2 Air Quality
- 5.3 Climate and Meteorology
- 5.4 Geology
- 5.5 Physiography and Soils
- 5.6 Groundwater
- 5.7 Surface Water
- 5.8 Wetlands and Floodplains
- 5.9 Biological Resources
- 5.10 Cultural Resources
- 5.11 Land Use
- 5.12 Aesthetics
- 5.13 Transportation and Traffic
- 5.14 Noise and Vibration
- 5.15 Utility Systems
- 5.16 Materials and Waste Management
- 5.17 Human Health, Safety, and Accidents
- 5.18 Community Services
- 5.19 Socioeconomics
- 5.20 Environmental Justice

Each resource section provides an introduction, describes the region of influence (ROI) and the method of analysis, and discusses the affected environment and the environmental impacts from construction and operation of the FutureGen Project at the candidate site. The affected environment discussion describes the current conditions at the proposed power plant site, sequestration site, and utility and transportation corridors. This is followed by a discussion of potential construction and operational impacts. A summary and comparison of impacts for all four candidate sites are provided in the EIS Summary and in Chapter 3. Unavoidable adverse impacts, mitigation measures, and best management practices (BMPs) for all four candidate sites are also provided in Chapter 3.

5.1.1 POWER PLANT FOOTPRINT

The specific configuration of the power plant, rail loop, and access roads within the candidate sites would be determined after site selection, during the site-specific design phase. For purposes of analysis, the impact assessment for the proposed power plant site assumed a representative configuration or layout depicted in Chapter 2, Figure 2-18. The proposed power plant site would involve up to 200 acres (81 hectares) to house the power plant, coal and equipment storage, associated processing facilities, research facilities, railroad loop surrounding the power plant envelope, and a buffer zone; the site could ultimately be located anywhere within the larger power plant parcel. Therefore, impact discussions in this chapter identify environmentally sensitive areas to be avoided and address potential impacts to be evaluated, avoided, or mitigated within the entire power plant parcel.

5.1.2 NO-ACTION ALTERNATIVE

As discussed in Chapter 2, Proposed Action and Alternatives, the No-Action Alternative is treated in this EIS as the "No-Build" Alternative. That is, under the No-Action Alternative, the Alliance would not undertake a FutureGen-like project in the absence of Department of Energy (DOE) funding assistance. In the unlikely event that the Alliance did undertake a FutureGen-like project in the absence of DOE funding assistance, impacts might be similar to those predicted in this EIS. However, the Alliance would not be subject to the oversight or the mitigation requirements of DOE.

One goal of the FutureGen Project would be to test and prove a technological path toward minimization of greenhouse gas (GHG) emissions from coal-fueled electric power plants. Should the FutureGen Project prove successful and the concept of carbon dioxide (CO_2) capture and geologic sequestration receive widespread application across the U.S. and around the world, the current trend of increasing CO_2 emissions to the atmosphere from coal-fueled power plants could be reduced. In the absence of concept proof, industry and governments may be unwilling to initiate all of the technological changes that would help to significantly reduce current trends and consequential increase of CO_2 concentrations in the Earth's atmosphere.

Impacts associated with the No-Action Alternative are provided in Chapter 3.

5.1.3 TUSCOLA SITE

Proposed Tuscola Power Plant Site

The proposed Tuscola Site consists of approximately 345 acres (140 hectares) of farmland located approximately 1.5 miles (2.4 kilometers) west of the City of Tuscola, in Douglas County, Illinois. Key features of the Tuscola Site are listed in Table 5.1-1. Township Road (TR) 86 (750E) borders the western side of the proposed plant site and TR 47 (1050N) runs along its northern border. A CSX Railroad runs along its southern border. Potable water would be supplied through an existing water line along the southern border of the proposed site. Process water would be pumped from a water holding pond fed by the Kaskaskia River and located at the nearby Lyondell-Equistar Chemical Company. Sanitary wastewater would be treated either through a new on-site WWTP or by constructing a new sanitary force-main to the wastewater treatment system at the Lyondell-Equistar plant. The proposed power plant would connect to the power grid via existing or new high voltage transmission lines. Natural gas would be delivered through an existing line that runs through the proposed plant site. The proposed sequestration site is currently farmland situated 11 miles (17.7 kilometers) directly south of the proposed plant site. A new CO_2 pipeline would be constructed within the existing road and utility ROWs, and new ROWs running parallel to existing ROWs if required. Following Table 5.1-1, Figures 5.1-1, 5.1-2, and 5.1-3 illustrate the Tuscola Power Plant Site, utility corridors, and sequestration site, respectively.

5.10 CULTURAL RESOURCES

5.10.1 INTRODUCTION

Section 106 of the National Historic Preservation Act of 1966 (NHPA) and its implementing regulations at 36 CFR Part 800 (incorporating amendments effective August 5, 2004) require federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings.

Historic properties are a specific category of cultural resources. Cultural resources are any resources of a cultural nature (King, 1998). As defined at 36 CFR 800.16[l][1], a historic property is a cultural resource that is any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior. Historic properties include artifacts, records, and remains related to and located within such properties, as well as properties of traditional religious and cultural importance to Native American tribes or Native Hawaiian organizations, and properties that meet National Register criteria for evaluation (36 CFR 60.4).

The **National Historic Preservation Act** of 1966 (16 USC 470), establishes a program for the preservation of historic properties throughout the Nation.

The **National Register** criteria for evaluation states that:

The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

(a) that are associated with events that have made a significant contribution to the broad patterns of our history; or

(b) that are associated with the lives of persons significant in our past; or

(c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

(d) that have yielded, or may be likely to yield, information important in prehistory or history.

36 CFR Part 800 outlines procedures to comply with NHPA Section 106. At 36 CFR Part 800(a), federal agencies are encouraged to coordinate Section 106 compliance with any steps taken to meet NEPA requirements. Federal agencies are to also coordinate their public participation, review, and analysis to meet the purposes and requirements of both the NEPA and the NHPA in a timely and efficient manner. The Section 106 process has been initiated for this undertaking with the intent of coordinating that process with the DOE's obligations under NEPA regarding cultural resources.

For purposes of this document, cultural resources are:

- Archaeological resources, including prehistoric and historic archaeological sites;
- Historic resources, including extant standing structures;
- Native American resources, including Traditional Cultural Properties (TCPs) important to Native American tribes; or
- Other cultural resources, including extant cemeteries and paleontological resources.

Participants in the Section 106 process include an agency official with jurisdiction over the FutureGen Project, the ACHP, consulting parties, and the public. Consulting parties include the State Historic Preservation Officer; Native American tribes and Native Hawaiian organizations; representatives of local government; and applicants for federal assistance, permits, licenses, and other approvals. Additional consulting parties include individuals and organizations with a demonstrated interest in the proposed FutureGen Project due to their legal or economic relation to the undertaking or affected properties, or their concern with the effects of the undertakings on historic properties. In Illinois, the State Historic Preservation Officer is the Director of Historic Preservation within the Illinois Historic Preservation Agency (IHPA).

The NHPA Section 106 process is paralleled by the Illinois Section 707 process. The Section 707 process is embodied in the Illinois State Agency Historic Resources Preservation Act (20 ILCS 3420) governing projects under the direct or indirect jurisdiction of a State agency, or licensed or assisted by a state agency. The Archaeological and Paleontological Resources Protection Act (20 ILCS 3435) applies to all Illinois public lands and contains criminal sanctions for those who disturb burial mounds, human remains, shipwrecks, and other archaeological resources or fossils on public lands. Human burials are afforded additional protection under the Human Skeletal Remains Protection Act (20 ILCS 3440), forbidding disturbance of human skeletal remains and grave markers in unregistered cemeteries, including isolated graves and burial mounds, that are at least 100 years old. Younger graves and registered cemeteries are protected under the Cemetery Protection Act (765 ILCS 835).

The IHPA (20 ILCS 3410) establishes and maintains the Illinois Register of Historic Places that parallels the NRHP. Under the IHPA a Comprehensive Statewide Historic Preservation Plan, prepared in 1995 and updated in 2005, broadly outlines a historic preservation in the state.

5.10.1.1 Region of Influence

The ROI for cultural resources includes (1) the proposed power plant and sequestration site area within 1 mile (1.6 kilometers) of the proposed power plant site boundaries; (2) all related areas of new construction and those within 1 mile (1.6 kilometers) of said areas; and (3) the land area above the proposed sequestration reservoir(s). NHPA Section 106 states the correlate of the ROI is the Area of Potential Effects (APE).

> The **Area of Potential Effects** is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if such properties exist (36 CFR 800.16[d]).

Adverse effects to archaeological, paleontological, and cemetery resources are generally the result of direct impacts from ground disturbing activities. Therefore, the APE for such resources coincides with those areas where direct impacts from the construction and operation of the proposed facility would occur. Adverse effects to historic resources (i.e., standing structures) may occur through direct impacts that could change the character of a property's use or physical features within a property's setting that contribute to its historic significance. Adverse effects may also occur through indirect impacts that could introduce visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features. For historic resources, the APE encompasses the ROI as defined. TCPs may be subject to both direct and indirect impacts.

5.10.1.2 Method of Analysis

DOE reviewed the results of research and studies performed by the Alliance to determine the potential for impacts based on the following criteria:

- Archaeological Resources – Cause the potential for loss, isolation, or alteration of an archaeological resource eligible for NRHP listing.

- Historic Resources – Cause the potential for loss, isolation, or alteration of the character of a historic site or structure eligible for NRHP listing. Introduce visual, audible, or atmospheric elements that would adversely affect a historic resource eligible for NRHP listing.
- Native American Resources – Cause the potential for loss, isolation, or alteration of Native American resources, including graves, remains, and funerary objects. Introduce visual, audible, or atmospheric elements that would adversely affect the resource's use.
- Other Cultural Resources
  - Paleontological Resources – Cause the potential for loss, isolation, or alteration of a paleontological resource eligible for listing as a National Natural Landmark (NNL).
  - Cemeteries – Cause the potential for loss, isolation, or alteration of a cemetery.

The Alliance conducted archival research to determine whether archaeological and historic resources are known to exist or may exist within the APE/ROI. This research included review of the Illinois Archaeological Survey site files and the IHPA Historic Architectural and Archaeology Resources Geographic Information System (HAARGIS). The Alliance also consulted with personnel at the IHPA (FG Alliance, 2006b). A Phase I archaeological survey of the ROI that included supplemental archival research, a pedestrian survey, and shovel testing in areas of the ROI with poor surface visibility was also conducted (Finney, 2006).

To identify Native American tribes that potentially have TCPs within the ROI, the Alliance used the National Park Service (NPS) Native American Consultation Database (FG Alliance, 2006b).

The Alliance used FAUNMAP to determine the potential for paleontological resources in the proposed project area. FAUNMAP is a database of the late Quaternary distribution of mammal species in the U.S., as well as the histories of Coles and Douglas counties. Though paleontological resources are generally geological in nature rather than cultural, several environmental regulations have been interpreted to include fossils as cultural resources. The Antiquities Act of 1906 refers to historic or prehistoric ruins or any objects of antiquity situated on lands owned or controlled by the U.S. Government, but the term "objects of antiquity" has been interpreted by the NPS, Bureau of Land Management (BLM), U.S. Forest Service (USFS), and other federal agencies to include fossils. An area rich in important fossil specimens can be a NNL as defined in the NPS's National Registry of Natural Landmarks (NRNL) (36 CFR 62.2). Paleontological resources are not analyzed under NHPA Section 106 unless they are recovered within culturally related contexts (e.g., fossils included within human burial contexts, a mammoth kill site).

5.10.2 AFFECTED ENVIRONMENT

5.10.2.1 Archaeological Resources

Review of the Illinois Archaeological Survey site files identified four previously recorded archaeological sites and six previously recorded isolated finds in the ROI (FG Alliance, 2006b). Table 5.10-1 lists the four archaeological sites with their cultural or temporal affiliation and the ROI within which they are located. The cultural and temporal affiliation of the six isolated finds is not given; however, five are within the power plant ROI and a sixth is within the electrical transmission line corridor ROI.

An archaeological survey was conducted of areas that would be subject to direct impact from construction, including the proposed plant site, waterline west of Tuscola, CO_2 corridor, the Arcola injection site, and Segment 1 of the proposed electrical transmission line corridor (Finney, 2006). Segment 2 of the proposed electrical transmission line corridor follows an existing transmission line corridor that has not been surveyed. Segment 3 of the proposed electrical transmission line would occupy a new ROW that has not been surveyed.

Table 5.10-1. Previously Recorded Archaeological Sites Within ROI

Site Number	Site Type	ROI
11Do92	Prehistoric, indeterminate age and historic late 19th – early 20th century	Power plant
11Do93	Historic, late 19th – early 20th century	Power plant/Electrical transmission line corridor
11Do94	Historic, late 19th – early 20th century	Power plant
11Do148	Historic, late 19th – early 20th century	Electrical transmission line corridor, Segment 2

Source: FG Alliance, 2006b.

Background research before the survey identified one previously recorded isolated find in the survey area, but no archaeological sites had been recorded. Three of the archaeological sites referenced above (11Do92, 11Do93, and 11Do94) and three isolated finds were recorded within 1 mile (1.6 kilometers) of the survey area. A recent survey for a gas pipeline identified a single isolated historic whiteware ceramic fragment in the proposed power plant site, but it is not evaluated as an archaeological site (Finney, 2006). No prehistoric or historic archaeological sites were identified by the survey and it was recommended that the project area be cleared from an archaeological perspective (FG Alliance, 2006b). IHPA concurrence has been received and no further investigations are needed (see Appendix A).

5.10.2.2 Historic Resources

The HAARGIS database shows no historic properties listed in the NRHP within the ROI (FG Alliance, 2006b).

5.10.2.3 Native American Resources

No publicly documented TCPs are known to exist within the ROI for the proposed power plant site, related areas of new construction, or in the land above the sequestration reservoir. DOE initiated consultation with federally recognized Native American tribes that may have an interest in the project area on December 6, 2006 (see Appendix A). The following tribes received consultation letters:

- Kickapoo Tribe of Kansas
- Kickapoo Tribe of Oklahoma
- Miami Tribe of Oklahoma
- Prairie Band of the Potawatomi Nation
- Peoria Tribe of Indians of Oklahoma

Regional Directors for the Bureau of Indian Affairs in the Southern Plains and Eastern Oklahoma Regions also received copies of the consultation letter. The Bureau of Indian Affairs South Plains and Eastern Oklahoma Regional offices both responded that they do not have jurisdiction over the alternative sites in Illinois (see Appendix A). The Eastern Oklahoma Regional Office has provided notice to the Bureau of Indian Affairs Eastern Region Office, which does have jurisdiction, of the FutureGen Project. A response has not yet been received. To date, no Native American tribes have responded.

5.10.2.4 Other Cultural Resources

Two rural cemeteries, Hammett and Murdock, are within the ROI for Segment 2 of the proposed 345-kV transmission corridor, but well outside of the corridor's boundaries. There are no known paleontological resources within the project ROI.

5.10.3 IMPACTS

5.10.3.1 Construction Impacts

Construction impacts to cultural resources would primarily be direct and result in earth-moving activities that could destroy some or all of a resource. There are no known cultural resources in areas where earth moving would take place. Therefore, no direct or indirect impacts would occur on known cultural resources. The potential for the discovery or disturbance of an unknown cultural resource exists, particularly in areas where there has been no prior land disturbance. Although consultation with Native American tribes has not revealed the presence of TCPs in areas where disturbance could take place, this consultation is ongoing (see Appendix A) and the presence of these resources remains somewhat uncertain. However, before construction, previously unsurveyed areas with a potential for cultural resources would be surveyed. Potential impacts to cultural resources discovered during construction would be mitigated through avoidance or through other measures, including those identified through consultation with the IHPA or the respective Native American tribes.

Power Plant Site

There are no known cultural resources in areas that would be disturbed by construction at the proposed power plant site (Finney, 2006). Therefore, no direct or indirect impacts would occur on known cultural resources. IHPA concurrence with the results and recommendations contained in the archaeological survey report is pending.

Sequestration Site

There are no known cultural resources in areas that would be disturbed by construction at the proposed sequestration site (Finney, 2006). Therefore, no direct or indirect impacts would occur on known cultural resources. On January 30, 2007, IHPA concurrence was received stating that no significant historic, architectural, and archaeological resources are located in the proposed project area (see Appendix A).

Utility Corridors

There are no known cultural resources in areas that would be disturbed by construction within the proposed CO_2 corridor, the process water corridor, or Segment 1 of the electrical transmission line corridor (Finney, 2006).

If Segment 2 of the transmission line is upgraded, no impacts to cultural resources would be expected; however, if new construction should take place in a parallel ROW, the potential for impacting undocumented cultural resources would exist. Segment 3 of the electrical transmission line would be in a new ROW that was not surveyed. Corridor construction in a new or previously undisturbed ROW would have a higher potential for impacting undocumented cultural resources.

On January 30, 2007, IHPA concurrence was received stating that no significant historical, architectural, and archaeological resources are located in the proposed project area. However, Segment 3 of the electrical transmission line would be in this new ROW and would require a survey if the Tuscola Site is selected and the proposed electrical transmission line corridor is disturbed for construction of the line.

Transportation Corridors

Potential roadway improvements are unspecified, pending traffic studies that would be conducted if the Tuscola site is selected. Therefore, potential impacts to cultural resources as a result of road improvements are unknown at this time. If road improvements take place in new, undisturbed ROWs, there would be a potential for impact to undocumented cultural resources. The IHPA would need to be consulted regarding the need for cultural resource investigations before construction of improvements.

Because the rail spur is co-located on the proposed power plant site, potential impacts would be the same as described for the proposed power plant site.

5.10.3.2 Operational Impacts

The potential for impacts to cultural resources related to the proposed FutureGen Project operations would be limited to indirect impacts that could alter the historic character of a resource or its setting. There is minimal potential for direct impacts (e.g., a historic façade becoming coated with dust or ash) as a result of operations. Because there are no known cultural resources in areas where the proposed FutureGen Project operations would take place, no direct or indirect impacts are anticipated.

5.11 LAND USE

5.11.1 INTRODUCTION

This section identifies land uses that may be affected by the construction and operation of the proposed FutureGen Project at the Tuscola Power Plant Site, sequestration site, and related corridors. It addresses the existing land use environment as well as potential effects on land uses and land ownership, relevant local and regional land use plans and zoning, airspace, public access and recreation sites, identified contaminated sites, and prime farmland. It also addresses potential effects related to subsurface rights for the land area above the proposed Tuscola Sequestration Reservoir.

5.11.1.1 Region of Influence

The ROI for land use includes the area within 1 mile (1.6 kilometers) of the boundaries of the proposed Tuscola Power Plant Site, sequestration site, and all related areas of new construction, including proposed utility corridors.

5.11.1.2 Method of Analysis

In preparing the description of the affected environment for land use and the analysis of potential impacts, DOE reviewed information provided in the Tuscola EIV (FG Alliance, 2006b) and relevant land use data, including the City of Tuscola's Comprehensive Plan (City of Tuscola, 2001) and zoning ordinances (City of Tuscola, 2006), City of Arcola zoning ordinances (City of Arcola, 2006), Federal Aviation Administration (FAA) regulations, and various databases related to contaminated sites. DOE also reviewed aerial photographs and conducted site visits to note site-specific land use characteristics.

DOE assessed the potential impacts based on whether the proposed FutureGen Project would:

- Introduce structures and uses that are incompatible with land uses on adjacent and nearby properties;
- Introduce structures or operations that require restrictions on current land uses on or adjacent to a proposed site;
- Conflict with a jurisdictional zoning ordinance and a jurisdictional noise ordinance; or
- Conflict with a local or regional land use plan or policy.

5.11.2 AFFECTED ENVIRONMENT

The proposed Tuscola Power Plant Site consists of a 345-acre (140-hectare) parcel of land located in Tuscola Township, Douglas County, Illinois (FG Alliance, 2006b). It is situated 161 miles (259 kilometers) south of Chicago; 152 miles (245 kilometers) west of Indianapolis, Indiana; and 153 miles (246 kilometers) northwest of St. Louis, Missouri. The entire site is currently used for agricultural row crops.

The proposed Tuscola Sequestration Site is located 11 miles (16 kilometers) south of the Tuscola Power Plant Site on a 10-acre (4-hectare) parcel of land in Arcola Township, Douglas County, Illinois, at 1,087,141.666 North and 984,488.654 East, Illinois State Plane E – NAD 83 (North American Datum of 1983). The site is physically located approximately 0.25 mile (0.4 kilometer) east of CR 750E along CR 000N, the Douglas-Coles County line (FG Alliance, 2006b). This entire site is currently used for agricultural row crops.

5.11.2.1 Local and Regional Land Use Plans

Only one municipality, the City of Tuscola, has a master planning document within the ROI. The City of Tuscola created its Comprehensive Plan to manage development and public infrastructure to promote efficient and desirable patterns for growth and redevelopment within the city limits and in a 1.5-mile (2.4-kilometer) radius beyond the city limits referred to as "extra-territorial" lands (City of Tuscola, 2001). In the extra-territorial lands, the City of Tuscola has the discretion of enforcing its zoning ordinances (City of Tuscola, 2006). The Comprehensive Plan indicates that the proposed Tuscola Power Plant Site lies partially within these extra-territorial lands. The plan also identifies the land use at the plant site as industrial for future use. Figure 5.11-1 depicts the City of Tuscola's current land uses for the extraterritorial lands. Figure 5.11-2 depicts the current Coles County land uses for the proposed sequestration site and the proposed CO_2 corridor. Douglas County does not have county-wide zoning and does not have detailed land use maps that show public and private land ownership or uses.

5.11.2.2 Zoning

As noted above, the City of Tuscola's zoning jurisdiction includes the 1.5-mile (2.4-kilometer) extra-territorial area outside the city limits, and the proposed Tuscola Power Plant Site is partially within the extra-territorial area. The City of Tuscola has the discretion of enforcing its zoning ordinances around the proposed Tuscola Power Plant Site (City of Tuscola, 2006) (see Appendix A).

The City of Arcola is the nearest municipality to the proposed Tuscola Sequestration Site with zoning regulations. The City of Arcola, in accordance with its zoning ordinance 25-2-1, controls zoning 1.5 miles (2.4 kilometers) beyond the municipal boundary. Any new development within 1.5 miles (2.4 kilometers) of the municipal boundary requires a building permit (City of Arcola, 2006) (see Appendix A).

The proposed process water pipeline and sanitary sewer lines would occupy property owned by Lyondell-Equistar Chemicals, and would be located outside of the zoning jurisdiction for the City of Tuscola and its 1.5-mile (2.4-kilometer) extra-territorial zoning area.

The proposed electrical transmission line would occupy both existing and new ROWs within the municipality of Tuscola and its zoning jurisdiction, as well as the Townships of Camargo and Murdock, which do not have zoning authority.

The proposed CO_2 transmission corridor would occupy both existing roadway ROW and new ROW southwest of Tuscola and west of the City of Arcola. The proposed CO_2 transmission line would be located outside of the zoning jurisdiction for the City of Tuscola and City of Arcola and their 1.5-mile (2.4-kilometer) extra-territorial zoning areas.

5.11.2.3 Airspace

The Tuscola Airport is approximately 1.5 miles (2.4 kilometers) south of the proposed plant site. The Tuscola Airport is a small, low traffic field with a 2,660-foot (811-meter) oil and chip runway (improved surface) with a parallel grass landing strip. Because the proposed project would include a 250-foot (76-meter) heat recovery steam generator stack and 250-foot (76-meter) flare stack, DOE reviewed FAA regulations to determine their applicability to the project. In administering 14 CFR Part 77—Objects Affecting Navigable Airspace—the prime objectives of the FAA are to promote air safety and the efficient use of the navigable airspace.

Pursuant to 14 CFR Part 77, the FAA must be notified if any of the following construction or alteration is being examined:

(1) Any construction or alteration of more than 200 feet (61 meters) in height above the ground level at its site.
(2) Any construction or alteration of greater height than an imaginary surface extending outward and upward at one of the following slopes:
    (i) 100 to 1 for a horizontal distance of 20,000 feet (6,096 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with at least one runway more than 3,200 feet (975 meters) in actual length, excluding heliports.
    (ii) 50 to 1 for a horizontal distance of 10,000 feet (3,048 meters) from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with its longest runway no more than 3,200 feet (975 meters) in actual length, excluding heliports (14 CFR 77).

A majority of the proposed Tuscola Power Plant Site falls within the 10,000-foot (3,048-meter) radius of the Tuscola Airport, and therefore the notification requirements of 14 CFR Part 77 would be applicable.

5.11.2.4 Public Access Areas and Recreation

Walnut Point State Park is the nearest public access area to the proposed Tuscola Power Plant Site at a distance of approximately 15.5 miles (24.9 kilometers). Lake Shelbyville, operated by USACE as a flood control project on the Kaskaskia River, is located approximately 22 miles (35.4 kilometers) southwest of the proposed site. The lake provides camping, hiking trails, boating access, and picnicking facilities.

The City of Tuscola has two parks, Ervin Park and Wimple Park, that provide a range of recreational activities. Ervin Park is located 1 mile (1.6 kilometers) east of the proposed Tuscola Power Plant Site within the northeast section of the city limits. The proposed transmission line corridor follows an existing transmission line corridor that runs along the northern edge of the park. Ervin Park contains 36 acres (14.6 hectares) and includes four baseball diamonds, a baseball batting cage, two basketball courts, five horseshoe pits, three picnic pavilions, three playgrounds, four public restrooms, a 250,000-gallon (946,353-liter) swimming pool, four tennis courts, one volleyball court, and one walking path. Wimple Park, located approximately 2.5 miles (4.0 kilometers) southeast of the proposed Tuscola Power Plant Site and just over 2 miles (3.2 kilometers) south of the proposed transmission line corridor, is a 20-acre (8.1-hectare) park that offers a pond and walking trail. It is adjacent to the South Tuscola Sanitary Treatment Facility (City of Tuscola, 2001).

Iron Horse Golf Course is located approximately 1.3 miles (2.1 kilometers) northeast of the proposed Tuscola Power Plant Site. The proposed transmission line corridor follows an existing transmission line corridor that runs along the southern edge of the golf course. The Iron Horse Golf Course is an 18-hole public course and has a clubhouse that offers a sports bar and a restaurant. There are residences located within the golf course.

5.11.2.5 Contaminated Sites

DOE review of the Illinois Environmental Protection Agency (IEPA) databases (IEPA, 2006) for the proposed Tuscola Power Plant Site indicates that it is not associated with cleanup under regulations related to voluntary site remediation program units, leaking underground storage tanks, the Resource Conservation and Recovery Act (RCRA), permitted activities, or solid waste landfills.

DOE review of the CERCLIS Database for Douglas County, Illinois, reveals no environmental issues requiring remediation (EPA, 2006) in the vicinity of the proposed Tuscola Power Plant Site.

> The Comprehensive Environmental Response, Compensation and Liability Information System (**CERCLIS**) Database contains general information on sites across the nation and U.S. territories, including location, contaminants, and cleanup actions taken (CERCLIS, 2006).

5.11.2.6 Land Ownership and Uses

Power Plant Site

The proposed Tuscola Power Plant Site land usage is 100 percent agricultural, consisting of row crops. There is a Trunkline Gas Company natural gas pipeline that runs underground through the site, but the surface of the ROW is tilled along with the remainder of the site. The site totals 345 acres (140 hectares) and includes six parcels owned by three private individuals. All of the property owners have agreed to an exclusive option contract to sell their property if the site is selected for the FutureGen Project.

The surrounding area within 1 mile (1.6 kilometers) has been agricultural farmland with scattered heavy industrial, commercial, and rural residential uses for more than 50 years. Two chemical facilities, Cabot Corporation and Lyondell Equistar Chemicals, occupy large parcels west and southwest of the proposed Tuscola Power Plant Site (see non-agricultural land use designations on Figure 5.11-2). The two chemical facilities contain water intake reservoirs, treatment ponds, four injection wells (drilled to a depth of 5,300 to 5,524 feet [1,615 to 1,684 meters]), holding tanks, fly ash landfill, and a water treatment plant.

There are three small residential parcels that directly abut the proposed Tuscola Power Plant Site on the north, seven residences within 0.5 mile (0.8 kilometer), and several dozen additional residences within 1 mile (1.6 kilometers) of the site, almost all of which are near the 1-mile (1.6-kilometer) boundary of the ROI on the western edge of the City of Tuscola near the Illinois Central Gulf Railroad line. A CSX rail corridor is immediately adjacent to the southern boundary of the proposed site. The majority of the land bordering the site on the north and east is farmland, historically planted in corn and soybean in annual rotation. The plant site is located less than 0.5 mile (0.8 kilometer) from a road construction company, a chemical transport firm, and natural gas pipeline companies. The remaining non-industrial area surrounding the plant site is rural farmland. In addition to the residences and facilities noted above, there are also two township roads, one state highway, a CSX railroad siding, an Ameren Corporation-CIPS substation, and a hog market within 1 mile (1.6 kilometers) of the site (FG Alliance, 2006b). There are no hospitals, schools, or nursing residences within 1 mile (1.6 kilometers) of the proposed plant site.

Sequestration Site

The proposed 10-acre (4-hectare) injection site is part of a larger parcel of 80 acres (32.4 hectares). The area above the proposed Tuscola Sequestration Reservoir is farmland located on Land Trust number L-745, where the trustee is the First National Bank of Arcola and the beneficiaries are four private individuals. The trustee and beneficiaries have agreed to an exclusive binding option contract for a 10-acre (4-hectare) portion of the site, including subsurface/mineral rights, and have also indicated a willingness to offer a smaller amount of acreage at the same price (FG Alliance, 2006b).

Regarding properties with improvements (buildings) on the land, there are 14 private landowners above the target formation for the sequestration reservoir, including 58 parcels of farmland. There are 7.9 miles (12.6 kilometers) of township roads and 0.5 mile (0.8 kilometer) of state highway adjacent to the site. Additionally, there is some aboveground piping for area natural gas pipelines and storage areas in the surrounding ROI (FG Alliance, 2006b).

Complete title searches for subsurface rights at the injection site, proposed Tuscola Sequestration Site, and surrounding area have not been performed for this EIS. Entities with potential property rights include the land surface owners, mineral interest owners, royalty owners, and reversionary interest owners (that is, owners of an interest in a reservoir that becomes effective at a specified time in the future [de Figueiredo et al., 2005]).

Utility Corridors

Potable water from the Illinois American Water Company runs along the southern boundary of the proposed power plant site parallel to the CSX rail line. If an on-site treatment facility is not built, the proposed sanitary wastewater pipeline would be approximately 0.9 mile (1.4 kilometer) long and would be constructed on property owned by Lyondell-Equistar Chemicals and Tuscola Township Road ROW. This wastewater corridor would parallel the proposed process water corridor, where the existing land use in the ROI includes industrial uses, row crops, and a small number of agricultural farmsteads (FG Alliance, 2006b).

The proposed process water supply line would run west approximately 1.5 miles (2.4 kilometers) from the proposed site to an existing 150 million-gallon (568 million-liter) surface water storage facility operated by Equistar Chemical Company. The proposed process water pipeline would occupy property owned by either Lyondell-Equistar Chemicals plus an existing township ROW. The existing land use for this ROI includes industrial uses, row crops, road and utility ROWs, and a small number of agricultural farmsteads (FG Alliance, 2006b).

Under Option 1 of the electrical transmission line options, the plant would tie into an existing 138-kV line located approximately 0.5 mile (0.8 kilometer) north of the site. Connection to this line would require an additional ROW alongside CR 750E. There are several farmsteads within the ROI of this corridor, and the remainder of the ROI is cropland. Option 2 proposes a new 345-kV transmission line that would parallel or replace the existing 138-kV line. This transmission line would run approximately 17 miles (27.4 kilometers) and connect to a substation east of Murdock. The existing transmission line corridors would be used for the first 14 miles (22.5 kilometers) and the last 3 miles (4.8 kilometers) would fall on new ROW. The new ROW required for the last 3 miles (5 kilometers) of the proposed transmission line would affect nine landowners (FG Alliance, 2006b).

The existing land uses in the transmission corridor's ROI include industrial facilities, row crops, agricultural farmsteads, the Iron Horse Golf Course, Ervin Park, the municipality of Tuscola, and the townships of Camargo and Murdock. Within the municipality of Tuscola, the proposed transmission line would come within 1 mile (1.6 kilometers) of Jarman Senior Living Center and North Ward Elementary School (FG Alliance, 2006b). There is one mine located within the 1-mile (1.6-kilometer) ROI of the transmission line in Murdock. This mine is currently closed (FG Alliance, 2006b).

The proposed 11-mile (17.7-kilometer) CO_2 pipeline corridor from the proposed Tuscola Power Plant Site to the proposed Sequestration Site would occupy new ROW parallel to CR 750E and CR 700E. Existing land use in the ROI includes industrial uses, row crops, and agricultural farmsteads. The ROI extends to the westernmost boundary of the City of Arcola (FG Alliance, 2006b).

5.11.2.7 Prime Farmland

> The U.S. Department of Agriculture (**USDA**) Natural Resource Conservation Service's (**NRCS**) website defines prime farmland as land that has the best combination of physical characteristics for producing food, feed, forage, and oilseed crops and is available for these uses (NRCS, 2000).

Illinois had 20,894,000 acres (8,455,502 hectares) of soils classified as prime farmland in 1997. About 18,679,800 (7,559,447 hectares) (89.4 percent) of these acres were used as cropland. The remaining amount was used for pastureland, forestland, Conservation Reserve Program (CRP) land, and other rural land. Between 1982 and 1997, 409,500 acres (165,719 hectares) of prime farmland were lost (approximately 27,060 acres [10,951 hectares] per year) (NRCS, 2000).

The Farmland Protection Policy Act (FPPA) of 1981 directs all federal agencies to evaluate their programs and projects and to modify their actions to produce the least impact on farmland. The FPPA also seeks to ensure that federal programs are administered in a manner that, to the extent practicable, will be compatible with state and local government policies, as well as private programs, to protect farmland. The Illinois Department of Agriculture (ILDOA) reviews programs, projects, and activities of federal agencies for compliance with the Farmland Preservation Act (state law) and the FPPA. The purpose of the review is a systematic procedure to assist in determining which proposed governmental action would incur the least harm to the agricultural environment. The ILDOA established the Land Evaluation and Site Assessment (LESA) system as a tool to use in making such evaluations. The National Resources Conservation Service (NRCS) also uses the LESA system to evaluate the viability of farmland proposed for non-agricultural use by a federally sponsored project (ILDOA, 2001).

On the 345-acre (140-hectare) proposed Tuscola Power Plant Site, NRCS identified all 345 acres (140 hectares) as prime farmland and unique farmland that is currently producing major crops of corn, soybean, wheat, and hay. According to the LESA scale, the total relative value of the site's farmland was assigned 98 points out of 100 possible points. The total site assessment was assigned 141 points out of a possible 200 points, totaling 239 LESA points out of a possible 300 (FG Alliance, 2006b). Within the proposed utility corridors, several of the soil types have been identified as prime farmland or would be prime farmland if drained. DOE did not conduct a formal farmland conversion impact rating for these corridors because they are on existing utility ROWs or because they would not result in conversion of significant areas of soil to non-agricultural uses. Since the pipelines would be buried and the electrical transmission lines would be elevated, agricultural use of the land could continue following construction on any new ROWs.

5.11.3 IMPACTS

5.11.3.1 Construction Impacts

Power Plant Site

The 345-acre (140-hectare) proposed Tuscola Power Plant Site and area within 1 mile (1.6 kilometers) consists of farm crops, heavy industrial use, and seven small rural residential parcels. The proposed project would require a laydown area for construction equipment and materials, and would require construction of a power plant, rail loop, parking area, coal storage site, visitor center, and research and development center. Project construction would have a major, long-term impact on the current mainly agricultural land use of the 345-acre (140-hectare) parcel. Up to 200 acres (81 hectares) would be disturbed during construction. The remaining 145 acres (59 hectares) could be available for continued farming under a lease agreement if construction is limited to the 200-acre (81-hectare) envelope. The industrial use would be compatible with the heavy industrial use already occurring in the general vicinity of the site but could have a major impact on the three residential parcels that abut the site on the north side.

The City of Tuscola's Comprehensive Plan identifies the future land use at the proposed plant site as industrial. Therefore, construction of the proposed Tuscola Power Plant would fall within the parameters set by the City of Tuscola for future land use and would be compatible with the local comprehensive plans and zoning ordinances.

Most of the proposed Tuscola Power Plant Site falls within the 10,000-foot (3,048-meter) radius of the airport required for FAA Part 77 Airspace Obstruction Analysis. Patrick Engineering Inc. (2006) conducted an FAA Part 77 Airspace Obstruction Analysis to determine whether airspace obstruction would occur within 10,000 feet (3,048 meters) of Tuscola Airport. All corners of the proposed power plant site that fell within 10,000 feet of the airport, as well as the center of the site, were analyzed (five total locations). Patrick Engineering Inc. estimated the ground elevation of each location using the ISGS 7.5-minute topographic map for the Tuscola, Illinois, Quadrangle, and then added 250 feet (76 meters) to account for the height of the heat recovery steam generator stack for the proposed power plant. They then calculated the slope of the surface from the airport runway to each location and compared this calculation to the minimum guideline from the FAA of 50H:1V (that is, a 50 to 1 ratio of horizontal distance to vertical distance). The five locations ranged from 26H:1V to 37H:1V and all exceeded the FAA Airspace Obstruction guideline of 50H:1V within 10,000 feet (3,048 meters) of the Tuscola Airport (Patrick Engineering, 2006). The analysis shows that a 250-foot (76-meter) stack constructed at nearly any location on the proposed site would extend into the 50:1 surface defining the controlled airspace around the Tuscola Airport. Construction would require advance FAA notification and evaluation, and signal lights would be required atop the heat recovery steam generator and flare stacks. FAA regulations require such lighting for any structure of more than 200 feet (61 meters) high (14 CFR Part 77). The FAA charts show several other existing obstructions in the vicinity of the proposed site, including grain storage facilities, mobile telephone towers, and the stacks at the Lyondell-Equistar Power Plant, which are 193 feet (59 meters) tall. The proposed Tuscola Power Plant Site would be located north of the runway, which is oriented west to east.

As noted above, construction of the Tuscola Power Plant would convert up to 200 acres (81 hectares) of prime farmland to industrial use. This would represent 0.7 percent of the approximate 27,060 acres (10,951 hectares) the NRCS reports as lost annually in Illinois. The proposed Tuscola Power Plant Site's LESA score of 239 points exceeds the 225-point threshold for lands that, under the Illinois LESA System, should be reevaluated so that the site could be retained for agricultural use; however, such conversions are not prohibited, and as noted in Section 5.11.2.1, the City of Tuscola Comprehensive Plan identifies the site's future land use as industrial (City of Tuscola, 2001).

Sequestration Site

Construction at the proposed Tuscola Sequestration Site would have temporary, minor effects on the agricultural land use during the actual construction period due to trenching for the pipeline corridor, construction of the injection structure, equipment movement, and material laydown. After construction is complete, the areas not used for wells and equipment would be regraded and revegetated in accordance with applicable permits, with no permanent change in the existing agricultural land use.

Utility Corridors

Construction within the proposed wastewater and process water pipeline corridor would have temporary, minor effects on the primarily industrial uses, along their respective 0.85-mile (1.4-kilometer) and 1.5-mile (2.4-kilometer) corridors during the actual construction period due to trenching, equipment movement, and material laydown. The same is true of the agricultural use of the 11-mile (18-kilometer) CO_2 pipeline corridor. After construction is complete, the areas would be regraded and revegetated if needed, and all original land uses would continue.

Where the proposed transmission line corridor coincides with an existing transmission line corridor, there would be no change in current land use. Construction within the proposed transmission line corridor, if needed to upgrade the existing line, would have temporary, minor effects on land use (agricultural use, industrial use) during the actual construction period. The proposed corridor would either be 0.5 or 17 miles [0.8 to 27.4 kilometers]) in length. After construction is complete, the areas would likely return to their current use.

If the new ROW required for the last 3 miles (4.8 kilometers) of the proposed transmission line were needed, it would affect nine landowners. Construction within the new ROW would make the ROW temporarily unavailable for its current, mostly agricultural, use. After construction is complete, the areas would likely return to their current use.

Construction of the proposed transmission line would come within 1 mile (1.6 kilometers) of the closed mine located in the township of Murdock, but would have no effect on the mine.

Transportation Corridors

The property adjacent to the southern property line of the proposed power plant site belongs to CSX Transportation. This property is used both as a switch yard and as mainline rail facilities. Access to the CSX mainline rail would be gained through the CSX Transportation ROW. A new proposed rail spur corridor would not be needed to gain access to the CSX Transportation rail facilities, and project construction would have no effect on current offsite land use.

5.11.3.2 Operational Impacts

Power Plant Site

As noted in Section 5.11.3.1, construction of the proposed Tuscola Power Plant would permanently remove at least 200 acres (81 hectares) of the site from its current agricultural use. The remainder of the site (145 acres [59 hectares]) could be leased for continued crop production, although it could also be developed at some future date. Such development is a reasonably foreseeable event in terms of defining potential cumulative impacts, but is not proposed as part of the FutureGen Project. The introduction of industrial operations adjacent to residential property would permanently alter the land use mix of the area, particularly with respect to the three residences adjacent to the north border of the site and the other residences within 1 mile (1.6 kilometers) of the site. As noted in Section 5.11.2.6, most of the several dozen additional residences are near the 1-mile (1.6-kilometer) boundary of the ROI, on the western edge of the City of Tuscola near the Illinois Central Gulf Railroad line. While the facility would be visible from those residences, it would not affect the land use of that area.

Sequestration Site

Over the long term, the presence of the injection wells and equipment would permanently remove up to 10 acres (4 hectares) from agricultural use at the proposed sequestration site. It is likely that the rest of the site would continue in its current agricultural use.

The option contract for the land at the sequestration site includes all subsurface rights, including any oil, gas, water, and mineral rights for the properties. Obtaining mineral rights from the 13 additional landowners located over the expected 30-year sequestration plume (there may be additional landowners if subsurface rights are needed to the 0.25-mile [0.4-kilometer] buffer) may be required and, in Douglas County this historically has not been difficult or uncommon (FG Alliance, 2006b). There are no economic mineral deposits known to exist in the Mt. Simon sandstone and surrounding formations; therefore, mining would most likely not occur over this formation (FG Site Proposal (Tuscola, Illinois), 2006).

Utility Corridors

Once the utility pipelines were in place, the lands would be returned to their pre-existing land use, such as roadway, cropland, industrial use, or utility corridor, so permanent loss of land would only occur at the pole locations. There would be no permanent change in the existing land use, although the presence of underground utilities would preclude future development of the ROW for incompatible uses.

Over the long term, the presence of the electrical transmission line would permanently eliminate the locations of the towers as land for agricultural production or other uses, but the remainder of the ROW could continue in its current, primarily agricultural use. There could be some long-term minor impacts on land use within the transmission line corridor due to routine vegetative maintenance in areas where crops are not grown. The transmission line ROW would permanently preclude the future development of incompatible uses, such as residential construction, within the ROW.

Transportation Corridors

There would be no change in land use associated with the rail spur because the rail spur would not require any off-site ROW.

INTENTIONALLY LEFT BLANK

5.12 AESTHETICS

5.12.1 INTRODUCTION

This section identifies viewsheds and scenic resources that may be affected by the construction and operation of the proposed FutureGen Project at the Tuscola Power Plant Site, sequestration site, and related corridors. It addresses the appearance of project features from points where those features would be visible to the general public, and takes into account project characteristics such as light and glare. The distance from which the proposed power plant and associated facilities would be visible depends upon the height of the structures associated with the facilities, including buildings, towers, and electrical transmission lines, as well as upon the presence of existing intervening structures and local topography. Effects on visual resources can result from alterations to the landscape, especially near sensitive viewpoints, or an increase in light pollution.

5.12.1.1 Region of Influence

The ROIs for aesthetic resources include areas from which the proposed Tuscola Power Plant Site and all related areas of new construction would be visible. The ROIs are defined as 10 miles (16.1 kilometers) surrounding the proposed power plant site, 1 mile (1.6 kilometers) around the proposed sequestration site and on either side of the proposed electrical transmission line corridor, and immediately adjacent to the proposed underground utility corridors.

5.12.1.2 Method of Analysis

DOE identified land uses and potential sensitive receptors in the ROIs of the proposed power plant site, sequestration site, and utility corridors based on site visits, information in the Tuscola EIV (FG Alliance, 2006b), and review of aerial photography. DOE used two approaches to assess the potential impacts of the proposed FutureGen Project on aesthetic resources. First, DOE applied Geographic Information Systems (GIS)-based terrain modeling, combined with height information associated with the proposed project facilities (i.e., the 250-foot [76-meter] HRSG stack and 250-foot [76-meter] flare stack), to determine the distance from which the facilities could be seen if there were no intervening structures or vegetation to screen the view. Secondly, DOE considered two artistic concepts of the proposed FutureGen Power Plant to depict a range of aesthetic approaches to the project. One concept is of a typical power plant with minimal screening and architectural design, while the second concept includes extensive screening and architectural design. DOE compared and contrasted the two concepts to assess the relative level of visual intrusiveness for each concept.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect a national, state, or local park or recreation area;
- Degrade or diminish a federal, state, or local scenic resource;
- Create visual intrusions or visual contrasts affecting the quality of a landscape; and
- Cause a change in a BLM Visual Resource Management classification.

5.12.2 AFFECTED ENVIRONMENT

5.12.2.1 Landscape Character

Natural and human-created features that give the landscape its character include topographic features, vegetation, and existing structures. The landscape of the proposed Tuscola Power Plant Site, shown in

Figure 5.12-1, is typical of farmland throughout the area, which is primarily used for row crop production of corn and soybeans. The topography of the site is relatively flat. Two industrial facilities, Cabot Corporation and Lyondell-Equistar Chemicals, are visible from the site to the west. The tallest visible feature associated with the Lyondell-Equistar and Cabot Corporation facilities is a 193-foot (59-meter) tall stack at the Lyondell-Equistar Power Plant (Ruppenkamp, 2006). A 101-foot (31-meter) tall Cargill grain elevator is visible from the site to the east (Zack, 2007). On its south side, the site is bordered by the CSX Transportation (CSX) Decatur Subdivision rail line and a CSX rail siding.

A few residences are located near the Tuscola Power Plant Site. Three single-family residences are located along the northern boundary of the site on CR 1050N. If the facility were located in the middle of the site, the residences would be about 600 feet (182.9 meters) from the facility. Other residences within 0.5 mile (0.8 kilometer) of the site include two residences to the north located between the site and CR 1150N, and five residences south of the site on or near SR 36. Additionally, there are several dozen residences within 1 mile (1.6 kilometers) of the site, almost all of which are near the 1-mile (1.6-kilometer) boundary of the ROI on the western edge of the City of Tuscola near the Illinois Central Gulf Railroad line.

As noted in Section 5.10, there are three previously recorded archaeological sites and five isolated finds within the ROI of the proposed power plant site. There are no historic sites within the ROI.

Figure 5.12-1. Proposed Tuscola Power Plant Site

The landscape of the proposed Tuscola Sequestration Site is similar to the proposed power plant site in that it has a relatively flat topography and is devoted to corn and soybean production. Figure 5.12-2 is a photograph of the proposed sequestration site. Aerial photography (Douglas County Highway Department, 2006) indicates that fewer than 10 residences are located on the proposed Tuscola Sequestration Site.

The landscape of the proposed underground utility corridors consists of typical Illinois farmland that is used for row crop production, with scattered farmsteads and other residences. Based on a review of aerial photography (Douglas County Highway Department, 2006), the proposed CO_2 pipeline corridor, which would run from the proposed power plant site south along CR 700E, would pass within 0.25 mile (0.4 kilometer) of approximately 12 residences.

As noted in Section 5.10, there are no recorded archaeological or historic resources within the ROI of the proposed sequestration site.

Figure 5.12-2. Proposed Tuscola Sequestration Site

One transmission line option (Option 1) would require only a 0.5-mile (0.8-kilometer) transmission line from the proposed power plant site to an existing 138-kV transmission line that runs east through farmland areas and periodically crosses slightly rolling, small, constructed drainage swales, bermed ponds, two creeks, and the Embarras River (Figure 5.12-3). The Option 2 transmission line corridor would parallel the existing 138-kV line for approximately 17 miles (27.4 kilometers), and would also include about 3 miles (4.8 kilometers) of new ROW. Residences located within 0.25 mile (0.4 kilometer) of the existing transmission line ROW include residences in the Iron Horse golf course community, along Ascot Way, in Brookstone Estates, and in Lakeview Estates, as well as scattered residences along the north-south roads from CR 750E to CR 2250E. Aerial photography (Douglas County Highway Department, 2006) does not reflect all of the most recent construction in the area, but the photographs and subsequent construction suggest that there are about 120 to 150 residences within 0.25 mile (0.4 kilometer) of the existing 138-kV transmission line. The area within 0.5 mile (0.8 kilometer) of the existing line also includes North Ward Elementary School, two churches, and the community of Murdock.

The ROI for the proposed transmission line also includes two archaeological resource sites and an isolated find, as well as two rural cemeteries, as described in Section 5.10.

There are no BLM visual resource management classifications or designated scenic vistas within the ROIs of the proposed power plant site, sequestration site, or corridors (BLM, 2004).

Figure 5.12-3. Proposed Tuscola Electrical Transmission Line Corridor

5.12.2.2 Light Pollution Regulations

ROIs for the proposed power plant site, sequestration site, and utility corridor are not regulated by any state or local light pollution abatement plans or goals (FG Alliance, 2006b).

5.12.3 IMPACTS

5.12.3.1 Construction Impacts

Power Plant Site

During construction at the proposed Tuscola Power Plant Site, the nearest neighbors, especially the three residences along the northern border of the site boundary on CR 1050N and the other seven residences within 0.5 mile (0.8 kilometer) of the site, would have an unobstructed view of the construction site and equipment moving on and off the site during the 44-month construction period, which would be a direct short-term impact. The construction site would also be visible from the several dozen residences on the west side of Tuscola, near the outer perimeter of the 1-mile (1.6-kilometer) ROI.

As noted in Section 5.10, construction at the proposed power plant site is not anticipated to have any direct or indirect effects on cultural resources in the ROI (see IHPA concurrence letter in Appendix A).

Sequestration Site

The landscape at the sequestration site is similar to that at the proposed power plant site. During construction at the proposed Tuscola Sequestration Site, fewer than 10 residential properties would have nearly unobstructed and temporary views of construction activities at the site.

Utility Corridors

During construction along the proposed pipeline corridors, equipment used for trenching, pipe laying, and other construction activities would be visible only to viewers immediately adjacent to the pipeline corridors and construction laydown areas, including the 12 residences within 0.25 mile (0.4 kilometer) of the proposed CO_2 pipeline corridor and persons driving along CR 700E. This would constitute a direct short-term impact on residences nearest the corridors during the construction period, which is estimated at 3 to 6 weeks each for the process water and CO_2 pipelines (FG Alliance, 2006b).

Construction along the 17-mile (27.3-kilometer) Option 2 electrical transmission line corridor would be visible from within the 1-mile (1.6-kilometer) ROI, particularly to persons living in the 120 to 150 residences estimated to be within 0.25 mile (0.4 kilometer) of the existing 138-kV line in the corridor, which would be a direct short-term impact for the duration of the construction period. Construction along the 0.5-mile (0.8-kilometer) Option 1 corridor would be visible at only a few houses and to motorists on that portion of CR 750E.

Construction along the transmission line corridor is not anticipated to affect the archaeological sites or rural cemeteries within the ROI (see IHPA concurrence letter in Appendix A).

Transportation Corridors

The existing roadways meet the current needs of traffic in the area of the proposed Tuscola Power Plant Site (FG Alliance, 2006b). If the site is selected for the FutureGen Project and a feasibility or traffic study indicates that the access roads need to be reconstructed, construction activity would be visible only to those immediately adjacent to the construction sites.

5.12.3.2 Operational Impacts

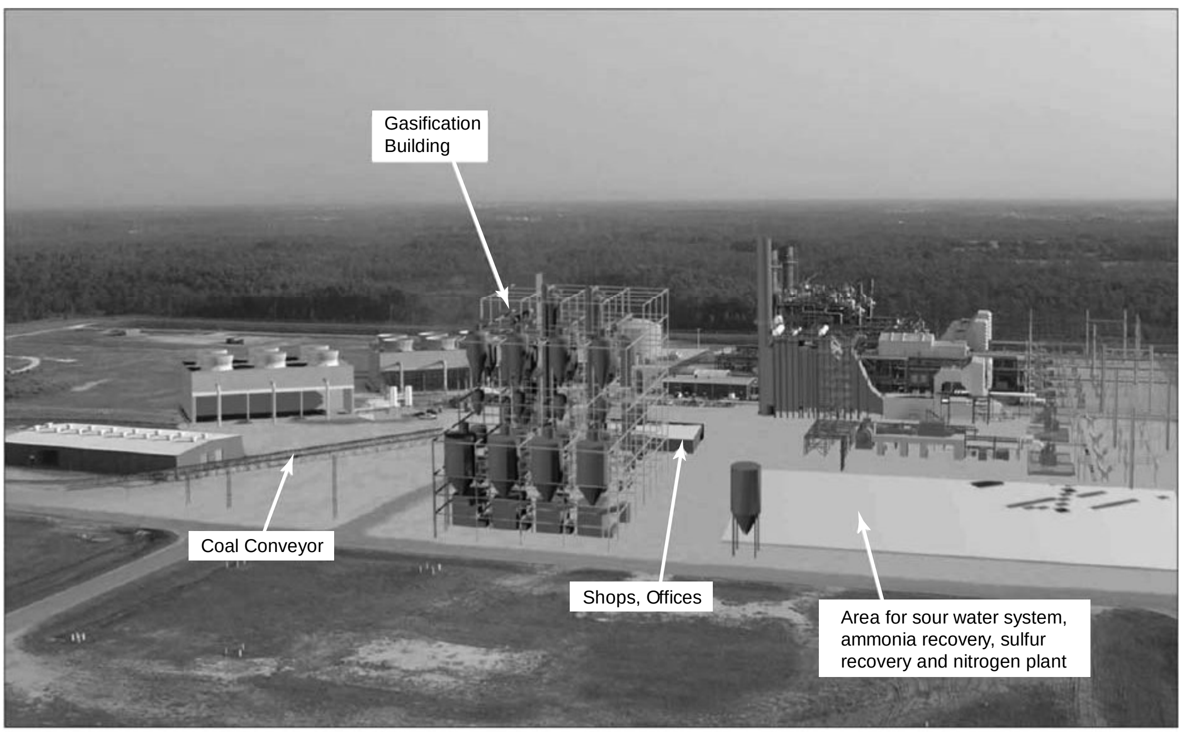
Power Plant Site

Major equipment for the power plant would include the gasifier and turbines, a 250-foot (76-meter) tall HRSG stack, a 250-foot (76-meter) tall flare stack, synthesis gas cleanup facilities, coal conveyance and storage systems, and particulate filtration systems. Additionally, the project would include on-site infrastructure, such as a rail loop for coal delivery, plant roads and parking areas, administration buildings, ash handling and storage facilities, water and wastewater treatment systems, and electrical transmission lines, towers, and a substation.

Once construction is complete, the tallest structures associated with the proposed Tuscola Power Plant Site would include the main building, stacks, and communication towers. The maximum proposed height of the facility is 250 feet (76 meters). Residences closest to the site, including the three residences on the north edge of the proposed Tuscola Power Plant Site and seven other residences within 0.5 mile (0.8 kilometer) of the site, would have a nearly unobstructed view of the power plant. People at additional scattered residences located farther from the site, as well as people on the western edge of Tuscola and in public places such as Ervin Park, would also be able to see the plant because of the relatively flat topography and lack of structures, woodlands, or tree lines in the area. DOE's terrain analysis indicates that the facility would be visible from a distance of 7 to 8 miles (11.3 to 12.9 kilometers). The proposed FutureGen Power Plant would have aesthetic characteristics similar to other existing industrial facilities in the immediate area, such as the Cabot Corporation and Lyondell-Equistar facilities, grain elevators, and cement plants.

With respect to the site layout, the visual impact at the three nearest residences would be reduced if the facility were laid out such that the less intrusive features, such as administrative offices and similar buildings and parking areas, were located nearest the residences (i.e., on the north side of the site) and the more industrial features and coal storage piles were located farthest from the residences, near the rail line on the site's southern border. This configuration would move the more intrusive industrial features nearer the five residences south of the site, but these residences would still be more than 2,000 feet (610 meters) from the plant.

For those viewing the proposed power plant from the adjacent roads or nearby residences or from a greater distance, the appearance of the facilities would depend upon the degree of architectural development and visual mitigation included in the design. Figures 5.12-4 and 5.12-5 show two points on a range of conceptual IGCC plant designs. Figure 5.12-4 is an artist's rendering of an IGCC facility proposed for Orlando, Florida (DOE, 2006a). This rendering shows a plant with minimal screening or enclosure of the facility components. Figure 5.12-5 is the artist's conceptual design of the proposed FutureGen Power Plant that was used during the scoping process for this EIS (DOE, 2006b). This rendering shows a plant with a high degree of architectural design, including enclosure of most of the plant features.



Source: DOE, 2006a

Figure 5.12-4. Artist's Rendering of an IGCC Plant with Minimal Screening and Architectural Design Elements

Source: DOE, 2006b

Figure 5.12-5. Artist's Rendering of an IGCC Plant with Extensive Screening and Architectural Design Elements

The proposed facility is still in the design stage, and decisions have not yet been made about the final configuration or appearance of the power plant. A plant design similar to Figure 5.12-4 would create a more industrial appearance. Although still very large in scale, a plant design similar to Figure 5.12-5 would have less of an industrial appearance, and would be visually less intrusive than the plant design shown in Figure 5.12-4. As noted above, the visual impact at nearby residences would be reduced if the facility were laid out so that the less intrusive features, such as administrative offices and similar buildings and parking areas, were located nearest the residences and the more industrial features and coal storage piles were located farthest from the residences.

Regardless of the final appearance of the proposed power plant, plant lighting and the flare would be highly visible at night, especially from nearby residences. The existing Cabot Corporation and Lyondell-Equistar industrial facilities can be seen from approximately 7 to 8 miles (11.3 to 12.9 kilometers) away at night when the agricultural crops are still in the fields. This distance is increased in late fall, winter, and spring when the fields are barren or the crops have just been planted or harvested. The proposed FutureGen facility, including the vapor plumes, would likely be visible for a comparable distance. Intervening buildings, vegetation, and topography would reduce the visibility of the plant from some vantage points.

The plant is not anticipated to have any effect on the archaeological sites within the ROI (see Section 5.10 and IHPA concurrence letter in Appendix A).

Because there are no BLM visual resource management classifications or designated scenic vistas in the power plant site, sequestration site, or transmission line ROIs, the project would not have any effect on those classifications. Additionally, because there are no applicable light pollution standards in the area, the plant would create no conflict with such standards. Nonetheless, the choice of appropriate outdoor lighting and the use of various design mitigation measures (e.g., luminaries with controlled candela distributions, well-shielded or hooded lighting, directional lighting) could reduce the amount of nighttime glare associated with the plant lighting.

Sequestration Site

Once construction is complete, the tallest structure associated with the proposed Tuscola Sequestration Site would be about 10 feet (3.0 meters) tall. The facility would be visible to those passing by on the adjacent county roads, but would not be visible from a distance. It is likely that farming would continue on the Tuscola Sequestration Site, which would provide screening for the injection facility during the growing season. Thus, the project would create a direct, minor visual intrusion for those nearest the site primarily in the fall after harvest, during the winter, and in the spring before crops achieve their full growth.

Utility Corridors

Once construction is complete, the pipeline corridors would be returned to their pre-construction condition and would have essentially the same appearance as before construction. However, pump stations or compressor stations associated with proposed pipelines would be noticeable to nearby residences and those traveling on adjacent roadways.

On the proposed transmission line corridor, the visibility of the line would depend upon whether a new, parallel line or taller towers would be needed. This will not be known until certain transmission studies are completed. Any new line would be at least as visible as the existing 138-kV line, including at the 120 to 150 residences within 0.25 mile (0.4 kilometer) of the existing line and in the areas where the existing line abuts Ervin Park and the Iron Horse Golf Course. Any new substation would be visible to those nearby.

Transportation Corridors

If studies show that any road construction is required, the transportation corridors would appear similar to other transportation facilities. Once construction is complete and the power plant is in operation, the visual impacts would be similar to those for the power plant site, sequestration site, and utility corridors.

5.13 TRANSPORTATION AND TRAFFIC

5.13.1 INTRODUCTION

This section discusses the existing conditions of the roadway and railroad networks that may be affected by the construction and operation of the proposed FutureGen Project at the Tuscola Power Plant Site.

5.13.1.1 Region of Influence

The ROI for the proposed power plant site includes a 50-mile (80.5-kilometer) radius around the site, as shown in Figure 5.13-1. The Tuscola Power Plant Site is located on CR 750E approximately 0.5 miles (0.8 kilometers) north of U.S. Highway (US) 36 and approximately 2.5 miles (4.0 kilometers) from the center of Tuscola. It is approximately 2.5 road miles (4.0 kilometers) from the US 36 interchange with US 45 and 4 road miles (6.4 kilometers) from the US 36 interchange with Interstate 57 (I-57). Because most vehicle trips to the proposed site would use US 36 from the I-57 interchange, this transportation analysis focuses on the area within the 4-mile (6.4-kilometer) corridor on US 36 passing along the south edge of Tuscola. This analysis includes possible alternate routes using CR 1050 North, city streets, and US 45, and thus includes Tuscola's city street network and the area north to CR 1050.

5.13.1.2 Method of Analysis

DOE reviewed information provided in the Tuscola EIV (FG Alliance, 2006b), which characterizes elements in the roadway hierarchy within the ROI based on function (e.g., city street and rural arterial), traffic levels, and observed physical condition. The EIV also contains traffic data obtained from the Illinois Department of Transportation (IDOT). The number of vehicle trips generated during construction and operations was based on data provided in the Tuscola EIV (FG Alliance, 2006b).

> **LOS** is a qualitative measure that describes operational conditions within a traffic stream, generally in terms of service measures as speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000).

Traffic impacts were assessed using the planning methods outlined in the Transportation Research Board's "2000 Highway Capacity Manual" (2000 HCM) (TRB, 2000), which assigns a level of service (LOS) to a particular traffic facility based on operational conditions within a traffic stream, generally in terms of such service measures as speed. travel time, freedom to maneuver, traffic interruptions, comfort, and convenience (TRB, 2000);, and The American Association of State Highway and Transportation Officials' (AASHTO) "A Policy on the Design of Highways and Streets" (the Green Book) (AASHTO, 2004), which describes LOS in more qualitative terms. The Green Book defers to the 2000 HCM to define LOS by facility type. The measures of effectiveness to assign LOS vary depending on traffic facility. Highway Capacity Software Plus (HCS+) was used to perform capacity analysis.

For two-lane highways, the measure of effectiveness in assessing operations is the percent of time spent following another vehicle. LOS A through LOS F are assigned to a facility based on this measure of effectiveness. The LOS is dependent on the Highway Class (I or II), lane and shoulder widths, access-point density, grade and terrain, percent of heavy vehicles, and percent of no-passing zones within the analysis segment. Class I two-lane highways, according to the 2000 HCM, are highways where a motorist expects to travel at relatively high speeds. They are typically primary links in a state or national highway network and serve long-distance trips. A Class II two-lane highway typically operates at lower speeds and most often serves shorter trips. Class II also includes scenic or recreational routes. Table 5.13-1 defines each LOS category for Class I and II two-lane highways.

Table 5.13-1. Level of Service Criteria, Two-Lane Highways

LOS	Class I Two-Lane Highway		Class II Two-Lane Highway
	Percent Time Spent Following Another Vehicle	Average Travel Speed (mph [kmph])	Percent Time Spent Following Another Vehicle
A	<35	>55 (88.5)	<40
B	> 35 - 50	> 50 - 55 (80.5 – 88.5)	> 40 - 55
C	> 50 - 65	> 45 - 50 (72.4 – 80.5)	> 55 - 70
D	> 65 - 80	> 40 - 45 (64.4 – 72.4)	> 70 - 85
E	> 80	≤ 40 (64.4)	> 85

LOS F applies whenever the flow rate exceeds the capacity of the highway segment.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For multi-lane highways, the primary measure of effectiveness is density, measured in passenger cars per mile per lane. The traffic density is based on the free-flow speed, ranging from 45 to 60 mph (72.4 to 96.6 kilometer per hour). The LOS depends on the lane width, lateral clearance, median type, number of access points, free-flow speed, and percent of heavy vehicles. Table 5.13-2 defines the LOS criteria for each free-flow speed on a multi-lane highway.

Table 5.13-2. Level of Service Criteria, Multi-Lane Highways

Free-Flow Speed (mph [kmph])	Criterion	LOS				
		A	B	C	D	E
60 (96.6)	Maximum density (pc/mi/ln)	11	18	26	35	40
55 (88.5)		11	18	26	35	41
50 (80.5)		11	18	26	35	43
45 (72.4)		11	18	26	35	45

LOS F is not included in the table; vehicle density is difficult to predict due to highly unstable and variable traffic flow.
mph = miles per hour; kmph = kilometers per hour; LOS = Level of Service.
Source: TRB, 2000.

For basic freeway segments, the measure of effectiveness is density, measured in passenger cars per mile per lane. The LOS is dependent on the lane width, lateral clearance, number of lanes, interchange density, free-flow speed, and percent of heavy vehicles. Table 5.13-3 defines the LOS criteria for each free-flow speed.

The Green Book describes LOS in qualitative terms as follows: LOS A represents free flow, LOS B represents reasonably free flow, LOS C represents stable flow, LOS D represents conditions approaching unstable flow, LOS E represents unstable flow, and LOS F represents forced or breakdown flow (AASHTO, 2004).

Table 5.13-3. Level of Service Criteria, Basic Freeway Segments

LOS	Passenger Cars Per Mile Per Lane
A	0 – 11
B	>11 – 18
C	>18 – 26
D	>26 – 35
E	>35 – 45
F	>45

LOS = Level of Service.
Source: TRB, 2000.

No information is available for turning movements at specific intersections within the ROI. Therefore, intersection LOS has not been estimated for this analysis. However, DOE identified key intersections and evaluated the LOS qualitatively based on the relative traffic volumes on intersecting roadways.

Though there are accident reduction factors that can be used to estimate a reduction in crashes based on a specific type of highway improvement, no methods are available for estimating the increase in crashes due to increased roadway volume. In addition, specific recent accident data for the roadways around the proposed power plant site are not available (IDOT, 2005a). DOE reviewed IDOT's Comprehensive Highway Safety Plan (CHSP) (IDOT, 2005b), which provides generic statistics and information about crashes at at-grade highway-railroad crossings and at intersections on a national and statewide basis. DOE qualitatively assessed potential safety impacts in this analysis.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Increase traffic volumes as to degrade LOS conditions on roadways;
- Alter traffic patterns or circulation movements;
- Alter road and intersection infrastructure;
- Conflict with local or regional transportation plans;
- Increase rail traffic compared to existing conditions on railways within the ROI; and
- Conflict with regional railway plans.

5.13.2 AFFECTED ENVIRONMENT

5.13.2.1 Roads and Highways

Figure 5.13-2 shows the local highway network in relationship to the regional network around the proposed Tuscola Power Plant Site. The proposed site is primarily accessed via I-57, immediately east of Tuscola and 4 road miles (6.4 kilometers) from the proposed Tuscola Power Plant Site. The proposed Tuscola Sequestration Site is located approximately 10 miles (16.1 kilometers) south of Tuscola and 1 mile (1.6 kilometers) west of US 45. Access to the proposed sequestration site would be via US 45 and CR 1700N or CR 1900N.

There are two potential routes to the proposed Tuscola Power Plant Site from I-57. The site could be accessed via US 36 to CR 750E, entering the proposed Tuscola Power Plant Site on its west side or via US 36, US 45, and CR 1050N to enter the proposed Tuscola Power Plant Site on its north side.

IDOT Highways

Marked and unmarked routes under the jurisdiction and maintenance of the IDOT are typically one of four types of pavement: full depth bituminous, bituminous pavement overlay on a rigid base, concrete pavement, or a combination of concrete and bituminous. These pavements would be "high quality" pavements and surface types. According to IDOT (as cited in FG Alliance, 2006b), there are no "sharp or hazardous curves" on any of the state-maintained roads.

A **Class I truck route** is defined as a limited access, divided highway that can handle 5-axle tractor semi trailers of any length, up to 8.5 feet (2.6 meters) wide and up to 13.5 feet (4.1 meters) high, and have a gross weight of up to 80,000 pounds (36,287 kilograms).

I-57 is a four-lane divided north-south highway that connects with I-70 approximately 50 miles (80.5 kilometers) to the south and via I-70 to Indianapolis and St. Louis. In Illinois, all interstates are designated as Class I truck routes.

In addition to I-57, the principal north-south highway is US 45, a two-lane highway that makes up the western border of Tuscola and runs parallel with I-57. US 45 connects with Arcola and Mattoon to the south and with Pesotum, Tolono, and Champaign to the north. US 45 is classified as a major collector roadway.

US 36 is a two- to four-lane east-west principal arterial highway on the southern edge of the Tuscola street grid, connecting with I-57 in a full interchange. US 36 intersects US 45 and I-57 approximately 2 miles (3.2 kilometers) and 3.5 miles (5.6 kilometers), respectively, to the east of the intersection of CR 750E and US 36. It crosses US 45 on an overpass with connections immediately southwest of the city. US 36 also serves the Lyondell-Equistar facility approximately 1 mile (1.6 kilometers) west of the proposed project site.

A **Class II truck route** is defined as a roadway that allows 80,000-pound (36,287-kilogram) vehicles up to 60 feet (18.3 meters) long with a width of 8.5 feet (2.6 meters).

US 36 and US 45 are designated as Class II truck routes. The characteristics of each roadway class are shown in Table 5.13-4.

Table 5.13-4. Roadway Class Characteristics

Type of Highway or Street	Width (feet [meters])	Height (feet [meters])	Length (feet [meters])	Maximum Weight (pounds [kilograms])
Class I	8.5 (2.6)	13.5 (4.1)	any	80,000 (36,287)
Class II	8.5 (2.6)	13.5 (4.1)	60 (18.3)	80,000 (36,287)
Class III	8 (2.4)	13.5 (4.1)	55 (16.8)	80,000 (36,287)

Source: IDOT, 2005c.

County Roads

The proposed plant site is bordered by two county roads under the jurisdiction of the Tuscola Township Road Commissioner and the Douglas County Engineer. Either of these roads could serve as an access route to the proposed Tuscola Power Plant Site from US 45 and US 36. CR 750E parallels the western boundary of the proposed Tuscola Power Plant Site and CR 1050N parallels the northern boundary.

CR 750E is a two-lane rural roadway classified as a local roadway that runs north-south. CR 750E intersects US 36 approximately 0.5 mile (0.8 kilometer) to the south of the proposed Tuscola Power Plant Site. Access to the proposed Tuscola Power Plant Site could be made via this road. CR 750E currently has approximately 8 inches (20.3 centimeters) of oil and chip pavement with an oiled-earth base, and is roughly 20 feet (6.1 meters) wide. It has a weight capacity of 36 tons (32.7 metric tons).

CR 1050N (TR 47) is a two-lane minor collector roadway that runs along the north edge of the proposed Tuscola Power Plant Site and is rated at 36 tons (32.7 metric tons). CR 1050N intersects US 45 approximately 1 mile (1.6 kilometers) east of the proposed site and continues east to become Tuscola's North Line Road. I-57 can be accessed from this route by traveling approximately 9 miles (14.4 kilometers) north on US 45 to the I-57/US 45 interchange in Pesotum, Illinois; or by traveling 1 mile (1.6 kilometers) south to the intersection/interchange of US 45/US 36, then 1.5 miles (2.4 kilometers) east to the US 36/I-57 interchange.

The Douglas County highway system routes range from bituminous treatment on 8 to 12 inches (20.3 to 30.5 centimeters) of compacted aggregate, bituminous overlay of rigid pavement, or concrete (rigid) pavements. Approximately 50 percent of the county's 102 miles (164 kilometers) of pavement is "high quality" pavements and surfaces.

Local Roads

Tuscola's street pattern is a grid of major and minor streets. Figure 5.13-3 shows the street network in Tuscola and key intersections. The township roads in Douglas County include dirt roads, aggregate roads, oiled earth, and bituminous seal coat on 6 to 8 inches (15.2 to 20.3 centimeters) of compacted aggregate. Approximately 85 percent of the township mileage in the county is either oiled earth or bituminous seal coat on compacted aggregate.

There are five key intersections in the vicinity of the proposed plant site. Turning movements for these intersections are not available; therefore, DOE used the LOS of adjacent road segments to estimate potential effects of the proposed FutureGen Project on these intersections.

- US 36 and I-57 Northbound ramps
- US 36 and I-57 Southbound ramps
- US 36 and South Prairie Street
- US 36 and US 45 ramps
- US 36 and CR 750E
- US 45 and CR 1050N

Programmed Transportation Improvements

IDOT has a Proposed Highway Improvement Program (HIP) for Fiscal Years 2007 to 2012 for each of its nine districts. The area within and adjacent to the 4-mile (6.4-kilometer) focus area is covered in the District 5 plan. The following are programmed improvements in the HIP and the approximate distance from the proposed Tuscola Power Plant Site:

- Bear Creek Bridge replacement, US 36 (3 miles [4.8 kilometers]);
- US 36 resurfacing, Moultrie County line to Washington Street in Tuscola (0.75 mile [1.2 kilometers]);
- Hackett Branch Bridge replacement, US 36, 2.4 miles (3.9 kilometers) east of I-57 (5 miles [8.0 kilometers]); and
- US 45 over Union Pacific Railroad and CSX Railroad, and over US 36 at Tuscola, new construction/bridge replacement (3 miles [4.8 kilometers]).

5.13.2.2 Railroads

There are four Class I railroads located within the ROI: CSX Transportation, Union Pacific, Canadian National, and Norfolk Southern. The proposed Tuscola Power Plant Site is bordered to the south by the CSX Transportation Decatur Subdivision rail line and a CSX rail siding (FG Alliance, 2006b).

Class I – Gross annual operating revenues of $277.7 million or more

Class II – Non-Class I railroad operating 350 or more miles and with gross annual operating revenues between $40 million and $277.7 million

Class III – Gross annual operating revenues of less than $40 million

The Surface Transportation Board categorizes rail carriers into three classes based upon annual earnings. The earnings limits for each class were set in 1991 and are adjusted annually for inflation.

CSX Transportation operates 1,044 miles (1,680 kilometers) of track in Illinois, provides service to 270 industries in Illinois, and employs 1,000 Illinois residents. CSX invested $7.5 million to maintain and upgrade its Illinois track in 2004. A CSX rail line borders the full southern boundary of the proposed Tuscola Power Plant Site. The CSX line that serves the proposed Tuscola Power Plant Site is the Decatur Subdivision, which connects Decatur with CSX lines to the east in Chrisman, Illinois, and Hillsdale, Indiana. Currently, between four and six trains operate per day on this line; far below its capacity. The line can handle loads of up to 286,000 pounds (129,727 kilograms). Part of the line is currently restricted from six-axle locomotives. This section would require an upgrade to handle the traffic volume planned for the proposed FutureGen Project.

Union Pacific operates the largest railroad in Illinois, with 2,247 miles (3,616 kilometers) of track and 4,000 employees in Illinois. Tuscola is located on Union Pacific's main line track that connects Chicago and St. Louis. Daily freight train counts on this Union Pacific main line average 22 trains per 24-hour period. This Union Pacific main line has a 286,000-pound (129,727-kilogram) weight capacity as coal trains currently use this line. In addition to providing access to the St. Louis gateway, this line goes south at Findlay, Illinois, and serves southern Illinois points. Lines from Mt. Vernon to Chester and Benton to Gorham have recently had substantial track work and provide additional links to Union Pacific's main line to Texas and the Gulf ports.

Canadian National operates the second largest railroad in Illinois, with 1,519 miles (2,444 kilometers) of track. Through the Chicago gateway, the Canadian National moves freight between Canada and points in the Mississippi Valley, the Gulf Coast, and Mexico. The Canadian National main line between Effingham and Champaign, Illinois, passes through Tuscola approximately 1.5 miles (2.4 kilometers) east of the proposed Tuscola Power Plant Site and parallels US 45. Canadian National runs 12 freight trains with service six days per week through Tuscola. The track is classified by the Federal Railroad Administration (FRA) as Class IV (maximum freight speed of 60 mph [96.6 kmph]). In addition, four Amtrak passenger trains classified at 79 mph (127.1 kmph) pass through Tuscola each day.

Class IV track, classified by the Federal Railroad Administration (FRA), allows a maximum freight speed of 60 mph (96.6 kmph).

Norfolk Southern operates 1,260 miles (2,028 kilometers) of track in Illinois. The Norfolk Southern main line between Decatur and Danville, Illinois, is the closest Norfolk Southern track to Tuscola. This section is a main line with approximately 36 through trains per day. The track along that line can support car loadings of up to 286,000 pounds (129,727 kilograms). The Norfolk Southern Railroad has access to the proposed Tuscola Power Plant Site via an existing rail yard/switch yard located in Decatur, Illinois, approximately 30 miles (48.3 kilometers) west of Tuscola.

5.13.2.3 Local and Regional Traffic Levels and Patterns

Regional Traffic

According to IDOT, in 2005, I-57 carried approximately 19,300 vehicles per day (vpd, also referred to as average daily traffic [ADT]) south of Tuscola and approximately 26,600 vpd north of the city in 2005 (FG Alliance, 2006b). US 45 carried approximately 2,400 vpd in the vicinity of US 36, and US 36 carried approximately 4,450 vpd in the vicinity of CR 750E. Typically, morning and afternoon peak hour volumes range from 8 to 12 percent of the ADT (Table 5.13-5). Peak hour truck percentages are typically slightly lower than the daily truck percentage because trucks travel in off-peak hours. However, to be conservative, the existing daily truck percentages were maintained to calculate the peak hour truck volumes for this analysis.

Table 5.13-5. 2005 Average Daily and Peak Hour Traffic Volumes

Roadway	ADT (vpd)[1]	Truck ADT (vpd)[1]	Weekday Peak Hour Volume (vph)[2]	Weekday Peak Hour Truck Volume (vph)[2]	LOS[3]
I-57, north of Tuscola	26,600	7,750	2,660	775	B
I-57, south of Tuscola	19,300	6,450	1,930	645	B
US 45	2,400	300	240	30	A
US 36	4,450	650	445	65	C
CR 1050N	390	47	39	5	A
CR 750E	90	11	9	1	A

[1] Source: FG Alliance, 2006b.
[2] DOE estimate of peak hour volume and LOS assumed peak hour equals 10 percent of ADT.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

IDOT (Region 3-District 5) does not keep records of LOS for the highways under state, county, or municipal control. The only time IDOT uses LOS is during capacity analysis and design of unsignalized and signalized intersections. However, Region 3-District 5 has performed an analysis to determine the LOS for the roadways in the vicinity of the proposed Tuscola Power Plant Site (FG Alliance, 2006b). Based on the existing roadway LOS reported in Table 5.13-5, DOE concluded that the key intersections near the proposed Tuscola Power Plant Site are likely to be operating smoothly as well.

Truck Traffic

Information provided by IDOT indicates that in 2005 there were approximately 7,750 trucks per day, or 29 percent of the ADT, using I-57 north of Tuscola; and approximately 6,450 trucks per day, or 33 percent of the ADT, using I-57 south of Tuscola (FG Alliance, 2006b). US 45 carried approximately 300 trucks per day in the vicinity of US 36, which is 13 percent of the ADT. US 36 carried approximately 650 trucks per day, or 15 percent of the ADT, in the vicinity of CR 750E. CR 1050N carried approximately 47 trucks per day, while CR 750E carried 11 trucks per day, both of which represent 12 percent of their respective ADTs.

There are several truck routes in the vicinity of the proposed Tuscola Power Plant Site. These truck routes use county roads near the proposed power plant site. I-57 is a Class I truck route, and US 36 and US 45 are Class II truck routes in the vicinity of the proposed Power Plant Site. The county roads have weight-bearing capacities of 36 tons (32.7 metric tons).

Rail Traffic

The proposed Tuscola Power Plant Site would be served by the CSX Railroad, which borders the proposed site's southern boundary. This line runs at approximately 25 percent capacity today (FG Alliance, 2006b). Accessing the proposed power plant site would require no new at-grade rail crossing.

5.13.3 IMPACTS

5.13.3.1 Construction Impacts

Power Plant Site

Based on the necessary permitting and design requirements, DOE expects that construction would begin on the proposed Tuscola Power Plant and related infrastructure is 2009 (FG Alliance, 2006b). Table 5.13-6 shows 2009 No-Build traffic volumes, which DOE projected to the construction year by applying a background growth rate of 1 percent per year to 2005 volumes. DOE determined this growth rate by reviewing other IDOT project EISs and study documentation (IDOT, 2005c).

Table 5.13-6. 2009 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[1] (vpd)	Weekday Peak Hour Volume[1] (vph)	Weekday Peak Hour Truck Volume[1] (vph)	LOS[2]
I-57, north of Tuscola	27,680	7,857	2,768	786	B
I-57, south of Tuscola	20,084	6,712	2,008	671	B
US 45	2,297	312	250	31	A
US 36	4,631	676	463	68	C

Table 5.13-6. 2009 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[1] (vpd)	Weekday Peak Hour Volume[1] (vph)	Weekday Peak Hour Truck Volume[1] (vph)	LOS[2]
CR 1050N	406	49	41	5	A
CR 750E	94	11	9	1	A

[1] DOE estimate based on 1 percent growth per year from 2005.
[2] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Based on the 2009 No-Build volumes, DOE estimated the capacity of each roadway (Table 5.13-6). Because there is no predicted change in the roadway LOS between the 2005 existing conditions and 2009 No-Build conditions, DOE concluded that there would be no change in LOS at key intersections near the proposed power plant site. All intersections are expected to continue to operate at LOS C or better under the No-Build conditions.

Over a 44-month construction period, the construction workforce for the proposed power plant site is estimated to average 350 workers on a single shift, with a peak period of 700 workers (FG Alliance, 2006e). DOE assumed that 100 percent of the construction workforce would arrive at the construction site in single-occupant vehicles. For the analysis of construction conditions, DOE used the peak period of construction in order to estimate the highest level of potential impact during construction.

Trips would be largely oriented to Tuscola and the I-57/US 36 interchange east of the city, and to Decatur 30 miles (48.3 kilometers) to the west on US 36. Principal routes to the interstate would be via CR 750E and US 36, and via CR 1050E, US 45, and US 36. The balance of trips would come to the proposed site via US 45 from the north and south and US 36 from the west. The expected trip distribution is summarized in Figure 5.13-2. All personal vehicles and trucks would use a single site entrance.

DOE assumed that the construction workforce would work a 10-hour work day, 5 days per week. Construction workforce trips would generally occur before the morning peak hours (7:00 am to 9:00 am) and coincide with the afternoon peak hours (4:00 pm to 6:00 pm). It is unlikely that many, if any, trips would occur during mid-day, as construction workers typically do not leave a job site during the half-hour lunch period.

Based on these construction workforce estimates, DOE estimated the percent change in ADT and peak-hour traffic volumes from 2009 No-Build conditions for the likely routes to the site during the expected 44-month construction period (2009-2012) (Table 5.13-7). CR 750E and CR 1050N would see the most direct impact during construction with ADT volumes possibly increasing 370 and 1,600 percent, respectively. Though some of the percentage increases are very large, this is partially due to the low existing volumes on each road.

Table 5.13-7. 2009 Average Daily and Peak Hour Construction Traffic Volumes

Roadway	ADT[1,2] (vpd)	Change in ADT[1,2] (percent)	Weekday Peak Hour Volume[1,3] (vph)	Change in Weekday Peak Hour Volume[2] (percent)	LOS[4]
I-57 north of Tuscola	28,832	4	3,331	20	B
I-57 south of Tuscola	20,228	1	2,079	4	B

Table 5.13-7. 2009 Average Daily and Peak Hour Construction Traffic Volumes

Roadway	ADT[1,2] (vpd)	Change in ADT[1,2] (percent)	Weekday Peak Hour Volume[1,3] (vph)	Change in Weekday Peak Hour Volume[2] (percent)	LOS[4]
US 45	3,678	47	827	231	A
US 36	4,890	6	590	27	C
CR 1050N	1,587	291	618	1,422	C
CR 750E	1,534	1,538	713	7,517	C

[1] DOE estimate based on peak workforce of 700 workers arriving at site in SOVs, plus 40 truck trips per day (20 entering and 20 exiting the site).
[2] Trip distribution on area roadways is shown in Figure 5.13-2.
[3] DOE derived peak hour volumes were derived assuming half of all passenger car trips occur in peak hour and truck trips are evenly distributed over a ten-hour work day.
[4] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

The I-57 interchange with US 36 would provide the main access route for all truck traffic from the north, south, and east to the proposed Tuscola Power Plant Site, while truck traffic from the west would use US 36 and CR 750E directly to the site entrance. This would not cause a large direct traffic impact on these roads due to the available capacity.

As shown in Table 5.13-7, the number of passenger vehicle trips by construction workers would be relatively small in terms of available roadway capacity, and direct traffic impacts due to construction would be relatively minor. The capacity analysis of the roadways during the construction period is shown in Table 5.13-7. I-57 would continue to operate at LOS B both north and south of Tuscola, and US 45 and US 36 would continue to operate at LOS A and LOS C, respectively. CR 1050N and CR 750E would operate at LOS C (stable flow), compared to LOS A (free flow) under the 2009 No-Build conditions. Given that the roadways would be operating at LOS C or better, there is no reason to conclude that there would be any notable increase in traffic accidents.

Based on the volumes and LOS on these roadways during construction, the key intersections around the proposed site should be able to accommodate these daily and peak hour traffic volumes. The ramp termini intersections at I-57 and US 36, as well as the ramps from US 45 to US 36, could see some temporary change in LOS due to the traffic volumes generated during construction. Changes to traffic signal timings may be required at the US 36/I-57 ramp intersections to accommodate changes in the turning volumes at those intersections.

In addition to worker traffic, materials and heavy equipment would be transported to the proposed site on trucks from I-57 and via the adjacent rail line. Heavy equipment would remain at the proposed site for the duration of its use. Material deliveries and return trips by empty trucks would likely occur throughout the workday. Tuscola is served by several large construction material supply firms, offering both concrete and asphalt, within 20 miles (32.2 kilometers) of the proposed Tuscola Power Plant Site. DOE did not estimate a specific numbers of trips by trucks from any specific supply location; however, DOE included 40 truck trips per day (20 entering and 20 exiting the site) in the analysis. Based on the available roadway capacities and the fact that estimated 2009 No-Build LOS are C or better, DOE concluded that 40 truck trips per day would not have a significant direct impact on traffic operations on roadways surrounding the proposed site. Moreover, DOE also concluded that even if the number of trips did occasionally exceed

40 per day, it is highly unlikely that it would result in a significant direct impact on roadways surrounding the proposed site.

Sequestration Site

There would be much less construction activity at the proposed Tuscola Sequestration Site and along the CO_2 pipeline connecting the proposed sequestration site to the proposed power plant site, than at the power plant site. Construction traffic to the proposed sequestration site and utility corridor would have a negligible direct impact on roadways and traffic.

Utility Corridors

All underground utilities (potable water, process water, wastewater, natural gas, and CO_2) are proposed to be constructed using open trenching (FG Alliance, 2006b). Though there would be a need for staging areas for this construction, DOE assumes that typical construction practices would be employed and all roadways would maintain one lane of traffic in each direction during construction. Construction of several of the proposed utility lines (process water, wastewater, and CO_2) is expected to last for approximately four to six weeks (FG Alliance, 2006b). During this time there would be minor disruptions to traffic, but they would not create a substantial direct impact to traffic operations.

Construction of the utility lines would require approximately 45 persons for all construction to occur concurrently (FG Alliance, 2006b). In the most conservative case, all construction workers would travel in single-occupant vehicles. Therefore, there would be approximately 90 additional daily trips on the roadway network during construction of the utilities. Assuming that construction operations typically start earlier than the morning peak period of traffic, 45 trips would take place before the morning peak hour. The 45 afternoon trips made by construction workers leaving job sites would likely coincide with the afternoon peak period. Given the proposed locations of the utility corridors, these trips would be spread out on various roadways within the ROI and are not expected to have any appreciable direct impact on traffic operations.

Transportation Corridors

Based upon the analysis of 2009 construction conditions, no additional transportation infrastructure would be required to accommodate the proposed Tuscola Power Plant Site. DOE recommends that a truck route be implemented during construction to include I-57, US 36, CR 1050N, and CR 750E. Implementation of a truck route would also include signs on the affected roadways to and from the site.

A new private sidetrack from the CSX railroad would be constructed on the proposed Tuscola Power Plant Site and CSX ROW. The property adjacent to the southern boundary of the proposed power plant site belongs to CSX Transportation and is used as a switch yard and mainline rail facility. Access to the CSX mainline rail would be provided through the CSX Transportation ROW. DOE expects that construction of the new track would require approximately 9 to 11 months that could be spread over more than one construction season. It is estimated that up to 18 construction workers would be traveling to and from the proposed site, resulting in an additional 36 trips per day on the roadway network. Eighteen of those trips would take place before the morning peak period, assuming that construction activities typically begin earlier than the regular work day. The other 18 trips would occur during the afternoon peak period, assuming a 10-hour work day. Given that all roadways would be operating at LOS C or better during construction (see Table 5.13-7), these trips would not be expected to appreciably change traffic operations on the roadway network.

During the connection of the rail loop to the existing CSX railroad, railroad safety flaggers would be required. This construction should have minimal, if any, impact on CSX railroad operations because the CSX ROW in this location contains switching facilities, which would allow approaching trains to be switched away from the track to which the private sidetrack was being connected.

5.13.3.2 Operational Impacts

The proposed FutureGen Project is expected to begin operating in 2012 (FG Alliance, 2006e). Table 5.13-8 shows 2012 No-Build traffic volumes, which DOE projected by applying a background growth rate of one (1) percent per year to 2005 volumes. This growth rate was determined through review of other IDOT project EISs and study documentation (IDOT, 2005c). Based on the 2012 No-Build volumes, DOE estimated the capacity of each roadway (Table 5.13-8).

Table 5.13-8. 2012 Average Daily and Peak Hour No-Build Traffic Volumes

Roadway	ADT[1] (vpd)	Truck ADT[1] (vpd)	Weekday Peak Hour Volume[1] (vph)	Weekday Peak Hour Truck Volume[1] (vph)	LOS[2]
I-57 north of Tuscola	27,680	7,857	2,768	786	B
I-57 south of Tuscola	20,084	6,712	2,008	671	B
US 45	2,497	312	250	31	A
US 36	4,631	676	463	68	C
CR 1050N	406	49	41	5	A
CR 750E	94	11	9	1	A

[1] DOE estimate based on 1 percent growth per year from 2005.
[2] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

Power Plant Site

The operating workforce for the proposed plant would be approximately 200 employees (FG Alliance, 2006e), of which 80 administrative personnel would work a regular office day (9:00 am to 5:30 pm), and 40 shift workers would work a daytime shift (7:00 am to 3:30 pm) and each of the two nighttime shifts. The workforce would result in 160 new peak hour trips in both the morning and afternoon peak periods. For this analysis, DOE assumed that these employees would arrive at the proposed plant in single-occupant vehicles and that the trip distribution would be the same as assumed for the construction worker trips, with the majority coming from Tuscola or from I-57 and reaching the proposed plant site via US 36. A portion of the workforce would come from communities to the west via US 36. Depending on the plant orientation, a single access gate could be located on either CR 1050N or CR 750E (FG Alliance, 2006b).

There would be a small number of delivery truck trips to the proposed plant to support personnel and administrative functions, and to deliver spare parts. Coal would be delivered by rail. Other bulk materials used by the plant and byproducts are expected to be delivered or removed from the proposed Tuscola Power Plant Site by truck. DOE estimates that 13 trucks per week would be required for delivery of materials, while 98 trucks per week would be required for removal of byproducts, including slag, sulfur, and ash. DOE estimated the number of truck trips required based on the estimated quantities of materials and byproducts (FG Alliance, 2006e). Based on these estimates and assuming an even distribution of trucks over each day of the week materials delivery would result in 4 truck trips per day, 2 entering and 2 exiting, and byproduct removal would result in an additional 28 trips per day, 14 entering and 14 exiting. Delivery truck trips would not appreciably affect traffic on the truck route.

Estimated 2012 Build ADT and peak hour traffic volumes are given in Table 5.13-9. The most direct impact would be seen on CR 1050N and CR 750E, which directly abut the proposed site. It is assumed that every trip to or from the proposed Tuscola Power Plant Site would use either or both of these routes for access. Daily traffic volumes on CR 1050N and CR 750E would increase 103 and 446 percent, respectively. Although these percentages are very high, this is partially due to the low volumes that currently exist on these roads.

Table 5.13-9. 2012 Average Daily and Peak Hour Build Traffic Volumes

Roadway	ADT[1] (vpd)	Change in ADT[1] (percent)	Weekday Peak Hour Volume[2] (vph)	Change in Weekday Peak Hour Volume[2] (percent)	LOS[3]
I-57 north of Tuscola	28,781	1	2,983	5	B
I-57 south of Tuscola	20,725	<1	2,086	1	B
US 45	2,842	11	392	52	A
US 36	5,203	9	507	6	C
CR 1050N	850	103	176	322	B
CR 750E	528	448	174	1,700	B

[1] DOE derived ADT using the maximum operating workforce (200 persons, 400 vpd) passenger car trips (FG Alliance, 2006e) and assuming 32 operations-related truck trips daily (16 entering and 16 exiting the site).
[2] DOE derived peak hour volumes assuming that administration and 1/3 of shift workers arrive in peak hour, and that 4 truck trips occur in each peak hour.
[3] DOE used HCS+ to perform capacity analysis.
ADT = average daily traffic; vpd = vehicles per day; vph = vehicles per hour; LOS = Level of Service.

As shown in Table 5.13-9, each roadway has enough available capacity to absorb these increases. I-57 would continue to operate at LOS B both north and south of Tuscola. US 45 and US 36 would continue to operate at LOS A and C, respectively. CR 1050N and CR 750E would operate at LOS B (reasonably free flow), compared to LOS A (free flow) under the 2012 No-Build conditions. Given that the roadways would be operating at LOS C or better, there is no reason to conclude that there would be any notable increase in traffic accidents.

Based on the volumes and LOS on these roadways under the proposed operating conditions, DOE concluded that the key intersections around the proposed site should be able to accommodate these daily and peak hour traffic volumes. Changes to traffic signal timings may be required at the US 36/I-57 ramp intersections to accommodate changes in turning volumes at those intersections.

The primary component of materials transport would be the delivery of coal to the plant by rail, using the spur track. It is anticipated that deliveries would require five 100-unit trains per week or 10 entering or exiting train trips per week (FG Alliance, 2006e). This would equal a 24 to 36 percent increase in the number of trains on the CSX line through Tuscola, which currently accommodates 28 to 42 trains per week (four to six freight trains per day seven days per week) (FG Alliance, 2006b). Coal trains would use this line to and from the east and west. The line can handle loads of up to 286,000 pounds

(129,727 kilograms). A section of the line is currently restricted from six-axle locomotives, and would require an upgrade to handle the rail traffic volume for the proposed FutureGen Project.

There is one at-grade crossing of the CSX track by CR 750E near the proposed Tuscola Power Plant Site. This at-grade crossing does not have actuated gates and warning lights, as the only warnings of a crossing are the old crossbuck railroad signs on either side. IDOT's Comprehensive Highway Safety Plan specifically targets at-grade rail crossings as locations that should be improved to better highway safety with actuated gates and warning lights. All grade crossings within the Tuscola city limits are gate controlled; therefore, similar crossing protection would be required for any new crossings.

The additional 10 train trips per week would create additional delays for some road users, would slightly increase the risk of a vehicle-train accident, and could have an impact on emergency vehicle response time at the crossing. A unit train car ranges from 48 to 53 feet (14.6 to 16.2 meters) long; therefore, a 100-car unit train is approximately 1 mile (1.6 kilometers) long. Train speed through at-grade crossings varies from 10 to 40 mph (16.1 to 64.4 kmph) (FRA, 2006). DOE assumed trains would pass through the at-grade crossing at approximately 10 mph (16.1 kmph). A 100-unit train traveling at 10 mph (16.1 kmph) would take approximately six to seven minutes to clear the at-grade crossing. DOE did not estimate the number of other trains trips needed to deliver or remove other materials, such as ammonia or sulfur; however, these additional trains would not appreciably alter the results of this analysis.

Sequestration Site

There would be very little operational traffic to and from the proposed Tuscola Sequestration Site, and thus negligible direct traffic or roadway impact.

Utility Corridors

The proposed utility corridors would have little or no direct or indirect impacts on traffic operations or roadway LOS once the proposed FutureGen Project is operational. There would be no direct impact to traffic unless there was a problem with a utility line that required open trenching to repair. It is expected that this would be an infrequent occurrence, thus having no long-term potential to affect traffic.

Transportation Corridors

There are no proposed transportation infrastructure improvements required in order for the existing roadway network to accommodate the proposed power plant and proposed sequestration site.

Operations using the proposed rail spur on the proposed Tuscola Power Plant Site would have little to no direct or indirect impact on the rail operations on the CSX line.

5.14 NOISE AND VIBRATION

5.14.1 INTRODUCTION

Noise is defined as any sound that is undesired or interferes with a person's ability to hear something. The basic measure of sound is the sound pressure level (SPL), commonly expressed as a logarithm in units called decibels (dB). Vibration, on the other hand, consists of rapidly fluctuating motions having a net average motion of zero that can be described in terms of displacement, velocity, or acceleration. This section provides the results of the analyses completed for both noise and vibration. Specific details of the noise and vibration analyses are provided in sequence under each subsection, with the results of the noise analysis presented first followed by those of the ground-borne vibration analysis.

5.14.1.1 Region of Influence

The ROI for noise and vibration includes the area within 1 mile (1.6 kilometers) of the proposed Tuscola Power Plant Site boundary and within 1 mile (1.6 kilometers) of the boundaries of all related areas of new construction, including the proposed sequestration site and the utility and transportation corridors.

5.14.1.2 Method of Analysis

This section provides the methods DOE used to assess the potential noise and vibration impacts of construction and operational activities related to the proposed Tuscola Power Plant Site, sequestration site, and related corridors. In preparing the noise and vibration analysis, DOE evaluated information presented in the Tuscola EIV (FG Alliance, 2006b) and estimated increases in ambient noise and ground-borne vibration levels, and evaluated the potential impacts on sensitive receptors.

DOE assessed the potential for impacts based on the following criteria:

- Conflicts with a jurisdictional noise ordinance;
- Permanent increases in ambient noise levels at sensitive receptors during operations;
- Temporary increases in ambient noise levels at sensitive receptors during construction;
- Airblast noise levels in excess of 133 dB;
- Blasting peak particle velocity (PPV) greater than 0.5 inches per second (in/sec) (12.7 millimeters per second [mm/sec]) at off-site structures; and
- Exceeding the Federal Transit Administration's (FTA) distance screening and human annoyance thresholds for ground-borne vibrations of 200 feet (61 meters) and 80 vibration decibels (VdB).[1]

Noise Methods

Generally, ambient conditions encountered in the environment consist of an assortment of sounds at varying frequencies (FTA, 2006). To account for human hearing sensitivities that are most perceptible at frequencies ranging from 200 to 10,000 Hertz (Hz) or cycles per second, sound level measurements are often adjusted or weighted and the resulting value is called an "A-weighted" sound level.

The **A-weighted** scale is the most common weighting method used to conduct environmental noise assessments and is expressed as a dBA.

[1] FTA threshold standards are not applicable to this project, but were used as a basis for comparing effects.

A-weighted sound measurements (dBA) are standardized at a reference value of zero decibels (0 dBA), which corresponds to the threshold of hearing, or SPL, at which people with healthy hearing mechanisms can just begin to hear a sound. Because the scale is logarithmic, a relative increase of 10 decibels represents an SPL that is nearly 10 times greater. However, humans do not perceive a 10-dBA increase as 10 times louder; rather, they perceive it as twice as loud (FTA, 2006). Figure 5.14-1 lists measured SPL values of common noise sources to provide some context.

The following generally accepted relationships (Bolt et al., 1973) are useful in evaluating human response to relative changes in noise level:

- A 2- to 3-dBA change is the threshold of change detectable by the human ear in the ambient conditions;
- A 5-dBA change is readily noticeable; and
- A 10-dBA change is perceived as a doubling or halving of the noise level.

The SPL that humans experience typically varies from moment to moment. Therefore, a variety of descriptors are used to evaluate noise levels over time. Some typical noise descriptors are defined below:

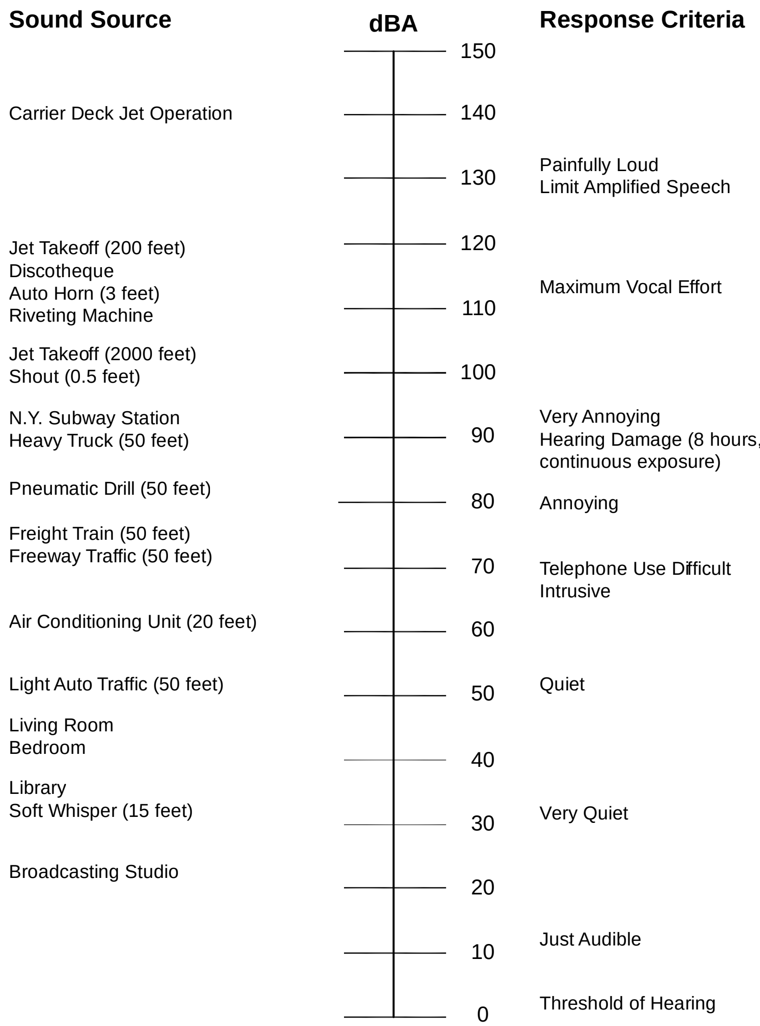
- L_{eq} is the continuous equivalent sound level. The sound energy from fluctuating SPLs is averaged over time to create a single number to describe the mean energy or intensity level. Because L_{eq} values are logarithmic expressions, they cannot be added, subtracted, or compared as a ratio unless that value is converted to its root arithmetic form.
- L_{max} is the highest, while L_{min} is the lowest SPL measured during a given period of time. These values are useful in evaluating L_{eq} for time periods that have an especially wide range of noise levels.

For this analysis, DOE evaluated noise levels generated by stationary (e.g., fixed location) sources such as construction-related and power plant operating equipment, and mobile (e.g., moving) sources such as construction-related vehicle trips and operational deliveries by rail, car, and truck. DOE predicted stationary source noise levels during construction and normal plant operations at sensitive receptor locations in direct line-of-sight of proposed project facilities by summing anticipated equipment noise contributions and applying fundamental noise attenuation principles. DOE used the following logarithmic equation (Cowan, 1994) to predict noise levels at the sensitive receptor locations selected for the stationary source analysis:

$SPL_1 = SPL_2 – 20 \log (D_1/D_2) – A_e$, where:

- SPL_1 is the noise level at a sensitive receptor due to a single piece of equipment operating throughout the day;
- SPL_2 is the equipment noise level at a reference distance D_2;
- D_1 is the relative distance between the equipment noise source and a sensitive receptor;
- D_2 is the reference distance at which the equipment noise level is known; and
- A_e is a noise level reduction factor applied due to other attenuation effects.

DOE compared the calculated results to the existing ambient noise levels. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment is not available. In lieu of project-specific data, DOE used comparable noise data predicted for the proposed Orlando IGCC power plant facility (DOE, 2006) to estimate the increase in the noise level at sensitive receptors in the vicinity of the proposed Tuscola Power Plant Site. Residences and any schools, hospitals, nursing homes, houses of worship, and parks within the 1-mile (1.6-kilometer) ROI were considered as being sensitive receptors in this analysis.



Source: Barksdale, 1991

Figure 5.14-1. SPL Values of Common Noise Sources

For mobile sources, DOE estimated noise levels using traffic noise screening techniques to compare the vehicle traffic mix data for the future Build and No-Build traffic conditions on each roadway studied. DOE calculated the ratio of the future Build and future No-Build traffic volumes using the following equation (FHWA, 1992):

Predicted Change in Noise Level (dBA) = 10 Log (Future Build PCE/Future No-Build PCE), where one heavy truck = 28 passenger car equivalents (PCEs)

In applying this equation, a doubling of traffic means future Build conditions are predicted to be twice the future No-Build condition. A doubling in the vehicle traffic volume would result in a 3-dBA increase in noise level (10 Log [2/1] = 3 dBA). A ten-fold increase in traffic would result in a +10 dBA change (10 Log [10/1] = 10 dBA).

For this analysis, DOE used a predicted 3-dBA increase in the ambient noise level at sensitive receptors located adjacent to the project-related transportation routes as a threshold indicating that further detailed noise analysis (e.g., modeling) would be needed during evaluation of the final design to determine if the impacts would be potentially significant. Otherwise, DOE concluded that the anticipated increase in noise levels resulting from project-related activities would not be noticeable and would require no further analysis.

Vibration Methods

> **Vibration** is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration.

The concept of vibration is easily understood in terms of displacement as it relates to the distance a fixed object (e.g., floor) moves from its static position. Common measurements of velocity are not well understood by the average person. For example, the preferred vibration descriptors used to assess human annoyance/interference and building damage impacts are the root-mean-square (RMS) vibration velocity level and the PPV, respectively. The RMS vibration level is expressed in units of VdB. The PPV, expressed in in/sec or mm/sec, represents the maximum instantaneous speed at which a point on the floor moved from its static position (FTA, 2006).

Generally, the background vibration velocity level encountered in residential areas is 50 VdB or lower (FTA, 2006). The threshold of perception for humans to experience vibrations is 65 VdB. Typical sources of vibration include the operation of mechanical equipment indoors, slamming of doors, movement of trains on rails, and ground-breaking construction activities such as blasting and pile driving. The effects on vibration-sensitive receptors from these activities can range from feeling the window and the building floor shake, to rumbling sounds, to causing minor building damage (e.g., cracks in plaster walls) in rare cases. The criterion for minor structural damage is 100 VdB, or 0.12 in/sec (3.05 mm/sec) in terms of PPV, for fragile buildings (FTA, 2006).

DOE performed the vibration analysis using progressive levels of review. Initially, DOE prepared a vibration screening analysis to evaluate the potential effects that ground-borne vibrations generated by project-related construction and operational activity would have on adjacent sensitive receptors, including humans, buildings, and vibration-sensitive equipment. If the results of this preliminary analysis showed that screening thresholds would be exceeded, DOE applied further vibration study methods to determine if the impacts would be potentially significant.

5.14.2 AFFECTED ENVIRONMENT

5.14.2.1 Power Plant Site

The proposed Tuscola Power Plant Site and the majority of the land area within 1 mile (1.6 kilometers) of its boundary are currently in agricultural use. There are three farmsteads (e.g., farm houses, outbuildings, silos, and pasture land) and single-family residences adjacent to the site, and several dozen additional residences within 1 mile (1.6 kilometers) of the site, almost all of which are near the 1-mile (1.6-kilometer) boundary of the ROI on the western edge of the City of Tuscola near the Illinois Central Gulf Railroad line.

Several existing noise sources contribute to the ambient sound levels in the vicinity of the proposed Tuscola Power Plant Site. These sources include existing United States (US) 36 and US 45; CSX, Union Pacific, and Canadian National rail lines; chemical/industrial facilities; County Road (CR) 750E, CR 850E, and CR 1050N; and farmsteads. The Tuscola EIV presents existing ambient noise levels based on daytime and nighttime measurements collected on August 30, 2006, at various locations along and within 1 mile (1.6 kilometers) of the proposed site boundary, as shown in Figure 5.14-2 (FG Alliance, 2006b). In addition, DOE took supplemental measurements on October 12 and 13, 2006, to record ambient noise levels at the nearest sensitive receptor location relative to the CSX rail line that is proposed to be used for project-related coal deliveries. Table 5.14-1 describes geographic information and identifiers used for each noise measurement location.

Table 5.14-1. Noise Measurement Locations Near the Proposed Tuscola Power Plant

Site ID	Location	Proximity to Proposed Tuscola Power Plant Site
SL-1	Intersection of CR 750E and CR 1050N	Northwest corner of proposed site near existing farmstead
SL-2	CR 1050N between CR 750E and CR 850E	Along northern boundary of proposed site near existing farmstead
SL-3	Intersection of CR 850E and CR 1050N	Northeast corner of proposed site near existing farmstead
SL-4	Access Road adjacent to CSXT railroad tracks	Along southern boundary of proposed site
SL-5	CR 750E at CSXT railroad crossing	Southwest corner of proposed site
SL-6	CR 1150N between CR 750E and CR 850E	Approximately 1 mile (1.6 kilometers) north of proposed site boundary between two farmsteads
SL-7	Near Jarman Senior Center on Main Street	Approximately 1 mile (1.6 kilometers) east of proposed site boundary
SL-8	Intersection of Wilson and Washington Streets	Along Wilson Street near single-family residences

Source: FG Alliance, 2006b – SL-1 through SL-7; SL-8 measured by DOE.

Daytime noise measurements were collected at all locations shown on Figure 5.14-2, and nighttime measurements were collected at four locations: SL-1, SL-6, SL-7, and SL-8. These locations were chosen because they represent ambient noise levels along the property boundary and at sensitive receptors (residences and Jarman Senior Center) that are proximate to the proposed Tuscola Power Plant Site (FG Alliance, 2006b). Under Title 35 of the Illinois Administrative Code, Part 900 - "*General Provisions*," daytime hours are the hours between 7:00 AM and 10:00 PM, and nighttime hours are the hours between 10:00 PM and 7:00 AM Existing noise levels were collected using a Reed Model 322 and Quest Model 2900 digital sound level meter with a data logging function in accordance with noise measurements procedures outlined in Title 35 of the Illinois Administrative Code, Part 910 (FG Alliance, 2006b). The Type II sound level meter was equipped with a windscreen and mounted on a tripod approximately 4 feet (1.2 meters) above ground level, away from any reflective surface. Broadband noise levels were collected and recorded in dBA at each receptor location over sampling periods ranging from 6 to 10 minutes.

As described in the Tuscola EIV (FG Alliance, 2006b), no octave band measurements were taken. The sound level meter was field calibrated and weather conditions (e.g., temperature, wind) were noted before each sampling period. The ambient noise environment at SL-1 through SL-8 ranged from 39.2 to 66.1 dBA, which is generally typical of a quiet, rural setting. Intermittent increases in the ambient noise due to road and rail traffic fluctuations were recorded, which is indicated by the recorded peak maximum levels of 78.9 and 75.7 dBA during the day- and nighttime measurement periods, respectively, at SL-8 and SL-7. During the 4:00 PM to 5:00 PM measurement period at the SL-8 location (corner of Wilson and Washington streets), ambient noise was influenced by three heavy trucks traveling on the adjacent roadway and a 100-unit freight train passing by. The maximum SPL values recorded during this 6-minute measurement period was 78.9 dBA. Table 5.14-2 lists the recorded Leq noise levels as well as the maximum and minimum SPL values.

Table 5.14-2. Measured Ambient Noise Levels and Maximum and Minimum Sound Pressure Level Values

Location	Daytime Noise Levels in dBA			Nighttime Noise Levels in dBA			Time Collected	
	L_{max}	L_{min}	L_{eq}	L_{max}	L_{min}	L_{eq}	Day	Night
SL-1	74.5	45.5	49.2	73.9	49.2	52.4	10:24 AM	6:02 AM
SL-2	61.3	40.6	50.9	-	-	-	9:08 AM	-
SL-3	69.3	42.8	47.8	-	-	-	7:55 AM	-
SL-4	53.8	43.8	47.3	-	-	-	7:30 AM	-
SL-5	67.2	44.1	47.9	-	-	-	7:12 AM	-
SL-6	46.3	41.8	43.9	67.4	41.2	46.1	8:46 AM	6:45 AM
SL-7	76	40.7	47.5	75.7	42.2	51.6	9:30 AM	6:20 AM
SL-8	65.6	32.1	48.0	52.9	31.6	39.2	8:00 AM	6:25 AM
SL-8	78.9	37.8	66.1	-	-	-	4:23 PM	-

dBA = A-weighted decibels; L_{max} = highest sound pressure level; L_{min} = lowest sound pressure level; L_{eq} = continuous equivalent sound level.
Source: SL-1 to SL-7, FG Alliance, 2006b; SL-8 measured by DOE.

5.14.2.2 Sequestration Site

The Tuscola Sequestration Site is primarily agricultural farmland (e.g., corn fields) with a few single-family residences along the outskirts of the 1.1-mile (1.8-kilometer) plume radius. Farther beyond the 1.1-mile (1.8-kilometer) CO_2 plume radius boundary, there is a cluster of residences in the rural community of Arcola.

An ambient noise measurement was taken on October 13, 2006, in the area adjacent to where the CO_2 injection well is proposed to be installed. At the intersection of CR 000N and 700E, a L_{eq} value of 34.4 dBA was recorded during the early morning, with the minimum and maximum SPLs ranging from 26.8 to 53.4 dBA. This location is primarily influenced by the surrounding background noise levels; there are minimal vehicular traffic noise contributions in this area. The same noise measurement procedures were followed as described above.

5.14.2.3 Utility Corridors

The proposed transmission line corridor originates from the northwest corner of the proposed Tuscola Power Plant Site, as shown in Figure 5.14-2, heads north, and then follows a path due east along the right-of-way (ROW) for an existing 138-kV transmission line. The proposed corridor would occupy between 0.5 miles (0.8 kilometers) and 3 miles (4.8 kilometers) of new ROW, depending upon the option chosen. The existing land use along the ROW for the proposed transmission line is primarily agricultural farmland for crops such as corn and soybeans; however, there are a few sensitive receptors including farm houses and North Ward Elementary School in the vicinity of the corridor. The proposed transmission line corridor, which includes both the 138-kV and 345-kV options, traverses three townships, including Tuscola, Camargo, and Murdock, spanning approximately 17 miles (27 kilometers). No noise measurements were taken along this corridor, but the noise environment is likely to be similar to that of the rural setting described in Section 5.14.2.1. However, slightly elevated noise levels are expected in the area where the transmission line corridor crosses US 57, a major highway thoroughfare.

CO_2 Pipeline Corridor

The proposed CO_2 pipeline would occupy new ROW in an area where existing land use in the ROI is primarily agricultural farmland with a few industrial facilities and residences. DOE took an ambient noise measurement on October 13, 2006, at a representative location along the CO_2 pipeline corridor. At the intersection of CR 750N and 700E, the recorded L_{eq} value was 37.0 dBA during the daytime, with the minimum and maximum SPLs ranging from 31.6 to 55.6 dBA. This location is primarily influenced by the surrounding background noise levels; there are minimal vehicular traffic noise contributions in this area. DOE followed the same noise measurement procedures as described above.

Process Water/Wastewater Pipeline Corridors

The proposed process water pipeline and sanitary sewer lines would occupy existing property owned by Lyondell-Equistar Chemicals. The existing land use for this region of influence is industrial, row crops, and a small number of agricultural farmsteads. No noise measurements were taken along this corridor, but existing ambient levels are likely to be the same as that of the proposed Tuscola Power Plant Site.

Potable Water Pipeline Corridor

The proposed potable water pipeline extends to the west of the proposed power plant site in the same general area as the process water/wastewater pipelines. No noise measurements were taken along this corridor, but existing ambient levels are likely to be the same as cited above.

5.14.2.4 Transportation Corridors

The existing ambient noise level along US 36 (SL-9) is estimated to range from 57 to 67 dBA, a range that is typical of a busy highway.

5.14.2.5 Regulatory Setting

There are no federal, state, or local government noise standards applicable to proposed construction activities, and neither the City of Tuscola nor Douglas County has noise ordinances or codes that would apply to activities proposed for this project. For plant operation, the State of Illinois has established maximum noise level threshold standards. Additionally, the FTA establishes guidelines and threshold standards for noise and vibration related to projects affecting transit facilities (FTA, 2006).

State of Illinois Noise Code

Operational activities at the proposed Tuscola Power Plant Site and its related constructed corridors, including the electrical transmission line, CO_2, process water, wastewater, and potable water corridors, would be governed by the noise regulations outlined in Title 35 of the Illinois Administrative Code, Part 901 – "*Sound Emission Standards and Limitations for Property Line-Noise-Sources.*" These regulations define property use by three distinct land classes: Class A properties are considered the most sensitive receptors (i.e., residences), Class B properties are considered businesses and services, and Class C properties are considered utilities, manufacturing, and industrial (i.e., railroads, industrial plants, and agricultural). The proposed Tuscola Power Plant Site is currently a Class C property (agricultural). Properties within the vicinity of the proposed site and its corridors are currently Class A (residences), Class B (businesses), and Class C (roads, industrial, agricultural, and railroads).

Part 901 establishes maximum allowable octave band noise levels emitted from any property-line-noise-source located on any Class A, B, or C land to any receiving Class A property. Tables 5.14-3 and 5.14-4 provide threshold values that should not be exceeded to conform to noise spectrum levels at the octave band center frequencies for daytime and nighttime hours, respectively. The noise spectrum limitations do not apply to sound emitted from equipment being used for construction or to impulsive sound produced by blasting activities.

Table 5.14-3. Daytime Maximum Allowable Octave Band Noise Level Emitted to Receiving Class A Property in dB

Octave Band Center Frequency (Hertz)	Class C Property	Class B Property	Class A Property
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

dB = decibels.
Source: Illinois Administrative Code Title 35, Part 901(35 IAC Part 901) - ***Sound Emission Standards and Limitations for Property Line-Noise-Sources During Daytime Hours***

Table 5.14-4. Nighttime Maximum Allowable Octave Band Noise Levels Emitted to Receiving Class A Property in dB

Octave Band Center Frequency (Hertz)	Class C Property	Class B Property	Class A Property
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

dB = decibels.
Source: Illinois Administrative Code Title 35, Part 901(35 IAC Part 901) - ***Sound Emission Standards and Limitations for Property Line-Noise-Sources During Nighttime Hours***

5.14.2.6 FTA Noise and Vibration Impact Assessment Criteria

FTA established guidelines and methods to perform noise and vibration impact assessments for proposed projects involving transit facilities (FTA, 2006). To assess noise impacts, FTA recommends applying the same methods described in Section 5.14.1.2 to identify receptors that the project could potentially affect and to estimate noise contributions from project related mobile and stationary sources. To determine if the proposed transit project would significantly increase ambient conditions at a particular sensitive receptor, FTA established incremental change and absolute daytime/nighttime limits. For vibration, FTA recommends progressive levels of analysis depending on the type and scale of the project, the stage of project development, and the environmental setting. Such analysis typically begins with a screening process, which evaluates relative distance information between the source of ground-borne vibrations and the vibration-sensitive receptors that have been identified. If the relative distance from the source of ground-borne vibrations to a residential receptor is greater than 200 feet (61 meters), FTA guidelines indicate that it is reasonable to conclude that no further consideration of potential vibration impacts is needed (FTA, 2006). Otherwise, FTA provides criteria to assess the impacts of human annoyance, as well as building and vibration-sensitive equipment damage using detailed quantitative analyses to predict VdB and PPV values generated by the proposed project.

5.14.3 IMPACTS

5.14.3.1 Construction Impacts

Construction of the proposed Tuscola Power Plant is expected to be typical of other power plants in terms of schedule, equipment used, and other related activities. Noise and vibration would be generated by a mix of mobile and stationary equipment noise sources, including bulldozers, dump trucks, backhoe excavators, graders, jackhammers, cranes, pumps, air compressors, and pneumatic tools during construction of the proposed power plant and related utilities. For the purposes of this analysis, DOE evaluated the proposed project site an area-wide stationary source with construction equipment operating within its boundary. The results of DOE’s noise and vibration analyses show that, in the absence of mitigation, the proposed project would increase ambient noise levels for the sensitive receptors located within the 1-mile (1.6-kilometer) ROI, and possibly beyond. However, impacts from ground-borne vibrations would not be expected.

Power Plant Site

Noise levels generated during construction at the proposed Tuscola Power Plant Site would vary depending upon the phase of construction. Typical power plant construction activity entails the following phases:

- Site preparation and excavation;
- Foundation and concrete pouring;
- Erection of building components; and
- Finishing and cleanup.

DOE’s anticipates that construction noise contributions would be greatest at the site during the initial site preparation and excavation phase due to the almost constant loud engine and earth breaking noises generated by the use of heavy equipment such as a backhoe excavator, earth grader, compressor, and dump truck. In addition, noise level increases are anticipated along the off-site routes leading to the site because of entry/exit truck movements, especially during the foundation and concrete pouring construction phase. The other phases would generate less audible noise because the equipment used for these activities (e.g., crane) generally would be transient in nature or would not generate much noise.

Table 5.14-5 provides standard noise levels for construction equipment measured at a reference distance of 50 feet (15 meters).

Table 5.14-5. Common Equipment Sources and Measured Noise Levels at a 50-foot (15-meter) Reference Distance

Equipment	Noise Level in dBA
Backhoe Excavator	85
Bulldozer	80
Grader	85
Dump Truck	91
Concrete Mixer	85
Crane	83
Pump	76
Compressor	81
Jackhammer	88
Pile Driver	101

dBA = A-weighted decibels.
Source: Bolt et al., 1971.

Due to the proximity of the receptors located along the perimeter of the proposed site (SL-1, SL-2, and SL-3), mitigation would be necessary to reduce impacts resulting from the construction of the power plant. To evaluate the potential maximum effects of the anticipated noise level increases on the sensitive receptors located to the north, south, and east of the site boundary, DOE predicted equipment source noise levels using the logarithmic equation described in Section 5.14.1.2.

First, the combined noise level expected from the three noisiest pieces of equipment (excavator, grader, and dump truck) used during the initial phase of construction was attenuated over the relative distances from the site boundary to the following seven directional noise-sensitive receptors:

- SL- 1: Northwest corner of proposed site near existing farmstead
- SL- 2: Along northern boundary of proposed site near existing farmstead
- SL- 3: Northeast corner of proposed site near existing farmstead
- SL-6: North of proposed site boundary between two farmsteads
- SL-7: East of proposed site boundary
- SL-8: Along Wilson Street near single family residences
- SL-9: Along US 36, south of the proposed site boundary

The existing and distance-attenuated noise levels were then logarithmically summed to predict an estimated noise level at each receptor location identified above, as shown in Table 5.14-6. This represents a maximum noise prediction estimate because sound waves generated by the noisiest pieces of equipment are assumed to start at site boundary and continuously propagate in open air. In addition, the result does not account for any decibel-reducing factors due to atmospheric and ground attenuation effects.

Table 5.14-6. Estimated Noise Level at Selected Residential Receptor Locations

Residential Receptor	Relative Distance in miles (kilometers)	Existing Ambient Noise Level (dBA)	Combined Equipment Noise Level (dBA)[1]	Equipment Noise Level Attenuated by Distance (dBA)	Estimated Noise Level (dBA)	Change in dBA
SL-1	0	47.8	93	93.0	93.0	+45.2
SL-2	0	47.3	93	93.0	93.0	+45.7
SL-3	0	47.5	93	93.0	93.0	+45.5
SL-6	1 (1.6)	43.9	93	52.5	53.1	+9.2
SL-7	0.9 (1.4)	47.5	93	53.0	54.1	+6.6
SL-8	1.1 (1.8)	48.0	93	51.5	53.1	+5.1
SL-9[2]	0.5 (0.8)	62[2]	93	59.4	63.9	+1.9

[1] Combined equipment noise level at 50 feet (15 meters) from source.
[2] No noise measurements were taken at SL-9 located on US 36; however, ambient noise is estimated to range from 57 to 67 dBA because receptor is near major roadway and is influenced by heavy traffic noise (FHWA, 1998).
dBA = A-weighted decibels.

A comparison of the predicted noise levels with the measured daytime ambient noise levels at SL-1, SL-2, SL-3, SL-6, SL-7, and SL-8 shows that during the hours when construction equipment would be operating as described above (that is, with the noisiest equipment operating), construction of the proposed Tuscola Power Plant would be noticeable to these receptors because the incremental change from the existing condition would be 45.2, 45.7, 45.5, 9.2, 6.6, and 5.1 dBA, respectively. Noise level changes of 45 to 46 dBA would be very significant, as expected with heavy equipment operating right at the boundary of three properties (SL-1, SL-2, and SL-3). The 9.2 dBA noise increase at SL-6 would be perceived as nearly a doubling in the noise level. The 5 to 6 dBA increases at SL-7 and SL-8 would be readily perceptible to the human ear. Mitigation measures would need to be considered to reduce the effects of construction, particularly at the three residences adjacent to the site boundary (SL-1, SL-2, and SL-3). At SL-9, even with the noisiest equipment operating, construction noise from the proposed plant site would not be noticeable because the incremental change resulting from construction activity would be less than 2 dBA.

To evaluate the potential maximum impacts at sites where ambient noise measurements were not taken, DOE estimated the change in noise level that would occur if the entire area in the vicinity of the power plant had a background noise level of 47 dBA, which is about average for the measurements taken at Sl-1 through SL-7 (see Table 5.14-6), and allows for the most conservative analysis. Based on an assumed 47 dBA background level, Figure 5.14-3 depicts the change in noise level at various distances from the power plant site. Under this assumption, the threshold 3 dBA increase detectable to the human ear would occur about 1.9 miles (3.1 kilometers) from the boundary of the power plant site, an area that would encompass much of downtown Tuscola. However, at any point where the background noise level was actually higher, such as on downtown streets and near the Illinois Gulf Central Rail line, US 36, or US 45. Figure 5.14-3 overstates the increase in noise level at those locations.

During power plant startup, steam blowdown would be required toward the end of the construction phase. The blowdown activity would consist of several blows to test the IGCC system, including the gasifier steam lines, HRSG, and steam turbine. DOE anticipates that very loud noises as high as 102 dBA would be generated during all steam blows. The blowdown noise is assumed to originate at the center of the property and would attenuate to approximately 72 dBA at the property boundary, which would affect the three closest residences (SL-1, SL-2, and SL-3). Noise levels at these three receptors would increase by as much as 25 dBA compared to the measured background levels shown in Table 5.14-2. At residential receptors located beyond the perimeter of the site (SL-6, SL-7, SL-8, and SL-9), the ambient noise generated by the steam blows could range from 58 to 66 dBA, which is up to 15 dBA higher than the existing ambient conditions in the vicinity of the proposed power plant, resulting in short-term adverse impacts. Precautionary measures that could be taken to mitigate this impact include limiting steam blows to the daytime hours, providing advance notice to citizens residing near the power plant, and establishing a community outreach program to inform the community at large before commencing plant blowdown activity. Blowdown activities generally would last no more than 2 weeks.

DOE anticipates little or no vibration impacts at sensitive receptors during construction because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment, are not located within the 200-foot (61-meter) distance screening and human annoyance threshold for ground-borne vibrations defined by FTA guidance (2006).

Sequestration Site

Construction at the sequestration site would be limited to the installation of CO_2 injection wells. No noise and vibration impacts on sensitive land uses are anticipated at the injection well locations. Noise level increases during construction would be less than 3 dBA at the nearest residences.

Utility Corridors

Transmission Corridor

Construction of the proposed transmission line in any of the corridor options would occur mostly across agricultural farmland. No major noise and vibration impacts are anticipated, although a temporary increase in noise due to construction would occur. No major noise and vibration impacts are anticipated at the few residences identified along the transmission line routes because of the nature of transmission line construction techniques and the fact that the duration of construction would be limited to less than 6 months even if the 17-mile (27-kilometer), 345-kV transmission line were built. Temporary construction activities would include activities such as installing concrete footings and erecting towers or poles using an excavator, crane, and handheld tools at discrete intervals along the proposed transmission line corridor.

Pipeline Corridors

Trench excavations or horizontal directional drilling techniques used to install utility pipelines would take less than 6 months to complete and would result in a temporary increase in noise during construction. Elevated noise levels would be experienced by sensitive receptors located in the vicinity of the proposed construction activity. However, due to the temporary and linear nature of the pipeline construction, DOE expects minimal impacts at adjacent noise- and vibration-sensitive receptors. The primary equipment used for these types of short-term linear and limited ground disturbance construction activities includes an excavator and a dump truck. At roadway and rail crossings, a boring machine would be used to complete excavation under the roadway or rail line.

Transportation Corridors

The truck routes connecting Interstate 57 (I-57) to the proposed Tuscola Power Plant Site are US 36, US 45, CR 750E, and CR 1050N. Existing vehicle traffic count data along the transportation routes leading into the proposed site are provided in Table 5.14-7. It is anticipated that additional traffic resulting from construction-related truck trips entering or leaving the proposed site would cause the ambient noise levels to increase. To determine the extent of the anticipated traffic-caused noise level increases, DOE evaluated the existing and projected Build and No-Build traffic data for each roadway and applied a factor to account for the greater noise energy contribution from the movement of trucks compared to passenger cars when traveling along roadways near sensitive receptors. Traffic noise screening results listed in Table 5.14-7 show that, in the absence of mitigation, construction-related vehicles (e.g., passenger cars and trucks) traveling on CR 750E and CR 1050N to and from the proposed power plant would appreciably increase the noise level (that is, cause a change greater than 3 dBA) at nearby noise-sensitive receptors. Conversely, the impacts on noise-sensitive receptors adjacent to US 36 would not be noticeable. Mitigation measures to reduce noise impacts on CR 750E and CR 1050 could include diverting most of the construction-related truck traffic traveling along CR 750E to the CSX access roadway on the south side of the proposed site and adjusting construction worker shifts to lower the total vehicle trips during the morning and evening peak hours.

Table 5.14-7. Projected Noise Level Increase during Construction

Roadway Segment	Existing Peak Hour Volume	Future No-Build Peak Hour Volume	Project New Total/Truck Trips	Future Build Peak Hour Volume	Projected Noise Level Increase
US 36, east of CR 750E	445/65	463/68	127/1	590/69	0.3 dBA
CR 750E, north of US 36	9/1	9/1	704/4	713/5	13.7 dBA
CR 1050N, west of US 45	39/5	41/5	577/3	618/8	6.8 dBA

Peak hour traffic data are provided as total/truck volumes.
Build/No-Build Year: 2009.
AM peak and PM peak hour volumes are the same.
Project New Total/Truck Trips were obtained from Table 5.13-9.
dBA = A-weighted decibels.

During construction of the rail spur loop, the noise and vibration impacts would be the same as described above for the proposed power plant site.

5.14.3.2 Operational Impacts

Projected noise levels that were calculated using the noise screening and analysis methods described in Section 5.14.1.2 show that there would be significant permanent ambient noise level increases resulting from operation of the proposed power plant facility at receptors located to the north along the perimeter of the proposed power plant site. Mitigation would be necessary to reduce impacts resulting from plant operations. Results from the mobile source analysis show that project-induced traffic noise would be noticeable to noise-sensitive receptors identified near assigned transportation routes, except for the one residence adjacent to US 36. DOE expects no operational impacts at the constructed CO_2, natural gas, potable water, and wastewater pipeline corridors because the pipelines would be buried underground. The 345-kV transmission line, as well as the pumps and compressors that are used to convey liquid and gaseous flow through the pipelines, may generate some additional noise to the existing ambient environment; however, the results of the impacts analysis show that any noise impacts would be minimal.

Power Plant Site

The principal equipment noise sources during plant operation include the gas combustion turbine/generator, steam turbine/generator, heat recovery systems, turbine air inlets, exhaust stack, six-cell mechanical-draft cooling tower, coal crusher, coal mill, pumps (e.g., feed, circulating), fans, and compressors, as well as noise from piping flow and flared gas. For the most part, these noise sources would be enclosed inside a building. In addition, noise sources within the building would be fitted with acoustical enclosures or other noise dampening devices to attenuate sound. Conversely, noise by equipment installed without full enclosures and exposed to the outside environment could potentially increase the ambient noise levels in the surrounding community.

To determine the impacts of normal plant operations, DOE used a noise prediction algorithm to estimate projected equipment noise contributions at the closest sensitive receptor location. Because the FutureGen Project is in the early pre-design stage, noise specification data for the power plant operating equipment is not available. DOE used comparable noise data estimated for the proposed Orlando IGCC power plant facility (DOE, 2006) to determine the potential effects of operational noise on sensitive receptors in the vicinity of the proposed Tuscola Power Plant Site. Using the predicted noise level of 53 dBA at 0.6 miles (1.0 kilometer) that was obtained in the model run completed for the Orlando gasification project (DOE, 2006), DOE used the logarithmic distance attenuation formula to derive an estimated source noise level of 89 dBA for the proposed Tuscola Power Plant.

DOE applied the source noise level to the proposed 345-acre (140-hectare) site to compute the attenuated noise level at the property boundary, assuming the noise sources would be at the center of the property. Based on a relative distance of 0.3 mile (0.5 kilometer) from the center of the property to the site's perimeter, DOE predicted a noise level of 59 dBA at the property boundary. A comparison of the predicted versus the existing noise level shows that the proposed power plant would cause an increase of up to 12 dBA at the property boundary, which would increase the noise levels at the three closest residences (SL-1, SL-2, and SL-3). Correspondingly, the predicted noise level at the closest residential receptor to the south (e.g., SL-9, approximately 0.8 mile [1.3 kilometers] from the center of the property) would be 51 dBA. Adding the predicted noise contribution from the proposed power plant site to the lowest anticipated ambient noise level of 57 dBA at SL-9 resulted in an estimated combined noise level of 58 dBA, a 1 dBA increase that would be imperceptible to the human ear. The closest directional receptors that are approximately 1.3 miles (2.1 kilometers) to the north and 1.25 miles (2.0 kilometers) to the east of the site would experience an incremental change of 4.3 and 2.6 dBA in the ambient noise level, respectively. Based on this analysis, DOE anticipates little or no noticeable impact at sensitive receptors located to the south and east of the proposed power plant. However, in the absence of mitigation, significant permanent ambient noise level increases would be expected for the receptors located to the north and along the perimeter of the site (e.g., SL-1, SL-2, SL-3, and SL-6).

To evaluate the potential maximum impacts at sites where ambient noise measurements were not taken, DOE estimated the change in noise level that would occur if the entire area in the vicinity of the power plant had a background noise level of 47 dBA. Based on an assumed 47 dBA background level, Figure 5.14-4 depicts the change in noise level at various distances from the power plant site. Under this assumption, the threshold 3 dBA increase detectable to the human ear would occur about 1.2 miles (1.9 kilometers) from the center of the power plant site (not the boundary, which was used for the assessment of construction-related noise impacts), an area that would encompass only a few residences. At any point where the background noise level was actually higher than 47 dBA, such as near the Illinois Gulf Central Rail line, US 36, or US 45, the figure overstates the increase in noise level that would actually occur at those sites. As noted above, the actual predicted change at SL-9, which is within the 3-dBA contour shown on Figure 5.14-4, would be just 1 dBA because of the higher ambient noise level associated with that location near US 36.

During coal deliveries, noise would be generated by unloading/loading activities such as the movement of containers, placement of coal feedstock on conveyors systems, and surficial contact of rail containers with other metallic equipment. Based on the estimated number of coal deliveries anticipated for the proposed power plant site, DOE predicted an hourly L_{eq} of 69 dBA from unloading/loading activities at the rail yard using the noise prediction equations listed in Table 5-6 of FTA's guidance document (FTA, 2006). To determine the maximum effects on nearby receptors, DOE assumed that the rail yard noise would occur along the site boundary closest to the receptor. Adding the predicted values for plant operational noise at the boundary (59 dBA) to that of rail yard noise, a combined noise level of 69 dBA was estimated to be generated at the boundary of the site during unloading/loading activity. However, DOE anticipates little or no increase in the noise level at the three closest residences (Sl-1, SL-2, and Sl-3), because the coal delivery area would likely be located near the southern boundary of the site near the existing railroad, which is more then 0.5 mile (0.8 kilometer) from SL-1, Sl-2, and SL-3.

The foregoing analysis does not include additional intermittent noise and vibrations that may be generated by rail car shakers if they are used to loosen coal material from the walls of the rail cars during unloading. Typically, the shakers are mounted on a hoist assembly and are used intermittently for a 10-second period to induce material movement in the rail car (Bolt et al., 1984). Pneumatic or electrical rail car shakers could generate noise levels up to 118 dBA (VIBCO, Undated-a; VIBCO, Undated-b; Western Safety Products, 2007). If the shaker is used on every rail car, it is estimated that the shaker would be used 253 to 428 times per week. Final design of the coal handling equipment should consider the noise and vibration contributions from the rail car shakers.

During unplanned or unscheduled restarts of the power plant, combustible gases would be diverted to the flare for open burning, which would increase the noise level at sensitive receptor locations. Potential noise sources from flare operation that could affect nearby receptors include steam-turbulent induced noise in piping flow and noise generated by pulsating or fluttering flames from the incomplete combustion of the gases. These noise sources could temporarily increase the ambient noise levels in the vicinity of the flare to a range of 96 to 105 dBAs. Positioning the flare unit at a location farthest away from a receptor and implementing measures to control the flow of flare gas or steam through piping connected to the flare unit and the incomplete combustion of gases resulting would reduce the impacts. Measures to minimize these short-term impacts would be addressed during the final conceptual design of the IGCC power plant.

Upon completion of final design plans for the proposed Tuscola Power Plant, octave band field measurements would be taken and compared to the state of Illinois noise spectrum limitations. Mitigation measures would be implemented if measured octave band noise levels exceeded the Illinois noise spectrum limitations.

Sequestration Site

Operations at the sequestration site would entail pumping CO_2 underground. Only minimal noise impacts are anticipated during operation and maintenance at the injection well point. During borehole micro-seismic testing and surface seismic surveys performed at the sequestration injection site, ground-borne vibrations may be experienced by nearby receptors.

Utility Corridors

Transmission Corridors

No major impacts are anticipated from operation of the electrical transmission lines. However, under wet weather conditions, the transmission lines may generate audible or low frequency noises, commonly referred to as a "humming noise." The audible noise emitted from transmission lines is caused by the discharge of energy (corona discharge) that occurs when the electrical field strength on the conductor surface is greater than the "breakdown strength" (the field intensity necessary to start a flow of electric current) of the air surrounding the conductor. The intensity of the corona discharge and the resulting audible noise are influenced by atmospheric conditions. Aging or weathering of the conductor surface generally reduces the significance of these factors.

Corona noise would not be noticeable because humans are generally insensitive to low frequency noise. However, in some cases, corona noise could be annoying to receptors that are located very near the transmission lines. To mitigate this occurrence, transmission lines are now designed, constructed, and maintained to operate below the corona-inception voltage.

Corona noise is caused by partial discharge on insulators and in air surrounding electrical conductors of overhead power lines.

Pipeline Corridors

The CO_2 pipeline would be buried except where it is necessary to come to the surface for valves and metering. Although valve spacing has not been determined at this time, a typical distance between metering stations is 5 miles (8 kilometers). Typically, these features are installed on concrete pads and surrounded by fencing. Alternatively, these features can be enclosed in metal buildings. These features do not have to be above ground; it is not uncommon for valves and meters to be located below grade in concrete vaults. Limited noise impacts from equipment above ground would be anticipated along the proposed CO_2 pipeline corridor during plant operation.

No noise or vibration impacts would be anticipated at the other proposed pipeline corridors during plant operation.

Transportation Corridors

Additional traffic resulting from operational truck trips entering or leaving the proposed site would be expected to increase the ambient noise levels at sensitive receptors near the assigned truck transportation routes. To determine the extent of the anticipated noise level increases, the existing traffic and the proposed Build and No-Build traffic data were evaluated for each roadway as described in Section 5.14.1.2. Results show vehicle trips on roadways leading to the proposed Tuscola Power Plant Site would have minimal effects on noise-sensitive receptors near US 36 during normal plant operations because the predicted change in the ambient noise level is much less than 3 dBA. However, in the absence of mitigation, sensitive receptors near CR 750E and CR 1050N would experience permanent ambient noise level increases of up to 9.2 and 3.5 dBA, respectively. Table 5.14-8 details the projected noise level increase during plant operation.

During the early phase of plant operation, short-term traffic noise impacts are anticipated along the transportation routes related to an increased level of trucks entering/leaving the proposed power plant. Adhering to the recommended truck routes and limiting trips to the daytime hours would help reduce noise impacts at residences along transportation routes.

Table 5.14-8. Projected Noise Level Increase during Plant Operation

Roadway Segment	Existing Peak Hour Volume	Future No-Build Peak Hour Volume	Project New Total/Truck Trips	Future Build Peak Hour Volume	Projected Noise Level Increase
US 36, east of CR 750E	445/65	477/70	30/1	507/71	0.1 dBA
CR 750E, north of US 36	9/1	10/1	164/4	174/5	9.2 dBA
CR 1050N, west of US 45	39/5	42/5	164/3	176/8	3.5 dBA

Peak hour traffic data are provided as total/truck volumes.
Build/No-Build Year: 2012.
AM peak and PM peak hour volumes are the same.
Project New Total/Truck Trips were obtained from Table 5.13-13.
dBA = A-weighted decibels.

No noise and vibration-sensitive land use impacts would be anticipated along access leading to the pipeline corridors.

Five 100-unit trains per week for coal deliveries would use the CSX rail line. Based on the estimated noise levels listed in FTA's guidance document (FTA, 2006), L_{max} values ranging from 76 to 88 dBA are anticipated from the locomotive, rail cars, whistles/horns, and track switches/crossovers as the freight train passes through the City of Tuscola. The L_{max} values are based on an operating speed of 30 mph (48.3 kmph), as measured approximately 50 feet (15.2 meters) from the track's centerline. Comparing the number of additional rail trips projected for coal deliveries during plant operations with the existing four to six rail trips per day on the CSX rail line, DOE estimates that the number of trains on the line would increase about 24 to 36 percent (five trains coming and going [10 trips] added to an average 35 trains per week). Given that the change would amount to about one additional train per day coming or going from the site, the incremental change in the noise environment would be minimal. No vibration impacts are anticipated at sensitive receptors near the Tuscola Power Plant Site because the closest vibration-sensitive receptors, including humans, buildings, and sensitive equipment, are not located within the 200-foot (61-meter) perimeter defined by FTA's distance screening threshold guidance. The closest residential receptor (SL-8) that could possibly be affected by ground-borne vibrations generated by project-related rail deliveries is approximately 320 feet (97.5 meters) from the CSX rail line.

In some cases geologic conditions, such as stiff clayey soils or shallow bedrock occurring at depths less than 30 feet (9.1 meters) below the surface can result in ground-borne vibrations propagating through the subsurface soils at greater than expected distances from the track (FTA, 2006). Based on the nature of the subsurface soils (e.g., silty clay and loam) and a depth to bedrock of 250 feet (76.2 meters) at the proposed Tuscola Power Plant Site, ground-borne vibrations are not expected to propagate over extended distances (FG Alliance, 2006e).

5.15 UTILITY SYSTEMS

5.15.1 INTRODUCTION

This section identifies utility systems that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Tuscola Power Plant Site, sequestration site, and related corridors. It addresses the ability of the existing utility infrastructure to meet the needs of the proposed FutureGen Project while continuing to meet the needs of other users, and also addresses the question of whether construction of the proposed FutureGen Project could physically disrupt existing utility system features (pipelines, cables, etc.) encountered during construction.

5.15.1.1 Region of Influence

The ROI for utility systems includes two components: (1) the existing infrastructure that provides process and potable water, sanitary wastewater treatment, electricity, and natural gas to nearby existing users and that would also provide service to the proposed project; and (2) pipelines, transmission lines, and other utility lines that lie within or cross the proposed power plant site, sequestration site, or utility corridors.

5.15.1.2 Method of Analysis

Based on data provided in the Tuscola EIV (FG Alliance, 2006b), DOE performed a comparative assessment of the FutureGen Project utility needs versus the existing infrastructure to determine if the proposed project would strain any of the existing systems. Additionally, DOE used data provided in the EIV (FG Alliance, 2006b) to identify the presence of utility infrastructure that could be affected by project construction.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Affect the capacity of public water utilities directly or indirectly;
- Require extension of water mains involving off-site construction for connection with a public water source;
- Require water supply for fire suppression that would exceed water supply capacity;
- Affect the capacity of public wastewater utilities;
- Require extension of sewer mains involving offsite construction for connection with a public wastewater system; and
- Affect the capacity and distribution of local and regional energy and fuel suppliers.

5.15.2 AFFECTED ENVIRONMENT

5.15.2.1 Potable Water Supply

Several options exist near the proposed Tuscola Power Plant Site for potable water service. An existing water line operated by the Arcola-Tuscola Joint Water Agency runs parallel to the CSX rail line on the north side of the rail line. This 8-inch (20.3-centimeter) line would be available to provide potable water to the proposed Tuscola Power Plant Site. Less than 1 mile (1.6 kilometers) of pipeline along new ROW would be required to connect to the existing pipeline.

Illinois American Water Company was unable to provide specific information regarding demand versus capacity of the 8-inch line (20.3-centimeter) adjacent to the plant site. However, it provided information concerning the 14-inch (35.6-centimeter) transmission line located approximately 0.75 mile (1.2 kilometers) east of the proposed plant site. At this location, the 14-inch (35.6-centimeter) main connects into two separate 8-inch (20.3-centimeter) mains, with one serving the City of Tuscola and the other serving the City of Arcola. The 14-inch (36-centimeter) main currently supplies up to 2.0 MGD (7.6 MLD) for both cities. This amount is dictated by an existing agreement between the Cities of Arcola, Tuscola, and Illinois American Water. The actual daily use of water by both cities from this line is roughly 1.0 MGD (3.8 MLD).

The ultimate design capacity of the 14-inch (35.6-centimeter) line is between 3.0 and 3.5 MGD (11.4 and 13.3 MLD), which results in an "in main water velocity" of 4 to 4.5 feet (1.2 to 1.4 meters) per second. The pumps and impellers of the upstream pump station would need to be re-configured in order to reach the ultimate design capacity of the 14-inch (35.6-centimeter) line. Thus, the current demand on the 14-inch (35.6-centimeter) line is about 28.6 percent of the ultimate design capacity. It is not known whether the same demand versus capacity ratio could be applied to the existing 8-inch (20.3-centimeter) main that is located along the south property line of the proposed Tuscola Power Plant Site.

5.15.2.2 Process Water Supply

The proposed Tuscola Power Plant Site would receive its required 4.3 MGD (16.3 MLD) non-potable water supply from a 150-million-gallon (568-million-liter) holding pond at Lyondell-Equistar Chemical Company, located west of the site and operated by Duke Energy Generation Services. Lyondell-Equistar Chemical Company currently supplies its holding pond with raw water pumped from the adjacent Kaskaskia River. Table 5.15-1 provides a summary of raw water usage by the Lyondell-Equistar plant for 2003 through 2005.

Table 5.15-1. Consumption/Discharge Data at Lyondell-Equistar Chemical Company Water Intake

	2003		2004		2005	
	MGD	MLD	MGD	MLD	MGD	MLD
River Flow Near Intake						
Maximum	345	1,308	477	1,808	487	1,846
Minimum	4.0	15.2	5.0	18.9	3	11.4
Average	19	72	36.59	138.7	8.85	33.5
Return Discharge						
Maximum	5.81	22	5.62	21.3	8.54	32.4
Minimum	0.39	1.5	0.44	1.7	0.3	1.14
Average	1.56	5.9	1.73	6.6	1.34	5.1
Consumption Rate						
Maximum	3.0	11.4	3.01	11.4	2.6	9.9
Minimum	1.83	6.9	1.69	6.4	1.71	6.5
Average	2.19	8.3	2.01	7.6	1.96	7.4

MGD = million gallons per day; MLD = million liters per day.
Source: Behl, 2006.

Based on the information provided in Table 5.15-1, Lyondell-Equistar Chemical Company's average consumption rate from 2003 to 2005 is 2.05 MGD (7.8 MLD), and the average return discharge to the river is 1.54 MGD (5.8 MLD). These are far below the maximum capacity of the system. During normal flow periods in the Kaskaskia River, the plant regularly pumps water from the Kaskaskia River to maintain the water level in the holding pond. During low-flow periods, however, the plant typically does not pump from the river to maintain the holding pond level, but instead continues to draw water from the pond. Lyondell-Equistar Chemical Company estimates that the pond can supply its plant without pumping from the river for 30 to 45 days. During low flow periods, the company has access to groundwater that can be pumped into the Kaskaskia River from the Mahomet aquifer, upstream of the facility near Bondville, Illinois, to augment the river flow.

Lyondell-Equistar Chemical Company has the future potential to become a "zero discharge" plant (Behl, 2006). This would mean that the plant would discontinue discharge of its treated effluents, and would reuse the effluent for plant processes. If that occurs, less water would need to be pumped from the Kaskaskia River for Lyondell-Equistar Chemical Company's processing needs, and the company would be able to provide water to the proposed Tuscola Power Plant Site at a flow rate of 3,000 gallons (11,356 liters) per minute or 4.3 MGD (16.3 MLD).

Fire protection at the proposed Tuscola Power Plant Site would be provided by use of the proposed force main from Lyondell-Equistar Chemical Company. Construction of an on-site reservoir to hold water for fire protection as well as other purposes is also an option.

5.15.2.3 Sanitary Wastewater System

Two options exist for sanitary wastewater treatment at the Tuscola Power Plant Site. Wastewater from the power plant could be treated by Duke Energy Generation Services, the same facility that would provide non-potable makeup water. The wastewater treatment plant operated by Duke Energy is located less than 1 mile (1.6 kilometers) from the proposed Tuscola Power Plant Site, and is operating at less than 25 percent of its rated capacity. An existing line, formerly used as a potable water line, dead ends directly across the road to the west of the proposed Tuscola Power Plant Site. This line could be used as a force main to run wastewater from the power plant site to Duke Energy's wastewater treatment facility. This would allow for wastewater treatment without the installation of a new wastewater line.

The other option for sanitary wastewater systems would be to construct an on-site wastewater treatment facility that would be capable of meeting the future needs of the proposed power plant.

5.15.2.4 Electricity Grid, Voltage, and Demand

The proposed Tuscola Power Plant Site is located in the Southeastern Electric Reliability Corporation (SERC) region. The SERC region includes portions of 16 states in the southeastern and central U.S., and covers an area of approximately 560,000 square miles (1,450,400 square kilometers). SERC is the regional reliability organization for this part of the country, charged with operating and ensuring reliability of the electrical transmission grid.

> Annual average sales of electrical energy in the U.S. are expected to grow from 3,567,000 GWh in 2004 to 5,341,000 GWh by 2030—an increase of about 50 percent (EIA, 2006). The FutureGen Project is scheduled to go on line in 2012 and may contribute toward meeting this need; however, its primary purpose is to serve as a research and development project.

Peak demand in the SERC region occurs during the summer months. As of 2006, the total internal demand was 188,763 MW, which is forecast to increase to 226,921 MW by 2015 (North American Electric Reliability Council [NERC], 2006), representing a growth rate of

2.1 percent per year. Annual electric energy usage in the region was 962,054 gigawatt-hours (GWh) in 2005 and was forecast to be 973,215 GWh in 2006. Energy usage is forecast to grow at 1.7 percent per year over 10 years, which would result in a potential energy demand of 1,132,654 GWh by 2015 (NERC, 2006).

Current resources in the SERC region equal nearly 250,000 MW (NERC, 2006). This supply, combined with new energy resources of 36,759 MW projected to come on line between 2006 and 2015 (NERC, 2006), would lead to regional supplies exceeding demand by about 60,000 MW in 2015. Thus, the SERC region will likely have significantly more generation capability than needed to meet reliability and adequacy concerns in 2015.

The proposed power plant could tie into a 138-kilovolt (kV) line 0.5 mile (0.8 kilometer) north of the site. This line is owned and operated by Ameren Corporation, and runs east/west. It connects with a 345-kV line about 17 miles (27.4 kilometers) to the east (the Sidney-Kansas 345-kV line, near Murdock, Illinois). Another option would be for the plant to connect to a new 345-kV line that would parallel or replace the 138-kV line and connect to the 345-kV Sidney-Kansas line.

A preliminary interconnection (PowerWorld Corporation, 2006) estimates the capacities of the existing transmission network to deliver power from the proposed facility (Table 5.15-2). The system interconnection was modeled with both 138- and 345-kV system connections.

Table 5.15-2. Capacities of Existing Transmission Network

Scenario	ATC (Thermal Capacity)		PV (Voltage Capacity)	
	Summer	Winter	Summer	Winter
138-kV	187 MW	244 MW	375 MW	385 MW
345-kV	631 MW	464 MW	1038 MW	1085 MW

kV = kilovolts; MW = megawatts.
Source: PowerWorld Corporation, 2006.

Directly south of the proposed Tuscola Power Plant Site, immediately on the south side of the CSX rail line, is a 69-kV substation operated by Ameren Corporation. A 69-kV line runs parallel to the south border of the plant site from this substation.

5.15.2.5 Natural Gas

Illinois produces minimal quantities of natural gas and consumes roughly five times what it produces. The state receives substantial natural gas supplies from traditional U.S. source regions along the Gulf Coast and in the mid-continent, as well as from Canada. Illinois ranks first in the nation in per capita annual residential natural gas demand, second in total residential consumption, and third in total commercial consumption of natural gas among the states. Illinois is an important natural gas distribution and storage state, ranking fifth in the nation in natural gas storage capacity, primarily through underground storage of gas used to meet peak winter heating demand in the Midwest and Northeast.

The proposed Tuscola Power Plant Site would be serviced by a natural gas transmission line operated by Trunkline Gas Company, a subsidiary of Southern Union Company. The gas pipeline that would serve the proposed power plant site is a high pressure line. The pipelines on the discharge side of the station are 26 and 30 inches (66 and 76 centimeters) in diameter. The discharge of the nearest compressor station has a pressure range of 650 to 850 psig (pounds per square inch gauge) (4.5 to 5.9 megapascals). The flow rate for the station is typically more than 1 billion cubic feet (28 million cubic meters) per day, or 42 million cubic feet (1.2 million cubic meters) per hour. This is more than sufficient to supply the demands of the proposed FutureGen Project, which could require up to 1.8 million cubic feet (50,970 cubic meters) per hour. Therefore, the operational needs of the project would not have an adverse effect on the ability of the system to supply existing and other future demands for natural gas**.**

5.15.2.6 CO_2 Pipeline

No CO_2 pipelines exist in the vicinity of the proposed power plant or sequestration sites.

5.15.3 IMPACTS

5.15.3.1 Construction Impacts

During construction, construction equipment, particularly trenching equipment, could accidentally sever or damage existing underground lines. Additionally, construction equipment could damage power or telephone poles and lines if the equipment were to come into contact with them. However, all of the proposed ROWs have sufficient width to allow for the safe addition of project-related lines without interfering with the existing utilities if standard construction practices are followed. Construction requirements for new utility infrastructure are presented in Table 5.15-3.

Table 5.15-3. Utility System Construction Requirements

Infrastructure Element	Equipment	Duration	Manpower
Potable water pipeline Using existing line – no construction except to access and tap existing line (<1 mile [1.6 kilometer] pipeline)	n/a	n/a	n/a
Process water pipeline From Lyondell-Equistar Chemical Company for 1.5 miles (2.4 kilometers)	Track hoe/backhoe, trench safety equipment, dump trucks, forklifts, water tankers for hydrostatic testing of the pipeline, compaction equipment, dozers, and graders for finish grading and site cleanup	3 weeks	8 to 10 workers
Sanitary wastewater pipeline Option for Lyondell-Equistar Chemical Company for 0.9 mile (1.4 kilometers), or use existing line	Track hoe/backhoe, trench safety equipment, dump trucks, forklifts, water tankers for hydrostatic testing of the pipeline, compaction equipment, dozers, and graders for finish grading and site cleanup	4 weeks	8 to 10 workers
Transmission line Several options along existing and new ROWs (up to 17 miles [27.4 kilometers])	Crane for setting poles, bulldozer for earth moving and path leveling, and several bucket trucks	Not estimated	15, in 3 crews of 5 each
Natural gas pipeline Using existing line – no construction except to access and tap the existing line	n/a	n/a	n/a

Table 5.15-3. Utility System Construction Requirements

Infrastructure Element	Equipment	Duration	Manpower
CO_2 pipeline 11 miles (17.7 kilometers) to sequestration site	Track hoe/backhoe, trench safety equipment, dump trucks, forklifts, welder rig, gang truck with tools, water tankers for hydrostatic testing of the pipeline, compaction equipment, dozers, and graders for finish grading and site cleanup	4 to 6 weeks	8 to 10 workers

n/a = not applicable.
Source: FG Alliance, 2006b.

Power Plant Site

The 200-acre (81-hectare) envelope, which includes the power plant footprint and railroad loop, could ultimately be located anywhere within the proposed 345-acre (140-hectare) Tuscola Power Plant Site. There are two known natural gas lines that traverse the proposed plant site. Other unknown utilities may occur at the site. To prevent damage to any utilities that might occur at the site, the existing utility locations would be confirmed before construction. Existing utility lines would either be avoided or relocated during siting and construction of the power plant causing the potential for temporary service outages.

Sequestration Site

Construction at the proposed Tuscola Sequestration Site would not affect existing utilities or utility systems because the site is currently undeveloped, and there are no known utilities at the site. Utility needs at the sequestration site would be limited to the provision of an electric service line to operate pumps and other equipment.

Utility Corridors

The proposed utility corridors are shown in Figure 5.15-1.

Potable Water Supply

The proposed Tuscola Power Plant Site has an existing 8-inch (20.3-centimeter) water transmission line that abuts the site's southern boundary. A new potable water corridor would not be needed, although a service tap would need to be installed.

Process Water Supply

The proposed process water pipeline would be approximately 1.5 miles (2.4 kilometers) long and would be constructed on property owned by Lyondell-Equistar Chemical Company and on Tuscola Township road ROW. This line would be connected to the existing water works plant on the west side of the Lyondell-Equistar Chemical Company facility.

In addition, an abandoned 8-inch (20.3-centimeter) water transmission line could potentially be used as a redundant process water line. The line was originally constructed to serve as a potable water transmission line from the Lyondell-Equistar water treatment plant to the city of Tuscola. This line would need to be hydraulically tested before it could be put into service.

Sanitary Wastewater System

An on-site WWTP could be constructed at the power plant site to treat sanitary wastewater that could then be used as process water. Alternatively, a proposed sanitary wastewater pipeline could be constructed that would be approximately 0.9 mile (1.4 kilometers) long and would be constructed on property owned by Lyondell-Equistar Chemical Company and on Tuscola Township road ROW. This wastewater corridor would parallel the proposed process water corridor. This line would be connected to an existing sanitary lift station located in the center of the Lyondell-Equistar Chemical Company facility. Tuscola Township has control of the proposed sanitary wastewater pipeline ROW and has committed to allow the pipeline to be placed on the ROW. An existing abandoned 8-inch (20.3-centimeter) water transmission line could potentially be used as a sanitary force main.

Transmission Line Corridors

Two options for the electric transmission lines are being considered. The first option would be for a proposed 138-kV interconnection to primarily use existing utility corridors, except for a new 0.5-mile (0.8-kilometer) long segment required to connect the plant site with the 138-kV line.

A second option would connect the power plant to a proposed 345-kV transmission corridor that could be separated into three segments. The need to upgrade/construct these individual segments of the proposed transmission line corridor would be determined from the results of a MISO feasibility study that is currently underway. MISO has not provided a schedule for completion of this study. The 345-kV connection would consist of the following three segments totaling 17 miles (27.4 kilometers) in length:

- Segment #1 would run from the proposed power plant site north along CR 750E along an existing 69-kV transmission line for approximately 0.5 mile (0.8 kilometer).
- Segment #2 would run east along an existing 138-kV transmission line approximately 13.5 miles (21.7 kilometers) through Tuscola, Camargo, and Murdock townships, ending at a point approximately 0.75 mile (1.2 kilometers) north of Murdock, Illinois. The existing 69-kV and 138-kV transmission lines are owned by Ameren Corporation.
- Segment #3 would continue due east approximately 3 miles (4.8 kilometers) to an existing 345-kV transmission line that is owned and operated by Ameren Corporation. The third segment of the proposed transmission line would occupy new ROW.

Natural Gas Pipeline

An existing natural gas mainline runs through the proposed Tuscola Power Plant Site, so no new corridor would be required. The gas pipeline is a high-pressure line. A new tap and delivery station would be required.

CO_2 Pipeline

The proposed CO_2 pipeline corridor would be approximately 11 miles (17.7 kilometers) long. The pipeline would occupy new ROW parallel to CRs 750E and 700E to the proposed CO_2 sequestration site. Table 5.15-3 contains information on estimated construction requirements, staffing, and timing for the proposed utility corridors.

5.15.3.2 Operational Impacts

As described below, all of the proposed operational requirements for potable and process water needs, sanitary wastewater needs, and natural gas are well within the capacities of currently existing systems. A report from MISO, scheduled for completion in 2007, is expected to provide a feasibility analysis of operational impacts on the existing transmission system.

Power Plant Requirements

Potable Water Supply

The daily potable water demand from the proposed Tuscola Power Plant Site would be limited to the sanitary needs of a workforce of 200 employees (FG Alliance, 2006b). For 200 employees using 30 gallons (113.6 liters) of potable water per day, the potable water consumption rate would average 4.2 gallons (15.9 liters) per minute, which would be negligible compared to the water supply capacity of 2 MGD (7.6 billion liters per day) in the 14-inch (35.6-centimeter) line that would be tapped to provide potable water. Therefore, the operational needs of the FutureGen Project would have no adverse effect on the ability of the potable water supply system to meet any foreseeable demands.

Process Water Supply

The proposed Tuscola Power Plant Site would receive its process water supply from a 150-million-gallon (568-million-liter) holding pond at Lyondell-Equistar Chemical Company, located west of the site and operated by Duke Energy Generation Services. The proposed Tuscola Power Plant Site would require construction of a force main from the holding pond to the site. The proposed force main would be approximately 1.5 miles (2.4 kilometers) long. This water source would also be used for fire protection. A small reservoir could be constructed on the power plant site to store additional fire protection water.

Lyondell-Equistar Chemical Company has the future potential of becoming a “zero discharge” plant. This would mean that the plant would discontinue discharge of its treated effluents, and would reuse the effluent for plant processes. If that occurs, they would be able to provide water directly to the proposed power plant site at a flow rate of 3,000 gallons (11,356 liters) per minute or 4.3 MGD (16.3 MLD).

Sanitary Wastewater System

Because the FutureGen Project would use a ZLD system, there would be no process-related wastewater discharge associated with the project. The daily sanitary wastewater effluent from the power plant would be limited to the sanitary needs of a workforce of 200 employees. Assuming 30 gallons (113.6 liters) of sanitary wastewater per employee per day (FG Alliance, 2006e), the wastewater needs would equal 6,000 gallons (22,712 liters) per day. As noted above, the proposed power plant wastewater force main would connect to an existing wastewater treatment facility with a 0.9-mile (1.4-kilometer) pipeline that is operating at 25 percent capacity. An alternative may include construction of an on-site wastewater treatment facility. The operational requirements of the project would have no adverse effect on the existing community wastewater treatment plant’s ability to meet current and future treatment needs.

Transmission Line System

The proposed power plant would provide a nominal 275 MW of capacity. The project is proposed to operate at an 85 percent plant factor over the long term, which would result in an average of 2,047,650 MWh of energy per year.

The results of the MISO study will determine the extent to which the proposed transmission corridor would need to be upgraded to transport the electricity generated at the proposed power plant site to the existing power grid. If the MISO study determines that there is not enough available capacity to connect at the existing 138-kV line or substation, then the longer, new 345-kV transmission line would be needed. One option to upgrade the corridor to a 345-kV line is to construct a separate line next to the existing line, requiring an additional 100-foot (30.5-meter) easement. Another option would be a completely new double-circuit line, with new towers and conductors, in place of the existing 138-kV structures.

As noted above, the electrical system interconnection was evaluated with both 138-kV and 345-kV connection options (PowerWorld Corporation, 2006). To satisfy stability margins, it is likely that the 138-kV interconnection may require more supplemental voltage support than the 345-kV interconnection. If the MISO study determines that there is not enough available capacity in the existing 138-kV line and a new 345-kV transmission line is needed, all three transmission line segments would need to be constructed or upgraded. This would include the construction of two new interconnect substations. The first interconnection would be located approximately 0.5 mile (0.8 kilometer) north of the proposed Tuscola Power Plant Site, where the new 345-kV line would interconnect with the existing 138-kV transmission line. The second interconnection would be constructed at the point where the proposed new 345-kV transmission line would tie into the existing 345-kV transmission line.

If the MISO study determines that the existing 138-kV transmission line would be adequate or that the line needed to be upgraded with a new conductor, only Segments #1 and #2 (previously described) would be required. Segment #1 would need to be upgraded-reconstructed to a 138-kV transmission line, and Segment #2 would be restrung to meet the anticipated projected capacity. This scenario would require the construction of one new interconnection facility approximately 0.5 mile (0.8 kilometer) north of the proposed Tuscola Power Plant Site. The existing 138-kV transmission line passes through the existing interconnect substation located east of Murdock, Illinois.

The third scenario under analysis in the MISO study assumes that the existing 138-kV transmission line is adequate for the projected output of the proposed Tuscola Power Plant. This scenario would require construction of a new 138-kV transmission line along the existing 69-kV corridor to the existing 138-kV transmission line. A new interconnect substation would be needed for the proposed new 138-kV line at the point of connection with the existing 138-kV transmission line.

Based on the conclusions of PowerWorld's report (2006), both the 138-kV and 345-kV interconnections would be capable of supporting the rated output of the proposed power plant. However, it is possible that either of the proposed interconnections could be subject to curtailment under specific loading conditions and contingencies not modeled in PowerWorld's study. Curtailment occurs when the system controller from the Independent System Operator (in this case, MISO) observes a thermal or voltage limit overload for an operating situation or, upon performing a contingency analysis, predicts a thermal or voltage limit overload for a planned project. If this occurs MISO notifies the participant or power source that new transmission facilities must be completed to avoid this problem. If the facility is predicted to cause an overload, it would have to operate in a curtailed mode. If the power source is already operating and an overload is apparent, MISO would issue a directive to curtail the production of energy from a particular facility or more than one facility on a pro-rata basis if several facilities are involved in causing the overload. The MISO feasibility study that has been requested would provide further clarification on the ultimate line requirements.

Natural Gas Pipeline

The proposed Tuscola Power Plant Site has an existing natural gas transmission line, operated by Trunkline Gas Company, that passes through the proposed plant site with a capacity of almost 700,000 cubic feet (19,822 cubic meters) per minute, which is more than sufficient to supply the demands of the proposed FutureGen Project (startup: 500 standard cubic feet per minute at 450 psi [15 cubic meters at 3.1 megapascals] to 30,000 standard cubic feet [900 cubic meters] per minute). Therefore, the operational needs of the project would not have an adverse effect on the ability of the system to supply existing and other future demands for natural gas.

CO_2 Pipeline

Upon completion of construction of the new pipeline, there would be sufficient capacity to accommodate the CO_2 expected from the proposed Tuscola Power Plant.

Sequestration Site

Once construction was completed, operation of the injection wells at the sequestration site would have no effect on the operation of other utilities present in the area.

Utility Corridors

Once construction was completed, the operation of project-related utilities would have no effect on the operation of other utilities sharing the corridor.

5.16 MATERIALS AND WASTE MANAGEMENT

5.16.1 INTRODUCTION

Construction and operation of the FutureGen Project would require a source of coal, access to markets for sulfur products, a means to reuse by-products such as slag, and the ability to capture and sequester CO_2 and dispose of any waste that is generated. This section discusses the capabilities of the proposed Tuscola Site to meet each of these requirements. It describes the potential impact of the demands posed by the FutureGen Project on the supply of construction and operational materials in the region. It also discusses the impacts to regional waste management resources.

5.16.1.1 Region of Influence

The ROI includes waste management facilities; industries that could use the FutureGen by-products; and the suppliers of construction materials, coal, and process chemicals used in the construction and operation of the proposed FutureGen Project (power plant, sequestration site, CO_2 distribution system, and associated utilities and transportation infrastructure). The extent of the ROI varies by material and waste type. For example, the ROI for construction material suppliers and solid waste disposal facilities is small (within about 50 miles [80 kilometers] of the proposed Tuscola Site) because these types of resources are widely available and the large volumes of materials that would be needed or waste that would be generated are costly to transport over large distances. Treatment and disposal facilities for hazardous waste are less common and the associated ROI includes a multi-state (Illinois, Indiana, Ohio, Michigan) area extending 100 to 400 miles (160 to 644 kilometers) from the site. The ROI for coal and process chemicals, as well as the sulfur product, includes the State of Illinois and could extend farther if the cost or value of the commodity makes it economical to transport over a greater distance.

5.16.1.2 Method of Analysis

DOE evaluated impacts by comparing the demands posed by construction and operation of the FutureGen power plant, sequestration site, utility corridors, and transportation infrastructure to the capacities of materials suppliers and waste management facilities within the ROI. The analysis also evaluated regional demand and access to markets for sulfur products. DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause new sources of construction materials and operational supplies to be built, such as new mining areas, processing plants, or fabrication plants;
- Affect the capacity of existing material suppliers and industries in the region;
- Create waste for which there are no commercially available disposal or treatment technologies;
- Create hazardous waste in quantities that would require a treatment, storage or disposal (TSD) permit;
- Affect the capacity of hazardous waste collection services and landfills;
- Create reasonably foreseeable conditions that would increase the risk of a hazardous waste release; and
- Create reasonably foreseeable conditions that would increase the risk of a hazardous material release.

DOE reviewed information provided in the Tuscola Site EIV (FG Alliance, 2006b) and proposal (FG Site Proposal [Tuscola, Illinois], 2006). Letters of interest, bid prices, and other prospective material supplier information were identified for use in the EIS. DOE then consulted waste management and

material supplier information compiled by state agencies and trade organizations to confirm availability of these resources in the ROI. Uncertainty regarding the specific technologies that would be employed in the FutureGen facility and variability in the potential coal feeds made it difficult to quantify operational materials requirements and waste generation. The maximum value for each item was used in the analysis to bound the potential impacts of the technologies that could be selected. Limited information is available regarding materials requirements or waste generation for construction. DOE used NEPA documentation and design information for facilities of similar scope and size to augment the FutureGen-specific information.

5.16.2 AFFECTED ENVIRONMENT

The Tuscola Power Plant Site is 345 acres (140 hectares), which is entirely in agricultural row crops, and would be located less than 0.5 mile (0.8 kilometer) east of an existing heavy industrial area housing multiple chemical manufacturing companies, a road construction company, a large grain elevator, a chemical transport firm, and natural gas pipeline companies. The remaining non-industrial area surrounding the power plant site is rural farmland planted in row crops. The sequestration site is also rural, primarily consisting of agricultural land with row crops. There are no existing waste management operations associated with the plant site or sequestration site.

A review of various IEPA databases indicates that the proposed site is not associated with voluntary cleanup, leaking underground storage tanks, Resource Conservation and Recovery Act (RCRA) permitted activities, or solid waste landfills. There are no known existing site hazards (FG Alliance, 2006b).

5.16.2.1 Construction Materials

Concrete, asphalt, and aggregate producers within a 50-mile (80-kilometer) radius of the Tuscola Site were asked to identify their capacity to provide materials to support construction of the FutureGen facility. Inquiries were also made regarding the availability and amount of fill material.

Concrete

The following summarizes the concrete production capacity in the vicinity of the Tuscola Site. Stationary production facilities could provide concrete at a total rate of 330 cubic yards (252 cubic meters) per hour. Two area suppliers have the capability to provide a mobile batch plant (FG Alliance, 2006b).

- A.J. Walker Construction Company, located in Mattoon, is capable of producing 90 cubic yards (69 cubic meters) per hour.
- Charleston Farrier, located in Charleston, is capable of producing 100 cubic yards (76 cubic meters) per hour.
- Tuscola Builders, located in Tuscola, has the capability to provide a mobile batch plant.
- Mid-Illinois Concrete, located in Toledo, is capable of producing 140 cubic yards (107 cubic meters) per hour.
- Prairie Central, with multiple locations throughout Illinois, has the capability to provide a mobile batch plant.

Asphalt

The asphalt producers in the area are capable of providing approximately 1,900 tons (1,724 metric tons) of asphalt per hour.

- Apcon Corporation, located in Urbana, is capable of producing 440 tons (399 metric tons) per hour.
- Ne-Co Asphalt, located in Charleston, is capable of producing 130 tons (118 metric tons) per hour.
- Cross Construction, located in Urbana, is capable of producing 225 tons (204 metric tons) per hour.
- Howell Asphalt Company, with multiple locations throughout Illinois, is capable of producing 920 tons (825 metric tons) per hour.
- Dunn Company, located in Decatur, is capable of producing 190 tons (172 metric tons) per hour (FG Alliance, 2006b).

Aggregate and Fill Material

There are multiple quarries in the vicinity of the Tuscola Site with a combined capacity of approximately 4.4 million tons (4.0 MMT) of aggregate per year (FG Alliance, 2006b). The Tuscola Stone Company, located approximately 3 miles (5 kilometers) east of the proposed power plant site, has production capacity of 750 tons (680 metric tons) per hour. Material Service Corporation operates four quarries in central Illinois. Their Nokomis and Fairmont operations provide a combined capacity of 2.5 million tons (2.3 MMT) per year. Charleston Stone Company owns two quarries with an annual production totaling 750,000 tons (680,000 metric tons) of aggregate (FG Alliance, 2006b).

- Mid-Illinois Quarry, located in Casey, has an aggregate capacity of 125,000 tons (113,000 metric tons) per year, with no fill availability.
- Material Service Corporation, with multiple locations throughout Illinois, has an aggregate capacity of 2.4 million tons (2.2 MMT) per year, with no fill availability.
- Lawrence Gravel, Inc., located in West Union, has fill availability.
- Brush Creek Quarry, located in Mode, has an aggregate capacity of 300 tons (272 metric tons) per hour, with no fill availability.
- Charles Heuerman Trucking Company, located in Charleston, has an aggregate capacity of 200,000 tons (180,000 metric tons) per year, with no fill availability.
- Prairie Materials, located in Mahomet, has an aggregate capacity of 300,000 tons (272,000 metric tons) per year, with no fill availability.
- Tuscola Stone Company, located in Tuscola, has an aggregate capacity of 750 tons (680 metric tons) per hour, and a fill availability of 4 million cubic yards (3 million cubic meters).
- Charleston Stone Company, located in Charleston, has an aggregate capacity of 750,000 tons (680,000 metric tons) per year, with fill availability.
- Whitesville Mill, located in Crawfordsville, Indiana, has an aggregate capacity of 91,000 tons (83,000 metric tons) per year, with no fill availability.
- Mid-American Sand and Gravel, located in Mahomet, has an aggregate capacity of 500,000 tons (450,000 metric tons) per year, and a fill availability of 100,000 cubic yards (76,000 cubic meters).
- Parke County Aggregates, LLC, located in Montezuma, Indiana, has fill availability.
- Vulcan Materials Company, located in Kankakee, has fill availability.

There is a little more than 4 million cubic yards (3 million cubic meters) of fill material available in the area, with the majority available from Tuscola Stone Company. In addition, the Tuscola Site consists of 345 acres (140 hectares) and would require some excavation for detention ponds; thus, some fill would be available at the site (FG Alliance, 2006b).

5.16.2.2 Process-Related Materials

Coal Supply Environment

Illinois coal-fueled electric generating facilities use mainly sub-bituminous PRB coal from Wyoming or bituminous Illinois Basin coal from Illinois, Indiana, or Kentucky. Small amounts of coal from Colorado and Utah also are used in Illinois (FutureGen Alliance, 2006b). Because Pittsburgh coal is not generally utilized by Illinois power plants, delivered pricing is not available.

The best-price quotes shown in Tables 5.16-1 and 5.16-2 indicate coal and transportation bids for the Tuscola Site. Illinois Basin coal could be transported via truck or rail. There would be no truck-delivered option for PRB coal to the Tuscola Site due to distance. The quotes reflect 2006 costs.

Table 5.16-1. Illinois Basin Bituminous Coal

	Rail Dollars per ton (Dollars per metric ton)	Truck Dollars per ton (Dollars per metric ton)
Coal price	30 (33)	28 (30.80)
Transportation cost	6.5 (7.15)	19 (20.90)
Delivered price	36.5 (40.15)	47 (51.70)

Source: FG Site Proposal (Tuscola, Illinois), 2006.

Table 5.16-2. Western-PRB Sub-Bituminous Coal

	Rail Dollars per ton (Dollars per metric ton)
Coal price	14.15 (15.56)
Transportation cost	16 (17.60)
Delivered price	30.15 (33.16)

Source: FG Site Proposal (Tuscola, Illinois), 2006.

Figure 5.16-1 shows the locations of coal mines and probable locations of coal deposits in relation to the proposed Tuscola Power Plant Site. Although coal is present throughout the Illinois Basin, relatively small areas of Springfield and Herrin coal are available for mining in the local area. “Available” coal means coal that is not known to have geological, technological, or land-use restrictions that would negatively impact the economics or safety of mining. The resources are not necessarily economically mineable at the present time, but they are expected to have mining conditions comparable with those currently being mined in the State. The Springfield and Herrin coals, where available for mining, average approximately 3.5 to 5.5 feet (1.0 to 1.7 meters) thick in this area, with the areas of available Herrin containing some coal thicker than 5.5 feet (1.7 meters) in the northern part of Douglas County.

Overall, the thickness of the coals is quite variable in this area, and the coals are thin (less than 2.5 feet [0.8 meters] thick) and are eroded outside of the areas classified as available for mining. The Herrin and Springfield coals average 800 to 900 feet (244 to 274 meters) deep near the Tuscola Site (FG Alliance, 2006b).

The nearest active coal mining area is approximately 35 miles (56 kilometers) to the east-northeast, in Vermilion County, Illinois, where the Black Beauty Coal Company operates the Riola and Vermilion Grove Mines. These mines are in the Herrin Coal, at an average depth of 250 feet (80 meters) and seam thickness of 5 to 6 feet (1.5 to 1.8 meters). Production for each mine was approximately 1 million tons (900,000 metric tons) in 2004 (FG Alliance, 2006b). The Murdock Mine, shown on Figure 5.16-1, in Eastern Douglas County is closed.

Process Chemical Supply Markets

The process chemicals required by the proposed project are common water treatment and conditioning chemicals that are widely used in industry with broad regional and national availability. Large suppliers of water and waste treatment chemicals in the area include Ciba, Kemira, Nalco, Stockhausen, and the SNF Group.

5.16.2.3 Sulfur Markets

The technologies that would be available for sulfur removal at the proposed power plant are similar to the technologies employed in the petroleum refining industry. These treatment technologies result in the production of elemental sulfur, which is marketable. Sulfur is used in the manufacture of numerous chemical, pharmaceutical, and fertilizer products. U.S. production of sulfur was 13.6 million tons (12.3 MMT) in 2002 (TIG, 2002).

The worldwide supply of sulfur is expected to exceed demand by 5.4 and 5.9 million tons (4.9 and 5.4 MMT) in 2006 and 2011, respectively. The surplus could increase up to 12.1 million tons (11 MMT) in 2011 if clean fuel regulations continue to be implemented worldwide. However, the Sulphur Institute, an international non-profit organization founded by the world's sulfur producers to promote and develop uses for sulfur, sees market potential in developing plant nutrient sulfur products and sulfur construction materials, especially sulfur asphalt. The estimate for the plant nutrient sulfur market is 10.5 million tons (9.5 MMT) annually by 2011. The Sulphur Institute estimates that the potential consumption of sulfur in the asphalt industry in North America could reach 0.45 million tons (0.41 MMT) by 2011 (assuming sulfur captures 5 percent of the 30 million ton [27 MMT] asphalt market and an average of 30 percent by weight of asphalt replaced by sulfur). Tests on asphalt made with sulfur show it to have a greater resistance to wheel rutting and cracking than conventional asphalt (Morris, 2003).

5.16.2.4 Recycling Facilities

The bottom slag and ash produced by the gasifier would have local and regional markets for reuse. The American Coal Ash Association (ACAA), a non-profit organization that promotes the beneficial use of coal combustion products, reported that 96.6 percent of the bottom slag and up to 42.9 percent of the ash generated by power plants in 2005 was beneficially used rather than disposed of. Primary uses of slag are as blasting grit and as roofing granules, with lesser amounts in structural and asphalt mineral fills. Ash is primarily used in concrete products, structural fills, and road base construction. The ACAA expects the demand for coal combustion products to increase in the next few years. Some of the increase would be due to federal and State transportation departments promoting the use of coal combustion products for road construction (ACAA, 2006).

5.16.2.5 Sanitary Waste Landfills

The Illinois Solid Waste Management and Landfill Capacity Report (IEPA, 2005) provides the general location and life expectancies of the landfills in the region. Table 5.16-3 lists the sanitary waste landfills in the region and their remaining disposal capacity. Regional landfill availability in the Tuscola area would be up to 116 years (based on closure of the Illinois Landfill in 2122). Space on the 345-acre (140-hectare) proposed Tuscola Power Plant Site would be available for a landfill if needed. Figure 5.16-2 shows the location of these facilities in relation to the Tuscola Site.

Table 5.16-3. Nearby Sanitary Waste Landfills

Landfill	City	State	Remaining Disposal Capacity in Place[1] (yd^3 [m^3])	Expected Closure Date	Approximate Distance from Site (miles [km])
ERC Coles County Landfill	Charleston	IL	799,000 (610,897)	2008[2]	30 (50)
Onyx Valley View Landfill	Decatur	IL	3,831,000 (2,929,000)	2010	45 (72)
Landfill 33 Ltd.	Effingham	IL	3,280,000 (2 507 739)	2017	55 (89)
Clinton Landfill #2	Clinton	IL	3,518,000 (2,689,704)	2030	56 (90)
Brickyard Disposal and Recycling, Inc.	Danville	IL	18,837,000 (14,401,920)	2022	64 (102)
Illinois Landfill	Hoopeston	IL	21,503,000 (16,440,223)	2122	74 (118)

[1] Capacity as of January 2005.
[2] A transfer station is being developed at the landfill site with an average capacity of 750 tons (680 metric tons) per day. After closure, waste will be transferred to the Onyx Valley View Landfill.
yd^3 = cubic yards; m^3 = cubic meters; km = kilometers.
Source: IEPA, 2005 and FG Alliance, 2006b.

The IEPA concluded that the East Central Illinois region (a 19-county region that includes the Tuscola Site) had 15 years of remaining solid waste landfill capacity at the 2004 rate of disposal (IEPA, 2005). New disposal capacity was permitted in 2004, increasing disposal capacity in the region by more than 170 percent (IEPA, 2005). Capacity at hazardous waste landfills is also substantial. The closest hazardous waste landfill alone has remaining capacity of over 14 million cubic yards (11 million cubic meters).

5.16.2.6 Hazardous Waste Treatment, Storage, or Disposal Facilities

Table 5.16-4 provides the locations of hazardous waste landfills closest to the Tuscola Site that have historically received hazardous waste from Illinois sources (FG Alliance, 2006b):

Special waste includes hazardous waste, potentially infectious medical waste, pollution control waste, and industrial process waste.

In Illinois, pollution control waste is a special waste, which must be managed in accordance with State of Illinois regulations (Title 35 of the Illinois Administrative Code [IAC] Part 808). Numerous Illinois municipal landfills are approved to accept special waste. A special waste can also be certified as non-special, which allows it to be disposed in a municipal landfill. In addition, coal combustion waste is often reclaimed for beneficial uses, depending on their composition. The bottom slag produced from the coal gasification process is expected to be highly marketable.

Table 5.16-4. Hazardous Waste Landfills

Hazardous Waste Landfill	City	State	Remaining Disposal Capacity in Place[1] (yd^3 [m^3])	Approximate Distance from Site (miles [km])
Heritage Environmental	Roachdale	IN	14,665,907 (11,212,890)	90 (145)
PDC	Peoria	IL	660,944 (505,328)	120 (190)
CID Recycling & Disposal Facility #4	Calumet City	IL	88,269 (67,486)	150 (240)
Envirosafe of Ohio, Inc.	Oregon	OH	822,000 (628,464)	370 (595)
Wayne Disposal	Belleville	MI	2,134,101 (1,631,637)	385 (620)

[1] Capacity as of January 2004.
yd^3 = cubic yards; m^3 = cubic meters; km = kilometers.
Source: FG Alliance, 2006b.

A non-hazardous special waste certification is required to make a determination that industrial process or pollution control waste is a "non-special waste." This certification must be made in writing and must be provided when requested by IEPA, the waste transporter, the disposal site, and any other entity involved in managing the waste. If the process that generates the waste changes or the raw materials change, a new certification is required (FG Alliance, 2006b). The information contained in this certification would include (as applicable):

- A description of the process that generated the waste;
- The method for determining that the waste is not hazardous;
- The method for determining that the waste is not a liquid, does not contain polychlorinated biphenyls (PCBs) or asbestos, is not formerly hazardous waste rendered non-hazardous, and is not shredded recyclable metals;
- Any analytical results, or relevant Material Safety Data Sheet; and
- An explanation as to why any analysis was not performed or required.

5.16.3 IMPACTS

5.16.3.1 Construction Impacts

Power Plant Site

Power plant construction materials would consist primarily of structural steel beams and steel piping, tanks, and valves. Locally obtained materials would include crushed stone, sand, and lumber for the proposed facilities and temporary structures (e.g., enclosures, forms, and scaffolding). Components of the facilities would also include concrete, ductwork, insulation, electrical cable, lighting fixtures, and transformers.

Waste from construction of the proposed facilities would include excess materials; metal scraps; and pallets, crates, and other packing materials. Excess supplies of new materials would be returned to vendors or be retained for future use. Surplus paint and other consumables, partial spools of electrical cable, and similar leftover materials would also be retained for possible future use in maintenance, repairs, and modifications. Scrap metal that could not be reused on site would be sold to scrap dealers. Other scrap materials could also be recycled through commercial vendors. Packaging material (e.g., wooden pallets and crates), support cradles used for shipping large vessels and heavy components, and cardboard and plastic packaging would be collected in dumpsters and periodically transported off site for recycling or disposal.

Construction equipment would include cranes, forklifts, air compressors, welding machines, trucks, and trailers. Operation of heavy equipment would require oils, lubricants, and coolants. Should any of these require disposal, they would be special waste or hazardous waste and would be appropriately managed by the construction contractor.

Petroleum products are sometimes spilled at construction sites as a result of equipment failure (split hydraulic lines, broken fittings) or human error (overfilled tanks). To mitigate the impacts of spills, use of petroleum products, solvents, and other hazardous materials would be restricted to designated areas equipped with spill containment measures appropriate to the hazard and volume of material being stored on the construction site. Refueling, lubrication, and degreasing of vehicles and heavy equipment would take place in restricted areas. A Spill Prevention, Control, and Countermeasure (SPCC) Plan would be prepared in accordance with 40 CFR 112.7. Personnel would be trained to respond to petroleum and chemical spills, and the necessary spill control equipment would be available on site in immediately accessible locations.

The proposed Tuscola Power Plant Site would require up to 200 acres (81 hectares) to allow for the power plant, coal and equipment storage, associated processing facilities, research facilities, the railroad loop surrounding the power plant envelop, and a buffer zone. Debris would be generated as a result of clearing and grading. Only about 60 acres (24 hectares) of the site would be required for the facilities comprising the power plant footprint (see Figure 2-18). Any excavated material could be used as fill on the site. Debris would be disposed on site or transported to an off-site landfill for disposal. In Illinois, on-site non-hazardous landfills do not require a permit. Regulations for on-site landfills are found in Illinois Administrative Code Title 35, Subtitle G – Waste Disposal, Part 815, Procedural Requirements for All Landfills Exempt from Permits (FG Alliance, 2006b).

The Tuscola Site would have adequate acreage for placement of an on-site solid waste landfill, if one should be required at the site.

The large amount of solid waste disposal capacity in the region is detailed in Table 5.16-3. Because the quantity of waste from construction of the Tuscola Power Plant would be small in comparison with the landfill capacity and waste quantities routinely handled, the impact to waste collection and disposal services would be negligible.

Sequestration Site

The proposed sequestration site is approximately 10 miles (16 kilometers) south of the proposed power plant site. The only components to be constructed at the sequestration site would be the injection well, backup well, associated piping from the plant to the wells, and access road. The materials needed for well components are piping and concrete for seaming. Sources for these construction materials are well established nationally, and none of the quantities of materials required would create demand or supply impacts.

The materials would be ordered in the correct sizes and quantities, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill that accepts construction debris. Heavy equipment would be used that requires fuel, oils, lubricants, and coolants. Should any of these hazardous materials require disposal, they would be special waste or hazardous waste and would be appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. There would be no impact to waste collection services or disposal capacity. Solid and hazardous waste disposal capacity in the region is detailed in Tables 5.16-3 and 5.16-4. There would be no impact to waste collection services or disposal capacity.

Utility Corridors

The following utility and CO_2 corridors and pipelines would be constructed to support the proposed FutureGen facility:

- 11-mile (17.7-kilometer) long CO_2 pipeline to the proposed sequestration injection location using a combination of existing and new ROWs.
- 17 miles (27.4 kilometers) of transmission line using 14 miles (22.5 kilometers) of existing corridor that may require upgrading and 3 miles (4.8 kilometers) of new ROW (option involving 0.5 mile (0.8 kilometer) of transmission line in new ROW is also being evaluated).
- 1.5 miles (2.4 kilometers) of process water pipeline on Lyondell-Equistar Chemicals property and new ROW.
- Less than 1 mile (1.6 kilometers) of potable water pipeline in new ROW.
- 0.9-mile (1.4-kilometer) long sanitary wastewater force main from the power plant site to an existing lift station located on Lyondell-Equistar Chemicals property using new ROW (construction of an on-site wastewater treatment facility is also being evaluated).

The proposed power plant site is crossed by an existing natural gas pipeline and a potable water line; therefore, the power plant would tap into these existing sources (FG Alliance, 2006b).

The existing corridors would require clearing of vegetation and grading, creating land clearing debris that may require removal from the site. The new ROWs may require more extensive land clearing and grading. However, adequate construction debris disposal capacity is available at area landfills.

The construction of the pipelines would require metal and PVC pipe, as well as joining and welding materials including compressed gasses, steel cable and structures, and insulated wiring for transmission lines. Sources for these construction materials are well established nationally, and the quantities of materials required to construct the pipelines and transmission lines would not create demand or supply impacts.

Construction materials would be ordered in the correct sizes and quantities, resulting in small amounts of excess material that could be saved for use on a different project and very small amounts of waste to be disposed in a permitted landfill that accepts construction debris. Heavy equipment would be used that requires fuel, oils, lubricants, and coolants. Should any of these hazardous materials require disposal, they would be special waste or hazardous waste, and would be appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Tables 5.16-3 and 5.16-4. There would be no impact to waste collection services or disposal capacity.

Transportation Corridors

Roads

The materials needed for road construction include concrete, aggregate, and asphalt. Road construction results in minimal waste due to recycling and reuse of these materials. Excavated soil would be used for fill elsewhere along the route and asphalt would be recycled. Road construction would require heavy equipment that would need fuel, oils, lubricants, and coolants. Should any of these hazardous materials require disposal, they would be special waste or hazardous waste, and would be appropriately managed by the construction contractor. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Tables 5.16-3 and 5.16-4. There would be no impact to waste collection services or disposal capacity.

Rail

The materials needed for construction of an industrial rail siding and loop track (approximately 2 miles [3.2 kilometers] of track [FG Alliance, 2006b]) would be steel rails, pre-cast concrete railbed ties, and rock for ballast. The sources for rails and railbed ties are well established nationally, and none of the quantities of materials required for constructing a rail spur would create demand or supply impacts. Furthermore, these materials would be ordered in the correct sizes and quantities, resulting in small amounts of excess material that could be saved for use on a different project and extremely small amounts of waste to be disposed in a permitted landfill that accepts construction debris.

In addition to the materials to be installed, construction of the rail spur would require fuel, oils, lubricants, and coolants for heavy machinery, and compressed gasses for welding. Should any of these hazardous materials require disposal, they would be special waste or hazardous waste, and would be shipped to permitted hazardous waste treatment and disposal facility or other disposal facility permitted to accept the waste. Precautions would be taken to mitigate the impacts of petroleum and chemical spills, and personnel would be trained and equipped to respond to spills when they occur. Solid and hazardous waste disposal capacity in the region is detailed in Tables 5.16-3 and 5.16-4. There would be no impact to waste collection services or disposal capacity.

5.16.3.2 Operational Impacts

Power Plant Site

The FutureGen Power Plant would be capable of using various coals. For the purpose of analysis, the following coals are evaluated:

- Northern Appalachian Pittsburgh seam;
- Illinois Basin from the states of Illinois, Indiana, and Kentucky; and
- PRB from Wyoming.

Coal consumption would vary depending on the gasification technology and type of coal. Table 5.16-5 provides the range of values based on the conceptual design for the FutureGen Project. The Case 3B option is a smaller, side-stream power train that would enable more research and development activities than the main train of the power plant. To estimate the operating parameters for analysis of impacts in this EIS, DOE assumed this smaller system could be paired with any of the other designs under consideration. The Illinois Basin and PRB are the main sources of coal used by Illinois electric generating facilities and are the most viable options for the Tuscola Site. For those fuel types, the maximum coal consumption rate would be approximately 254 tons (230 metric tons) per hour (FG Alliance, 2007) or up to 1.89 million tons (1.71 MMT) per year based on 85 percent availability (FG Alliance, 2006e). This represents 3.5 percent of the 53.8 million tons (48.8 MMT) of coal of all types consumed by electric utilities within the state in 2005 (EIA, 2006). Coal would be delivered to the power plant site by rail and would be stored in two coal piles, each providing storage capacity for approximately 15 days of operation (FG Alliance, 2006e). If required, runoff from the coal storage areas would be collected and treated in the plant’s zero liquid discharge (ZLD) wastewater treatment system.

Table 5.16-5. Coal Consumption

Coal Gasification Technology	Type of Coal (pounds [kilograms] per hour)		
	Pittsburgh	Illinois Basin	Powder River Basin
Case 1	224,745 (101,943)	248,370 (112,659)	281,167 (127,535)
Case 2	213,287 (96,745)	244,153(110,746)	353,809 (160,485)
Case 3A	208,425 (94,540)	238,577 (108,217)	342,790 (155,487)
Case 3B (optional)[1]	97,625 (44,282)	111,791 (50,708)	154,349 (70,012)

[1] Case 3B is an optional add-on to the other technology cases (1, 2, 3A) but is considered unlikely to be implemented.
Source: FG Alliance, 2007.

The estimated consumption of process chemicals by the proposed power plant is presented in Table 5.16-6. The table also provides the estimated on-site storage requirements assuming a 30-day chemical supply would be maintained at the power plant site. Potential impacts from storage of the chemicals are discussed in Section 5.17. These chemicals are commonly used in industrial facilities and are widely available from national suppliers. The materials needed in the largest quantities would be sulfuric acid, sodium hypochlorite, and lime. The polymer and antiscalants and stabilizers needed for the cooling tower, makeup water, and wastewater systems are not specified at this time, and a variety of products are available from national suppliers including the Illinois-based Nalco and the largest producer of water treatment specialty chemicals, Ciba (Nalco, 2006 and Ciba, 2006).

Table 5.16-6. Process Chemicals Consumption and Storage

Chemical	Annual Consumption (tons [metric tons])	Estimated Storage On Site (gallons [liters])
Selective Catalytic Reduction (NO_x emission control)		
Aqueous Ammonia (19 percent)	1,333 (1,209)	28,700 (108,641)
Cooling Tower		
Sulfuric Acid (98 percent)	8,685 (7,879)	94,200 (356,586)
Antiscalant	0.47 (0.42)	8 (30)
Sodium Hypochlorite	1,684 (1,527)	32,900 (124,540)
Make-up Water and Wastewater Treatment Demineralizers		
Sodium Bisulfite	12 (10.9)	155 (587)
Sulfuric Acid	106 (95.8)	1,150 (4,353)
Liquid Antiscalant & Stabilizer	27 (24.5)	443 (1,677)
Clarifier Water Treatment		
Lime	1,237 (1,122)	7,380 (27,936)
Polymer	295 (268)	5,020 (19,000)
Acid Gas Removal		
Physical Solvent	11,300 gallons (42,775 liters)	940 (3,558)

Source: FG Alliance, 2007.

The coal gasification process would annually consume approximately 8,790 tons (7,974 metric tons) of sulfuric acid, 1,680 tons (1,524 metric tons) of sodium hypochlorite, and 1,240 tons (1,125 metric tons) of lime. As discussed in Section 5.16.2.3, the sulfur market is expected to have a surplus for the next few years as production increases, so additional demand would not adversely impact the sulfur market. Sodium hypochlorite has producers located across the U.S. including Illinois, Indiana, Michigan, and Missouri. The U.S. sodium hypochlorite production capacity is vastly underused. Industrial sodium hypochlorite production capacity is estimated at 1.55 billion gallons (5.87 billion liters) per year (TIG, 2003). The current (2006) demand is projected to be 292 million gallons (1.1 billion liters), less than 20 percent of the production capacity (TIG, 2003). Worldwide production of lime was 141 million tons (128 MMT) in 2005, with the U.S. producing 22 million tons (20 MMT) (USGS, 2006a). Charmeuse, one of the 10 largest lime producers in the U.S., operates plants in South Chicago, Illinois and in Buffington, Indiana (USGS, 2006b). Given that the chemicals required to operate the proposed FutureGen facility are common industrial chemicals that are widely available and produced in large quantities in the U.S., the chemical consumption impact would be minimal.

The byproducts generated by the proposed power plant would be sulfur, bottom slag, and ash. As previously discussed, there are established markets and demand for these materials.

Sulfur production would depend on the gasification technology and the type of coal used. The maximum amount of sulfur generated would be 133 tons (121 metric tons) per day (FG Alliance, 2007) for an annual maximum of 41,232 tons (37,405 metric tons) assuming 85 percent availability. The U.S. production of sulfur in 2002 was 13.6 million tons (12.4 MMT). The maximum potential FutureGen sulfur production represents 0.30 percent of the total U.S. production. Supply of sulfur exceeds demand; however, new uses of sulfur are being promoted by sulfur producers that should help balance future supply and demand of sulfur. The worldwide supply is estimated to exceed demand by up to 12.1 million tons (11 MMT) in 2011 without the development of new markets. The FutureGen Project maximum production would increase this surplus by less than 0.34 percent.

As previously noted, operation of the FutureGen Project would require a source of sulfuric acid. Assuming a complete conversion to sulfuric acid, the facility would generate about 126,000 tons (115,000 metric tons) per year of sulfuric acid. This would be sufficient to meet the demand for sulfuric acid at the power plant site.

The FutureGen facility would generate an estimated 96,865 tons (87,875 metric tons) of bottom slag or ash annually based on the three primary technology cases (1, 2, and 3A) (FG Alliance, 2007). If Case 3B were implemented, the amount of slag or ash would increase by approximately 49 percent over the base case. Nearly all of the bottom slag (96.6 percent) produced in the U.S. enters the market and is beneficially used, and the availability of bottom slag is expected to decrease (ACAA, 2006). Based on the 2006 statistics from ACAA for beneficial use of slag, 3.4 percent of the bottom slag that would be generated annually would be disposed as waste (see Table 5.16-7). Further characterization would be necessary to determine whether the quality of the slag produced by the power plant would support this level of reuse. Based on the average of the ACAA (2006) statistics for bottom ash and fly ash, 58.1 percent of the ash that would be generated annually would be disposed as waste (see Table 5.16-7). The recycled bottom slag and ash produced by the proposed power plant would not be expected to have an adverse impact on the market, as future supply is expected to be equal to or less than the demand.

Chemical waste would be generated by periodic cleaning of the heat recovery steam generator and turbines. This waste would consist of alkaline and acidic cleaning solutions and wash water. They are likely to contain high concentrations of heavy metals. Chemical cleaning would be performed by outside contractors who would be responsible for the removal of associated waste products from the site. Precautions would be taken to prevent releases by providing spill containment for tankers used to store cleaning solutions and waste.

Table 5.16-7. Waste Generation

Waste	Annual Quantity (tons [metric tons])	Classification
Unrecycled bottom slag (Cases 1, 2, 3B)	3,290 (2,985)[1]	Special waste (Coal combustion byproduct)
Unrecycled ash (if non-slagging gasifiers are used)	56,280 (51,056)[2]	Special waste (Coal combustion byproduct)
ZLD (wastewater system) clarifier sludge	1,545 (1,402)	Special waste
ZLD filter cake	5,558 (5,042)	Special waste
Sanitary solid waste (office and break room waste)[3]	336 (305)	Municipal solid waste

[1] Based on ACAA (2006) statistics, DOE assumed that all but 3.4 percent of total slag production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[2] Based on ACAA (2006) statistics, DOE assumed that 41.9 percent of total ash production would be recycled rather than disposed of. If Case 3B were implemented, quantities would increase by 49 percent.
[3] Quantity estimated for 200 employees using an industrial waste generation rate of 9.2 pounds (4.2 kilograms) per day per employee (CIWMB, 2006).
Source: FG Alliance, 2007, except as noted.

Other waste would include solids generated by water and wastewater treatment systems, such as activated carbon used in sour water treatment. Sulfur-impregnated activated carbon would be used to remove mercury from the synthesis gas. This mercury sorbent would be replaced periodically and the spent carbon would likely be hazardous waste. The spent carbon would be regenerated and reused at the site. It could also be returned to the manufacturer for treatment and recycling, or be transferred to an off-site hazardous waste treatment facility. Used oils and used oil filters would be collected and transported off site by a contractor for recycling or disposal.

The FutureGen facility would have the option of disposing of some of its non-hazardous waste in an on-site landfill, if one was developed. In addition, the operator could apply to certify its special waste as non-hazardous and dispose of those waste streams in a municipal landfill permitted to dispose of non-hazardous special waste. Given the sanitary and hazardous waste disposal capacities available in the region, the impact of disposal of FutureGen-generated waste would be minimal. Given the small amount of hazardous waste (e.g., paints and solvents) that would be generated and the availability of commercial treatment and disposal facilities, the on-site waste management activities are not expected to require a RCRA permit.

Sequestration Site

During normal operations, the sequestration site components would generate minimal waste due to routine maintenance and presence of workers. The waste could be special/hazardous (e.g., lubricants and oils) and sanitary waste (e.g., packaging and food waste). The expected minimal waste quantities would not impact disposal capacities of area landfills and waste collection services.

Several pre-injection hydrologic tests would be performed during site characterization to establish the hydrologic storage characteristics and identify the general permeability characteristics at the sequestration site. The following water-soluble tracers may be used:

- Potassium bromide (as much as 220 lb [100 kg])
- Fluorescein (as much as 132 lb [60 kg])
- 2,2-dimethyl-3-pentanol (as much as 4.4 lb [2.0 kg])

- Pentafluorobenzoic acid (as much as 8.8 lb [4.0 kg])

A suite of gas-phase tracers would be co-injected with the CO_2 to improve detection limits for monitoring. The tracers expected to be used include:

- Perfluoromethylcyclopentane (as much as 330 lb [150 kg])
- Perfluoromethylcyclohexane (as much as 2,646 lb [1,200 kg])
- Perfluorodimethylcyclohexane (as much as 330 lb [150 kg])
- Perfluorotrimethylcyclohexane (as much as 2,646 lb [1,200 kg])
- Sulfur Hexafluoride (SF_6) (as much as 66 lb [30 kg]]
- Helium-3 (^3He) (as much as 0.033 lb [15 g])
- Krypton-78 (^{78}Kr) (as much as 0.44 lb [200 g])
- Xenon-124 (^{124}Xe) (as much as 0.088 lb [40 g])

The last three are stable, non-radioactive, isotope noble gas tracers. Tracers are a key aspect of the planned monitoring activities for the FutureGen sequestration site. The tracers would 1) contact the CO_2, water, and minerals, 2) limit the problem of interference from naturally occurring CO_2 background concentrations, and 3) provide a statistically superior monitoring and characterization method because of the redundancy built in by using multiple tracers. Tracers would be purchased in the required amounts and would be consumed (injected into the subsurface) as a result of the site characterization and monitoring activities.

Utility Corridors

During normal operations, the utility corridors and pipelines and CO_2 pipeline and corridor would not require additional materials and would not generate waste other than cleared vegetation, if necessary, that could be disposed of at a non-hazardous waste landfill.

Transportation Corridors

Roads

On-site roads would require periodic re-surfacing at a frequency dependent on the level of use and weathering. Asphalt removed from the road surface would be recycled. Road re-surfacing would involve heavy equipment that would require oils, lubricants, and coolants. Should any of these materials require disposal, they would be special waste or hazardous waste, and would be appropriately managed by the construction contractor.

Rail

Maintenance of the rail spur would consist of replacing the rails and equipment at a frequency dependent on the level of use and weathering. Replacement materials would be obtained in the correct sizes and quantities from established suppliers, and the small amount of waste remaining after materials are reused or recycled would be disposed of in a permitted facility. Any special or hazardous waste (e.g., oils and coolants) generated during rail replacement would be properly managed by the contractor.

5.17 HUMAN HEALTH, SAFETY, AND ACCIDENTS

5.17.1 INTRODUCTION

This section describes the potential human health and safety impacts associated with the construction and operation of the proposed project. The health and safety impacts are evaluated in terms of the potential risk to both workers and the general public. The level of risk is estimated based on the current conceptual design of the proposed project, applicable health and safety and spill prevention regulations, and expected operating procedures.

Federal, state, and local health and safety regulations would govern work activities during construction and operation of the proposed project. Additionally, industrial codes and standards also apply to the health and safety of workers and the general public.

5.17.1.1 Region of Influence

The ROI for human health, safety, and accidents is the area within 10 miles (16.1 kilometers) of the boundaries of the proposed power plant site, sequestration site, and CO_2 pipeline. At the proposed Tuscola Sequestration Site, modeling of the deep saline formation with an injection rate of 1.1 million tons (1 MMT) per year for 50 years produced a CO_2 plume radius of 1.1 miles (1.8 kilometers) (FG Alliance, 2006b). Because this is a first of its kind research project, 10 miles (16.1 kilometers) was chosen as a conservative distance in terms of the ROI for the proposed sequestration site.

5.17.1.2 Method of Analysis

DOE performed analyses to evaluate the potential effects of the proposed power plant and sequestration activities on human health, safety, and accidents. The potential for occupational or public health impacts was based on the following criteria:

- Occupational health risk due to accidents, injuries, or illnesses during construction and normal operating conditions;
- Health risks (hazard quotient or cancer risk) due to air emissions from the proposed power plant under normal operating conditions;
- Health risks due to unintentional releases associated with carbon sequestration activities; and
- Health risks due to terrorist attack or sabotage at the power plant or carbon sequestration site.

Potential occupational safety impacts were estimated based on national workplace injury, illness, and fatality rates. These rates were obtained from the U.S. Bureau of Labor Statistics (USBLS) and are based on similar industry sectors. The rates were applied to the anticipated numbers of employees for each phase of the proposed project. From these data, the projected numbers of Total Recordable Cases (TRCs), lost work day cases (LWDs), and fatalities were calculated. These analyses are presented in Section 5.17.2.

The calculated cancer risks and hazard quotients for air emissions under normal operating conditions are summarized in Section 5.17.3.1. Potential hazards from the accidental release of toxic/flammable gas for different plant components were evaluated by Quest (2006). This study addressed failure modes within the proposed plant boundary and was performed to identify any systems or individual process unit components that would produce a significantly larger potential for on-site or off-site impact based on different plant configurations. The results are summarized in Section 5.17.3.2.

Potential health effects were evaluated for workers and the general public who may be exposed to releases of captured gases (CO_2 and H_2S) during pre- and post-sequestration conditions. Gas releases were evaluated at the proposed plant, during transport via pipeline, at the sequestration site, and during subsurface storage (Tetra Tech, 2007). The results of these risk analyses are summarized in Section 5.17.4.

The potential impacts from a terrorism or sabotage event were determined by examining the results of the accident analysis of major and minor system failures or accidents at the proposed plant site and gas releases along the CO_2 pipeline(s) and at injection wells. The results of this analysis are provided in Section 5.17.5.

5.17.2 OCCUPATIONAL HEALTH AND SAFETY

5.17.2.1 Typical Power Plant Health and Safety Factors and Statistics

Power Plant Construction

Table 5.17-1 shows the injury/illness and fatality rates for utility related construction. These rates are expressed in terms of injury/illness per 100 worker-years (or 200,000 hours) for TRCs, LWDs, and fatalities.

Power Plant Operation

Because of the gasification and chemical conversion aspects of the proposed power plant, it would operate more like a petrochemical facility rather than a conventional power plant. As a result, occupational injury/illness rates for the petrochemical manufacturing sector were used in the analysis of the proposed power plant operation (Table 5.17-1). These rates are presented for TRCs, LWDs, and fatality rates.

Table 5.17-1. Occupational Injury/Illness and Fatality Data for Project Related Industries in 2005

Industry	2005 Average Annual Employment (thousands)[1]	Total Recordable Case Rate (per 100 workers)[1]	Lost Work Day Cases (per 100 workers)[1]	Fatality Rate (per 100 workers)[2]
Utility system construction	388.2	5.6	3.2	0.028
Petrochemical Manufacturing	29.2	0.9	0.4	0.001
Electric power transmission, control, and distribution	160.5	5.1	2.4	0.0062
Natural Gas Distribution	107.0	5.9	3.2	0.0025

[1] Source: USBLS, 2006a.
[2] Source: USBLS, 2006b.

Transmission Lines and Electro-Magnetic Fields

Magnetic fields are induced by the movement of electrons in a wire (current); and electric fields are created by voltage, the force that drives the electrical current. All electrical wiring, devices, and equipment, including transformers, switchyards, and transmission lines, produce electromagnetic fields (EMF). The strength of these fields diminishes rapidly with distance from the source. Building material, insulation, trees, and other obstructions can reduce electric fields, but do not significantly reduce magnetic fields. Electrical field strength is measured in kilovolts per meter, or kV/m. Magnetic field strength is expressed as a unit of magnetic induction (Gauss) and is normally expressed as a milligauss (mG), which is one thousandth of a Gauss. The average residential electric appliance typically has an electrical field of less than 0.003 kV/ft (0.01 kV/m). In most residences, when in a room away from electrical appliances, the magnetic field is typically less than 2 mG. However, very close to an appliance carrying a high current, the magnetic field can be thousands of milligauss.

Electric fields from power lines are relatively stable because line voltage does not vary much. However, magnetic fields on most lines fluctuate greatly as current changes in response to changing loads (consumption or demand).

Transmission lines contribute a relatively small portion of the electric and magnetic fields to which people are exposed. Nonetheless, over the past two decades, some members of the scientific community and the public have expressed concern regarding human health effects from EMFs during the transmission of electrical current from power plants. The scientific evidence suggesting that EMF exposures pose a health risk is weak. The strongest evidence for health effects comes from observations of human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults (NIEHS, 1999). The National Institute of Environmental Health Sciences report concluded that, "extremely low-frequency and magnetic field exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard" (NIEHS, 1999). While a fair amount of uncertainty still exists about the EMF health effects issue, the following determinations have been established from the information:

- Any exposure-related health risk to an individual would likely be small;
- The types of exposures that are most biologically significant have not been established;
- Most health concerns relate to magnetic fields; and
- Measures employed for EMF reduction can affect line safety, reliability, efficiency, and maintainability, depending on the type and extent of such measures.

CO_2 and Natural Gas Pipeline Safety

More than 1,500 miles (2,414 kilometers) of high-pressure long distance CO_2 pipelines exist in the U.S (Gale and Davison, 2004). In addition, numerous parallels exist between CO_2 and natural gas transport. Most rules and regulations written for natural gas transport by pipeline include CO_2. These regulations are administered and enforced by DOT's Office of Pipeline Safety. States also may regulate pipelines under partnership agreements with the Office of Pipeline Safety. The rules are designed to protect the public and the environment by ensuring safety in pipeline design, construction, testing, operation, and maintenance. Risks associated with pipeline activities are determined to be low (IOGCC, 2005). However, in pipelines that carry captured CO_2 for sequestration, other gases may be captured and transported as well, and could affect risks posed to human health and the environment. For the proposed FutureGen Project, the captured gases might contain up to 100 parts per million by volume (ppmv) of H_2S in the pipeline on a routine basis, and should any of the captured gases escape to the environment, risks from exposure to H_2S would have to be estimated, as well as risks from CO_2 exposure.

Table 5.17-1 shows the occupational injury/illness and fatality rates for 2005 for operation of natural gas distribution systems. These rates are expressed in terms of injury/illness rate per 100 workers (or 200,000 hours) for TRCs, LWDs, and fatality rates. These rates are used to indicate occupational injuries associated with pipelines, although the properties and types of hazards of natural gas are different from those of CO_2. Because natural gas is highly flammable, these rates are determined to be conservative in relation to CO_2 pipelines.

5.17.2.2 Impacts

This subsection describes potential occupational health and safety risks associated with construction and operation of the proposed project. Features inherent in the design of project facilities as well as compliance with mandatory regulations, plans, and policies to reduce these potential risks are summarized within each risk category.

Construction

Power Plant Site

Potential occupational health and safety risks during construction of the proposed power plant and facilities are expected to be typical of the risks for major industrial/commercial construction sites. Health and safety concerns include the movement of heavy objects, including construction equipment; slips, trips, and falls; the risk of fire or explosion from general construction activities (e.g., welding); and spills and exposures related to the storage and handling of chemicals and disposal of hazardous waste.

Risk of Fire or Explosion from General Construction Activities

Contractors experienced with the construction of coal and gas-fired electricity generating plants and refineries would be used on the proposed project. Construction specifications would require that contractors prepare and implement construction health and safety programs that are intended to control worker activities as well as establish procedures to prevent and respond to possible fires or explosions. The probability of a significant fire or explosion during construction of the proposed project has been determined to be low. With implementation of BMPs and procedures described in the following paragraphs, health and safety risks to construction workers and the public would also be low.

During construction, small quantities of flammable liquids and compressed gases would be used and stored on site. Liquids would include construction equipment fuels, paints, and cleaning solvents. Compressed gases would include argon, acetylene, helium, nitrogen, and O_2 for welding. Potential risk hazards associated with the use of flammable liquids and compressed gases would be reduced by compliance with a construction health and safety program and proper storage of these materials when not in use, in accordance with all applicable federal, state, and local regulations. The construction health and safety program would include the following major elements:

- An injury and illness prevention program;
- A written safety program (including hazard communication);
- A personnel protection devices program; and
- On-site fire suppression and prevention plans.

Storage and Handling of Hazardous Materials, Fuels and Oils

Hazardous materials used during construction would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of materials would be stored in a flammable storage locker, and drums and tanks would be stored in a secondary containment. Storage of the various types of chemicals would conform to Occupational Safety and Health Administration (OSHA) and applicable state guidelines. Construction personnel would be trained in handling chemicals, and would be alerted to the dangers associated with the storage of chemicals. An on-site Environmental Health and Safety Representative would be designated to implement the construction health and safety program and to contact emergency response personnel and the local hospital, if necessary. Material Safety Data Sheets for each chemical would be kept on site, and construction employees would be made aware of their location and content.

To limit exposure to uncontrolled releases of hazardous materials and ensure their safe handling, specific procedures would be implemented during construction, including:

- Lubrication oil used in construction equipment would be contained in labeled containers. The containers would be stored in a secondary containment area to collect any spillage.
- Vehicle refueling would occur at a designated area and would be closely supervised to avoid leaks or releases. To further reduce the possibility of spills, no topping-off of fuel tanks would be allowed.
- If fuel tanks are used during construction, the fuel tank(s) would be located within a secondary containment with an oil-proof liner sized to contain the single largest tank volume plus an adequate space allowance for rainwater. Other petroleum products would be stored in clearly labeled and sealed containers or tanks.
- Construction equipment would be monitored for leaks and undergo regular maintenance to ensure proper operation and reduce the chance of leaks. Maintenance of on-site vehicles would occur in a designated location.
- All paint containers would be sealed and properly stored to prevent leaks or spills. Unused paints would be disposed of in accordance with applicable state and local regulations.

Overall, BMPs would be employed that would include good housekeeping measures, inspections, containment maintenance, and worker education.

Spill Response and Release Reporting

Small quantities of fuel, oil, and grease may leak from construction equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations. If a large spill from a service or refueling truck were to occur, a licensed, qualified waste contractor would place contaminated soil in barrels or trucks for off-site disposal.

The general contractor's responsibility would include implementation of spill control measures and training of all construction personnel and subcontractors in spill avoidance. Training would also include appropriate response when spills occur, and containment, cleanup, and reporting procedures consistent with applicable regulations. The primary plan to be developed would describe spill response and cleanup procedures. In general, the construction contractor would be the generator of waste oil and miscellaneous hazardous waste produced during construction and would be responsible for compliance with applicable federal, state, and local laws, ordinances, regulations, and standards. This would include licensing, personnel training, accumulation limits, reporting requirements, and record keeping.

During construction, the potential exists for a major leak during the chemical cleaning of equipment or piping before it is placed into service. This method of cleaning could consist of an alkaline degreasing step (in which a surfactant, caustic, or NH_3 solution is used), an acid cleaning step, and a passivation step. Most of the solution would be contained in permanent facility piping and equipment. The components of the process that would be most likely to leak are the temporary chemical cleaning hoses, pipes, pump skids, and transport trailers. The cleaning would be within curbed areas, and spills would be manually cleaned up and contaminated materials disposed of in accordance with the applicable regulations.

Due to the limited quantities and types of hazardous materials used during construction, the likelihood of a spill reaching or affecting off-site residents would be low.

Medical Emergencies during Construction

Selected construction personnel would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid or stabilization of the victim(s) until professional medical attention could be attained. Any injury or illness that would require treatment beyond first aid would be referred to the local hospital.

Worker Protection Plan

The construction contractor would develop, implement and maintain a Worker Protection Plan. This plan would implement OSHA requirements (1910 and 1926) and would define policies, procedures, and practices implemented during the construction process to ensure protection of the workforce, environment, and the public. The minimum requirements addressed by the Worker Protection Plan would include:

- Environment, Safety, and Health Compliance
- Working Surfaces
- Scaffolding
- Powered Platforms, Manlifts, and Vehicle-Mounted Platforms
- Fall Protection
- Cranes, Derricks, Hoists, Elevators, and Conveyors
- Hearing Conservation
- Flammable and Combustible Liquids
- Hazardous Waste Operations
- Personal Protective Equipment
- Respiratory Protection
- Confined Space Program
- Hazardous Energy Control
- Medical and First Aid
- Fire Protection
- Compressed Gas Cylinders
- Materials Handling and Storage
- Hand and Portable Powered Tools
- Welding, Cutting and Brazing
- Electrical Safety
- Toxic and Hazardous Substances
- Hazardous Communications
- Heat Stress

Industrial Safety Impacts

Based on data for the construction of similar projects, the construction workforce would average about 350 employees, with a peak of about 700 during the most active period of construction. Since the nature of the activities to be performed across all areas of the proposed project would be similar in scope, industrial safety impacts were calculated for the proposed project and not for each construction sector. Based on the employment numbers during the construction phase, the TRCs, LWDs, and fatalities presented in Table 5.17-2 would be expected. As shown in Table 5.17-2, based on the estimated number of workers during construction, no fatalities would be expected (calculated number of fatalities is less than one).

Table 5.17-2. Calculated Annual Occupational Injury and Fatality Cases for Power Plant Construction

Construction Phase	Number of Employees	Total Recordable Cases	Lost Workday Cases	Fatalities
Average	350	20	11	0.098
Peak	700	39	22	0.196

Sequestration Site

Accidents are inherently possible with any field or industrial activities. Well drilling can lead to worker injuries due to: being struck with or pinned by flying or falling parts and equipment; trips and falls; cuts, bruises, and scrapes; exposure to high noise; and muscle strains due to overexertion. Catastrophic accidents could involve well blowouts, derrick collapse, exposure to hydrogen sulfide and other hazardous gases, fire, or explosion. Although catastrophic accidents frequently involve loss of life as well as major destruction of equipment, they represent only a small percentage of the total well drilling occupational injury incidence and severity rates. Most well drilling injuries (60 to 70 percent) were reported by workers with less than six months of experience (NIOSH, 1983). To avoid well drilling accidents, a worker protection plan and safety training (particularly for new workers) would be instituted, covering all facets of drilling site safety.

Utility Corridors

Risks and hazards associated with construction of power lines, substations, and pipelines would be addressed through the Worker Protection Plan. Many of these types of construction activities may be undertaken by public utilities or companies specializing in this type of work and would be governed by their worker protection programs.

Transportation Infrastructure Corridors

Risks and hazards associated with construction activities for access roads, public road upgrades and the rail loop would be addressed through the Worker Protection Plan. Construction activities on public roads may be undertaken by city or county public works departments and would be governed by their worker protection programs.

Operational Impacts

Two categories of accidents could occur that would pose an occupational health and safety risk to individuals at the proposed power plant, on the CO_2 pipeline, at the CO_2 sequestration site, or in the project vicinity; risk of fire or explosion either from general facility operations or specifically from a proposed gas release (e.g., syngas, hydrogen, natural gas, H_2S, or CO_2); and risk of a hazardous chemical release or spill. Risk assessments evaluating accidents (e.g., explosions and releases) were performed to evaluate potential impacts for both workers and the public. The results of these assessments are summarized in Sections 517.3.2 and 5.17.4.

Power Plant Site

The operation of any industrial facility or power plant holds the potential for workplace hazards and accidents. To promote the safe and healthful operation of the proposed power plant, qualified personnel would be employed and written safety procedures would be implemented. These procedures would provide clear instructions for safely conducting activities involved in the initial startup, normal operations, temporary operations, normal shutdowns, emergency shutdowns, and subsequent restarts. The procedures for emergency shutdowns would include the conditions under which such shutdowns are required and the assignment of emergency responsibilities to qualified operators to ensure that procedures are completed in a safe and timely manner. Also covered in the procedures would be the consequences of operational deviations and the steps required to correct or avoid such deviations. Employees would be given a facility plan, including a health and safety plan, and would receive training regarding the operating procedures and other requirements for safe operation of the proposed power plant. In addition, employees would receive annual refresher training, which would include the testing of their understanding of the procedures. The operator would maintain training and testing records.

The proposed power plant would be designed to provide the safest working environment possible for all site personnel. Design provisions and health and safety policies would comply with OSHA standards and consist of, but not be limited to, the following:

- Safe egress from all confined areas;
- Adequate ventilation of all enclosed work areas;
- Fire protection;
- Pressure relief of all pressurized equipment to a safe location;
- Isolation of all hazardous substances to a confined and restricted location;
- Separation of fuel storage from oxidizer storage;
- Prohibition of smoking in the workplace; and
- Real-time monitoring for hazardous chemicals with local and control room annunciation and alarm.

Industrial Safety Impacts

The operational workforce is expected to average about 200 employees. As shown in Table 5.17-3, the number of calculated fatalities for operation of this facility would be less than one.

Table 5.17-3. Calculated Annual Occupational Injury/Illness and Fatality Cases for Power Plant Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
200	2	1	0.002

Risk of Fire or Explosion

Operation of the proposed facility would involve the use of flammable and combustible materials that could pose a risk of fire or explosion. The potential for fire or explosion at the proposed power plant would be minimized through design and engineering controls, including fire protection systems. The risks of fire and explosion could be minimized also through good housekeeping practices and the proper storage of chemicals. Workers would consult MSDS information to ensure that only compatible chemicals are stored together. Impacts of a potential large or catastrophic explosion are discussed in Section 5.17.3.2.

Risk of Hazardous Chemical Release or Spill

Chemicals and hazardous substances would be delivered, used, and stored at the proposed project site during operation. Petroleum products used on site during operation would be stored following the same guidelines described for construction. During operation, the worst-case scenario would be a major leak during chemical cleaning of equipment and associated piping.

The presence of hazardous environments during normal operations is not anticipated. Plant equipment would be installed, maintained, and tested in a manner that reduces the potential for inadvertent releases. Scheduled and forced maintenance would be planned to incorporate engineering and administrative controls to provide worker protection as well as mitigate any possible chemical releases. Facility and spot ventilation would provide for the timely removal and treatment of volatile chemicals.

Worker practices and facility maintenance procedures would provide for the containment and cleanup of non-volatile chemicals. Personnel and area monitoring will provide assurance that worker exposures are maintained well below regulatory limits.

Seven chemical compounds are identified that could produce harmful effects in exposed individuals. The severity of these effects is dependent on the level of exposure, the duration of the exposure, and individual sensitivities to the various chemical compounds. Table 5.17-4 describes chemical occupational exposure limits, potential exposure routes, organs targeted by the compounds, and the range of symptoms associated with exposures to these chemicals. The occupational exposure limits are defined in Table 5.17-5. Potential public exposures to accidental releases of these chemicals are described in Section 5.17.3.2.

While some of the chemicals listed in Table 5.17-4 would be generated during proposed power plant operation, others are stored on site and the potential for personnel exposure as the result of minor spills or leaks, while low, exists.

Table 5.17-5. Definitions of Occupational Health Criteria

Hazard Endpoint	Description
NIOSH REL C	NIOSH recommended exposure limit (REL). A ceiling value. Unless noted otherwise, the ceiling value should not be exceeded at any time.
NIOSH REL ST	NIOSH REL. Short-term exposure limit (STEL), a 15-minute TWA exposure that should not be exceeded at any time during a workday.
NIOSH REL TWA	NIOSH REL. Time-weighted average (TWA) concentration for up to a 10-hour workday during a 40-hour work week.
OSHA PEL C	Permissible exposure limit (PEL). Ceiling concentration that must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure.
OSHA PEL TWA	PEL. TWA concentration that must not be exceeded during any 8-hour work shift of a 40-hour workweek.
IDLH	Airborne concentration from which a worker could escape without injury or irreversible health effects from an IDLH exposure in the event of the failure of respiratory protection equipment. The IDLH was evaluated at a maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection should be permitted. In determining IDLH values, NIOSH evaluated the ability of a worker to escape without loss of life or irreversible health effects along with certain transient effects, such as severe eye or respiratory irritation, disorientation, and incoordination, which could prevent escape. As a safety margin, IDLH values are based on effects that might occur as a consequence of a 30-minute exposure.

NIOSH = National Institute of Occupational Safety and Health.
OSHA = Occupational Safety and Health Administration.
IDLH = Immediately Dangerous to Life and Health.
PEL = Permissible Exposure Limit.
REL = Recommended Exposure Limit.
TWA = Time-Weighted Average.
ST = Short-term.
C = Ceiling.

The FutureGen Project would use aqueous NH_3 in a selective catalytic reduction process to remove NO_X and thousands of pounds could be stored on-site. Three scenarios for the accidental release of NH_3 were evaluated using the EPA's ALOHA model: a leak from a tank valve, a tanker truck spill, and a tank rupture. (See Appendix F for summary of how the model was used, a description of input data, and the results of sensitivity analyses.) Health effects from inhalation of NH_3 can range from skin, eye, throat, and lung irritation; coughing; burns; lung damage; and even death. Impacts of NH_3 releases on workers and the public depends on the location of the releases, the meteorological conditions (including atmospheric stability and wind speed and direction) and other factors. The criteria used to examine potential health effects, are defined in Table 5.17-6 and Table 5.17-7.

Leakage of 400 pounds (180 kilograms) of aqueous NH_3 solution (19 percent NH_3) from a tank, through a faulty valve was selected as a plausible upper-bound accidental spill. It was assumed that this release would create a one-centimeter deep pool, with a surface area of 211 square feet (19.6 square meters). The temperature of the solution was assumed to be 97°F (36.1°C), based on the maximum daily air temperature in Tuscola for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 2,687 feet (819 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 5.17-8). Individuals exposed within a distance of 1,210 feet (369 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur only within 505 feet (154 meters) of the spill. Thus, only workers (assumed to be within 250 meters of a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3.. The peak concentrations are predicted to last about 5 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 250 meters.

Table 5.17-6. Hazard Endpoints for Individuals Potentially Exposed to an Ammonia Spill

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
1 hour	NH_3	Adverse effects	30	AEGL 1
		Irreversible adverse effects	160	AEGL 2
		Life Threatening	1,100	AEGL 3

[1]See Table 5.17-7 for descriptions of the AEGL endpoints.
AEGL = Acute Exposure Guideline Level.

Table 5.17-7. Description of Hazard Endpoints for Ammonia Spill Receptors

Hazard Endpoint	Description
AEGL 1	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
AEGL 2	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects, or an impaired ability to escape.
AEGL 3	The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

AEGL = Acute Exposure Guideline Level.
Source: EPA, 2007.

For the tanker truck spill scenario, it was assumed that all 46,200 pounds (20,956 kilograms) of the 19 percent NH_3 solution in the truck may be spilled on the ground surface. It was assumed that this release would create a ten-centimeter deep pool, with a surface area of 2,454 square feet (228 square meters). The temperature of the solution was assumed to be 97°F (36.1°C), based on the maximum daily air temperature in Tuscola for the past three years. Downwind atmospheric concentrations of volatilized (vapor-phase) NH_3 were calculated using a wind speed of 1.5 m/sec, Pasquill atmospheric stability class F (most conservative) using EPA's ALOHA model, which assumes a source duration of up to one hour. Concentrations within 14,107 feet (4,300 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 5.17-8). Individuals within a distance of 5,249 feet (1,600 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 1,752 feet (534 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would exceed the

AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters), but not inside a building.

For the tank rupture spill scenario, it was assumed that all 104,355 pounds (13,400 kilograms) of the 19 percent NH_3 solution in one of two on-site storage tanks may be released within the diked area around the tank. The tank discharge was assumed to create a 92-centimeter deep pool with a surface area of 601 square feet (55.8 square meters). Again the temperature of the solution was conservatively assumed to be 97°F (36.1 °C). The same atmospheric conditions as above, and EPA's ALOHA model with a source duration of 1 hour were used to calculate downwind atmospheric NH_3 concentrations. Concentrations within 7,545 feet (2,300 meters) of the pool would exceed AEGL Level 1 criteria for temporary health effects (30 ppmv – 1 hour) (see Table 5.17-8). Individuals within a distance of 2,739 feet (835 meters) of the pool would be expected to experience NH_3 concentrations above AEGL Level 2 for irreversible adverse effects (160 ppmv – 1 hour), while life threatening exposures (AEGL Level 3, i.e., 1,100 ppmv – 1 hour) could occur within 948 feet (289 meters) of the spill. Thus, workers and the general public (assumed to be located at least 820 feet [250 meters] from a release) could potentially be exposed to life-threatening levels of atmospherically dispersed NH_3. The peak concentrations are predicted to last about 10 minutes, and would not exceed the AEGL-3 criteria of 2,700 ppmv for a 10-minute exposure at 820 feet (250 meters).

The meteorological conditions specified for these analyses (F stability class) result in conservative estimates of exposure. At Tuscola, this stability class occurs about 5 percent of the time. Simulations of the other six stability classes showed that the predicted distances to a given criteria were no more than 35 percent of the distance for the conservative stability class F. The stability class (D12), which gave the second highest results, occurs about 2 percent of the time. Since NH_3 produces a distinct, pungent odor at low concentrations (approximately 17 ppmv (AIHA, 1997), it is expected that most workers and the public in the vicinity of an accident would quickly evacuate under the scenarios discussed above. Depending on the size and location of the accident, the public would be alerted to the appropriate response such as shelter-in-place procedures or evacuation for the public living near the accident.

Table 5.17-8. Effects of an Ammonia Spill at the Proposed Power Plant

Release Scenario	Gas	Effect[1]	Distance (feet [meters])
NH_3 leaky valve (400 pounds, 19 percent solution)	NH_3	Adverse Effects	2,687 (819)
		Irreversible adverse effects	1,210 (369)
		Life threatening effects	505 (154)
NH_3 tanker truck spill (46,200 pounds, 19 percent solution)	NH_3	Adverse Effects	14,107 (4300)
		Irreversible adverse effects	5,249 (1600)
		Life threatening effects	1,752 (534)
NH_3 tank rupture (104,355 pounds, 19 percent solution)	NH_3	Adverse Effects	7,545 (2300)
		Irreversible adverse effects	2,739 (835)
		Life threatening effects	948 (289)

Multiply distance in feet by 0.3048 to convert to meters.
[1] See Table 5.17-6 and Table 5.17-7 for an explanation of the effects.

Sections 5.17.3.2 and 5.17.4 discuss scenarios involving equipment failure or rupture at the proposed power plant site, along utility corridors, and at the injection site.

Medical Emergencies

All permanent employees at the facility would receive first aid and CPR training. On-site treatment would be provided in medical situations that require only first aid treatment or stabilization of the victim(s) until professional medical attention is obtained. Any injury or illness that requires treatment beyond first aid would be referred to the plant's medical clinic or to a local medical facility.

Coal Storage

The National Fire Protection Association (NFPA) identifies hazards associated with storage and handling of coal, and gives recommendations for protection against these hazards. NFPA recommends that any storage structures be made of non-combustible materials, and that they be designed to minimize the surface area on which dust can settle, including the desirable installation of cladding underneath a building's structural elements.

Coal is susceptible to spontaneous combustion due to heating during natural oxidation of new coal surfaces. Also, coal dust is highly combustible and an explosion hazard. If a coal dust cloud is generated inside an enclosed space and an ignition source is present, an explosion can ensue. Dust clouds may be generated wherever loose coal dust accumulates, such as on structural ledges, or if there is a nearby impact or vibration due to wind, earthquake, or even maintenance operations. Because of coal's propensity to heat spontaneously, ignition sources are almost impossible to eliminate in coal storage and handling, and any enclosed area where loose dust accumulates is at great risk. Further, even a small conflagration can result in a catastrophic "secondary" explosion if the small event releases a much larger dust cloud.

A Quonset hut-type building for on-site coal storage is being examined (FG Alliance, 2006e). This structure would protect the pile from rain and wind, which would otherwise foster spontaneous combustion in open-air piles and cause air and runoff pollution. Internal cladding would prevent dust accumulation on the structure. A breakaway panel may provide for accidental overloading and ventilation at the base, and exhaust fans or ventilation openings ensure against methane or smoke buildup. Dust suppression/control techniques would be employed. Fire detection and prevention systems may also be installed.

The surfaces of stored coal can be unstable, and workers can become entrapped and subsequently suffocate while working on stored coal piles (NIOSH, 1987). NIOSH recommendations for preventing entrapment and suffocation would be followed.

Sequestration Site

Industrial Safety Impacts

The operational workforce for the proposed sequestration site would be up to 20 employees. Since this proposed site would not be a permanently staffed facility, these personnel would be rotated from the permanent site pool. Based on these employment numbers, during operation of the proposed power plant, the TRCs, LWDs, and fatalities presented in Table 5.17-9 would be expected. As shown in Table 5.17-9, the number of calculated fatalities for operation of this facility would be less than one.

Table 5.17-9. Calculated Annual Occupational Injury and Fatality Cases for Sequestration Site Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Utility Corridors

Risk of Fire or Explosion

The proposed transmission line connector would be located high above ground (typically between 50 to 100 feet [15.2 to 30.5 meters] high). Only qualified personnel would perform maintenance on the proposed transmission lines. Sufficient clearance would be provided for all types of vehicles traveling under the proposed transmission lines. The operator of the line would establish and maintain safe clearance between the tops of trees and the proposed transmission lines to prevent fires. Ground and counterpoise wires would be installed on the proposed transmission system, providing lightning strike protection and thereby reducing the risk of explosion. However, a brush fire could occur in the rare event that a conductor parted and one end of the energized wire fell to the ground, or perhaps in the event of lightning strikes. Under these rare circumstances, the local fire department would be called upon.

Releases or Potential Releases of Hazardous Materials to the Environment

Hazardous materials used during maintenance of the proposed transmission facilities would be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux and gases, various lubricants, paint, and paint thinner. Small quantities of fuel, oil, and grease may leak from maintenance equipment. Such leakage should not be a risk to health and safety or the environment because of low relative toxicity and low concentrations.

Industrial Safety Impacts

The operational workforce for the proposed utility corridors would be less than 20 employees. As with the proposed sequestration site, the majority of these workers would not be on permanent assignment and would be drawn from the plant pool. Based on these employment numbers, during operation and maintenance of utility corridors, the TRCs, LWDs, and fatalities presented in Table 5.17-10 would be expected. As shown in Table 5.17-10, the number of calculated fatalities for operation of this facility would be less than one.

Table 5.17-10. Calculated Annual Occupational Injury and Fatality Cases for Utility Corridors Operation

Number of Employees	Total Recordable Cases	Lost Work Day Cases	Fatalities
20	<1	<1	0.0002

Transportation Corridors

Facility personnel would not be involved in activities associated with these infrastructure operations. Rail and road transportation activities would be performed by non-facility employees and vendors. Hazards related to the proposed transportation corridor operation would not be different from those posed by the normal transportation risks associated with product delivery.

5.17.3 AIR EMISSIONS

5.17.3.1 Air Quality – Normal Operations

Air quality impacts on human health were evaluated for HAPs potentially released during normal operation of the proposed Tuscola Power Plant and proposed sequestration site. HAP emissions from the FutureGen Project were estimated based on the Orlando Gasification Project. The methods used to analyze impacts are described in detail in Section 5.2.3 with supporting materials in Appendix E.

Assessment of the potential toxic air pollutant emissions demonstrated that all ambient air quality impacts for air toxics would be below the relevant EPA recommended exposure criteria. This section of the report provides a summary of the results of potential air quality impacts.

As described in Section 5.2.3 regarding the modeling approach, estimated emissions of HAPs were based on data taken from the Orlando Gasification Project (DOE, 2007). Although the Orlando project is an IGCC power plant, there are differences from the proposed project. Consequently, the Orlando project data were scaled, based on relative emission rates of VOCs and particulate matter, to produce more appropriate estimates of stack emissions from the proposed project.

Airborne HAP concentrations were determined by modeling the impact of 1 g/s emissions rate using AERMOD. Table 5.17-11 shows representative air quality impacts for several metallic and organic toxic air pollutants. Each of these airborne concentrations was evaluated using chronic exposure criteria (expressed as inhalation unit risk factors and reference concentrations) obtained from the EPA Integrated Risk Information System (IRIS) (EPA, 2006a). As appropriate, an inhalation unit risk factor was multiplied by the maximum annual average airborne concentration for each HAP to calculate a cancer risk. Hazard coefficients were calculated by dividing the maximum annual average airborne concentration for each HAP by the appropriate reference concentration taken from the EPA IRIS (EPA, 2006a). The cancer risks and hazard coefficients calculated for each HAP were then summed and compared to the EPA criteria for evaluating HAP exposures. The results of this analysis, as indicated in Table 5.17-11, show that predicted exposures are safely well below the EPA exposure criteria.

Normal Air Quality and Asthma

Asthma is a chronic respiratory disease characterized by attacks of difficulty breathing. It is a common chronic disease of childhood, affecting over 6.5 million children in the U.S. in 2005 and contributing to over 12.8 million missed school days annually (DHHS, 2006). In 2005, the prevalence of asthma among children in the U.S. was 8.9 percent. Asthma prevalence rates among children remain at historically high levels after a large increase from 1980 until the late 1990s.

Asthma-related hospitalizations followed a trend similar to those for asthma prevalence, rising from 1980 through the mid-1990s, remaining at historically high plateau levels. Asthma-related mortality rates in the U.S. have declined recently after a rising trend from 1980 through the mid-1990s (DHHS, 2006).

It remains unknown why some people get asthma and others do not (DHHS, 2006). Asthma symptoms are triggered by a variety of things such as allergens (e.g., pollen, dust mites and animal dander), infections, exercise, changes in the weather, and exposure to airway irritants (e.g., tobacco smoke and outdoor pollutants). Although extensive evidence shows that ambient air pollution (based on measurements of NO_2, particulate matter, soot, and O_3) exacerbates existing asthma, a link with the development of asthma is less well established (Gilmour et al., 2006).

A 2006 workshop sponsored by the EPA and the National Institute of Environmental Health Sciences (Selgrade et al., 2006) found that there are a number of scientific questions that need to be answered in order to make appropriate regulatory decisions for ambient air, including which air pollutants are of greatest concern and at what concentrations. Nevertheless, IGCC power plants that are currently in operation have achieved the lowest levels of criteria air pollutant (SO_2, CO, O_3, NO_2, lead, and respirable particulate matter) emissions of any coal-fueled power plant technologies (DOE, 2002). Tables 5.2-1 and 5.2-2 show that the IGCC technology under evaluation for the proposed project would exceed the performance of technologies used at more conventional types of coal-fueled power plants of comparable size. Furthermore, based on evaluations conducted for this proposed site (as described in Section 5.2), the maximum predicted concentrations of the criteria air pollutants would not exceed the National Ambient Air Quality Standards and would not significantly contribute to existing background levels. Based on these determinations, it is unlikely that the proposed project would be a factor in asthma-related health effects.

Table 5.17-11. Summary Analysis Results — Hazardous Air Pollutants

Chemical Compound	**CT/HRSG Emissions[1]**		**Inhalation Unit Risk Factor[2] $(\mu g/m^3)^{-1}$**	**Reference Concentration[2] $(\mu g/m^3)^{-1}$**	**Cancer Risk[3]**	**Hazard Coefficient[4]**
	(lb/hr)	**(g/s)**				
2-Methylnaphthalene	1.99E-04	2.51E-05	n/a	n/a	n/a	n/a
Acenaphthyalene	1.44E-05	1.81E-06	n/a	n/a	n/a	n/a
Acetaldehyde	9.99E-04	1.26E-04	2.20E-06	9.00E+00	7.20E-13	3.63E-08
Antimony	**5.59E-03**	**7.04E-04**	n/a	**2.00E-01**	n/a	**9.16E-06**
Arsenic	**2.94E-03**	**3.70E-04**	**4.30E-03**	**3.00E-02**	**4.14E-09**	**3.21E-05**
Benzaldehyde	1.61E-03	2.03E-04	n/a	n/a	n/a	n/a
Benzene	2.69E-03	3.39E-04	7.80E-06	3.00E+01	6.89E-12	2.94E-08
Benzo(a)anthracene	1.28E-06	1.61E-07	1.10E-04	n/a	4.60E-14	n/a
Benzo(e)pyrene	3.05E-06	3.84E-07	8.86E-04	n/a	8.84E-13	n/a
Benzo(g,h,i)perylene	5.26E-06	6.63E-07	n/a	n/a	n/a	n/a
Beryllium	**1.26E-04**	**1.59E-05**	**2.40E-03**	**2.00E-02**	**9.89E-11**	**2.06E-06**
Cadmium	**4.06E-03**	**5.12E-04**	**1.80E-03**	**2.00E-02**	**2.39E-09**	**6.65E-05**
Carbon Disulfide	2.49E-02	3.14E-03	n/a	7.00E+02	n/a	1.17E-08
Chromium[5]	**3.78E-03**	**4.76E-04**	**1.20E-02**	**1.00E-01**	**1.49E-08**	**1.24E-05**
Cobalt	**7.97E-04**	**1.00E-04**	n/a	**1.00E-01**	n/a	n/a
Formaldehyde	1.85E-02	2.33E-03	5.50E-09	9.80E+00	3.33E-14	n/a
Lead (Pb)	**4.06E-03**	**5.12E-04**	n/a	**1.50E+00**	n/a	**8.88E-07**
Manganese	**4.34E-03**	**5.47E-04**	n/a	**5.00E-02**	n/a	**2.84E-05**
Mercury (Hg)	**1.27E-03**	**1.60E-04**	n/a	**3.00E-01**	n/a	**1.39E-06**
Naphthalene	2.95E-04	3.72E-05	3.40E-05	3.00E+00	n/a	3.22E-08
Nickel	**5.45E-03**	**6.87E-04**	**2.40E-04**	**9.00E-02**	**4.29E-10**	**1.99E-05**
Selenium	**4.06E-03**	**5.12E-04**	n/a	**2.00E+01**	n/a	**6.65E-08**
Toluene	4.12E-04	5.19E-05	n/a	4.00E+02	n/a	3.37E-10
TOTAL					2.19E-08	1.73E-04
Risk Indicators					1.00E-06	1.00E+00
Percent of Indicator					2.2 percent	0.02 percent

[1] Emission rates scaled by the ratio of VOC or particulate emissions from Orlando EIS to FutureGen.
[2] Provided by EPA IRIS.
[3] Unit risk factor multiplied by maximum annual average impact of 0.0026 $\mu g/m^3$ determined by AERMOD at a 1 g/s emission rate.
[4] Maximum AERMOD annual average impact divided by reference concentration:
CT/HRSG = combustion turbine/heat recovery steam generator; lb/hr = pounds per hour; g/s = grams per second; $\mu g/m^3$ = micrograms per cubic meter; n/a = not available.
[5] Conservatively assumed all chromium to be hexavalent.
Compounds that are considered to be particulate matter in **bold** text.

5.17.3.2 Hazard Analysis

The "Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations" (referred to hereafter as the Quest Study) was conducted to define creditable upperbound impacts from potential accidental releases of toxic and flammable gas from the proposed systems (Quest, 2006). Risks associated with gas releases include asphyxiation, exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions.

A particular concern associated with the release of gas is exposure to a toxic component within the dispersing gas cloud. Many of the process streams of the proposed power plant could contain one or more toxic components. The Quest Study evaluated the extent of exposure to gas clouds containing NH_3, CO, Cl_2, HCl, H_2S, and SO_2. Additional analyses were performed to define the extent of potential asphyxiation hazard associated with exposure to high concentrations of CO_2.

The hazard of interest for flash fires was direct exposure to flames. Flash fire hazard zones were determined by calculating the maximum size of the flammable gas cloud before ignition. The LFL of the released hydrocarbon mixture was used as a boundary. The hazard of interest for the torch fires (ignition of a high velocity release of a flammable fluid, such as a hydrogen deflagration) was exposure to thermal radiation from the flame (Quest, 2006). For vapor clouds explosions, the hazard of interest was the overpressure created by the blast wave. For toxic components, potential impacts were determined by calculating the maximum distance at which health effects could occur.

Plant System Configurations

For the purposes of the analysis, the facility was assumed to be located in an area of reasonably flat terrain with limited vertical obstructions. This provided the bounding conditions that allow for the most conservative hazard impact analysis (Quest, 2006).

For the base case evaluation, the main process components for each of the proposed plant configurations were laid out in a rectangular area approximately 75 acres (30 hectares) in size. This area was surrounded by the rail line used to deliver the coal. The total area required for the project would consist of a minimum of 200 acres (81 hectares) (Quest, 2006).

Three other cases were also evaluated. Assuming the proposed facility is placed in the middle of a 200-, 400-, or 600-acre (81-, 162-, or 243-hectare) site, it was determined whether any explosion would extend beyond the boundaries of each site configuration.

Summary of Results

A full evaluation of the hazards associated with the preliminary designs of the four proposed gasifier systems for use in the proposed project was performed. This analysis was composed of the following three primary tasks:

- Task 1: Determine the maximum credible potential releases, for each process unit within each proposed system configuration for each candidate coal source.
- Task 2: For each release point identified in Task 1, determine the maximum downwind travel for harmful, but not fatal, consequences of the release under worst-case atmospheric conditions.
- Task 3: Using the results of Task 2 and the available general layout information for the proposed system configurations, develop a methodology to rank the potential impacts to the workers on site and the potential off-site public population.

Hazards Identification

In general, all four of the gasifier systems evaluated for the FutureGen Project are composed of similar equipment. All gas processing equipment downstream of the gasifier is in common use in the petroleum industry and does not provide any unique hazards (Quest, 2006).

Upperbound-Case Consequence Analysis

The Quest Study evaluated the largest releases to determine the extent of possible flammable and toxic impacts under maximum (upperbound) release conditions. The analysis included a combination of four gasifiers and three types of coal (12 gasifier/coal combinations). The impacts were defined as those that could cause injury to workers or members of the public.

None of the flammable hazards were found to have impacts that extended beyond the proposed plant property. The largest flash fire impact zones extended less than 200 feet (61 meters) from the point of release. Areas within the process units in each of the four project system designs would have the potential to be impacted by flammable releases. This result is not unexpected for a facility handling similar materials (Quest, 2006).

The upperbound for toxic impacts associated with the 12 gasifier/candidate coal combinations evaluated would have the potential to extend past the proposed project property line. The toxic impacts would be dominated by releases of H_2S and SO_2 from the Claus process unit. The resulting plumes could extend from 0.2 to 1.4 miles (0.3 to 2.3 kilometers) from the point of release. There are at least 17 family residences, farm home sites, or commercial properties within the 1.4-mile (2.3-kilometer) plume release radius.

The longest downwind toxic impact distance associated with any of the four gasifiers is due to the CO in the syngas process stream. These streams can produce toxic CO impacts extending from 0.4 to 0.6 mile (0.6 to 1.0 kilometer) from the point of release (Quest, 2006). There are at least three farm home sites within the 0.6-mile (1.0-kilometer) plume radius.

The potential health risks to these receptors are discussed in more detail in Section 5.17.5.

Hazard Ranking

Using the results from Tasks 1 and 2, a framework for ranking the flammable and toxic impacts associated with the upperbound release was designed as a function of the location of a worker or member of the public relative to the facility process units. Four zones were developed; two for the workers inside the property line and two for the public outside of the property lines (Quest, 2006).

Since none of the flammable hazards were found to have impacts that extended past the property line, there would be no off-site or public impacts due to flammable releases within the facility process units (Quest, 2006).

The upperbound for toxic impacts associated with all 12 gasifier/coal candidate combinations would have the potential to extend past the proposed project property line. In 11 of the 12 gasifier/candidate coal combinations, toxic impacts associated with the Claus unit would be greater than the impacts from any other process unit (Quest, 2006).

In general, all 12 gasifier/candidate coal systems would have the potential to produce toxic impacts that could extend into a public area outside of the property line for the 200-acre (81-hectare) base case layout. By this measure, all four gasifier systems, regardless of candidate coal, have the potential to produce similar worst-case impacts and thus, are ranked equally. This conclusion is also true for a 400-acre (162-hectare) layout and is true for 11 of the 12 gasifier/candidate coal systems assuming a 600-acre (243-hectare) site (Quest, 2006).

Conclusions

The identification and evaluation of the largest potential releases associated with the four gasifier system designs for the proposed project results in the following findings:

- There are no flammable hazard impacts that extend off the project property.
- All four gasifier designs produce similar toxic hazards. No design demonstrates a clear advantage over others in this respect.
- The potential toxic impacts associated with the four gasifier system designs are dominated by releases of H_2S and SO_2 from the Claus unit that is included in each design.
- All three candidate coals, when used as feed to any of the four gasifier designs, have the potential to produce off-site toxic impacts. The Powder River Basin coal, used in any of the gasifiers,

produces slightly smaller toxic impact distances strictly due to its lower sulfur content and thus, lower H_2S flow rates to the Claus unit (Quest, 2006).

5.17.4 RISK ASSESSMENT FOR CO_2 SEQUESTRATION

The "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement" (Tetra Tech, 2007) describes the results of the human health risk assessment conducted to support the proposed project. The risk assessment addresses the potential releases of captured gases at the proposed power plant, during transport via pipeline to the proposed geologic storage site, and during subsurface storage.

The approach to risk analysis for CO_2 sequestration in geologic formations is still evolving. However, a substantial amount of information exists on the risks associated with deep injection of hazardous waste and the injection of either gaseous or supercritical CO_2 in hydrocarbon reservoirs for enhanced oil recovery. There are also numerous projects underway at active CO_2 injection sites that are good analogs to determine the long-term fate of CO_2. The FutureGen Project assessment relies heavily on the findings from these previous and ongoing projects.

5.17.4.1 CO_2 Sequestration Risk Assessment Process

The human health risk assessment is presented in five sections: conceptual site models (CSMs); toxicity data and benchmark concentration effect levels; pre-injection risk assessment; the post-injection risk assessment; and the risk screening and performance assessment. The results of the risk screening of CO_2 sequestration activities are presented in Section 5.17.4.2.

Conceptual Site Models

A central task in the risk assessment was the development of the CSMs. Potential pathways of gas release during capture, transport, and storage were identified for the pre- and post-injection periods. Site-specific elements of the proposed Tuscola Site were described in detail based on information from the EIVs provided by the FutureGen Alliance (FG Alliance, 2006a - d). These data provided the basis for the CSM parameters and the analysis of likely human health exposure routes.

Toxicity Data and Benchmark Concentration Effect Levels

The health effect levels were summarized for the identified exposure pathways. The toxicity assessment provides information on the likelihood of the chemicals of potential concern to cause adverse human-health effects. These data provided the basis for the comparison of estimated exposures and the assessment of potential risks.

Risk Screening and Performance Assessment

Pre-Injection Risk Assessment

This assessment evaluated the potential risks associated with the proposed plant and aboveground facilities for separating, compressing, and transporting CO_2 to the proposed injection site. The risk assessment for the pre-injection components was based on qualitative estimates of fugitive releases of captured gases and quantitative estimates of gas releases from aboveground sources under different failure scenarios. Failures scenarios of the system included pipeline rupture, pipeline leakage through a puncture (3-square-inch [19.4-square-centimeter] hole), and rupture of the wellhead injection equipment. The volumes of gas released for the pipeline scenarios were calculated using site-specific data for the four sites and the equations for gas emission rates from pipelines (Hanna and Drivas, 1987).

In general, the amount of gas released from a pipeline rupture or puncture was the amount contained between safety valves, assumed to be spaced at 5-mile (8.0-kilometer) intervals. The amount of gas released by a wellhead rupture was assumed to be the amount of gas contained within the well casing itself. The atmospheric transport of the released gas was simulated using the SLAB model (Ermak, 1990), with the gas initially in a supercritical[1] state (pressure ~2000 psi, temperature ~90°F [32.2°C]). The evaluation was conducted for the case with CO_2 at 95 percent and H_2S at 100 ppmv. The predicted concentrations in air were used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors.

Post-Injection Risk Assessment

The post-injection risk assessment describes the analysis of potential impacts from the release of CO_2 and H_2S after the injection into the subsurface CO_2 storage formation. A key aspect of the analysis was the compilation of an analog database that included the proposed site characteristics and results from studies performed at other CO_2 storage locations and from sites with natural CO_2 accumulations and releases. The analog database was used for characterizing the nature of potential risks associated with surface leakage due to caprock seal failures, faults, fractures, or wells. CO_2 leakage from the proposed project storage formation was estimated using a combination of relevant industry experience, natural analog studies, modeling, and expert judgment.

Qualitative risk screening of the proposed site was based upon a systems analysis of the site features and scenarios portrayed in the CSM. Risks were qualitatively weighted and prioritized using procedures identified in a health, safety, and environmental risk screening and ranking framework developed by Lawrence Berkeley National Laboratory for geologic CO_2 storage site selection (Oldenburg, 2005). In addition, further evaluation was conducted by estimating potential gas emission rates and durations using the analog database for a series of release scenarios. Three scenarios could potentially cause acute effects: upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells.

Six scenarios could potentially cause chronic effects: upward leakage through caprock and seals by gradual failure; release through existing faults due to effects of increased pressure; release through induced faults due to effects of increased pressure (local over-pressure); upward leakage through the CO_2 injection wells; upward leakage through the deep oil and gas wells; and upward leakage through undocumented, abandoned, or poorly constructed wells. For the chronic-effects case for the latter three well scenarios, the gas emission rates were estimated to be at a lower rate for a longer duration. The predicted concentrations in air were then used to estimate the potential for exposure and any resulting impacts on workers, off-site residents, and sensitive receptors. Other scenarios including catastrophic failure of the caprock and seals above the sequestration reservoir and fugitive emissions are discussed, but were not evaluated in a quantitative manner.

[1] A supercritical fluid occurs at temperatures and pressures where the liquid and gas phases are no longer distinct. The supercritical fluid has properties of both the gaseous and liquid states; normally its viscosity is considerably less than the liquid state, and its density is considerably greater than the gaseous state.

5.17.4.2 Consequence Analysis

Risk Screening Results for Pre-Sequestration Conditions (CO_2 Pipeline and Injection Wellheads)

As with all industrial operations, accidents can occur as part of the CO_2 transport and sequestration activities. Of particular concern is the release of CO_2 and H_2S. The CO_2 sequestration risk assessment (Tetra Tech, 2007) identified three types of accidents that could potentially release gases into the atmosphere before sequestration. Accidents included ruptures and punctures of the pipeline used to transport CO_2 to the injection sites and rupture of the wellhead equipment at these sites. The frequency of these types of accidents along the pipelines or at the wellheads is expected to be low. The amount of gas released depends on the severity and the location of the accident (i.e., pipeline or wellhead releases).

> **Accident Categories and Frequency Ranges**
>
> **Likely:** Accidents estimated to occur one or more times in 100 years of facility operations (frequency ≥ 1 x 10^{-2}/yr).
>
> **Unlikely:** Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from 1 x 10^{-2}/yr to 1 x 10^{-4}/yr).
>
> **Extremely Unlikely:** Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency from 1 x 10^{-4}/yr to 1 x 10^{-6}/yr).
>
> **Incredible:** Accidents estimated to occur less than one time in 1 million years of facility operations (frequency < 1 x 10^{-6}/yr).

Health effects from inhalation of high concentrations of CO_2 gas can range from headache, dizziness, sweating, and vague feelings of discomfort, to breathing difficulties, increased heart rate, convulsions, coma, and possibly death. Exposure to H_2S can cause health effects similar to those for CO_2, but at much lower concentrations. In addition H_2S can cause eye irritation, abnormal tolerance to light, weakness or exhaustion, poor attention span, poor memory, and poor motor function.

Impacts of CO_2 and H_2S gas releases on workers and the public depends on the location of the releases, the equipment involved, the meteorological conditions (including atmospheric stability and wind speed and direction), the directionality of any release from a puncture (e.g., upwards and to the side), and other factors. The effects to workers near a ruptured or punctured pipeline or wellhead are likely to be dominated by the physical forces from the accident itself, including the release of gases at high flow rates (3,000 kilograms per second) and at very high speeds (e.g., ~ 500 mph [804.7 kmph]). Thus, workers involved at the location of an accidental release would be impacted, possibly due to a combination of effects, such as physical trauma, asphyxiation (displacement of O_2), toxic effects, or frostbite from the rapid expansion of CO_2 (2,200 psi to 15 psi). Workers near a release could also be exposed at a distance of up to a distance of 446 feet (136 meters) to very high concentrations of CO_2 (e.g., 170,000 ppm) for short durations of one minute, which could be life-threatening.

For this evaluation, risks to workers were evaluated at two distances: workers at a distance of 66 feet (20.1 meters) of a release and other workers at a distance of 820 feet (249.9 meters). For all ruptures or punctures these individuals may experience adverse effects up to and including irreversible effects when concentrations predicted using the SLAB model (Ermak, 1990) exceed health criteria. The criteria used for this determination were the RELs established as occupational criteria for exposures to CO_2 and H_2S, consisting, respectively, of a short-term exposure limit (averaged over 15 minutes) for CO_2 and a ceiling concentration for H_2S that should not be exceeded at any time during a workday (NIOSH, 2007). Each of these criteria is listed in Table 5.17-4. Table 5.17-12 summarizes locations where pipeline and wellhead accidents create gas concentrations exceeding allowable levels for facility workers. Workers would be expected to be affected by CO_2 concentrations equal to or greater than 30,000 ppm from a pipeline rupture out to a distance of 459 feet (140 meters) and out to a distance of 504 feet (.153.5 meters) for a pipeline puncture. H_2S concentrations would exceed worker criteria at least out to a distance from the proposed plant boundary 1,384 feet (422 meters) from a pipeline rupture and 551 feet (168 meters) for a pipeline puncture.

Table 5.17-12. Exceedance of Occupational Health Criteria[1] for Workers

Release Scenario	Frequency Category[2]	Exposure Time	Gas	Area of Exceedance
Pipeline Rupture	U	Minutes	CO_2	Near pipeline only[3]
			H_2S	Within plant boundaries[4]
Pipeline Puncture[5]	U	Approximately 4 hours	CO_2	Near pipeline only[3]
			H_2S	Near pipeline only[3]
Wellhead Rupture	EU	Minutes	CO_2	None
			H_2S	Near wellhead only[3]

[1] Occupational health criteria used were the NIOSH REL ST and NIOSH REL C for CO_2 and H_2S, respectively. See Table 5.17-4.
[2] U (unlikely)=frequency of 1x 10^{-2}/yr to 1x 10^{-4}/yr; EU (extremely unlikely)=frequency of 1x10^{-4}/yr to 1x 10^{-6}/yr.
[3] Distances for CO_2 are 459 feet (140 meters) for a pipeline rupture; 504 feet (153.5 meters) for a pipeline puncture; and at least 230 feet (70 meters) for a wellhead rupture.
[4] Within 820 feet (250 m) of release.
[5] 3-inch by 1-inch rectangular opening in pipe wall.

There is also interest in whether ruptures or punctures may affect non-involved workers. Non-involved workers are those workers present within the proposed plant boundary distance, but employed in activities distant from the release point.

The effects for non-involved workers were to extend to a distance of 820 feet (249.9 meters) from the release point. The same occupational health criteria were used to determine the potential effects to the non-involved workers. Potential effects were determined by comparing SLAB model calculated concentrations with health criteria at the distances of concern. As shown in Table 5.17-12, no effects were estimated for non-involved worker exposures to CO_2 from any of the evaluated accidental releases. Alternatively, H_2S could possibly affect non-involved workers exposed to releases from a pipeline rupture, but not a pipeline puncture or wellhead rupture.

Accidental releases from the pipeline or wellhead, although expected to be infrequent, could potentially have greater consequences and affect the general public in the vicinity of a release. To determine the potential impacts to the public, the CO_2 sequestration risk assessment (Tetra Tech, 2007) evaluated potential effects to the public for accidental releases of gases from the pipelines and wellheads. The CO_2 pipeline failure frequency was calculated based on data contained in the on-line

Health Effects from Accidental Chemical Releases

The impacts from accidental chemical releases were estimated by determining the number of people who might experience adverse effects and irreversible adverse effects.

Adverse Effects*:* Any adverse health effects from exposure to a chemical release, ranging from mild and transient effects, such as headache or sweating (associated with lower chemical concentrations) to irreversible (permanent) effects, including death or impaired organ function (associated with higher concentrations).

Irreversible Adverse Effects: A subset of adverse effects, irreversible adverse effects are those that generally occur at higher concentrations and are permanent in nature. Irreversible effects may include death, impaired organ function (such as central nervous system damage), and other effects that impair everyday functions.

Life Threatening Effects: A subset of irreversible adverse effects where exposures to high concentrations may lead to death.

library of the Office of Pipeline Safety (OPS, 2007). Accident data from 1994-2006 indicated that 31 accidents occurred during this time period. DOE categorized the two accidents with the largest CO_2 releases (4,000 barrels and 7,408 barrels) as rupture type releases, and the next four highest releases (772 barrels to 3,600 barrels) as puncture type releases. For comparison, five miles of FutureGen pipeline contains about 6,500 barrels, depending on the pipeline diameter. Assuming the total length of pipeline involved was approximately 1,616 miles (2,600 kilometers) based on data in Gale and Davison (2004), the rupture and puncture failure frequencies were calculated to be 5.92 x 10^{-5}/(km-yr) and 1.18 x 10^{-4}/(km-yr), respectively. Puncture failure frequencies are reported in failure events per unit length and time based on data for a particular length of pipeline and period of time.

The pipeline failure frequencies are only one component of the exposure frequency. The total exposure frequency also considered the percent of time the wind was blowing in the direction of the receptor, the percent of time the wind stability was the greatest, and the section of the pipeline that would have to fail to possibly allow the release to reach the exposed population.

The failure frequencies for pipeline ruptures and punctures are calculated as the product of the pipeline length at the site and the failure frequencies presented above (ruptures: 5.92 x 10^{-5}/km-yr; punctures: 1.18 x 10^{-4}/km-yr) (Gale and Davison, 2004). The failure rate of wellhead equipment during operation is estimated as 2.02 x 10^{-5} per well per year based on natural gas injection-well experience from an IEA GHG Study (Papanikolau et al., 2006). These failure frequencies provide the basis for the frequency categories presented in Tables 5.17-12 and Table 5.17-15.

The predicted releases, whether by rupture or puncture are classified as unlikely: the frequencies for ruptures is 1.1 x 10^{-3}, and the frequency for punctures is 2.1 x 10^{-3}. The predicted releases from wellhead failures are classified as extremely unlikely; the frequency for a wellhead rupture 1 x 10^{-6} to 2 x 10^{-5}/year. The criteria used to examine potential health effects, including mild and temporary as well as permanent effects are defined in Tables 5.17-7 and 5.17-13. The CO_2 and H_2S exposure durations that could potentially occur for the three types of release scenarios are noted in Table 5.17-14.

Table 5.17-13. Description of Hazard Endpoints for Public Receptors

Hazard Endpoint	Description
RfC	An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
TEEL 1	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
TEEL 2	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.
TEEL 3	The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects.

RfC = Inhalation Reference Concentration.
TEEL = Temporary Emergency Exposure Limits.
Sources: EPA, 2006a,b; DOE, 2006.

Table 5.17-14. Hazard Endpoints for Public Receptors

Exposure Time	Gas	Effect Category	Concentration (ppmv)	Hazard Endpoint[1]
Minutes (Pipelines)	CO_2	Adverse effects	30,000	TEEL 1
		Irreversible adverse effects	30,000	TEEL 2
		Life threatening	40,000	TEEL 3
	H_2S	Adverse effects	0.51	TEEL 1
		Irreversible adverse effects	27	TEEL 2
		Life threatening	50	TEEL 3
Minutes (Explosions[2])	H_2S	Irreversible adverse effects	41	AEGL 2 (10 minute)
		Life threatening	76	AEGL 3 (10 minute)
	SO_2	Irreversible adverse effects	0.75	AEGL 2 (10 minute)
		Life threatening	42	AEGL 3 (10 minute)[3]
Hours/Days	CO_2	Adverse effects	20,000	Headache, etc.[4,5]
		Life threatening	70,000	Headache, etc.[4,5,6]
	H_2S	Adverse effects	0.33	AEGL 1 (8 hour)
		Irreversible adverse effects	17	AEGL 2 (8 hour)
		Life threatening	31	AEGL 3 (8 hour)
Years	CO_2	Adverse effects	40,000	Headache, etc.[4,7]
		Life threatening	70,000	Headache, etc.[4,6,7]
	H_2S	Irreversible adverse effects	0.0014	RfC

1 See Tables 5.17-7 and 5.17-13 for descriptions of the TEEL and AEGL endpoints.
2 Used by Quest (2006) to evaluate releases from explosions.
3 Quest, 2006.
4 EPA, 2000.
5 Headache and dyspnea with mild exertion.
6 Unconsciousness and near unconsciousness.
7 Headache, dizziness, increased blood pressure, and uncomfortable dyspnea.
TEEL = Temporary Emergency Exposure Limit.
AEGL = Acute Exposure Guideline Level.
RfC = Inhalation Reference Concentration.

Simulation models were used to estimate the emission of CO_2 for the aboveground release scenarios when the gas is in a supercritical state. The SLAB model developed by the Lawrence Livermore National Laboratory and approved by U.S. EPA was used to simulate denser-than-air gas releases for both horizontal jet and vertically elevated jet scenarios. The model simulations were conducted for the case with CO_2 at 95 percent and H_2S at 100 parts per million by volume (ppmv). The state of the contained captured gas prior to release is important with respect to temperature, pressure, and the presence of other constituents. Release of CO_2 under pressure would likely cause rapid expansion and then reduction in temperature and pressure, which can result in formation of solid-phase CO_2, as explained in Appendix C-III of the risk assessment (Tetra Tech, 2007). The estimated quantity of solid-phase formed was 26 percent of the volume released; therefore 74 percent of the volume released from a pipeline rupture or puncture was used as input to the SLAB model for computing atmospheric releases of CO_2 and H_2S. Carbon dioxide is heavier than air and subsequent atmospheric transport and dispersion can be substantially affected by the temperature and density state of the initially released CO_2. The

meteorological conditions at the time of the release would also affect the behavior and potential hazard of such a release.

The potential effects of CO_2 and H_2S releases from pipeline ruptures and punctures were evaluated using an automated "pipeline-walk" analysis. The methodology (described briefly in Appendix D and in detail in Section 5.4.2 and Appendix C-IV of the risk assessment) estimates the maximum expected number of individuals from the general public potentially affected by pipeline ruptures or punctures at each site. The analysis takes into account the effects of variable meteorological conditions and the location of pipeline ruptures or punctures. For wellhead ruptures the potential impact zones corresponding to health-effects criterion values for H_2S and CO_2 were determined using the SLAB model and assuming meteorological conditions that resulted in the highest potential chemical exposures (i.e., assuming wind speeds of 2 meters per second and stable atmospheric conditions). The number of individuals potentially affected within the impact zone was determined from population data obtained from the 2000 U.S. Census.

This modeling approach to assess potential chemical exposures is based on the assumption that the population size and locations near the proposed project would not change during the time period assessed for this proposed project (i.e., 50 years for releases during the operation phase and 5,000 years for releases of sequestered gases).

Among the three types of accidental releases, the postulated accident that would result in the largest number of people with adverse health effects (including mild and temporary effects) is a pipeline rupture from about 7.4 miles (12 kilometers) to the injection site (see Table 5.17-15). If this type of accident occurred, it is estimated that up to 7 members of the general public might experience adverse effects, primarily from H_2S exposure (mild and temporary effects, such as headaches or exhaustion). Since the pipeline would extend approximately 11 miles from the proposed power plant to the injection wellhead, the public could be affected by releases along the pipeline, while workers are more likely to be exposed at the proposed power plant. None of the postulated accidents would cause irreversible health effects to the general public. No fatalities were projected for the same group.

As shown in Table 5.17-15, the number of individuals in the general public potentially with adverse effects from other types of accidents would be less, with 1 individual adversely affected by a pipeline puncture and less than one from a wellhead rupture. No fatalities were projected for a pipeline puncture or a wellhead rupture.

Although the potential for releases from pipelines or wellheads may be low, any releases from the pipeline or wellheads could be high consequence events. For this reason, there are well-established measures for preventing or reducing impacts of accidental releases. These include design recommendations (e.g., increasing pipeline wall thickness, armoring pipelines in specific locations such as water body and road crossings); use of newer continuous pipeline monitors and computer models to rapidly interpret changes in fluid densities, pressures, etc.; use of safety check valves at more frequent intervals (e.g., 1 to 3 miles [1.6 to 4.8 kilometers] instead of 5 miles [8 kilometers] in populated areas) that can quickly isolate damaged section of the pipeline; operational procedures (e.g., activating "bleed" valves to control location and direction of releases should a puncture occur); and emergency response procedures (e.g., notifying the public of events requiring evacuation). In high consequence areas such as high population densities, the pipeline could be buried at a deeper depth, valves could be buried in underground vaults, and the pipeline and wellhead locations could be marked and protected with chain link fences and posts. The pipeline could be routed to maximize the distance to sensitive receptors and to allow a buffer between the pipeline and nearest residence or business. In some cases it may be possible to further reduce the concentrations of effect-causing substances being transported (e.g., H_2S). These measures would be implemented, as appropriate.

Risk Screening Results for Post-sequestration Conditions

Under post-sequestration conditions, a slow continuous leak through a deep well was determined to be the only scenario that may cause adverse health effects to the general public (Tetra Tech, 2007). Since the deep wells within the vicinity of the proposed CO_2 injection wells would be properly sealed before initiation of CO_2 sequestration, and since the proposed CO_2 injection well(s) would also be properly sealed after their use, it is extremely unlikely that the proposed project would create a gas release of consequence from the subsurface (Table 5.17-16). However, if this type of release occurred at the proposed sequestration site, it is estimated that up to six members of the public might experience irreversible adverse effects from H_2S exposures (i.e., nasal lesions). This estimate is based on the assumption that the future population would be the same as current conditions, with the town of Arcola located along the periphery of the sequestration plume footprint. Also, this evaluation is based on the EPA RfC criterion for chronic (i.e., long-term and low level) exposures that incorporates a safety factor of 300 to be protective of sensitive individuals. The RfC criterion value for H_2S is an extremely low concentration: 0.0014 ppm.

Table 5.17-16. Number of Individuals with Adverse Effects from Potential Exposure to Post-Sequestration H_2S Gas Releases

Release Scenario	Frequency Category[1]	Number Affected[2]
Upward slow leakage through CO_2 injection well	EU	6
Upward slow leakage through deep oil and gas wells	n/a	n/a
Upward slow leakage through other existing wells	EU[3]	6

[1] EU (extremely unlikely)=frequency of $1x10^{-4}$/yr to $1x10^{-6}$/yr.
[2] Potentially irreversible adverse effects could occur within 745 feet of the release point; instances presented here are converted from meters, which were used in the risk assessment (see Appendix D). Also, assumed future population density would remain the same as current conditions, with the town of Arcola on the periphery of the sequestration plume footprint.
[3] Assumes that the other wells potentially within the sequestration plume footprint have been properly sealed before sequestration begins.
n/a = not applicable.

Since CO_2 sequestration is a relatively new technology, a series of mitigation and monitoring measures have been developed for these activities. In addition to plugging and properly abandoning wells, monitoring plans include use of remote sensing methods, atmospheric monitoring techniques, methods for monitoring gas concentrations in the subsurface and surface environments, and processes for monitoring subsurface phenomena associated with the injection reservoir and the caprock (FG Alliance, 2006a-d). A specific schedule for different types of monitoring has been proposed for the proposed Tuscola Sequestration Site and surrounding areas that would occur before and during sequestration activities (FG Alliance, 2006b). Also, after the cessation of injection monitoring, activities would be used to identify any long-term, post-closure changes in land surface conformation, soil gas, and atmospheric fluxes of CO_2.

5.17.5 TERRORISM/SABOTAGE IMPACT

As with any U.S. energy infrastructure, the proposed power plant could potentially be the target of terrorist attacks or sabotage. In light of two recent decisions by the U.S. Ninth District Court of Appeals (*San Luis Obispo Mothers v. NRC, Ninth District Court of Appeals, June 2, 2006; Tri Valley Cares v. DOE, No. 04-17232, D.C. No. CV-03-03926-SBA, October 16, 2006)* DOE has examined potential environmental impacts from acts of terrorism or sabotage against the facilities being proposed in this EIS.

Although risks of sabotage or terrorism cannot be quantified because the probability of an attack is not known, the potential environmental effects of an attack can be estimated. Such effects may include localized impacts from releases from the proposed power plant and associated facilities, assuming that such releases would be similar to what would occur under an accident or natural disaster (such as a tornado). To evaluate the potential impacts of sabotage/terrorism, failure scenarios are analyzed without specifically identifying the cause of failure mechanism. For example, a truck running over a wellhead at the proposed sequestration site would result in a wellhead failure, regardless of whether this was done intentionally or through mishap. Therefore, the accident analysis evaluates the outcome of catastrophic events without determining the motivation behind the incident. The accident analyses evaluated potential releases from pipelines, wellheads, and major and minor system failures/accidents at the proposed power plant site. These accidents could also be representative of the impacts from a sabotage or terrorism event.

Various release scenarios were evaluated including: pipeline rupture, pipeline puncture, and wellhead equipment rupture. Gaseous emissions were assumed to be 95 percent CO_2 and 0.01 percent H_2S. Table 5.17-15 provides effects levels for individuals of the public that could potentially be exposed to releases. Of these release scenarios at the proposed Tuscola Site, a pipeline rupture would result in impacts to the public over the largest distance. For a release of the CO_2 gas from a pipeline rupture, no impacts from CO_2 would occur beyond 459 feet (140 meters) of the release, while irreversible adverse impacts from the H_2S in the gas stream could occur within 0.3 mile (0.4 kilometer) of the release, tapering to no impact at a distance of 3.1 miles (5.0 kilometers). Under upperbound conditions, such a release could cause adverse health effects to about 7 people within the general populace.

For short-term CO_2 and H_2S co-sequestration testing over a two week period, the concentration of H_2S in the sequestered gas would be 2 percent (20,000 ppmv) or 200 times greater than the base case, which assumed the H_2S concentration would be 100 ppmv. Thus, impacts to the public (both mild and life-threatening effects) could extend to greater distances than shown for the base case in Table 5.17-15. Although short-term testing of co-sequestration (CO_2 with H_2S) is examined for two weeks during the DOE-sponsored phase of the proposed project, no decision has been made yet to pursue co-sequestration over a longer period. However, co-sequestration cannot be ruled out as a possible operating scenario.

In general, ruptures or punctures of pipelines are rare events. Based on Office of Pipeline Safety nationwide statistics, 31 CO_2 pipeline accidents occurred between 1994 and 2006. None of these reported accidents were fatal nor caused injuries (OPS, 2006). Should a CO_2 pipeline rupture occur, it would be immediately detected by the pipeline monitoring system, alerting the pipeline operator. Once the flow of gas has stopped, the gas would dissipate and chemical concentrations at the source of the release would decline to non-hazardous levels in a matter of minutes for a pipeline rupture and several hours for a pipeline puncture. However, the released gas then migrates downwind, as described in the preceding sections.

The potential health effects from "upperbound" explosion and release scenarios at the proposed power plant (Section 5.17.3.2) can be contrasted with those associated with the pipeline. Hazardous events evaluated for the proposed power plant included: gas releases and exposure to toxic gas clouds, flash fires, torch fires, and vapor cloud explosions. Evaluations of these results indicate:

- Toxic releases from the Claus unit that could extend from 0.2 to 1.4 miles (0.3 to 2.3 kilometers) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are at least 17 family residences, farm home sites, or commercial properties within the maximum distance potentially impacted by releases from the Claus unit (i.e., 1.4 miles [2.3 kilometers] from the site) under current conditions. Examination of population density estimates (see Section 5.17.4.2) suggests that such releases could potentially cause irreversible adverse effects in 115 individuals exposed to SO_2, with 3 exposed to potentially life threatening concentrations, and 15 people exposed to irreversible adverse effects and 8 exposed to potentially life threatening concentrations from H_2S (Table 5.17-17).

- Toxic releases from the gasifier could extend from 0.2 to 0.6 mile (0.3 to 1.0 kilometer) from the point of release (Quest, 2006). Based on aerial photographs of the region, there are at least four family residences, farm homes or commercial properties within this release footprint. Examination of the population density estimates suggests that such a release could potentially cause irreversible adverse effects in 21 individuals exposed to CO, with three exposed to potentially life-threatening effects.
- Fire hazards at the plant site would not extend off site.
- Under all worst case scenarios, plant workers would be the most at-risk of injury or death.

Table 5.17-17. Effects to the Public from Explosions at the FutureGen Plant

Release Scenario	Gas	Effect[1]	Distance[2] (miles [kilometers])	Number Affected
Claus Unit failure (release duration = minutes)	H_2S	Irreversible adverse effects	0.5 (0.8)	15
		Life threatening	0.4 (0.6)	8
	SO_2	Irreversible adverse effects	1.4 (2.3)	115
		Life threatening	0.2 (0.3)	3
Gasifier release (release duration = minutes)	CO	Irreversible adverse effects	0.6 (1.0)	21
		Life threatening	0.2 (0.3)	3

[1] See Table 5.17-6 and Table 5.17-7 for an explanation of the effects.
[2] Distances taken from Quest, 2006.

As discussed, if an explosion occurred at the proposed plant site as the result of a terrorist attack, it is likely that hazardous gases would cause injury and death of workers within the proposed plant site and most likely the public located within 1.4 miles (2.3 kilometers) of the proposed plant site.

5.18 COMMUNITY SERVICES

5.18.1 INTRODUCTION

This section identifies the community services most likely to be affected by the construction and operation of the proposed FutureGen Project at the Tuscola Power Plant Site in Douglas County, Illinois. This section addresses law enforcement, fire protection, emergency response, health care services, and the school system. Additionally, the potential effects that construction and operation of the proposed FutureGen Project could have on those services, as well as any proposed mitigation measures that could reduce any adverse effects, are discussed.

5.18.1.1 Region of Influence

The ROI for community services includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site and sequestration site. The proposed sequestration site is located approximately 11 miles (17.7 kilometers) south of the proposed plant site. As shown in Figure 5.18-1, the 50-mile (80.5-kilometer) radius for the sequestration site and the 50-mile (80.5-kilometer) radius for the power plant site largely overlap. The ROI for the proposed Tuscola Power Plant Site and sequestration site includes all land areas within the counties of Douglas, Champaign, Coles, Cumberland, Edgar, Macon, Moultrie and Piatt in Illinois; and some land area within the counties of Christian, Clark, Crawford, DeWitt, Effingham, Fayette, Ford, Jasper, Logan, McLean, Sangamon, Shelby and Vermilion in Illinois, and Vermillion and Vigo in Indiana.

Community services data are reported county-wide because this format is most often used in public information. This includes counties that have only a relatively small portion of land lying within the 50-mile (80.5-kilometer) radius. Therefore, if only a minor portion of a county was touched by the 50-mile (80.5-kilometer) radius and two or fewer small communities fall within that minor portion of the county, then that county was excluded from the analysis as not materially affecting the aggregate community services in the ROI. Those counties with two or fewer small communities that were excluded from the ROI include Iroquois and Montgomery in Illinois, and Fountain, Parke, Sullivan and Warren in Indiana. Excluding these counties from the ROI makes the remaining data more meaningful for determining project effects.

Although the analysis in this section addresses the entire ROI, the affected environment and environmental consequences focus on the proposed power plant site in Douglas County.

5.18.1.2 Method of Analysis

DOE evaluated the impacts to community services based on anticipated changes in demand for law enforcement, fire protection, emergency response, health care services, and schools using research provided in the Tuscola EIV (FG Alliance, 2006b). In many cases, the change in demand is directly related to the increased population.

DOE assessed the potential impacts based on the following criteria:

- Affect on law enforcement;
- Conflict with local or regional management plans for law enforcement;
- Affect on fire protection;
- Conflict with local or regional management plans for fire protection;
- Affect on emergency response;

- Conflict with local or regional management plans for emergency response;
- Affect on health care services;
- Conflict with local or regional management plans for health care services;
- Affect on local schools; and
- Conflict with local or regional management plans for local schools.

5.18.2 AFFECTED ENVIRONMENT

5.18.2.1 Law Enforcement

Douglas County is served by six municipal police departments located in Arcola, Arthur, Atwood, Newman, Tuscola, and Vila Grove, and all operate under a mutual aid agreement (UC, 2005a and FG Alliance, 2006b). Table 5.18-1 presents the staffing levels of these police departments. Thirty-four full-time and 29 part-time law enforcement officers work out of these six departments in Douglas County (FG Alliance, 2006b). Douglas County is also served by the Douglas County Sheriff's Office and District 10 of the Illinois State Police (UC, 2005a and ILSP, 2004).

Table 5.18-1. Staffing Levels of Police Departments in Douglas County

Community	Full-Time Officers	Part-Time Officers
Tuscola	7	1
Atwood	3	6
Arthur	4	4
Arcola	5	3
Villa Grove	4	1
Newman	1	4
Douglas Co. Sheriff	10	10
Total	**34**	**29**

Source: FG Alliance, 2006b and CD, 2002.

Champaign, Coles, Cumberland, Edgar, Macon, Moultrie, and Piatt counties in Illinois are served by a total of 29 municipal police departments and each county has its own Sheriff's Office (USACOPS, 2005a). Each of these counties is served by District 10 of the Illinois State Police, except Cumberland County, which is served by District 12 (ILSP, 2004). The other Illinois counties located in the ROI are served by a total of 69 municipal police departments, their own County Sheriff's Office, and the Illinois State Police (UC, 2005a and ILSP, 2004). Vermillion and Vigo counties in Indiana are served by a total of three municipal police departments, their own County Sheriff's Office, and District 32 of the Indiana State Police (UC, 2005b and INSP, 2006).

The U.S. has an average of 2.3 police officers per thousand residents (Quinlivan, 2003). In Douglas County, the ratio is approximately 2.4 officers per thousand residents based on the 2005 projected population and the equivalent of 49 full-time law enforcement officers. Douglas County's crime rate is also extremely low. Index offenses, which include criminal sexual assault, robbery, aggravated assault, burglary, theft, motor vehicle theft and arson, are a way of measuring and comparing crime statistics (ICJIA, 2004). The State of Illinois averaged 3,742 index offenses per 100,000 residents in 2003, whereas Douglas County reported 331 per 100,000 residents for the same year (The Disaster Center, 2005).

5.18.2.2 Emergency and Disaster Response

The Douglas County Sheriff's Office operates the county's 911 center and dispatches fire and rescue, ambulances, and emergency medical personnel. Douglas County and the entire ROI are served by 56 ambulance services, one air ambulance service, and the Illinois State Police. The Tuscola fire department, the Cabot Corporation and Lyondell-Equistar Chemicals provide hazardous materials emergency response in Douglas County (FG Alliance, 2006b; ILSP, 2004; and YYP, 2006a). Through the established Mutual Aid Box Alarm System, up to 120 ambulances from throughout Illinois could be made available within an hour of notification (FG Alliance, 2006b).

5.18.2.3 Fire Protection

Douglas County has nine fire departments with trained fire services personnel (ISFM, 2006). Both the Cabot Corporation and Lyondell-Equistar Chemicals, located less than 1 mile (1.6 kilometers) from the proposed Tuscola Power Plant Site, are members of the region's mutual aid association and would respond to a fire emergency (FG Alliance, 2006b). The ROI is served by a total of 213 fire departments in Illinois and at least 20 fire departments in Vermillion and Vigo counties in Indiana (ISFM, 2006 and YYP, 2006b). All Illinois fire departments are members of the region's mutual aid association and would assist in an emergency if called upon.

The Tuscola, Decatur, Charleston, Mattoon, Oakland, Urbana and Champaign fire departments have the capability to provide a high angle, vertical or confined space rescue (FG Alliance, 2006b).

5.18.2.4 Hazardous Materials Emergency Response

The Illinois counties within the ROI would be entirely served by Illinois' 36 Statewide Hazardous Materials (HazMat) Teams (IHS, 2003). All 36 teams are members of the mutual aid association and would respond to a hazardous materials emergency if so directed (IHS, 2003). Douglas County is also served by both the Cabot Corporation and Lyondell-Equistar Chemicals who respond outside of their own plant locations for hazardous materials emergencies. In addition, the Tuscola fire department has HazMat capability to include personnel and equipment support. HazMat units respond and perform functions to handle and control actual or potential leaks or spills of hazardous substances (OSHA, 1994).

5.18.2.5 Health Care Service

A total of 27 hospitals and medical centers serve the ROI, with 22 in Illinois counties and five in Vermillion and Vigo counties in Indiana (IHA, 2006; IDOH, 2006a; and IDOH, 2006b). Douglas County and its residents are served by seven large hospitals in the region, which include Provena-Covenant Hospital in Champaign, Sara Bush Lincoln Health Center in Mattoon, Decatur Memorial Hospital in Decatur, Paris Community Hospital in Paris, Kirby Hospital in Monticello, and Memorial Medical Center in Springfield.

There are approximately 3,626 beds in the 27 hospitals and medical centers in the ROI (HD, 2006; IDOH, 2006a; and IDOH, 2006b). Based on the 2005 total projected population for the ROI, there are 3.0 beds per thousand people within the ROI.

5.18.2.6 Local School System

Douglas County has four elementary schools, three junior high schools, four high schools, and as many as seven private schools (Swager, 2006; CD, 2002). Table 5.18-2 shows the expenditure per pupil per school year and the student-teacher ratios for Douglas County, the State of Illinois and the U.S.

Table 5.18-2. School Statistics for Douglas County, Illinois and the U.S. in 2005

	Expenditure per Pupil per School Year ($)	Pupils per Teacher (Elementary/Secondary)
Douglas County	12,080	15.7/12.3
Illinois	14,000	18.9/18.4
Nationwide	8,287	15.4/15.4

Source: FG Alliance, 2006b; USCB, 2006; and NCES, 2005.

5.18.3 IMPACTS

5.18.3.1 Construction Impacts

As discussed in Section 5.19, the need for construction workers would be limited in duration, but would likely cause an influx of temporary residents. Construction workers could be drawn from a large labor pool within the ROI, however some temporary construction workers with specialized training and workers employed by contractors from outside the ROI would also likely be employed to construct the facilities. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period.

Law Enforcement

The temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. The increased temporary population could affect the working capacities of individual local police departments, depending on where the workers chose to reside. The affected locations would depend on the degree to which the construction workers would be dispersed throughout the communities within the ROI. As discussed in Section 5.19, temporary construction workers would likely reside in short-term housing. Douglas County does not have enough hotel rooms, when occupancy rates are taken into account, to accommodate all of the temporary workers (FG Alliance, 2006b). Therefore, it is anticipated that the availability of local lodging would effectively disperse workers throughout communities within the ROI and law enforcement would not be affected.

The population in the ROI is expected to grow on average by 3 percent, or approximately 35,977 people, by 2010 (FG Alliance, 2006b). Additional police and other law enforcement services would be required to accommodate the growing population. The current number of law enforcement officers is above the U.S. average and county crime rates are extremely low, which is an indication that law enforcement is appropriately staffed (FG Alliance, 2006b; CD, 2002; and Quinlivan, 2003). The exact number of construction workers and their families who would temporarily relocate to the area for the proposed project is unknown, but any additional population is not anticipated to create a permanent unsustainable increase in the demand for law enforcement.

With companies such as the Cabot Corporation and Lyondell-Equistar Chemicals present in Douglas County, local law enforcement agencies have a history of maintaining order in an area with industrial occupancies. Within the ROI, the proposed project is not expected to increase the demand on these services substantially beyond the available capacities. In addition, construction activities would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 5.17, construction of the proposed facility would involve the use of flammable and combustible materials that pose an overall increase in risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during construction of the proposed project is low. Incidents during construction of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Illinois fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site. Currently, 213 fire departments within both the ROI and the State of Illinois are members of the State's mutual aid agreement. Any of these fire departments would be available to assist in a fire emergency if needed.

Emergency and Disaster Response

As discussed in Section 5.17, it is anticipated that construction of the proposed facilities would result in an average of 19.6 total recordable injury cases per year with a peak maximum of 39.2 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site would be adequately served in an emergency. Douglas County and the entire ROI are served by 56 ambulance services and one air ambulance service, and a total of 120 ambulances from throughout Illinois could be made available for local response within an hour of notification. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond current available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

The 350 to 700 temporary construction jobs created by the proposed FutureGen Project could cause an influx of temporary residents to the communities within the ROI. The ROI currently has 3.0 hospital beds per thousand residents, whereas the U.S. average is 2.9 hospital beds per thousand residents. However, even if all 700 temporary workers relocated within the ROI, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 3.0 and, therefore, no impacts are expected.

The **Hill-Burton Act of 1946** established the objective standard for the number of hospitals, beds, types of beds, and medical personnel needed for every 1,000 people, by county (Everett, 2004). It called for states to "afford the necessary physical facilities for furnishing adequate hospital, clinic, and similar services to all their people." The Hill-Burton standard is 4.5 beds per thousand residents (Everett, 2004). However, the U.S. average in 2001 was 2.9 beds per thousand residents, which is about 24 percent fewer beds per thousand residents than the current ratio within the ROI (Everett and Baker, 2004).

Local School System

Although some portion of the temporary construction workers may relocate to the ROI with their families, a large influx of school-aged children would not be anticipated. Because construction of the proposed facilities would create temporary work, it is unlikely that the construction workers would relocate with their families. It is more likely that temporary workers, who permanently reside outside of the ROI, would seek short-term housing for themselves during the work week. As a result, any influx of school-aged children would result in a minimal impact to local schools and their resources.

Project construction would not displace existing school facilities or conflict with school system plans.

5.18.3.2 Operational Impacts

As discussed in Section 5.19, the operational phase of the proposed facilities would require approximately 200 permanent staff. Although the exact number of permanent staff who would relocate to the ROI is unknown, the increase in population would be very small, even if all 200 positions were filled by staff relocating to the ROI. Based on the 2005 projected population and the average family size within the ROI, the relocation of 200 workers would result in a population increase of 490 people, representing a 0.04 percent increase in population within the ROI.

Law Enforcement

Law enforcement in the ROI would be sufficient to handle the 0.04 percent increase in population during facility operations. A 0.04 percent increase in population in the ROI would result in an imperceptibly small decrease, less than 0.02, in the ratio of law enforcement officers per thousand residents. In addition, the average crime rate in Douglas County, which is consistent with crime rates in rural communities in Illinois, is well below the national average. This is an indication that law enforcement is appropriately staffed and would be sufficient to handle a minor increase in population.

Project operation would not impede effective law enforcement or conflict with regional plans.

Fire Protection

As discussed in Section 5.17, operation of the proposed power plant would involve the use of flammable and combustible materials that pose an overall increase to risk of fire or explosion at the project site. However, the probability of a significant fire or explosion during operation of the proposed project is low. Incidents during the operational phase of the proposed facilities would not increase the demand for fire protection services beyond the available capacity of currently existing services. Illinois fire departments would have the capacity to respond to a major fire emergency at the proposed power plant site. There are currently 213 fire departments within both the ROI and the State of Illinois that are members of the State's mutual aid agreement. Any of these fire departments could assist in a fire emergency if needed.

Emergency and Disaster Response

As indicated in Section 5.17, it is anticipated that the operational phase of the proposed facilities would result in an average of 6.6 total recordable injury cases per year. Based on the number of emergency response organizations, the proposed power plant site would be adequately served in an emergency. Douglas County and the entire ROI are served by 56 ambulance services and one air ambulance service, and a total of 120 ambulances from throughout Illinois could be made available for local response within an hour of notification. Emergencies during construction of the proposed facilities would not be expected to increase the demand for emergency services beyond current available capacity. While it is not anticipated that actual conflicts would arise, the nature and timing of accidents could result in an increased response time when there are other accidents in the area, thereby increasing the demand for emergency services.

Health Care Service

It is anticipated that the 200 permanent jobs created by FutureGen Project operations could cause an influx of permanent residents to the communities within the ROI. This influx would result in an increase in population of 0.04 percent, representing approximately 490 new residents. Currently, health care capacity in the ROI is greater than the national average, with 3.0 hospital beds per thousand residents. The U.S. average is 2.9 hospital beds per thousand residents. Although the proposed project would increase the number of residents requiring medical care, the reduction in health care capacity would be extremely small. The ratio of hospital beds per thousand residents would remain at approximately 3.0 and, therefore, no impacts are expected.

Local School System

While the actual number of the 200 permanent staff who would relocate to the ROI with their families to work at the facility is unknown, based on the average family size and the percent of school-aged children within the ROI, it can be estimated that a maximum of 116 new school-aged children could relocate within the ROI (FG Alliance, 2006b). The projected 2007 public school enrollment for the Illinois counties within the ROI is 156,731 for kindergarten through 12^{th} grade (ISBE, 2005). An additional 116 new school-aged children would represent a 0.07 percent increase in the number of students who would share the current schools' resources in the ROI.

Project operation would not displace existing school facilities or conflict with school system plans.

5.19 SOCIOECONOMICS

5.19.1 INTRODUCTION

This section addresses the region's socioeconomic resources most likely to be affected by the construction and operation of the proposed FutureGen Project. This section discusses the region's demographics, economy, sales and tax revenues, per capita and household incomes, sources of income, housing availability, and the potential effects that construction and operation of the proposed project could have on socioeconomics.

5.19.1.1 Region of Influence

The ROI for socioeconomics includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors. The proposed sequestration site is located approximately 11 miles (17.7 kilometers) south of the proposed power plant site. As shown in Figure 5.18-1, the ROI for the proposed FutureGen Project includes all land area in the following counties: Douglas, Champaign, Coles, Cumberland, Edgar, Macon, Moultrie, and Piatt in Illinois. The ROI also includes some land area in the following counties: Christian, Clark, Crawford, DeWitt, Effingham, Fayette, Ford, Jasper, Logan, McLean, Sangamon, Shelby, and Vermillion in Illinois and Vermillion and Vigo in Indiana. Therefore, this section focuses on the socioeconomic environment at the county level rather than by the proposed power plant site, sequestration site, and utility and transportation corridors.

A few counties have a relatively small portion of land within the ROI and were, therefore, excluded from the analysis as not materially affecting the aggregate socioeconomics of the ROI. Iroquois and Montgomery counties in Illinois and Fountain, Parke, Sullivan, and Warren counties in Indiana contain no more than two small communities and were also excluded from the ROI. Although the analysis addresses the entire ROI, the affected environment and environmental consequences focus more on the proposed power plant site located in Douglas County.

5.19.1.2 Method of Analysis

DOE reviewed U.S. Census data, the Alliance EIVs, and other information to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Displace existing population or demolish existing housing;
- Alter projected rates of population growth;
- Affect the housing market;
- Displace existing businesses;
- Affect local businesses and the economy;
- Displace existing jobs; and
- Affect local employment or the workforce.

5.19.2 AFFECTED ENVIRONMENT

5.19.2.1 Regional Demographics and Projected Growth

The regional demographics for the ROI are provided in Table 5.19-1. In 2000, the total population for the counties within the ROI was 1,199,171 (USCB, 2000a). The total population for the ROI is anticipated to increase by approximately 3 percent by 2010 to 1,235,148 (FG Alliance, 2006b).

The 2000 Illinois population was 12,419,293 and is anticipated to increase by approximately 4 percent by 2010 to 12,916,894 (USCB, 2005a). The 2000 U.S. population was 282,125,000 and is anticipated to increase by approximately 9.5 percent by 2010 to 308,936,000and approximately 19 percent by 2020 to 335,805,000 (USCB, 2000b). Thus, the ROI population is anticipated to grow at a slower rate than the U.S. and Illinois (FG Alliance, 2006b). Douglas County had a total population of 19,922 in 2000 (FG Alliance, 2006b) and has the tenth smallest population within the ROI and a projected growth rate larger than the ROI's average growth rate. The median age of residents in 2000 was 35.3 years for the nation, 34.7 years for Illinois, and 37.4 years for Douglas County, indicating an older local population (USCB, 2000c and USCB, 2000d).

An Amish community is present in Douglas, Coles, and Moultrie counties, with the largest population located in Southwest Douglas County and Northwest Coles County.

5.19.2.2 Regional Economy

Income and Unemployment

Table 5.19-2 provides information about the workforce, and per capita and median household incomes for the counties located within the ROI. In July 2006, the average unemployment rate for the ROI was 6.2 percent and approximately 36,000 were unemployed (USBLS, 2006a). The average unemployment rate in July 2006 was 4.8 percent in the U.S. and 4.7 percent in Illinois (USBLS, 2004 and 2006b). Thus, the unemployment rate within the ROI is higher than that for either Illinois or the U.S.

In 1999, the average median household income for the ROI was $37,543 and the average per capita income was $18,502 in 1999 (FG Alliance, 2006b and USCB, 2000e). Respectively, the median household income for the U.S. was $41,994 and the per capita income was $21,587 (USCB, 2000f and USCB, 2000g). The State of Illinois had a median household income of $46,590 and a per capita income of $23,104 (USCB, 2000e). Douglas County had a median household income of $39,439 and a per capita income of $18,414 (FG Alliance, 2006b). Based on 2000 Census data, both Douglas County and the ROI have median household and per capita incomes less than both Illinois and U.S. averages.

Douglas County collected $21.2 million in property taxes in 2003 and $2.8 million in sales taxes in 2004 (FG Alliance, 2006b). The counties located within the ROI each collected an average of $11.3 million in sales taxes (FG Alliance, 2006b).

Table 5.19-2. Employment and Income for Counties Within the ROI

County	Employment		Income	
	2004 Labor Force	July 2006 Unemployment Rate[1]	1999 Per Capita Income	1999 Median Household
Counties Located Completely Within the ROI				
Douglas	10,796	n/a	$18,414	$39,439
Champaign	102,196	n/a	$19,708	$37,780
Coles	27,110	n/a	$17,370	$32,286
Cumberland	5,685	n/a	$16,953	$36,149
Edgar	10,411	n/a	$17,857	$35,203
Macon	18,239	n/a	$20,067	$37,859
Moultrie	8,218	n/a	$18,562	$40,084

Table 5.19-2. Employment and Income for Counties Within the ROI

County	Employment		Income	
	2004 Labor Force	July 2006 Unemployment Rate[1]	1999 Per Capita Income	1999 Median Household
Piatt	9,161	n/a	$21,075	$45,752
Subtotal or Average	**191,816**	**n/a**	**$18,751**	**$38,069**
Counties Located Partially Within the ROI				
Christian	17,334	n/a	$17,937	$36,561
Clark	8,840	n/a	$17,655	$35,967
Crawford	9,446	n/a	$16,869	$32,531
De Witt	49,909	n/a	$20,488	$41,256
Effingham	18,182	n/a	$18,301	$39,379
Fayette	10,399	n/a	$15,357	$31,873
Ford	7,431	n/a	$18,860	$38,073
Jasper	5,373	n/a	$16,649	$34,721
Logan	13,703	n/a	$17,953	$39,389
McLean	13,733	n/a	$22,227	$47,021
Montgomery	13,607	n/a	$16,272	$33,123
Sangamon	4,466	n/a	$23,173	$42,957
Shelby	122,780	n/a	$17,313	$37,313
Vermilion, IL	38,406	n/a	$16,787	$34,071
Vermillion, IN	8,094	n/a	$18,579	$34,837
Vigo, IN	50,176	n/a	$17,620	$33,184
Subtotal or Average	**391,881**	**n/a**	**$18,253**	**$37,016**
ROI Total or Average	**583,697**	**6.2 percent**	**$18,502**	**$37,543**
Illinois	**9,968,309**	**4.7 percent**	**$23,104**	**$46,590**
U.S.	**n/a**	**4.8 percent**	**$21,587**	**$41,994**

[1] Unemployment data was not available for Illinois counties for July 2006.
n/a = not available.
Source: FG Alliance, 2006b; USCB, 2000e; and USCB, 2000h.

Table 5.19-3 provides minimum and maximum hourly wages for Douglas County in November 2005 for trades that would be required for construction of the proposed project. Average wages for these trades were not available. Although actual wage costs would not be known until contractor selection, it is expected that wages for construction of the proposed FutureGen Project would be typical for construction trades in Douglas County adjusted for inflation.

Table 5.19-3. Minimum and Maximum Hourly Wages by Trade in Douglas County, Illinois, in November 2005

Trade	Minimum and Maximum Wages
Boilermaker	$27.75 - $30.25
Cement Mason	$25.83 - $27.08
Electric Power Equipment Operator	$28.84 - $34.10

Table 5.19-3. Minimum and Maximum Hourly Wages by Trade in Douglas County, Illinois, in November 2005

Trade	Minimum and Maximum Wages
Electric Power Groundman	$19.79 - $34.10
Electric Power Lineman	$32.04 - $34.10
Electrician	$32.10 - $34.01
Iron Worker	$26.42 - $28.17
Laborer	$22.92 - $23.92

Source: IDOL, 2006.

Housing

Table 5.19-4 provides total housing and vacant units by county within the ROI. As of 2006, there were 510,883 existing housing units within the ROI, with Douglas County accounting for 8,005 of those units (FG Alliance, 2006b). Of the existing housing units within the ROI, 6.9 percent, or 35,015, were vacant (FG Alliance, 2006b). Of the total vacant units, there were 14,821 units for rent and 6,777 units for sale (FG Alliance, 2006b). In addition, there were at least 5,580 short-term hotel and motel rooms within the ROI (FG Alliance, 2006b).

There are three residences located adjacent to, seven residences located within 0.5 mile (0.8 kilometer) of, and several dozen additional residences within 1 mile (1.6 kilometer) of the 345-acre (140-hectare) proposed power plant site.

5.19.2.3 Workforce Availability

Construction

In 2004, there were approximately 583,697 people within the ROI workforce (FG Alliance, 2006b). Because construction workers represented 6.3 percent of the workforce in Illinois, there were approximately 37,000 construction workers within the ROI (USCB, 2005b and FG Alliance, 2006b). This indicates that there could be a large local workforce from which some or all of the construction workers could be drawn.

Operations

Utility workers made up 0.7 percent of the workforce in Illinois in 2004, resulting in approximately 4,300 utility workers within the ROI (USCB, 2005b). Operations workers could be drawn from this workforce.

Table 5.19-4. Total Housing Units Within the ROI in 2006

County	Total Housing Units	Vacant Units			
		For Rent	For Sale	Seasonal Use	Other Vacant
Counties Located Completely Within the ROI					
Douglas	8,005	115	87	32	137
Champaign	75,280	2,306	653	214	1,189

Table 5.19-4. Total Housing Units Within the ROI in 2006

County	Total Housing Units	Vacant Units			
		For Rent	For Sale	Seasonal Use	Other Vacant
Coles	22,768	714	249	215	364
Cumberland	4,876	79	92	134	140
Edgar	8,611	175	140	57	314
Macon	50,241	1,628	554	139	981
Moultrie	5,743	56	81	31	132
Piatt	6,798	57	62	24	129
Subtotal	**182,322**	**5,130**	**1,918**	**846**	**3,386**
Counties Located Partially Within the ROI					
Christian	14,992	341	202	63	348
Clark	7,816	255	117	113	286
Crawford	8,785	362	214	56	243
De Witt	7,282	184	97	51	114
Effingham	13,959	282	156	201	231
Fayette	9,053	158	129	207	311
Ford	6,060	81	106	24	162
Jasper	4,294	87	53	30	143
Logan	11,872	203	153	28	211
McLean	59,972	1348	707	230	511
Sangamon	85,459	2,715	1,131	240	2,137
Shelby	10,060	132	170	166	445
Vermilion, IL	36,349	1,077	533	141	911
Vermillion, IN	7,405	714	249	215	364
Vigo, IN	45,203	1,752	842	302	701
Subtotal	**328,561**	**9,691**	**4,859**	**2,067**	**7,118**
Total	**510,883**	**14,821**	**6,777**	**2,913**	**10,504**

Source: FG Alliance, 2006b.

5.19.3 IMPACTS

5.19.3.1 Construction Impacts

Population

The need for construction workers would be limited to the estimated 44-month construction period, and a potential influx of temporary residents is not expected to cause an appreciable increase in the regional population. Monthly employment on the proposed power plant site would average 350 workers during construction, with a peak of 700 workers (FG Alliance, 2006e). Approximately 37,000 general construction workers residing within the ROI would provide a local workforce. Temporary construction workers with specialized training and workers employed by contractors from outside the ROI could also construct the proposed power plant facilities. Some of these workers would be expected to commute to the construction site on a daily or weekly basis, while others would relocate to the area for the duration of the construction period. Although it is not known how many workers would relocate, the required number of construction workers represents less than 0.1 percent of population within the ROI. Therefore, impacts on population growth within the ROI would be small.

The Tuscola-Douglas County FutureGen Task Force sent letters to the approximately 30 Amish Bishops associated with this community to provide information on the proposed project and solicit their input (see Appendix A). As a result, an Amish Bishop with the community in Arcola, Illinois, responded and requested additional information. Communication with the bishop indicates that he did not expect that the proposed FutureGen Project would affect the Amish community (see Appendix A). Based on the distance from the proposed power plant site to the Amish residences, it is not anticipated that construction nor operations of the proposed power plant would have an adverse effect on the Amish communities that reside in Douglas, Coles, and Moultrie counties.

Employment, Income, and Economy

Construction of the proposed facilities could result in 350 to 700 new jobs in Douglas County. These new jobs would represent a 0.06 to 0.1 percent increase in the number of workers employed in Douglas County (FG Alliance, 2006b). These workers would be paid consistent with wages in the area for similar trades. Wages for trades associated with power plant construction for November 2005 are provided in Table 5.19-3, although it is likely that actual wages could be higher than those presented because of inflation. Therefore, a direct, but small, positive impact on employment rates and income could occur within the ROI during the construction period.

Illinois and Douglas County could benefit from temporarily increased sales tax revenues resulting from project-related spending on payroll and construction materials. It is anticipated that construction workers would spend their wages on short-term housing, food, and other personal items within the ROI. Additional sales tax revenues could result from taxes that are embedded in the price of consumer items such as gasoline. Therefore, an indirect and positive impact could be expected for the local economy from increased spending and related sales tax revenue.

Illinois and Douglas County could also benefit from increased property tax revenue associated with properties acquired for the proposed FutureGen Project. Property taxes are applied to construction sites on the basis of an evaluation of work completed to date in each year. The amount paid would depend not only on levy rates at the time the construction is under way, but also on the construction schedule relative to the evaluation's timing. The facility's property tax could be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue could be in the millions of dollars each year. This increase would have a direct and positive impact on the total property tax revenue for Douglas County and Illinois. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance.

The proposed FutureGen Project could directly impact agriculture-related employment and income by converting up to 200 acres (81 hectares) of agricultural land for the proposed power plant and 10 acres (4 hectares) for the proposed sequestration site. Similar impacts could also occur on the additional 145 acres (60 hectares) of the proposed sites if these areas were removed from agricultural use. These impacts would be limited to those who till and harvest these properties. Indirect impacts related to incremental reduction in the supplies and equipment needed to farm the land, and in the amount of corn and soybeans being brought to market would also occur. These impacts would be minor when evaluated in the context of agricultural activities within the ROI.

Housing

A potential influx of construction workers may increase local housing demand, which would have a beneficial short-term impact on the regional housing market. The ROI has approximately 14,821 vacant housing units for rent with Douglas County accounting for approximately 115 of these units. There are at least 5,580 hotel rooms within the ROI, with Douglas County accounting for approximately 291 of these rooms. In 2005, Illinois had an average occupancy rate of 61.8 percent (IHI, 2006). Therefore, depending upon the percentage of construction jobs that could be filled by existing residents, the influx of workers from outside the region could increase the occupancy rate within the ROI by as much as 18.2 percent. This increase would result in a hotel occupancy rate of 80 percent and a positive, direct impact for the hotel industry within the ROI.

Power Plant Site

There are three residences located adjacent to, seven residences located within 0.5 mile (0.8 kilometer) of, and several dozen additional residences located within 1 mile (1.6 kilometer) of the 345-acre (140-hectare) proposed plant site. Though construction activities could adversely impact these properties (e.g., increased traffic), construction would not cause the displacement of residents or demolition of their houses. Potential impacts to property values are discussed in Section 5.19.3.2.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site; therefore, no existing population would be displaced.

5.19.3.2 Operational Impacts

Population

Operation of the proposed power plant could result in a very small increase in population growth. It is anticipated that power plant operation could require approximately 200 permanent workers. Based on the 2005 projected population and average family size within the ROI, the relocation of 200 workers could result in a population increase of 490 people. This increase would represent a 0.04 percent increase in population within the ROI and a 2.4 percent increase in Douglas County.

Employment, Income, and Economy

The operational phase of the proposed FutureGen Project could have a direct and positive impact on employment by creating 200 permanent jobs in Douglas County. These new jobs could represent a 0.03 percent increase in the total number of workers employed in Douglas County (FG Alliance, 2006b).

Each new operations job created by the proposed FutureGen Project would generate both indirect and induced jobs. An indirect job supplies goods and services directly to the plant site. An induced job results from the spending of additional income from indirect and direct employees. A job multiplier is used to determine the approximate number of indirect and induced jobs that would result. The Illinois Venture Capital Association reported a job multiplier of 2.2 for venture capital projects in Illinois (IVCA, 2006). A job multiplier of 2.2 means that for every direct job, 1.2 indirect or induced jobs could result (IVCA, 2006). Using this job multiplier, the 200 permanent operations jobs would create approximately

240 indirect or induced jobs for a total of 440 new jobs in and around Douglas County. Based on this multiplier, the proposed FutureGen Project could have an indirect impact on employment by creating approximately 240 indirect or induced jobs in and around Douglas County.

The proposed FutureGen Project would also have annual operation and maintenance needs that could benefit Douglas County. Local contractors could be hired to complete specialized maintenance activities that could not be undertaken by permanent staff, and items such as repair materials, water and chemicals could be purchased within the ROI. The 200 employees who would fill new jobs created by the proposed FutureGen Project could generate tax revenues from sales and use taxes on plant materials and maintenance. The property tax from the proposed FutureGen Project could be substantially greater than current property taxes paid for the properties to be acquired. Based on similar power plants, the increase in total property tax revenue would be in the millions of dollars each year. This increase would have a direct and positive impact on the total property tax revenue for Douglas County and Illinois. However, projected increases to property or sales tax revenues from the FutureGen Project may be less than anticipated if the state or local government were to waive or reduce usual assessments as an element of its final offer to the Alliance. Illinois would likely benefit from a public utility tax it would levy when power is produced by the proposed FutureGen Project.

Housing

During operation of the proposed power plant, employees relocating to the area would likely be distributed between owned and rental accommodations. Although it is not known how many of the permanent staff would relocate within the ROI, if all 200 permanent employees relocated, the increased demand for housing would be small. In Illinois, approximately 69.9 percent of housing units are owner-occupied (USCB, 2005c). Using this value, operation of the proposed power plant site would result in a 3.0 percent decrease in residences for sale and a 1.3 percent decrease in residences for rent within the ROI.

Power Plant Site

There are three residences located adjacent to, seven residences located within 0.5 mile (0.8 kilometer) of, and several dozen additional residences located within 1 mile (1.6 kilometers) of the 345-acre (140-hectare) proposed plant site that may have an unobstructed view of the facility. Direct and adverse long-term impacts on property value in relation to comparable property values in Tuscola may occur for these properties. The degree to which property values could be affected is uncertain because there are many variables associated with real estate markets and public sentiment.

Sequestration Site

There are no existing residences or buildings on the proposed sequestration site and, therefore, no existing population that would be displaced by the proposed sequestration site.

5.2 AIR QUALITY

5.2.1 INTRODUCTION

This section describes existing local and regional air quality and the potential impacts that may occur from constructing and operating the FutureGen Project at the Tuscola Power Plant Site and sequestration site. The FutureGen Project would use integrated gasification combined-cycle (IGCC) technology and would capture and sequester carbon dioxide (CO_2) in deep underground formations. Chapter 2 provides a discussion of the advancements in IGCC technology associated with the FutureGen Project that would reduce emissions of air pollutants. Because of these technologies, emissions from the FutureGen Project would be lower than emissions from existing IGCC power plants and state-of-the-art (SOTA), conventional coal-fueled power plants.

5.2.1.1 Region of Influence

The ROI for air quality includes the area within 50 miles (80.5 kilometers) of the boundaries of the proposed Tuscola Power Plant Site and within 50 miles (80.5 kilometers) of the boundaries of the proposed Tuscola Sequestration Site. Sensitive receptors that have been identified within the ROI are discussed in Section 5.2.2.3.

5.2.1.2 Method of Analysis

DOE reviewed available public data and also studies performed by the Alliance to determine the potential for impacts based on whether the proposed FutureGen Project would:

- Result in emissions of criteria pollutants and hazardous air pollutants (HAPs);
- Result in mercury (Hg) emissions and conflict with the Clean Air Mercury Rule (CAMR) as related to coal-fueled electric utilities;
- Cause a change in air quality related to the National Ambient Air Quality Standards (NAAQS);
- Result in consumption of Prevention of Significant Deterioration (PSD) increments as defined by the Clean Air Act (CAA), Title I, PSD rule;
- Affect visibility and cause regional haze in Class I areas;
- Result in nitrogen and sulfur deposition in Class I areas;
- Conflict with local or regional air quality management plans;
- Result in emissions of greenhouse gases (GHGs);
- Cause solar loss, fogging, icing, or salt deposition on nearby residences; and
- Discharge odors into the air.

> **Plant upset** is a serious malfunction of any part of the IGCC process train and usually results in a sudden shutdown of the combined-cycle unit's gas turbine and other plant components.

Based on the above criteria, DOE assessed potential air quality impacts from the construction and operational activities related to the FutureGen Project at the proposed Tuscola Power Plant Site and sequestration site. For impacts related to FutureGen Project operations, DOE conducted air dispersion modeling of criteria pollutants using EPA's refined air dispersion model, AERMOD (American Meteorological Society/EPA Regulatory Model). Details on the air modeling protocol are presented in Appendix E. To establish an upper bound for potential impacts, DOE used the FutureGen Project's estimate of maximum air emissions, which was developed by the Alliance and reviewed by DOE, for the air dispersion modeling based on 85 percent plant availability and unplanned restarts as a result of plant upset (also called unplanned outages) (see Table 5.2-1). The estimate of maximum air emissions was developed using the highest pollutant emission rates for various technology options being considered for the FutureGen Project (see Section 2.5.1.1). Surrogate data from similar existing or permitted units (e.g., the Orlando Gasification Project [Orlando Project]) were used for instances where engineering details and emission data were not available due to the early design stage of the FutureGen Project (DOE, 2007).

Table 5.2-1 presents expected emissions of air pollutants from the FutureGen Project during the 4-year research and development period and beyond. Emissions from the first year of proposed power plant operation, which are expected to be highest, represent the upper bound for potential air emissions and were modeled for this EIS. Emissions would be expected to decrease each year, as learning and experience would reduce the frequency and types of unplanned restart events from an estimated 29 in the first year to 3 in the fifth year and beyond (see Appendix E). Consequently, annual emissions would be expected to decrease progressively from the first year of operation to the fourth year of operation and beyond. Because emissions of some criteria pollutants are projected to exceed 100 tons per year (tpy) (90.7 metric tons per year [mtpy]) (even with less than 3 restarts per year), the FutureGen Project would be classified as a major source under Clean Air Act regulations.

Table 5.2-1. Yearly Estimates of Maximum Air Emissions from the FutureGen Project[1] (tpy [mtpy])

Pollutant	Year 1	Year 2	Year 3	Year 4	Year 5 Onward[2]
Sulfur Oxides[3] (SO_x)	543 (492)	322 (292)	277 (251)	255 (231)	100 (90.7)
Nitrogen Oxides[4] (NO_X)	758 (687)	754 (684)	753 (683)	753 (683)	750 (680)
Particulate Matter[5] (PM_{10})	111 (100)	111 (100)	111 (100)	111 (100)	111 (100)
Carbon Monoxide[5] (CO)	611 (554)	611 (554)	611 (554)	611 (554)	611 (554)
Volatile Organic Compounds[5] (VOCs)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)	30 (27.2)
Mercury[5] (Hg)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)	0.011 (0.01)

[1] Because the FutureGen Project would be a research and development project, DOE assumes that the maximum facility annual availability would be 85 percent. Values are estimated based on maximum emissions rates for design Case 1, 2, or 3A, plus maximum emissions rates for design Case 3B and includes emissions from unplanned restarts (upset conditions).
[2] Year 1 to Year 4 calculated based on information provided by the Alliance. Year 5 estimated by DOE; not provided by the Alliance.
[3] SO_x emissions from coal combustion systems are predominantly in the form of sulfur dioxides (SO_2).
[4] NO_x emissions from coal combustion are primarily nitric oxide (NO); however, for the purpose of the air dispersion modeling, it was assumed that all NO_x emissions are nitrogen dioxides (NO_2). One of the technologies being considered for the FutureGen Project is post-combustion selective catalytic reduction (SCR), which would reduce the annual NO_X emissions to 252 tpy (228.6 metric tpy).
[5] Values for PM_{10}, CO, VOCs, and Hg would remain constant between Year 1 through 5 because unplanned restarts would not affect these emissions. Conversely, SO_2 and NO_2 emissions would decrease each year due to expected decrease in restart events. See Appendix E, Tables E-2 and E-3.
tpy= tons per year; mtpy= metric tons per year.
Source: FG Alliance, 2007.

In addition to assessing impacts of criteria pollutant emissions, DOE assessed impacts of HAP emissions by estimating the annual quantities of HAPs that would be emitted from the proposed

FutureGen Power Plant. These estimates were developed based on emissions predicted for the Orlando Project, which would burn a carbon-rich syngas (DOE, 2007). The estimated HAPs may be overstated since the FutureGen Project would include new technologies that would produce syngas that would contain lower levels of carbon. The estimated emissions are presented in Section 5.2.3.2.

DOE also assessed the potential for impacts to local visibility from the vapor plume using qualitative measures because engineering specifications needed to conduct quantitative modeling for vapor plume sources (e.g., cooling towers) were not available. Class-I-related modeling, including pollutant dispersion and air-quality-related values (AQRV), were reviewed for their applicability. Potential effects to soil, vegetation, animals, human health, and economic development were also reviewed.

5.2.2 AFFECTED ENVIRONMENT

5.2.2.1 Existing Air Quality

The Illinois Environmental Protection Agency (IEPA) Bureau of Air has monitoring sites throughout the state, which monitor ambient air quality and designate areas or regions that either comply with all of the NAAQS or fail to meet the NAAQS for one or more criteria pollutants. The NAAQS specify the maximum allowable concentrations of six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead (Pb), and inhalable particles, which are also known as respirable particulate matter (PM). The PM_{10} standard covers particles with diameters of 10 micrometers or less and the $PM_{2.5}$ standard covers particles with diameters of 2.5 micrometers or less. Areas that meet the NAAQS for a criteria pollutant are designated as being in “attainment” for that pollutant, and areas where a criteria pollutant concentration exceeds the NAAQS are designated as “non-attainment” areas. Where insufficient data exist to determine an area’s attainment status, the area is designated as unclassifiable. Maintenance areas are those non-attainment areas that have been redesignated as attainment areas and are under a 10-year monitoring plan to maintain their attainment status.

The proposed Tuscola Power Plant Site and sequestration site are located in Douglas County, Illinois. Douglas County is part of the East Central Illinois Intrastate Air Quality Control Region (AQCR). No ambient air monitoring data are recorded in Douglas County (FG Alliance, 2006b); however, in the East Central Illinois Intrastate AQCR, monitors are located in Champaign County, which is within the proposed Tuscola Power Plant Site ROI, and McLean County, which is outside the ROI. These monitors measure O_3 and $PM_{2.5}$ concentrations. The East Central Illinois Intrastate AQCR has no history of non-attainment for the six criteria pollutants. The nearest SO_2 monitor within the ROI of the proposed site is in Macon County in the West Central Interstate AQCR. This monitor indicates attainment with the SO_2 NAAQS. Neither the East Central Illinois Intrastate AQCR nor other AQCRs within the ROI of the proposed Tuscola Power Plant Site and sequestration site has monitors for NO_X, PM_{10}, and CO concentrations. Concentrations of Pb have not been recorded in recent years due to a decrease in use of leaded gasoline in automobiles, which has lowered Pb concentrations in the ambient air to levels well below the NAAQS. Table 5.2-2 provides monitored background data of O_3, $PM_{2.5}$, and SO_2 for the proposed Tuscola Power Plant Site.

While the ROI for the proposed project is currently designated as in attainment or unclassified, air moving from nearby non-attainment areas could likely contribute to the air quality within the region of the proposed Tuscola Power Plant Site. The nearest non-attainment areas are located in Indianapolis, Indiana (152 miles [244.6 kilometers] away) and Vigo County, Indiana (71 miles [114.3 kilometers] away). Site-specific monitoring to collect representative background data for all criteria pollutants could be required at the proposed project site as part of the PSD permit application process (EPA, 1990), although the IEPA has indicated that such monitoring would not be required. However, the Alliance may choose to conduct site-specific monitoring for criteria pollutants as appropriate for development of a detailed site characterization if the proposed Tuscola Site is selected.

Table 5.2-2. Monitoring Stations and Ambient Air Quality Data

Monitoring Site Location	Distance from Proposed Site (miles [kilometers])	Pollutant and Averaging Time	Monitored Data[1]	Primary/ Secondary Standard[1]
Bondville, Illinois Champaign County East Central Illinois Interstate AQCR	28 (45.1)	$PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	12.6 31.8	15 35
Champaign, Illinois Champaign County East Central Illinois Interstate AQCR	29 (46.7)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	0.082 0.079 12,5 31.9	0.12 0.08 15 35
Decatur, Illinois Macon County West Central Illinois Interstate AQCR	38 (61.2)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour) SO_2 (Annual) SO_2 (24-hour) SO_2 (3-hour)	0.093 0.081 13.3 34.1 0.004 0.024 0.040	0.12 0.08 15 35 0.03 0.14 None
Normal, Illinois McClean County East Central Illinois Interstate AQCR	77 (123)	O_3 (1-hour) O_3 (8-hour) $PM_{2.5}$ (Annual) $PM_{2.5}$ (24-hour)	0.093 0.082 12.7 34.3	0.12 0.08 15 35

[1] Units for O_3 and SO_2 are in parts per million (ppm) and $PM_{2.5}$ are in micrograms per cubic meter (μg/m^3). To determine representative background data for both PM_{10} and $PM_{2.5}$, 24 hours and annual averaging periods, the monitored data are averaged over a period of three years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values each year for a period of 3 years (2003 to 2005) is used (see Appendix E).
Source: EPA, 2006a; EPA, 2006b.

5.2.2.2 Existing Sources of Air Pollution

Emissions from the proposed FutureGen Project and potential environmental consequences must be considered in the context of both regional air quality and existing local sources of emissions. Existing sources of emissions outside and within the ROI are discussed. Additionally, local sources (i.e., within 1 mile [1.6 kilometers] of the proposed Tuscola Power Plant Site) are discussed.

Outside the Region of Influence

Traffic-related pollution and pollution from existing industrial sources, associated with nearby large cities, can contribute to air quality problems in rural areas. Tuscola is not within 50 miles (80.5 kilometers) of any of the 10 largest cities in Illinois. The closest of the 10 largest cities to Tuscola is Springfield to the west. The greater metropolitan Chicago area is approximately 155 miles (249.4 kilometers) to the north of the proposed site and is in non-attainment for O_3 and $PM_{2.5}$. The St. Louis, Missouri area, which is 115 miles (185.1 kilometers) southwest of Tuscola, shares the Metropolitan St. Louis Interstate AQCR with many counties in Illinois and is also in non-attainment for O_3 and $PM_{2.5}$. However, because of the west-to-east trend of overall air patterns and closer proximity to the proposed site, the St. Louis area would probably have a greater influence on air quality in Tuscola than the greater metropolitan Chicago area. For pollutants for which there were no monitored background data, background data from cities such as Briadwood and Peoria, which are attainment areas but outside the ROI, were used.

Inside the Region of Influence

> A **major source** is a unit that emits any one criteria pollutant in amounts equal to or greater than thresholds of 100 tpy (90.7 mtpy) or one HAP in amounts greater than or equal to 10 tpy (9.1 mtpy) or a combination of HAPs in amounts greater than or equal to 25 tpy (22.7 mtpy). Additionally, an electric generating unit is one of the 28 categories defined by the PSD rule. For sources that are not in one of the 28 categories, the threshold is 250 tpy (226.8 mtpy) of criteria pollutants (40 Code of Federal Regulations [CFR] 52.21, 2006).

Small towns or cities within 10 miles (16.1 kilometers) of Tuscola include Carmargo, Garrett, Arcola, Atwood, Arthur, Pesotum, and Ivesdale, and could contribute to background ambient air quality. The types and quantities of air pollutants emitted from existing sources located within 10 miles (16.1 kilometers) of the proposed power plant site may contribute to the background concentrations of pollutants within and surrounding the ROI. Additionally, the medium-sized city of Decatur is located about 35 miles (56.3 kilometers) due west and is in a prevalent upwind direction from the proposed Tuscola Power Plant Site. According to the EPA Envirofacts website (http://www.epa.gov/enviro), the major sources of criteria pollutants and HAPs within a 10-mile (16.1-kilometer) radius, but outside a 1-mile (1.6-kilometer) radius, are Panhandle Eastern Pipeline Company and Masterbrand Cabinets (EPA, 2006c). Other sources include the vehicle traffic in Tuscola and surrounding areas. A small oil field exists about 3 miles (4.8 kilometers) to the southwest, and a few wells are scattered around to the north and west of the site. Gas storage wells are located to the immediate north of the planned CO_2 injection wells. Oil and gas wells and pipelines could be a minor source of fugitive emissions of hydrocarbons.

Local

There are several existing major air emissions sources within 1 mile (1.6 kilometers) of the proposed Tuscola Power Plant Site. These include the Cabot Corporation (a chemical company) and the Lyondell-Equistar Chemical Company, both located immediately west of the proposed Tuscola Power Plant Site. Trunkline Gas Company and TriGen-Cinergy Solutions of Tuscola are located a few thousand feet due south of the proposed plant site.

The area surrounding the proposed Tuscola Power Plant Site supports mostly agricultural activities (row crops). The croplands are not highly susceptible to wind erosion and most of the time would not present a source of wind-blown particulates or dust. However, during cultivation, tilling of the soil may cause some dust suspension or render the soil more susceptible to wind erosion for short periods of time.

5.2.2.3 Sensitive Receptors (Including Class I Areas)

The proposed Tuscola Power Plant Site is located in a rural area. Three single-family residences are located along the northern boundary of the site on CR 1050N, which is 600 feet (182.9 meters) from the center of the site. Within 0.5 mile (0.8 kilometer) of the site, two residences are located to the north on or near CR 1150N, and five residences are located to the south on or near State Route (SR) 36. Several dozen residences are located within 1 mile (1.6 kilometers) on the western edge of the City of Tuscola. There are no hospitals, schools, or nursing homes within 1 mile (1.6 kilometers) of the proposed plant site (FG Alliance, 2006b). There are 16 schools and three nursing homes within a 10-mile (16.1-kilometer) radius of the proposed Tuscola Power Plant Site and 12 schools and three nursing homes within a 10-mile (16.1-kilometer) radius of the proposed sequestration site (see Figure 5.2-1) (FG Alliance, 2006b).

Class I Areas

For areas that are already in compliance with the NAAQS, the PSD requirements provide maximum allowable increases in concentrations of pollutants, which are expressed as increments. Allowable PSD increments currently exist for three pollutants: SO_2, NO_2, and PM_{10}. They apply to the three types of areas classified under the PSD regulations: Classes I, II, and III, where the smallest allowable increments correspond to Class I areas (Table 5.2-3).

Table 5.2-3. Allowable PSD Increments (μg/m^3)

Pollutant, Averaging Period		Class I Area	Class II Area	Class III Area
SO_2	3-Hour	25	512	700
	24-Hour	5	91	182
	Annual	2	20	40
NO_2	Annual	2.5	25	50
PM_{10}	24-Hour	8	30	60
	Annual	4	17	34

μg/m^3 = micrograms per cubic meter.
Source: EPA, 2005a.

Class I areas, which are those areas designated as pristine, require more rigorous safeguards to prevent deterioration of the air quality, and include many national parks and monuments, wilderness areas, and other areas as specified in 40 CFR 51.166(e). The closest Class I area is 204 miles (328.3 kilometers) from the proposed Tuscola Power Plant Site and sequestration site (see Table 5.2-4), which is well beyond the 62-mile (100-kilometer) distance required to consider impacts to Class I areas under the PSD regulations. All other clean air regions are designated Class II areas, with moderate pollution increases allowed (FWS, 2007). The proposed Tuscola Power Plant Site and sequestration site are located in Class II areas.

Table 5.2-4. Nearest Class I Areas to Proposed Tuscola Power Plant Site

Class I Area/Location	Distance (miles)	Distance (kilometers)	Direction
Mammoth Cave National Park, Kentucky	204	328.3	SE
Mingo National Wildlife Refuge, Missouri	220	354.1	SW

Source: FG Alliance, 2006b.

5.2.2.4 Air Quality Management Plans

The CAA requires states to develop federally approved regulatory programs, called State Implementation Plans (SIPs), for meeting the NAAQS throughout the state. These plans aim to limit emissions from sources as necessary to achieve and maintain compliance. In part, SIPs focus on new major stationary sources and modifications to existing major stationary sources. A state's New Source Review (NSR)/PSD review program is defined and codified in its SIP. The Illinois SIP is available from the IEPA.

The FutureGen Project would be required to undertake the NSR/PSD permit application process after a host site is selected. State and local governmental officials contacted during the development of this EIS and the supporting Environmental Information Volume (EIV) indicate that there are no local air quality management plans currently in existence for the ROI (FG Alliance, 2006b). Additionally, these officials have no knowledge of specific local needs or concerns for air quality management at the proposed Tuscola Power Plant Site and sequestration site.

5.2.3 IMPACTS

5.2.3.1 Construction Impacts

Construction at the proposed power plant site, sequestration site, utility corridors, and transportation corridors would result in localized increases in ambient concentrations of SO_2, NO_X, CO, VOCs, and PM. These emissions would result from the use of construction equipment and vehicles, including trucks, bulldozers, excavators, backhoes, loaders, dump trucks, forklifts, pumps, and generators. In addition, fugitive dust emissions (i.e., PM emissions) would occur from various construction-related activities, including earth moving and grading, material handling and storage, and vehicles traveling over dirt and gravel areas.

Given the size of the proposed site and the short duration of the construction period, potential impacts would be localized and temporary in nature. Construction impacts would be minimized through the use of best management practices (BMPs), such as wetting the soil surfaces, covering trucks and stored materials with tarps to reduce windborne dust, and using properly maintained equipment (see Section 3.4).

Power Plant Site

DOE assumed that up to 200 acres (81 hectares) of the proposed 345-acre (140-hectare) site would be directly affected for the purposes of the air impact analysis. DOE estimates that construction of the proposed Tuscola Power Plant would take 44 months. PM concentrations would be localized because of the relatively rapid settling of larger dust particles and impacts to off-site receptors would be temporary. In addition, PM emissions would decrease with the total amount of land disturbed, as PM emissions were calculated on the basis of site acreage. Impacts of the SO_2, NO_X, CO, and VOC emissions from vehicular sources would be temporary in nature and could cause minor to moderate short-term degradation of local air quality. The air pollutant emissions would be minimized through the use of BMPs, such as limiting the amount of vehicle trips, wetting the soil surfaces, covering trucks, limiting vehicle idling, and properly maintaining equipment.

Sequestration Site

While the proposed sequestration site contains over 80 acres (32 hectares) (FG Alliance, 2006b), only a small fraction (10 acres [4 hectares]) of the land area would be disturbed by either exploratory investigations (e.g., geophysical surveys) or construction of the sequestration facilities. Construction-related impacts on air quality at the proposed sequestration site would be limited to preparation of well drilling sites and the drilling of wells, as discussed in Chapter 2. Exploratory wells would be installed to sample and test the underground reservoir systems, and injection wells and monitoring wells would be installed to inject CO_2 and monitor its fate. Site preparation and construction activities would involve grading and surface preparation by earth-moving equipment and would result in localized fugitive dust air emissions during construction. Impacts would be localized and temporary in nature and could cause minor to moderate short-term degradation of air quality in the areas where construction is taking place.

Utility Corridors

The proposed utility corridors could include a natural gas pipeline, process water pipeline, potable water pipeline, sanitary wastewater pipeline, and electric transmission line. Construction of the utility corridors would require less acreage, use less equipment, and take less time than the construction of the proposed power plant. The duration of utility corridor construction would range from 3 to 6 weeks. The emissions from construction would include SO_2, NO_X, PM, CO, and VOCs. Impacts from emissions of these pollutants would be localized and temporary in nature and could cause minor to moderate, short-term degradation of air quality in the areas where construction is taking place.

Transportation Corridors

Access to the proposed Tuscola Power Plant Site would be primarily via County Road (CR) 750E on the west boundary of the site and CR 1050N on the north boundary. Additionally, the CSX Transportation Decatur Subdivision Rail Line and a CSX rail siding borders the proposed site on the south. Delivery to and from the proposed site could be accomplished by either railway or roadway. The existing roadway meets the needs of current traffic in the area of the proposed power plant site; however, if Tuscola is chosen for the FutureGen Project, an upgrade of existing roadways may be needed. Because it is unclear how much (if any) road construction or reconstruction would be needed, potential air emissions impacts cannot be evaluated at this time. Impacts associated with upgrading the existing roadway would be dependent on the extent of construction activities required.

5.2.3.2 Operational Impacts

Power Plant Site

Sources of Air Pollution

Primary sources of air emissions associated with the FutureGen Project would be the combustion turbine, flare, gasifier preheat, cooling towers, and sulfur recovery system (see Figure 2-18). DOE and the Alliance have estimated the maximum potential emissions that would be expected (see Table 5.2-1) using data from equipment typical of an IGCC power plant. However, because the FutureGen Project is in the early stages of design, specific engineering and technical information on the equipment that would ultimately be used is not available. Other sources of air emissions could include mobile sources such as plant vehicular traffic and personnel vehicles, which would be equipped with standard pollution-control devices to minimize emissions.

Local traffic within the proposed power plant site would be expected to emit small amounts of criteria pollutants. In addition, coal delivery trains (five trains per week) would emit a small amount of criteria pollutants from the train exhaust, and potentially PM during coal unloading and handling. However, coal handling emissions are not expected to appreciably change air quality because the emissions would be reduced by minimizing points of transfer of the material, enclosing conveyors and loading areas, and installing control devices such as baghouses and wetting systems.

Clean Air Act General Conformity Rule

Section 176(c)(1) of the Clean Air Act requires that federal actions conform to applicable SIPs for achieving and maintaining the NAAQS for the criteria air pollutants. In 1993, EPA promulgated a rule titled "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," codified at 40 CFR Parts 6, 51, and 93. The rule is intended to ensure that criteria air pollutant emissions and their precursors (e.g., VOCs and NO_X) are specifically identified and accounted for in the attainment or maintenance demonstration contained in a SIP. The conformity rule applies to proposed federal actions that would cause emissions of criteria air pollutants above certain levels in locations designated as non-attainment or maintenance areas for the emitted pollutants. Under the rule, an agency must engage in a conformity review process and, depending on the outcome of that review, conduct a conformity determination.

DOE conducted a conformity review to assess whether a conformity determination (40 CFR Part 93) is needed for the proposed FutureGen Project. As discussed in Section 5.2.2.1, Douglas County is in attainment or unclassified with the NAAQS for all pollutants. Additionally, Douglas County is not designated as a maintenance area. Consequently, no conformity determination is needed (see Section 5.2.2.4).

Criteria Pollutant Emissions

DOE conducted refined modeling using AERMOD. Table 5.2-5 presents the results of the AERMOD modeling for the operational phase of the proposed Tuscola Power Plant. Limited amounts of background air concentration data for the Tuscola area were available for use in this EIS. For SO_2 and $PM_{2.5}$, representative background data were available from monitors within the same AQCR as Douglas County or within the ROI. For NO_2, PM_{10}, and CO, DOE used background data from monitors that were outside the ROI but within attainment areas to represent ambient concentrations for those pollutants. To determine representative background data for both PM_{10} and $PM_{2.5}$ 24-hour and annual averaging periods, DOE took the average of the second-highest monitored data over a period of 3 years (2003 to 2005). For all other pollutants and corresponding averaging periods, the highest of the second-highest values of each year for the period of 3 years (2003 to 2005) was used (see Appendix E).

Table 5.2-5 shows that concentrations of pollutants during the operational phase combined with background concentrations would be below their respective NAAQS during normal plant operation and plant upset. Additionally, the proposed FutureGen Project would not exceed the Class II PSD allowable increments; however, short-term 3-hour and 24-hour SO_2 concentrations could approach Class II PSD increment limits during plant upset from emissions associated with unplanned restart events. These unplanned restart emissions of SO_2 would typically be higher than steady-state SO_2 emissions, because syngas would be directly flared without the benefit of the sulfur recovery unit (see Appendix E). The probability of the proposed power plant exceeding the 3-hour SO_2 Class II PSD increment at the proposed Tuscola Power Plant Site during periods of plant upset is 0.22 percent and zero percent during normal operating scenarios. The probability of the proposed power plant exceeding the 24-hour SO_2 Class II PSD increment at the proposed Tuscola Power Plant Site is zero. Maximum concentrations of the pollutants would be limited to a radius of less than 2.6 miles (4.2 kilometers) from the center of the proposed Tuscola Power Plant Site. Currently, three single-family residences are approximately 600 feet (182.9 meters) from the site, and seven additional residences are within 0.5 mile (0.8 kilometer). These residences would be impacted.

Hazardous Air Pollutants

HAP emissions from the FutureGen Project were estimated based on the Orlando Project, a recent IGCC power plant that was determined to provide the best available surrogate data (DOE, 2007). DOE scaled the Orlando Project data based on relative emission rates of VOCs and PM to produce more appropriate estimates of emission rates for the FutureGen Project. However, only emissions from the gas turbine were considered to account for differences between the Orlando design and the FutureGen Project. These differences include the FutureGen Project's use of oxygen (O_2) in the gasifier instead of air, the use of a catalytic shift reactor to convert CO to CO_2, and CO_2 capture and sequestration features.

Table 5.2-5. Comparison of Maximum Concentration Increases with NAAQS and PSD Increments

Pollutant	Maximum Concentration FutureGen Project Alone[1] (µg/m³)	Maximum Concentration FutureGen Project + Background (µg/m³)	NAAQS (µg/m³)	Class II PSD Increments (µg/m³)	PSD Increment Consumed by FutureGen Project (percent)	Distance of Maximum Concentration (miles [kilometers])
SO_2 (normal operating scenario)[2]						
3-hour	0.54	123.57	1,300	512	0.10	1.75 (2.8)
24-hour	0.20	70.87	365	91	0.22	0.65 (1.0)
SO_2 (upset scenario)[3]						
3-hour	511.96	634.99	1,300	512	99.91	2.55 (4.1)
24-hour	67.00	137.67	365	91	73.63	2.55 (4.1)
SO_2 Annual[4]	0.05	10.52	80	20	0.24	0.73 (1.2)
NO_2[4, 5] Annual	0.07	30.16	100	25	0.27	0.73 (1.2)
PM/PM_{10}[4, 6]						
24-hour	0.39	57.73	150	30	1.31	0.65 (1.0)
Annual	0.01	26.01	50	17	0.06	0.73 (1.2)
PM/$PM_{2.5}$[4, 6]						
24-hour	0.39	32.33	35	n/a	n/a	0.65 (1.0)
Annual	0.01	12.51	15	n/a	n/a	0.73 (1.2)
CO[7]						
1-hour	9.47	5,620.90	40,000	n/a	n/a	1.71 (2.8)
8-hour	4.73	3,462.66	10,000	n/a	n/a	0.59 (1.0)

[1] Value based on site-specific meteorological and terrain data. Except for the 3-hour SO_2 during the upset scenario, the highest maximum predicted concentrations are provided for all pollutants and corresponding averaging times, based on the worst-case emissions rates, meteorological data, and terrain data. For the 3-hour SO_2 averaging time during the upset scenario, the 82nd highest maximum predicted concentration is provided. Although the highest maximum 3-hour SO_2 concentration could exceed the PSD increment during the upset scenario, the 3-hour increment would not be exceeded at least 99.78 percent of the time. The highest maximum predicted concentrations for the other pollutants and corresponding averaging times would not be expected to exceed the PSD Class II increment at any time.
[2] The normal operating scenario is based on steady-state emissions and is a period when the plant is operating without flaring, sudden restarts, or other upset conditions (see Appendix E).
[3] The upset scenario is based on unplanned restart emissions and is a period when a serious malfunction of any part of the IGCC process train usually results in a sudden shutdown of the combined-cycle units gas turbine and other plant components (see Appendix E).
[4] Annual impacts are based on maximum annual emissions (see Appendix E) over 7,446 hours per year.
[5] There are no short-term NAAQS for NO_2.
[6] There are no unplanned restart emissions of PM_{10} and $PM_{2.5}$ pollutants; therefore, short-term impacts (24-hour) are based on steady-state emissions.
[7] Although there are unplanned restart emissions of CO pollutants, the short-term impacts (1-hour and 8-hour) are based on steady-state emissions because steady-state CO emissions are larger than unplanned restart CO emissions.
n/a = not applicable; µg/m³ = micrograms per cubic meter.
Source: AERMOD modeling results (see Appendix E).

Predicted HAP emissions are presented in Table 5.2-6. These data indicate that the FutureGen Project would not emit any individual HAP above the 10-tpy (9.1-mtpy) major source threshold. Additionally, at 0.32 tpy (0.3 mtpy) of combined HAPs, the proposed FutureGen Project would not be a major source of HAPs as defined under the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Health hazards and risks associated with these HAP emissions and other air toxins are discussed in Section 5.17.

Table 5.2-6. Annual Hazardous Air Pollutant Emissions[1]

Chemical Compound	Combustion Turbine Emissions	
	tpy	mtpy
2-Methylnaphthalene	7.41E-04	6.72E-04
Acenaphthyalene	5.36E-05	4.86E-05
Acetaldehyde	3.72E-03	3.37E-03
Antimony[2]	2.08E-02	1.89E-02
Arsenic[2]	1.09E-02	9.93E-03
Benzaldehyde	5.99E-03	5.44E-03
Benzene	1.00E-02	9.09E-03
Benzo(a)anthracene	4.77E-06	4.32E-06
Benzo(e)pyrene	1.14E-05	1.03E-05
Benzo(g,h,i)perylene	1.96E-05	1.78E-05
Beryllium[2]	4.69E-04	4.26E-04
Cadmium[2]	1.51E-02	1.37E-02
Carbon Disulfide	9.27E-02	8.41E-02
Chromium[2, 3]	1.41E-02	1.28E-02
Cobalt[2]	2.97E-03	2.69E-03
Formaldehyde	6.89E-02	6.25E-02
Lead[2]	1.51E-02	1.37E-02
Manganese[2]	1.62E-02	1.47E-02
Mercury[2]	4.73E-03	4.29E-03
Naphthalene	1.10E-03	9.96E-04
Nickel	2.03E-02	1.84E-02
Selenium	1.51E-02	1.37E-02
Toluene	1.53E-03	1.39E-03
TOTAL	3.21E-01	2.91E-01

[1] Emission rates scaled by the ratio of VOC or PM emissions from Orlando Gasification Project EIS to the FutureGen Project. Orlando Project's VOC emissions were multiplied by a factor of 0.2727, based on 30 tpy (27.2 mtpy) VOC for the FutureGen Project divided by 110 tpy (99.8 mtpy) VOC for the Orlando Project. The Orlando Project's PM emissions were multiplied by a factor of 0.6894, based on 111 tpy (100.7 mtpy) PM for the FutureGen Project divided by 161 tpy (146.1 mtpy) PM for the Orlando Project.
[2] Compounds that are considered to be PM are in bold text.
[3] Conservatively assumed all chromium to be hexavalent.
tpy = tons per year; mpty = metric tons per year.
Source: DOE, 2007.

Mercury

The CAMR establishes standards of performance, limiting Hg emissions from new and existing coal-fueled power plants that produce more than 25-MW equivalent output and that would sell at least a portion of the electricity. The CAMR also creates a cap-and-trade program. Under the CAMR, the

Illinois Pollution Control Board requires controls that would reduce 90 percent of input Hg from various coal-fueled electrical generating units by mid-year 2009. The FutureGen Project would be subject to the CAMR because it is a unit that would generate approximately 275 megawatts-electrical (MWes) and would sell more than one-third of its potential electric output. The FutureGen Project would remove over 90 percent of Hg during the syngas cleanup process using activated carbon beds.

The maximum potential emissions of Hg from the FutureGen Project of 0.011 tpy (0.01 mtpy) would be well below the major source threshold for Hg of 10 tpy (9.1 mtpy) and significant emissions rate of 0.1 tpy (0.09 mtpy). The AERMOD analysis predicted that a negligible annual concentration of Hg (9.82×10^{-7} micrograms per cubic meter) would be deposited within 0.73 mile (1.7 kilometers) of the proposed power plant site.

Greenhouse Gases

GHGs include water vapor, CO_2, methane, NO_X, O_3, and several chlorofluorocarbons. Water vapor is a naturally occurring GHG and accounts for the largest percentage of the greenhouse effect. Next to water vapor, CO_2 is the second-most abundant GHG. Uncontrolled CO_2 emissions from power plants are a function of the energy output of the plants, the feedstock consumed, and the power plants' net efficiency at converting the energy in the feedstock into other forms of energy (e.g., electricity, useable heat, and hydrogen gas). Because CO_2 is relatively stable in the atmosphere and essentially uniformly mixed throughout the troposphere and stratosphere, the climatic impact of CO_2 emissions does not depend upon the CO_2 source location on the earth (DOE, 2006a). Although regulatory agencies are taking actions to address GHG effects, there are currently no Illinois or federal standards or regulations limiting CO_2 emissions and concentrations in the ambient air.

The proposed FutureGen Project would produce electricity and hydrogen fuel while emitting CO_2. DOE estimates that up to 0.28 million tons (0.25 million metric tons [MMT]) per year of CO_2 would be released into the atmosphere. A goal of the FutureGen Project is to capture and permanently sequester at least 90 percent of the CO_2 generated by the proposed power plant at a rate of 1.1 to 2.8 million tons (1.0 to 2.5 MMT) per year. By sequestering the CO_2 in geologic formations, the FutureGen Project aims to prove one technological option that could virtually eliminate future CO_2 emissions from similar coal-based power plants.

DOE's Energy Information Administration (EIA) report (DOE, 2006a) indicates that U.S. CO_2 emissions have grown by an average of 1.2 percent annually since 1990 and energy-related CO_2 emissions constitute as much as 83 percent of the total annual CO_2 emissions. DOE reviewed EPA's Emissions and Generation Resource Integrated Database (eGRID) to gain an understanding of the scale of the estimated CO_2 emissions from the proposed FutureGen Project compared to existing coal-fueled plants (EPA, 2006b). eGRID provides information on the air quality indicators for almost all of the electric power generated in the U.S.

The most recent data that can be accessed electronically are for the year 2000. A review of the database yielded the following information:

- In 2000, CO_2 emissions from all coal-fueled plants in Illinois equaled 94.7 million tons (85.9 MMT). The average emissions rate of these coal plants was 2,326 pounds (1,055 kilograms) per megawatt-hour.
- Based on the average CO_2 emissions rates of nine representative coal plants in the size range of 153 to 508 MW, a conventional 275-MW coal-fueled power plant would emit 2.17 million tons (2.0 MMT) per year at an 85 percent capacity factor. This is in the same range as the estimated

amount of CO_2 (1.1 to 2.8 million tons [1.0 to 2.5 MMT] per year) that would be sequestered by the proposed FutureGen Project.

Carbon capture and sequestration, if employed widely throughout the U.S. in future power plants or retrofitted existing power plants, could help reduce and possibly reverse the growth in national annual CO_2 emissions.

Acid Rain Requirements

Acid rain or acid deposition can occur when acid precursors (such as SO_2 and NO_X) are released into the atmosphere, and they react with O_2 and water to form acids (EPA, 2007). Acid rain can cause soil degradation; increase acidity of surface water bodies; and reduce growth, injure, or even cause death of forests and aquatic habitats. The Acid Rain Program, established under Title IV of the CAA, requires electric generating units greater than 25 MW to obtain a Phase II Acid Rain Permit and meet the objectives of the program, which are achieved through a system of marketable allowances. The FutureGen Project would be required to obtain a Phase II Acid Rain Permit and would operate in a manner that is consistent with EPA's overall efforts to reduce emissions of acid precursors. Continuous emissions monitoring for SO_2, NO_X, and CO_2, as well as volumetric gas flow and opacity, is a part of the acid rain regulations, which include requirements for monitoring, recordkeeping, and reporting. Upon facility startup, the FutureGen Project would need to obtain SO_2 allowances each year in an amount equal to the actual SO_2 emissions from the facility.

Odors

Operation of the FutureGen Project may cause noticeable odors. The chemical components that could cause noticeable odors are hydrogen sulfide (H_2S) and ammonia (NH_3). H_2S is formed during the gasification of coal containing sulfur. The FutureGen Project would use an acid gas removal system that would potentially remove 99 percent of the sulfur in the syngas stream, thereby reducing the amount of H_2S emitted and reducing the impact from H_2S odors. For the FutureGen Project, the fuel stock would be blown into the gasifier using O_2; therefore, the NH_3 in the syngas would be formed from fuel bound nitrogen. Additionally, NH_3 would be used in a selective catalytic reduction (SCR) system, a potential component of the FutureGen Project that controls NO_X emissions. While the current FutureGen Project design configurations include an SCR system, current research activities sponsored under the DOE Fossil Energy Turbine Program are investigating technologies that can achieve the NO_X emissions goals through combustion modifications only, thereby eliminating the need for post-combustion SCR (DOE, 2006b). The Alliance estimates that approximately 1,333 tons (1,209 metric tons) of NH_3 per year would be consumed in the FutureGen SCR process (FG Alliance, 2006e).

Both gases would normally only be emitted as small quantities of fugitive emissions (e.g., through valve or pump packing); however, if an accidental large release were to occur, such as a pipe rupture in the Claus Unit (the sulfur recovery unit) or from on-site NH_3 storage, a substantial volume of odor would be noticeable beyond the plant boundary. Other odors could be emitted from activities such as equipment maintenance, coal storage, and coal handling; however, these potential odors should be limited to the immediate site area and should not affect off-site areas. Illinois regulates all odors detected in the ambient air (i.e., beyond the fence line) under the provisions of Title 35 Part 245. Depending on the wind direction, even small volumes of H_2S and NH_3 odors could be a nuisance for the over 25 residences within 1 mile (1.6 kilometers) of the proposed Tuscola Power Plant Site.

Local Plume Visibility, Shadowing, Fogging, and Water Deposition

The proposed Tuscola Power Plant would have two main sources of water vapor plumes: the gas turbine exhaust stack and the cooling towers. The height of the cooling tower is typically less than the height of the gas turbine exhaust stack, which for the FutureGen Project is estimated to be 250 feet (76.2 meters) (FG Alliance, 2006e). Because of a reduced height, the cooling tower presents a greater concern than the gas turbine exhaust stack for impacts such as ground-level fogging, water deposition, and solids deposition (including precipitates). Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Potential deposition of solids would occur because the Tuscola Site proposes to use process water from the Lyondell-Equistar Chemical Plant that is held in surface ponds. This water would potentially contain a high concentration of solids (see Table 5.7-2). Effects from vapor plumes and deposition would be most pronounced within 300 feet (91.4 meters) of the vapor source and would decrease rapidly with distance from the source. Both cooling towers and the gas turbine exhaust plume may cause some concern for shadowing and aesthetics. Plume shadowing is generally a concern only when considering its effect on agriculture, which, due to the attenuation of sunlight by the plume's shadow, may reduce yield.

At the proposed Tuscola Power Plant Site, nearby residences or agriculture could be impacted by fogging, water deposition, icing, or solid deposition under rare meteorological events; however, the impacts would be minimal. The greatest concern would be for traffic hazards created on CR 750E, which borders the western side of the plant site and CR 1050N, which borders the north side of the plant site. Because the proposed Tuscola Site has 345 acres (140 hectares) and the FutureGen Project footprint requires 60 acres (24 hectares), it is unlikely that the boundary of the power plant would be built within 300 feet (91.4 meters) of either road; therefore, fog from the plant would have dissipated and deposition of solids on the road would not occur. Overall, solar loss, fogging, icing, or salt deposition from the proposed Tuscola Power Plant would not interfere with quality of life in the area.

Effects of Economic Growth

Any air quality impacts due to residential growth would be in the form of automobile and residential (fuel combustion) emissions that would be dispersed over a large area. Commercial growth would be expected to occur at a gradual rate in the future, and any significant new source of emissions would be required to undergo permitting by the IEPA. Impacts of economic growth on ambient air quality and PSD increments are unknown at this time. As part of the PSD permitting process, a determination of existing background concentrations of pollutants and additional modeling work would be required to estimate the maximum air pollutant concentrations that would be associated with the proposed Tuscola Power Plant as a result of future economic growth. Section 5.19, provides detailed discussions of the impacts of economic growth from the FutureGen Project on the local resources.

Effects on Vegetation and Soils

Section 165 of the Clean Air Act requires preconstruction review of major emitting facilities to provide for the prevention of significant deterioration and charges federal managers with an affirmative responsibility to protect the AQRVs of Class I areas. Implementing regulations requires an analysis of the potential impairment to visibility, soils, and vegetation. Subsequently, EPA developed "A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals," which specifies the air pollutant screening concentrations for which adverse effects may occur for various vegetation species and soils, depending on their sensitivity to pollutants (EPA, 1980). While the Tuscola Power Plant Site is more than 62 miles (100 kilometers) from a Class I area, it is surrounded by cropland that could be affected by the plant's air emissions. Therefore, DOE compared the power plant's predicted maximum air pollutant emissions with the EPA screening concentrations (Table 5.2-7). Based on this comparison, the power plant's emissions would be well below applicable screening concentrations. Emissions also would be well below the secondary NAAQS criteria, which are established to prevent unacceptable effects to crops and vegetation, buildings and property, and ecosystems.

Table 5.2-7. Screening Analysis for Effects on Vegetation and Soils

Pollutant	Averaging Period[1]	Maximum Total Concentration[2] (µg/m^3)	Screening Concentrations[3] (µg/m^3)	Secondary NAAQS (µg/m^3)
SO_2	3-hour	634.99	786	1,300
NO_2	Annual	30.16	94	100

[1] Maximum concentration for shortest averaging period available.
[2] Maximum concentration including background data (see Table 5.2-5).
[3] The most conservative values were utilized, based on the highest vegetation sensitivity category.
µg/m^3 = micrograms per cubic meter.
Source: EPA, 1980.

Effects on Animals

The secondary NAAQS were established to set limits to protect public welfare, including protection against harm to animals. The maximum predicted concentrations from the FutureGen Project estimated from the upper-bound emissions of the FutureGen Project's estimates of maximum air emissions, in addition to the ambient background concentration, are below the secondary NAAQS for all pollutants.

Sequestration Site

The proposed CO_2 sequestration would be within bedrock layers located approximately 1.2 to 1.5 miles (1.9 to 2.4 kilometers) beneath the ground surface, far below the soil zone, water table aquifer, and overlying unsaturated zone (see Section 5.5 and Chapter 2). Because co-sequestration of H_2S and CO_2 is being considered as part of research and development activities for the FutureGen Project, minor air emissions of H_2S and CO_2 would occur during routine operations over the lifetime of the proposed injection period, which DOE expects to be between 20 to 30 years, and possibly up to 50 years. Sources of emissions during sequestration site operations could include:

- Injection wells, monitoring wells, and other wells; and
- Aboveground valves, piping, and well heads that comprise the transmission system.

Injection Wells, Monitoring Wells, and Other Wells

Wells provide the greatest opportunity for the escape of sequestered fluids. The injection well would extend into a target injection zone, with steel pipe inserted its full length and cemented into the bore hole to prevent upward escape of sequestered fluid around the outside of the pipe. Within the steel casing, tubing is installed from the well head down to the top of the injection zone, with the annular space sealed against the casing with a packer. The annular space is filled with heavy liquid, such as brine, to help control any accidental leakage into the annular space. This tubing could be removed and replaced should it become corroded or damaged over time. The technology is standard for constructing a well of this type and no measurable fugitive emissions from the well would be expected. Monitoring wells would be constructed in a similar manner as the injection wells, so they would be secure and could also be monitored for leaks and repaired as needed. There should be no contact by CO_2 with the soils. The sequestration reservoir would be tested for assurance that no leak paths exist prior to project operations. Pre-existing oil wells that are not related to the FutureGen Project, present a greater risk of leakage. If

Tuscola is selected to host the FutureGen Project, DOE anticipates that some means of identifying the locations of pre-existing wells over the plume and monitoring these wells for leakage would be employed at levels commensurate with the risks posed by the pre-existing wells. Wells that provide leakage points would be repaired or plugged to prevent leakage and emissions. All exploratory wells would be properly plugged with concrete and abandoned before operation of the sequestration facility if they are not used as injection wells or monitoring wells, preventing potential fugitive emissions from the sequestered CO_2.

Aboveground Valves, Piping, and Well Heads

The supercritical CO_2 that would be piped from the plant to the injection wells would enter each well through a series of valves attached to the underground steel pipe to ensure proper direction and control of flow. These valves would be above ground and easily accessible to workers for controlling well operation and conducting well maintenance. There would typically be four valves with flanged fittings for each well. Fugitive emissions from each valve were estimated based on California South Coast Air Quality Management District (SCAQMD, 2003) valve emission factor of 0.0013 pound (0.6 gram) per hour for non-methane organic compounds. In addition to the expected fugitive emissions typical of gate valves, periodic well inspections, testing, and maintenance would be another source of emissions. The well valves would be periodically manipulated to allow insertion of inspection or survey tools to test the integrity of the system or to repair or replace system components. During each of those instances, some amount of CO_2 gas would be vented to the atmosphere.

The annual emissions estimate is based on the two injection wells required, accounting for the tubing volume and the number of evacuations that would occur each time a valve is opened. DOE estimates annual emissions of approximately 98 tons (88.5 metric tons) of CO_2. A number of tracers would also be used to track the fate and transport of the injected CO_2. Descriptions of these compounds are provided in Section 5.16. Fugitive emissions from valves, piping, and well heads may also contain very minute amounts of these tracers.

Utility Corridors

There are no planned operational activities along the proposed utility corridors that would cause air emissions impacts. Routine maintenance along the corridors would not result in fugitive emissions. However, if repairs were required and an underground line had to be excavated, there would be localized and temporary soil dust releases during the excavation process, which would be minimized through BMPs.

Transportation Corridors

During operation of the power plant, transportation-related air emissions would be produced from train and truck shipments to and from the plant and also from employee automobiles. Major pollutants emitted from automobiles, trucks, and trains include hydrocarbons (HC), NO_X, CO, PM, and CO_2. Trucks emit more HC and CO than trains on a brake horsepower per hour basis although they emit less NO_x and PM on the same basis. The higher values for HC and CO are caused by the differences in driving cycle—the truck driving cycle is much more dynamic than that of a train, which has more constant speed operations (Taylor, 2001). The FutureGen Project would aim to utilize train shipments for materials and waste to the greatest extent possible to increase transportation efficiency and reduce shipping costs but to also minimize related air pollution.

5.20 ENVIRONMENTAL JUSTICE

The U.S. Department of Energy defines "**Environmental Justice**" as: The fair treatment and meaningful involvement of all people—regardless of race, ethnicity, and income or education level—in environmental decision making. Environmental Justice programs promote the protection of human health and the environment, empowerment via public participation, and the dissemination of relevant information to inform and educate affected communities. DOE Environmental Justice programs are designed to build and sustain community capacity for meaningful participation for all stakeholders in DOE host communities (DOE, 2006).

Specific populations identified under Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 *Federal Register* 7629), are examined here along with the potential of effects on these populations from construction and operation of the proposed FutureGen facility. In the context of this EIS, Environmental Justice refers specifically to the potential for minority and low-income populations to bear a disproportionate share of high and adverse environmental impacts from activities within the project area and the municipalities nearest to the proposed Tuscola Power Plant Site, sequestration site, and related corridors.

5.20.1 INTRODUCTION

Executive Order 12898 directs federal agencies to achieve Environmental Justice as part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their actions on minority and low-income populations. Minorities are defined as individuals who are members of the following population groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. To classify as a minority population, an area must have a population of these groups that exceeds 50 percent of the total population, or the minority population percentage of the affected area should be meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis (59 *Federal Register* 7629).

The Council on Environmental Quality (CEQ) guidance recommends that low-income populations in an affected area be identified using data on income and poverty from the U.S. Census Bureau (CEQ, 1997). Low-income populations are groups with an annual income below the poverty threshold, which was $19,971 for a family of four for calendar year 2006.

5.20.1.1 Region of Influence

The ROI includes the land area within 50 miles (80.5 kilometers) of the boundaries of the proposed power plant site, sequestration site, reservoir, and utility and transportation corridors. The proposed sequestration site and reservoir are located approximately 10 miles (16 kilometers) south of the proposed plant site. The 50-mile (80.5-kilometer) radius for the sequestration site and the 50-mile (80.5-kilometer) radius for the plant site largely overlap. The ROI includes the counties of Douglas, Champaign, Coles, Cumberland, Edgar, Macon, Moultrie and Piatt in Illinois; some land area in the counties of Christian, Clark, Crawford, DeWitt, Effingham, Fayette, Ford, Jasper, Logan, McLean, Sangamon, Shelby and Vermilion in Illinois; and Vermillion and Vigo counties in Indiana. Section 5.19.1.1 describes the rationale for including these counties in the ROI.

5.20.1.2 Method of Analysis

DOE collected demographic information from the U.S. Census Bureau 2000 census to characterize low-income and minority populations within 50 miles (80.5 kilometers) of the proposed Tuscola Power Plant Site and Sequestration Site. Census data are compiled at various levels corresponding to geographic areas and include, in order of decreasing size, states, counties, census tracts, block groups, and blocks. In order to accurately characterize and locate minority and low-income populations, DOE followed CEQ Guidance (CEQ, 1997) to determine the minority and low-income characteristics using U.S., State of Illinois, regional (defined by the 23-county ROI) and individual county data. The data presented in Table 5.20-1 show the overall composition and makeup of both minority and non-minority populations, and low-income populations within the ROI. Where available, DOE obtained U.S. Census data for local jurisdictions (i.e., towns and cities) to further identify the presence of minority or low-income populations. DOE used Census block group data (FG Alliance, 2006b) to examine the distribution of minority and low-income populations within the ROI.

DOE used potential environmental, socioeconomic, and health impacts identified in other sections of this EIS to assess potential impacts to Environmental Justice that could occur with the proposed construction and operation of the FutureGen Project.

DOE assessed the potential for impacts based on the following criteria:

- A significant and disproportionately high and adverse effect on a minority population; or
- A significant and disproportionately high and adverse effect on a low-income population.

Table 5.20-1. County, Regional and National Population and Low-Income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-income (percent)
Counties Wholly Located Within the ROI								
Champaign	179,669	78.8	11.2	0.2	6.5	<0.1	2.9	16.1
Coles	53,196	95.4	2.3	0.2	0.8	<0.1	1.4	17.5
Cumberland	11,253	98.8	0.1	0.2	0.2	<0.1	0.6	9.5
Douglas	19,922	97.3	0.3	0.2	0.3	<0.1	3.5	6.4
Edgar	19,704	97.1	1.8	0.2	0.2	<0.1	0.8	10.5
Macon	114,706	83.5	14.1	0.2	0.6	<0.1	1.0	12.9
Moultrie	14,287	98.9	0.2	0.2	0.1	<0.1	0.5	7.8
Piatt	16,365	98.8	0.2	0.1	0.1	<0.1	0.6	5.0
Counties Partially Located Within the ROI								
Christian	35,372	96.3	2.1	0.2	0.4	<0.1	1.0	9.5
Clark	17,008	98.8	0.2	0.2	0.1	<0.1	0.3	9.2
Crawford	20,452	93.6	4.5	0.3	0.3	<0.1	0.5	11.2
DeWitt	16,798	97.8	0.5	0.2	0.3	<0.1	1.3	8.2
Effingham	34,264	98.7	0.2	0.2	0.3	<0.1	0.7	8.1

Table 5.20-1. County, Regional and National Population and Low-Income Distributions (2000)[1]

County	Total Population	White (percent)	Black (percent)	American Indian/ Alaska Native (percent)	Asian (percent)	Native Hawaiian/ Pacific Islander (percent)	Hispanic or Latino (all races) (percent)	Low-income (percent)
Fayette	21,802	94.0	4.9	0.1	0.2	<0.1	0.8	12.2
Ford	14,241	98.2	0.2	0.1	0.3	<0.1	1.2	7.0
Jasper	10,117	99.1	0.1	0.1	0.2	<0.1	0.5	9.9
Logan	31,183	91.7	6.6	0.2	0.5	<0.1	1.6	8.1
McLean	150,433	89.2	6.2	0.2	2.1	<0.1	2.5	9.7
Sangamon	188,951	87.4	9.7	0.2	1.1	<0.1	1.1	9.3
Shelby	22,893	98.9	0.2	0.1	0.2	<0.1	0.5	9.1
Vermilion	83,919	85.8	10.6	0.2	0.6	<0.1	3.0	13.3
Vermillion (IN)	16,788	98.4	0.3	0.2	0.1	<0.1	0.6	9.5
Vigo (IN)	105,848	90.7	6.0	0.3	1.2	<0.1	1.2	14.1
Regional and National Statistics								
23-County ROI	1,199,171	94.2	3.6	0.2	0.7	<0.1	1.2	10.2
Illinois	12,419,293	73.5	15.1	0.2	3.4	<0.1	12.3	10.7
U.S.	281,421,906	75.1	12.3	0.9	3.6	0.1	12.5	12.4

[1] Some of the minority population counted themselves as more than one ethic background, thus the counts do not add up to 100 percent.
Source: USCB, 2006.

5.20.2 AFFECTED ENVIRONMENT

5.20.2.1 Minority Populations

Table 5.20-1 compares the minority percentage and low-income percentage of county populations within the ROI with those of Illinois and the nation. The 2000 Census revealed a more diverse population in Illinois compared to the 1990 Census. In 2000, 26.5 percent of Illinois residents identified themselves as non-white, up from 21.6 percent in 1990 (USCB, 2006). The regional population within the ROI has non-minority populations (white) as the highest percentage (94.2 percent) compared to the state (73.5 percent) and U.S. (75.1 percent) percentages.

The higher minority percentages (above 10 percent) within the ROI are in counties with more urbanized areas including the communities of Decatur (22.4 percent non-white) and Urbana-Champaign (33 percent, 26.8 percent non-white, respectively) (USCB, 2006). Because the overall population in the ROI is far more homogeneous racially and ethnically (less than 5 percent non-white) than the general population of the state and country, a “minority population” as characterized by CEQ does not exist in the potentially affected area of the proposed project.

5.20.2.2 Low-Income Populations

The percentage of low-income populations for individuals, by county, is generally comparable to state (10.7 percent) and national (12.4 percent) percentages (Table 5.20-1). The majority of the ROI is at or above poverty level (annual household income above $19,971) (USCB, 2006). Low-income populations exceeding the national percentages occur in Champaign (16.1 percent), Coles (17.5 percent), Macon (12.9 percent), Montgomery (13.4 percent), Vermilion (13.3 percent), and Vigo (14.1 percent) counties.

The proposed power plant site is located within Douglas County, with a portion near the Coles County border. Other areas of low-income populations are located beyond 25 miles (40 kilometers) from the proposed power plant site and sequestration site, and include the communities of Decatur (21.0 percent), Urbana (27.3 percent), and West Terre Haute, Indiana (20.7 percent).

5.20.3 IMPACTS

This section discusses the potential for disproportionately high and adverse impacts on minority and low-income populations associated with the proposed FutureGen Project. The CEQ's December 1997 Environmental Justice Guidance (CEQ, 1997) provides guidelines regarding whether human health effects on minority populations are disproportionately high and adverse. CEQ advised agencies to consider the following three factors to the extent practicable:

- Whether the health effects, which may be measured in risks and rates, are significant (as defined by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death.
- Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as defined by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group.
- Whether health effects occur in a minority population, low-income population, or Native American tribe affected by cumulative or multiple adverse exposures from environmental hazards.

Based on the definitions in Section 5.20.1, the criteria outlined above, and the findings regarding environmental and socioeconomic impacts throughout this EIS, the analysis for Environmental Justice in this EIS was performed in the following sequence:

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a minority population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 5.20.1, was determined.

Using data from the 2000 Census, the potential for adverse environmental or socioeconomic impacts resulting from site-specific or corridor-specific project activities (construction or operation) to affect a low-income population in the ROI and have a disproportionately high and adverse effect, as defined by CEQ and described in Section 5.20.1, was determined.

Using the impacts analyzed in Section 5.17, the potential for adverse health risks in a wider radius from project sites and corridors was compared with the potential adverse health risks that could affect a minority population or low-income population at a disproportionately high and adverse rate.

Using the impacts analyzed in Section 5.17, the potential for health effects in a minority population or low-income population affected by cumulative or multiple adverse exposures to environmental hazards was determined.

5.20.3.1 Construction Impacts

As discussed in Section 5.20.2.1, no areas of minority population, as defined by EO 12898, are located within the ROI. Therefore, no disproportionately high and adverse impacts to minority populations are anticipated.

The power plant and sequestration sites would be located in Douglas and Coles counties. Coles County has a higher percentage of low-income population when compared to the regional (6.7 percent higher), state (6.8 percent higher) and national (5.1 percent higher) percentages; however, the percentage is far below the 50 percent threshold as defined in EO 12898. Due to some of the minority population counting themselves as belonging to more than one ethnic background, DOE calculated the percentages by subtracting the white population Census number from 100 percent (e.g., 100 percent – 95.4 percent = 4.6 percent for Coles County). No disproportionately high and adverse impacts are anticipated to the low-income population. Construction activities may cause temporary air quality, water quality, transportation and noise impacts to the general population (see Sections 5.2, 5.7, 5.13, and 5.14). Short-term beneficial impacts may include an increase in employment opportunities and potentially higher wages or supplemental income through jobs created during facility construction.

5.20.3.2 Operational Impacts

No areas of minority populations are located within the ROI for the proposed power plant site, sequestration site, and associated utility and transportation corridors. Therefore, no disproportionately high and adverse impacts to minority populations are anticipated.

Aesthetics, transportation, noise, and socioeconomic impacts (see Sections 5.12, 5.13, 5.14, and 5.19) resulting from operations were determined not to have a disproportionately high and adverse effect on the low-income population. The potential risks to health were determined to be from the unlikely event of pipeline rupture or puncture, the extremely unlikely event of a slow, upward leakage of H_2S from an injection or existing well, or a catastrophic accident, terrorism, or sabotage, which cannot be predicted (see Section 5.17). This potential would be uniform to the general population, and therefore, no disproportionately high and adverse impacts are anticipated.

Long-term beneficial impacts would be anticipated due to an increase in employment opportunities and potentially higher wage jobs associated with facility operation.

INTENTIONALLY LEFT BLANK

5.21 REFERENCES

5.1 Chapter Overview

Energy Information Administration (EIA). 2000. ***Energy Policy Act Transportation Rate Study: Final Report on Coal Transportation***. Accessed January 1, 2007 at ftp://ftp.eia.doe.gov/pub/pdf/coal.nuclear/059700.pdf

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

Patrick Engineering, Inc. 2006. "2D Seismic Survey of Proposed FutureGen Sites (Final Report)." IL.

5.2 Air Quality

40 CFR 6. "Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 51.166. "Requirements for Preparation, Adoption and Submittal of Implementation Plans: Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 52.21. "Prevention of Significant Deterioration of Air Quality." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 93. "Determining Conformity of Federal Actions to State or Federal Implementation Plans." U.S. Environmental Protection Agency, *Code of Federal Regulations*.

Food and Agriculture Organization of the United Nations (FAO). 1992. *Wastewater Treatment and Use in Agriculture – FAO Irrigation and Drainage Paper 47*. Accessed January 30, 2007 at http://www.fao.org/docrep/T0551E/T0551E00.htm#Contents

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FG Alliance. 2007. "Initial Conceptual Design Report."

South Coast Air Quality Management District (SCAQMD). 2003. *Guidelines for Fugitive Emissions Calculations*. Accessed January 3, 2007 at www.ecotek.com/aqmd/2006/forms_and_instructions_pdf/2003_fugitive_guidelines.pdf

Taylor, G. W. R. 2001. *Trucks and Air Emissions, Final Report*. Prepared for Transportation Systems Branch, Air Pollution Prevention, Environmental Protection Service, Environment Canada. March 2001. Accessed April 9, 2007 at http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/trucks/trucktoc.htm (last updated December 11, 2002).

U.S. Department of Energy (DOE). 2006a. “Emissions of Greenhouse Gases in the United States 2005.” Washington, DC.

DOE. 2006b. *The Turbines of Tomorrow*. Accessed January 5, 2007 at http://www.fe.doe.gov/programs/powersystems/turbines/index.html (last updated November 9, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1980. “A Screening Procedure for the Impacts of Air Pollution Sources on Plants, Soils, and Animals.” Washington, DC.

EPA. 1990. “New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting.” Draft, October 1990. Washington, DC.

EPA. 2005. “Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations.” Washington, DC.

EPA. 2006a. *National Ambient Air Quality Standards (NAAQS)*. Accessed November 8, 2006 at http://www.epa.gov/air/criteria.html (last updated October 13, 2006).

EPA. 2006b. *eGRID – Emissions and Generation Resource Integrated Database (eGRID).* Accessed December 1, 2006 at http://www.epa.gov/cleanenergy/egrid/index.htm (last updated October 30, 2006).

EPA. 2006c. *EnviroMapper for Envirofacts (Query Tuscola, Illinois).* Accessed December 28, 2006 at http://www.epa.gov/enviro/emef/ (last updated March 30, 2006).

EPA. 2007. *Acid Rain Program*. Accessed April 27, 2007 at http://www.epa.gov/airmarkets/progsregs/arp/index.html (last updated February 2, 2007).

U.S. Fish and Wildlife Service (FWS), 2007. *Permit Application, PSD Overview*. Accessed January 27, 2007 at http://www.fws.gov/refuges/AirQuality/permits.html (last updated August 14, 2006).

5.3 Climate and Meteorology

Blue Planet Biomes. 2006. *World Climates*. Accessed December 1, 2006 at http://www.blueplanetbiomes.org/climate.htm (last updated November 7, 2006).

FutureGen Alliance (FG Alliance). 2006b. “Tuscola Site Environmental Information Volume.”

The Tornado Project. 1999. *The Fujita Scale*. Accessed December 1, 2006 at http://www.tornadoproject.com/fscale/fscale.htm

National Oceanic and Atmospheric Administration (NOAA). 2006. *Storm Events*. Accessed December 2, 2006 at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms (updated daily).

5.4 Geology

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FutureGen Site Proposal (Tuscola, Illinois). 2006. "Proposal for FutureGen Host Site. Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site."

Illinois State Geological Survey (ISGS). 1968. *Geology and Oil Production in the Tuscola Area, Illinois. Illinois State Geological Survey Circular 424*. Accessed October 5, 2006 at http://www.isgs.uiuc.edu/oilgas/Circulars/Cir424_Geology_and_Oil_Production_in_the_Tuscola_Area_Illinois.pdf (last updated January 13, 2005).

ISGS. 1995a. *Earthquake Occurrence in Illinois*. Accessed October 5, 2006 at http://www.isgs.uiuc.edu/earthquakes/Articles/qk-fct-occur.pdf (last updated November 30, 1999).

ISGS. 1995b. *Damaging Earthquakes in Illinois*. Accessed October 5, 2006 at http://www.isgs.uiuc.edu/earthquakes/Articles/qk-fct-damag.pdf (last updated November 30, 1999).

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Louie, J. 1996. *What is Richter Magnitude?* Accessed October 5, 2006 at http://www.seismo.unr.edu/ftp/pub/louie/class/100/magnitude.html (last updated October 9, 1996).

Patrick Engineering, Inc. 2006. "2D Seismic Survey of Proposed FutureGen Sites (Final Report)." IL.

U.S. Geological Survey (USGS). 2006. *NEIC: Earthquake Search Results. U.S. Geological Survey Earthquake Database*. Accessed October 6, 2006 at http://eqint.cr.usgs.gov/neic/cgi-bin/epic/epic.cgi?SEARCHMETHOD=3&SLAT2=0.0&SLAT1=0.0&SLON2=0.0&SLON1=0.0&FILEFORMAT=4&SEARCHRANGE=HH&CLAT=39.737&CLON=-88.3&CRAD=193&SUBMIT=Submit+Search&SYEAR=&SMONTH=&SDAY=&EYEAR=&EMONTH=&EDAY=&LMAG=&UMAG=&NDEP1=&NDEP2=&IO1=&IO2=

5.5 Physiography and Soils

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

Natural Resources Conservation Service (NRCS). 2006a. *Official Series Description*. Accessed November 27, 2006 at http://www2.ftw.nrcs.usda.gov/

NRCS. 2006b. *Soil Regions of Illinois*. Accessed October 25, 2006 at http://www.il.nrcs.usda.gov/technical/soils/soil-regions/index.html

U.S. Department of Agriculture (USDA). 2006. *Soil Survey of Douglas County, Illinois*. Accessed October 10, 2006 at http://soildatamart.nrcs.usda.gov/Manuscripts/IL041/0/Douglas_IL.pdf (last updated September 13, 2006).

5.6 Groundwater

City of Tuscola. 2003. *2003 Water Quality Report, City of Tuscola*. Accessed December 4, 2006 at http://www.tuscola.org/forms/2003CCReport.pdf (last updated June 8, 2004).

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

The News Gazette. 2006. *Warning: Mahomet Aquifer Water Supply has Limits*. Accessed December 4, 2006 at http://www.news-gazette.com/news/local/2006/11/12/warning_mahomet_aquifer_water_supply_has_limits (last updated November 12, 2006).

Patrick Engineering, Inc. 2006. "2D Seismic Survey of Proposed FutureGen Sites (Final Report)." IL.

U.S. Environmental Protection Agency (EPA). 2006. *Designated Sole Source Aquifers in EPA Region V*. Accessed December 15, 2006 at http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg5.pdf

5.7 Surface Water

62 IAC 240.530. "The Illinois Oil and Gas Act, Completion Fluid and Completion Fluid Waste Handling and Storage." Effective June 3, 1997. *Illinois Administrative Code*.

Behl, L. 2006. Personal communication. Letter from Larry Behl, Production Team Group Leader, Duke Energy Generating Services, Tuscola, IL to Brian Moody, Executive Director, Tuscola Economic Development, Inc., Tuscola, IL.

Benson, S., R. Hepple, J. Apps, C. Tsang and M. Lippman. 2002. "Lessons Learned from Natural and Industrial Analogues for Storage of Carbon Dioxide in Deep Gas Formations." Earth Sciences Division, E.O. Lawrence Berkeley National Laboratory, Berkeley, CA.

Damen, K., A. Faaij and W. Turkenburg. 2003. "Health, Safety and Environmental Risks of Underground CO_2 Sequestration." Copernicus Institute for Sustainable Development and Innovation, Department of Science, Technology and Society, Utrecht, The Netherlands.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

Holloway, S. 1996. "The Underground Disposal of Carbon Dioxide." British Geological Survey, Keyworth, Nottingham, UK.

Illinois Environmental Protection Agency (IEPA). 1997. "IEPA Monitoring and Assessment Facility-Related Stream Survey Report." Facility: Urbana-Champaign SD SW, NPDES Permit 0031526, Discharge ID O 01902, Dated 08/12/1997.

IEPA. 2004. "IEPA Monitoring and Assessment Facility-Related Stream Survey Report." Facility: Urbana-Champaign SD SW, NPDES Permit 0031526, Discharge ID O 01902, Dated 09/01/2004.

IEPA. 2006. *Illinois Integrated Water Quality Report and Section 303(d) List- 2006*. Accessed March 13, 2007 at http://www.epa.state.il.us/water/water-quality/report-2006/2006-report.pdf

Illinois State Water Survey (ISWS). 2002. *Historical Climate Data: Precipitation Summary. Station: 118684 Tuscola, IL*. Accessed December 1, 2006 at http://www.sws.uiuc.edu/atmos/statecli/Summary/118684.htm (last updated September 11, 2002).

ISWS. 2004. "Sediment and Water Quality Monitoring for the Hurricane and Kickapoo Creek Watersheds, Coles and Cumberland Counties, Illinois." Champaign, IL.

National Oceanic and Atmospheric Administration (NOAA). 2005. *July Weather Trivia for Illinois*. Accessed December 2, 2006 at http://www.crh.noaa.gov/ilx/trivia/jultriv.php (last updated November 3, 2005).

Reichle, D., J. Houghton, B. Kane and J. Ekmann. 1999. "Carbon Sequestration Research and Development." U.S. Department of Energy, Office of Science, Office of Fossil Energy, Oak Ridge, TN.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

U.S. Geological Survey (USGS). 2006. *National Water Information System: Web Interface. Water Quality Samples for Illinois. USGS 05591200 Kaskaskia River at Cooks Mills, IL*. Accessed December 2, 2006 at http://waterdata.usgs.gov/il/nwis/qwdata

5.8 Wetlands and Floodplains

10 CFR 1022. "Compliance with Floodplain and Wetland Environmental Review Requirements." U.S. Department of Energy, *Code of Federal Regulations*.

42 *Federal Register* 26951. "Executive Order 11988 – Floodplain Management." Federal Register. May 24, 1977.

42 *Federal Register* 26961. "Executive Order 11990 – Protection of Wetlands." Federal Register. May 24, 1977.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. "Classification of Wetlands and Deepwater Habitats of the United States." U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Emergency Management Agency (FEMA). 2006a. "Flood Insurance Rate Map, Coles County, Illinois (digital, GIS format)." Jessup, MD.

FEMA. 2006b. "Flood Insurance Rate Map, Douglas County, Illinois (digital, GIS format)." Jessup, MD.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

Indiana Department of Natural Resources (IDNR). 2006. Letter from Michael Branham, Division of Ecosystems and Environment, IDNR, to Dan Wheeler, IL Department of Commerce & Economic Opportunity. September 13, 2006.

U.S. Army Corps of Engineers (USACE). 1987. "Corps of Engineers Wetlands Delineation Manual." Vicksburg, MS.

5.9 Biological Resources

Avian Power Line Interaction Committee (APLIC). Edison Electric Institute and Raptor Research Foundation. 1996. "Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996." Washington, DC.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FutureGen Site Proposal (Tuscola, Illinois). 2006. "Proposal for FutureGen Host Site. Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site."

Illinois Environmental Protection Agency (IEPA). 2002. Unpublished data.

Illinois Natural History Survey (INHS). 1996. "Inventory of Resource Rich Areas in Illinois: An Evaluation of Ecological Resources." Champaign, Illinois.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

U.S. Fish and Wildlife Service (FWS). 2006. Letter from Joyce A. Collins, Assistant Field Supervisor, Marion, Illinois, Suboffice, FWS, to Daniel Wheeler, Illinois Department of Commerce and Economic Development. April 14, 2006.

5.10 Cultural Resources

16 USC 470. "The National Historic Preservation Act of 1966, as amended through 2000." U.S. Federal Government, *U.S. Code*.

20 ILCS 3410. "Illinois Historic Preservation Act." State of Illinois, *Illinois Compiled Statutes*.

20 ILCS 3420. "Illinois State Agency Historic Resources Preservation Act." State of Illinois, *Illinois Compiled Statutes*.

20 ILCS 3435. "Archaeological and Paleontological Resources Protection Act." State of Illinois, *Illinois Compiled Statutes*.

20 ILCS 3440. "Human Skeletal Remains Protection Act." State of Illinois, *Illinois Compiled Statutes*.

36 CFR 60. “National Register of Historic Places.” U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 62. “National Natural Landmarks Program.” U.S. Department of the Interior, National Park Service, *Code of Federal Regulations*.

36 CFR 800. “Protection of Historic Properties.” U.S. Department of the Interior, Advisory Council on Historic Preservation, *Code of Federal Regulations*.

765 ILCS 835. “Cemetery Protection Act.” State of Illinois, *Illinois Compiled Statutes*.

Finney, F. 2006. “Archaeological Survey Short Report: Phase I Archaeological Survey for Proposed FutureGen Development Near Tuscola and Arcola, Douglas County, Illinois.” Prepared for Patrick Engineering, Inc., Springfield, IL, by Upper Midwest Archaeology, St. Joseph, IL.

FutureGen Alliance (FG Alliance). 2006b. “Tuscola Site Environmental Information Volume.”

King, T. F. 1998. “Cultural Resource Laws and Practice.” AltaMira Press, Walnut Creek, CA.

National Park Service (NPS). 2006. *Native American Consultation Database*. Accessed December 6, 2006 at http://home.nps.gov/nacd/ (last updated March 31, 2006).

5.11 Land Use

14 CFR 77. “Objects Affecting Navigable Airspace.” Federal Aviation Administration, *Code of Federal Regulations*.

City of Arcola. 2006. Letter from Bill Wagoner, City Administrator, City of Arcola, to Patrick Engineering, Inc. April 26, 2006.

City of Tuscola. 2001. “City of Tuscola Comprehensive Plan. Champaign County Regional Planning Commission in Cooperation with City of Tuscola.”

City of Tuscola. 2006. Letter from J. Drew Hoel, City Administrator, City of Tuscola, to FutureGen Industrial Alliance. September 13, 2006.

Comprehensive Environmental Response, Compensation and Liability Information System Database (CERCLIS). 2006. *Superfund Site Information*. Accessed March 11, 2007 at http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm (last updated December 20, 2006).

De Figueiredo, M. A., D. M. Reiner and H. J. Herzog. 2005. “Framing the Long-Term In Situ Liability Issue for Geologic Carbon Storage in the United States.” *Mitigation and Adaptation Strategies for Global Change* 10 (4): 647-657.

FutureGen Alliance (FG Alliance). 2006b. “Tuscola Site Environmental Information Volume.”

FutureGen Site Proposal (Tuscola, Illinois). 2006. “Proposal for FutureGen Host Site.” Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

Illinois Department of Agriculture (ILDOA). 2001. *Land Evaluation and Site Assessment* (Revised 2001). Accessed December 4, 2006 at http://www.agr.state.il.us/Environment/LandWater/LESA.pdf (last updated December 21, 2006).

Illinois Environmental Protection Agency (IEPA). 2006. ***Bureau of Land. Databases***. Accessed October 16, 2006 at http://www.epa.state.il.us/land/database.html

Natural Resources Conservation Service (NRCS). 2000. ***National Resource Inventory. Illinois Highlights. 1997 National Resources Inventory***. Accessed October 16, 2006 at http://www.il.nrcs.usda.gov/technical/nri/highlights.html (last updated December 2000).

Patrick Engineering, Inc. 2006. "Airspace Obstruction Analysis." IL.

U.S. Environmental Protection Agency (EPA). 2006. ***Superfund Information Systems***. Accessed October 16, 2006 at http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm (last updated August 25, 2006).

5.12 Aesthetics

Bureau of Land Management (BLM). 2004. ***Public Lands Managed by the BLM***. Accessed November 11, 2006 at http://www.blm.gov/nhp/facts/index.htm (last updated November 28, 2006).

Douglas County Highway Department. 2006. "FutureGen Project Aerial Photographs." Tuscola, Illinois.

Finney, F. 2006. "Archaeological Survey Short Report: Phase I Archaeological Survey for Proposed FutureGen Development Near Tuscola and Arcola, Douglas County, Illinois." Prepared for Patrick Engineering, Inc., Springfield, IL, by Upper Midwest Archaeology, St. Joseph, IL.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

Ruppenkamp, A. 2006. Personal communication. Telephone discussion between Ellen Hall, The Louis Berger Group, and Andy Ruppenkamp, Lyondell-Equistar Chemicals, Tuscola, Illinois. December 4, 2006.

U.S. Department of Energy (DOE). 2006a. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

DOE. 2006b. ***FutureGen - Tomorrow's Pollution-Free Power Plant***. Accessed December 28, 2006 at http://www.fossil.energy.gov/programs/powersystems/futuregen/ (last updated December 14, 2006).

Zack, L. 2007. Personal communication. Telephone discussion between Ellen Hall, the Louis Berger Group, and Libby Zack, Media Relations Assistant, Cargill, Minneapolis, MN. February 5, 2007.

5.13 Transportation and Traffic

American Association of State Highway and Transportation Officials (AASHTO). 2004. "A Policy on Geometric Design of Highways and Streets." Washington, DC.

Federal Railroad Administration (FRA). 2006. *Track Compliance Manual*. Accessed January 18, 2007 at http://www.fra.dot.gov/downloads/safety/track_compliance_manual/TCM%205.PDF

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

Illinois Department of Transportation (IDOT). 2005a. *Illinois Crash Data 2000 – 2003*. Accessed December 1, 2006 at http://www.dot.il.gov/trafficsafety/crashreports.html

IDOT. 2005b. *Comprehensive Highway Safety Plan*. Accessed December 4, 2006 at http://www.dot.il.gov/illinoisCHSP/plan.html

IDOT. 2005c. *Project Information*. Accessed December 1, 2006 at http://www.dot.state.il.us/projects.html

Transportation Research Board (TRB). 2000. "Highway Capacity Manual." Washington, DC.

5.14 Noise and Vibration

35 IAC 901. "Sound Emission Standards and Limitations for Property Line-Noise-Sources." *Illinois Administrative Code*.

Barksdale. 1991. "The Aggregate Handbook:" National Stone Association. Washington, DC.

Bolt, Beranek, and Newman 1971. "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances." Prepared for the U.S. Environmental Protection Agency, Washington, DC.

Bolt, Beranek, and Newman. 1973. "Fundamentals of Abatement and Highway." Federal Highway Administration.

Bolt, Beranek and Newman. 1984. "Electric Power Plant Environmental Noise Guide, Volume 1, 2nd edition." Prepared for Edison Electric Institute.

Cowan, J. P. 1994. "Handbook of Environmental Acoustics." John Wiley & Sons, Inc.

Federal Highway Administration (FHWA). 1992. *Highway Traffic Noise*. Accessed December 27, 2006 at http://www.fhwa.dot.gov/environment/htnoise.htm (last updated December 14, 2006).

FHWA. 1998. "FHWA Traffic Noise Model, Technical Manual (TNM Lookup Table)." Washington, DC.

Federal Transit Administration (FTA). 2006. "Transit Noise and Vibration Impact Assessment." Harris Miller Miller and Hanson, Inc. Washington, DC.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

U.S. Department of Energy (DOE). 2006a. "Draft Environmental Impact Statement for the Orlando Gasification Project." Orlando, FL.

VIBCO. Undated-a. "High Frequency Silent Models." Wyoming, RI.

VIBCO. Undated-b. "Silent Pneumatic CC Series." Wyoming, RI.

Western Safety Products. 2007. *Aldon Rail Safety Page 6.* Accessed April 3, 2007 at http://www.westernsafety.com/aldon/aldonpage6.html (last updated March 28, 2007).

5.15 Utility Systems

Behl, L. 2006. Personal communication. Letter from Larry Behl, Production Team Group Leader, Duke Energy Generating Services, Tuscola, IL to Brian Moody, Executive Director, Tuscola Economic Development, Inc., Tuscola, IL.

Energy Information Administration (EIA). 2006. "Annual Energy Outlook 2006 with Projections to 2030." Washington, DC.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

North American Electric Reliability Council (NERC). 2006. "2006 Long-Term Reliability Assessment: The Reliability of the Bulk Power Systems in North America." Princeton, NJ.

PowerWorld Corporation. 2006. "Generator Interconnection Study: Tuscola Site." Champaign, IL.

5.16 Materials and Waste Management

35 IAC 808. Environmental Protection: Special Waste Classifications. *Illinois Administrative Code*.

American Coal Ash Association (ACAA). 2006. *2005 Coal Combustion Product (CCP) Production and Use Survey*. Accessed November 4, 2006 at http://www.acaa-usa.org/PDF/2005_CCP_Production_and_Use_Figures_Released_by_ACAA.pdf

California Integrated Waste Management Board (CIWMB). 2006. *Estimated Solid Waste Generation Rates for Industrial Establishments*. Accessed November 9, 2006 at http://www.ciwmb.ca.gov/WasteChar/WasteGenRates/Industrial.htm (last updated December 7, 2004).

Ciba. 2006. *Water Treatment*. Accessed November 6, 2006 at http://www.cibasc.com/index/ind-index/ind-water_treatment.htm

Energy Information Administration (EIA). 2006. *U.S. Coal Consumption by End Use Sector, by Census Division and State*. Accessed December 7, 2006 at http://www.eia.doe.gov/cneaf/coal/page/acr/table26.html

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

FutureGen Site Proposal (Tuscola, Illinois). 2006. "Proposal for FutureGen Host Site." Submitted in Response to the March 7, 2006 Request for Proposals for FutureGen Facility Host Site.

FG Alliance. 2007. "Initial Conceptual Design Report."

Illinois Environmental Protection Agency (IEPA). 2005. *Eighteenth Annual Landfill Capacity Report -2004*. Accessed October 10, 2006 at http://www.epa.state.il.us/land/landfill-capacity/2004/index.html

Illinois State Geological Survey (ISGS). 2006. *Illinois Coal Resource Shapefiles*. Accessed December 18, 2006 at http://www.isgs.uiuc.edu/coalsec/coal/coalshapefiles.htm (last updated May 18, 2006).

Morris, R. J. 2003. *Sulphur Surplus in the Making Impacts Refineries*. Accessed October 30, 2006 at http://www.sulphurinstitute.org/Morris.NPRApaper.pdf

Nalco. 2006. *Nalco Locations, North America*. Accessed November 3, 2006 at http://www.nalco.com/ASP/region/region.asp?region=NA

The Innovation Group (TIG). 2002. *Chemical Profiles: Sulfur*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sulfur.htm

TIG. 2003. *Chemical Profiles: Sodium Hypochlorite*. Accessed November 6, 2006 at http://www.the-innovation-group.com/ChemProfiles/Sodium%20Hypochlorite.htm

U.S. Geological Survey (USGS). 2006a. *Mineral Commodity Summaries– Lime*. Accessed December 4, 2006 at http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/lime_mcs06.pdf

USGS. 2006b. *Mineral Industry Surveys – Directory of Lime Plants in the United States in 2005*. Accessed December 4, 2006 at http://minerals.er.usgs.gov/minerals/pubs/commodity/lime/limedir05.pdf

5.17 Human Health, Safety, and Accidents

American Industrial Hygiene Association (AIHA), 1997. "Odor Thresholds for Chemicals with Established Occupational Health Standards." Fairfax, VA.

Department of Health and Human Services (DHHS). 2006. "The State of Childhood Asthma, United States, 1980–2005." National Center for Health Statistics. Advance Data from Vital and Health Statistics. Number 381. Revised December 29, 2006.

Ermak, D. L. 1990. "User's Manual for SLAB: An Atmospheric Dispersion Model for Denser-Than-Air Releases." Report UCRL-MA-105607, University of California, Lawrence Livermore National laboratory, Livermore, CA.

FutureGen Alliance (FG Alliance). 2006a. "Mattoon Dole Site Environmental Information Volume."

FG Alliance. 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006c. "Heart of Brazos Site Environmental Information Volume."

FG Alliance. 2006d. "Odessa Site Environmental Information Volume."

FG Alliance. 2006e. "FutureGen Project EIS Project Description Data Needs Table Operational Parameters and Assumptions Unplanned Starts."

Gale, J. and J. Davison. 2004. "Transmission of CO_2 – Safety and Economic Considerations." *Energy* 29 (9-10): 1319–1328.

Gilmour, M I., M. S. Jaakkola, S. J. London, A. E. Nel and C. A. Rogers. 2006. "How Exposure to Environmental Tobacco Smoke, Outdoor Air Pollutants, and Increased Pollen Burdens Influences the Incidence of Asthma." *Environmental Health Perspectives* 114: 627-633.

Hanna, S. R. and P. J. Drivas. 1987. "Guidelines for Use of Vapor Cloud Dispersion Models." Center for Chemical Process Safety. American Institute of Chemical Engineers. NY.

Interstate Oil and Gas Compact Commission (IOGCC). 2005. "Carbon Capture and Storage: A Regulatory Framework for States - Summary of Recommendations." Oklahoma City, OK.

Intergovernmental Panel on Climate Change (IPCC). 2005. *Special Report on Carbon Dioxide Capture and Storage*. Accessed December 10, 2006 at http://www.ipcc.ch/activity/srccs/index.htm (last updated January 16, 2006).

Mills, W. B., D. B. Porcella, M. J. Ungs, S. A. Gherini, K. V. Summers, L. Mok, G. L. Rupp, G. L. Bowie and D.A. Haith. 1985. "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants in Surface and Ground Water." Volume 1. EPA/600/6-85/002a. U.S. Environmental Protection Agency, Washington, DC.

National Institute of Environmental Health Sciences (NIEHS). 1999. "Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields." NIH Publication No. 99-4493.

National Institute of Occupational Health (NIOSH). 1983. *Comprehensive Safety Recommendations for Land-Based Oil and Gas Well Drilling. Publication No. 83-127*. Accessed April 5, 2007 at http://www.cdc.gov/niosh/83-127.html

NIOSH. 1987. "Preventing Entrapment and Suffocation Caused by the Unstable Surfaces of Stored Grain and Other Material." NIOSH Publication No. 88-102.

NIOSH. 2007. *Pocket Guide to Chemical Hazards*. *NIOSH Publication No. 2005-149*. Accessed March 12, 2007 at http://www.cdc.gov/niosh/npg/npgsyn-a.html

Office of Pipeline Safety (OPS). 2006. *Hazardous Liquid Pipeline Accident Summary by Commodity. 1/1/2006-12/05/2006*. Accessed March 12, 2007 at http://ops.dot.gov/stats/LQ06_CM.HTM

OPS. 2007. *FOIA On-line Library*. Accessed March 12, 2007 at http://ops.dot.gov/stats/IA98.htm (last updated January 22, 2007).

Oldenburg, C. M. 2005. *Health, Safety, and Environmental Screening and Ranking Framework for Geologic CO_2 Storage Site Selection.* Accessed July 21, 2006 at http://repositories.cdlib.org/cgi/viewcontent.cgi?article=4279&context=lbnl

Papanikolau, N., B. M. L. Lau, W. A. Hobbs and J. Gale. 2006. "Safe Storage of CO_2: Experience from the Natural Gas Storage Industry." In *Proceedings of the 8th International Conference on Greenhouse Gas Control Technologies (GHGT-8)*, 19 - 22 June 2006. Trondheim, Norway.

Quest Consultants Inc. (Quest). 2006. "Consequence-Based Risk Ranking Study for the Proposed FutureGen Project Configurations." November 28, 2006. Norman, OK.

Scherer, G. W., M. A. Celia, J-H Prevost, S. Bachu, R. Bruant, A. Duguid, R. Fuller, S. E. Gasda, M. Radonijic and W. Vichit-Vadkan. 2005. "Leakage of CO_2 through Abandoned Wells: Role of Corrosion of Cement, in Carbon Dioxide Capture for Storage in Deep Geologic Formations." In *Carbon Dioxide Capture for Storage in Deep Geologic Formations – Results from the CO_2 Capture Project, Vol 2 – Geologic Storage of Carbon Dioxide with Monitoring and Verification*. Elsevier Science, London.

Selgrade, M. K., R. F. Lemanske Jr., M. I. Gilmour, L. M. Neas, M. D.W. Ward, P. K. Henneberger, D. N. Weissman, J. A. Hoppin, R. R. Dietert, P. D. Sly, A. M. Geller, P. L. Enright, G. S. Backus, P. A. Bromberg, D. R. Germolec and K. B. Yeatts. 2006. "Induction of Asthma and the Environment: What We Know and Need to Know." *Environmental Health Perspectives* 114: 615-619.

TetraTech. 2007. "Final Risk Assessment Report for the FutureGen Project Environmental Impact Statement." April 2007 (Revised). Lafayette, CA.

U.S. Bureau of Labor Statistics (USBLS). 2006a. *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2005*. Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/osh/os/ostb1619.pdf

USBLS. 2006b. *Fatal Occupational Injuries to Private Sector Wage and Salary Workers, Government Workers, and Self-employed Workers by Industry, All United States, 2005, Washington, DC.* Accessed November 10, 2006 at http://www.bls.gov/iif/oshwc/cfoi/cftb0207.pdf

U.S. Census Bureau. 2006. *Topologically Integrated Geographic Encoding and Referencing Database*. Accessed March 12, 2007 at http://www.census.gov/geo/www/census2k.html

U.S. Department of Energy (DOE). 2002. "Major Environmental Aspects of Gasification-Based Power Generation Technologies, Final Report." December, 2002. Washington, DC.

DOE. 2004. "ALOHA Computer Code Application Guidance for Documented Safety Analysis, Final Report." Report DOE-EH-4.2.1.3-ALOHA Code Guidance, June 2004, Office of Environment, Safety and Health, Washington, DC.

DOE. 2006. *Temporary Emergency Exposure Limits (TEELs) [Revision 21 of AEGLs, ERPGs and TEELs for Chemicals of Concern]*. Accessed March 12, 2007 at http://www.eh.doe.gov/chem_safety//teel.html (last updated October 16, 2006).

DOE. 2007. *Final Environmental Impact Statement for the Orlando Gasification Project, January 2007*. Accessed March 8, 2007 at http://www.eh.doe.gov/NEPA/eis/eis0383/index.html

U.S. Environmental Protection Agency (EPA). 1995. “SCREEN3 Model User’s Guide.” EPA-454/B-95-004. Research Triangle Park, NC.

EPA. 2000. “Carbon Dioxide as a Fire Suppressant: Examining the Risks.” EPA430-R-00-002. February 2000.

EPA. 2006a. *IRIS Database for Risk Information. Integrated Risk Information System (IRIS)*. Accessed March 12, 2007 at http://www.epa.gov/iris/ (last updated January 25, 2007).

EPA. 2006b. *Acute Exposure Guideline Levels (AEGLs)*. Accessed March 12, 2007 at http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (last updated January 9, 2007).

EPA. 2007. *Acute Exposure Guideline Levels (AEGLs): Ammonia Results*. Accessed April 16, 2007 at http://www.epa.gov/oppt/aegl/pubs/results88.htm (last updated August 28, 2006).

5.18 Community Services

City Data (CD). 2002. *City Data for Tuscola, Illinois*. Accessed November 30, 2006 at http://www.city-data.com/

Everett, L. 2004. *VA Losing the Ability to Care ‘For Him Who Has Borne the Battle’*. Accessed November 30, 2006 at http://www.larouchepub.com/other/2004/3118v_a_hosptls.html

Everett, L. and M. M. Baker. 2004. *LaRouche: Reverse the Policy that Created the Flu Crisis*. Accessed November 30, 2006 at http://www.larouchepub.com/eiw/public/2004/2004_40-49/2004-42/pdf/04-13_41_ecoflu.pdf

FutureGen Alliance (FG Alliance). 2006b. “Tuscola Site Environmental Information Volume.”

Hospital-Data (HD). 2006. *Hospital and Nursing Home Profiles*. Accessed November 30, 2006 at http://www.hospital-data.com/

Illinois Criminal Justice Information Authority. (ICJIA). 2004. *A Profile of the Coles County Criminal and Juvenile Justice Systems*. Accessed December 1, 2006 at http://www.icjia.org/public/pdf/CountyProfiles/Coles.pdf

Illinois Homeland Security (IHS). 2003. *Mutual Aid Box Alarm System*. Accessed November 30, 2006 at http://www.ready.illinois.gov/ittf/terrorismreport7.htm

Illinois Hospital Association (IHA). 2006. *IHA Member Hospitals and Health Systems (Region Listing)*. Accessed November 30, 2006 at http://www.ihatoday.org/about/find/regions.pdf

Illinois State Board of Education (ISBE). 2005. *Illinois Public School Enrollment Projections: 2004-05--2012-13*. Accessed December 1, 2006 at http://www.isbe.state.il.us/research/pdfs/public_school_enrollment.pdf

Illinois State Police (ILSP). 2004. *District Quick Finder*. Accessed December 1, 2006 at http://www.isp.state.il.us/districts/

Indiana State Department of Health (IDOH). 2006a. *Hospital Directory for Vermillion County*. Accessed November 30, 2006 at http://www.state.in.us/isdh/regsvcs/acc/hospital/ctyfac82.htm

IDOH. 2006b. *Hospital Directory for Vigo County*. Accessed November 30, 2006 at http://www.state.in.us/isdh/regsvcs/acc/hospital/ctyfac83.htm

Indiana State Police (INSP). 2006. *District Locations*. Accessed December 1, 2006 at http://www.in.gov/isp/districts/terrehaute.html

National Center for Educational Statistics (NCES). 2005. *Public and Private Elementary and Secondary Teachers, Enrollment, and Pupil/Teacher Ratios: Selected Years, Fall 1955 through Fall 2014*. Accessed December 3, 2006 at http://nces.ed.gov/programs/digest/d05/tables/dt05_063.asp

Occupational Safety and Health Administration (OSHA). 1994. *Member of a HazMat Team*. January 31, 1994. Accessed December 2, 2006 at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21384

Office of the Illinois State Fire Marshall (ISFM). 2006. *Fire Department List by County*. Accessed December 2, 2006 at http://www.state.il.us/osfm/NFIRS/R_FD_County_Short.pdf

Quinlivan, J. T. 2003. *Burden of Victory: The Painful Arithmetic of Stability Operations*. Accessed December 2, 2006 at http://www.rand.org/publications/randreview/issues/summer2003/burden.html (last updated August 2, 2006).

Swager, R. 2006. Personal communication. Email from Ronald Swager, Patrick Engineering, Springfield, IL, to Nancy Clark, Potomac-Hudson Engineering, Inc., Bethesda, MD, November 6, 2006.

The Disaster Center. 2005. *Illinois Crime Rates 1960-2005*. Accessed December 1, 2006 at http://www.disastercenter.com/crime/ilcrime.htm

U.S. Census Bureau (USCB). 2006. *National Spending per Student Rises to $8,287*. Accessed November 29, 2006 at http://www.census.gov/Press-Release/www/releases/archives/economic_surveys/006685.html

USACOPS (UC). 2005a. *Illinois Police Departments (by County).* Accessed December 1, 2006 at http://www.usacops.com/il/pollist.html

UC. 2005b. *Indiana Police Departments (by County).* Accessed December 1, 2006 at http://www.usacops.com/in/pollist.html

Yahoo Yellow Pages (YYP). 2006a. *Ambulance Service (within 50 miles of Tuscola, Illinois).* Accessed December 1, 2006 at http://yp.yahoo.com/py/ypResults.py?Pyt=Typ&city=Tuscola&state=IL&uzip=61953&country=us&msa=0000&cs=4&ed=d_Fo661o2Tx3OxC1dilSe4Y_rSgVNvLyBJtMNjUJOSkC&tab=B2C&stx=8104713&stp=y&desc=Ambulance+Service&qtx=Ambulance&doprox=1&sorttype=distance&beyond=1&stat=ClkByndLower

YYP. 2006b. *Fire Protection (in Terre Haute, Indiana).* Accessed December 1, 2006 at http://yp.yahoo.com/py/ypResults.py?Pyt=Typ&city=Terre+Haute&state=IN&uzip=47807&country=us&msa=8320&cs=4&ed=JiR0Mq1o2Tw8M4UXAx4KaVrA0tp7YSsJYohVWFdIrhp0&tab=B2C&stx=8104709&stp=y&desc=Fire+Protection&qtx=Fire+Department&doprox=1&sorttype=distance&beyond=1&stat=ClkByndLower

5.19 Socioeconomics

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

FG Alliance. 2006e. " FutureGen Project Description, Data Needs Table, Operational Parameters and Assumptions and Unplanned Starts."

Illinois Department of Labor (IDOL). 2006. *Douglas County Prevailing Wage for November 2006*. Accessed December 1, 2006 at http://www.state.il.us/agency/idol/rates/ODDMO/DOUGLAS9.htm

Illinois Hospitality Industry (IHI). 2006. *Illinois Hospitality Industry Health Indicators*. Accessed December 2, 2006 at http://www.tourism.uiuc.edu/itf/indicator/hospitality_current.pdf (last updated January 6, 2006).

Illinois Venture Capital Association (IVCA). 2006. *FAQ about Venture Capital & Private Equity*. Accessed December 1, 2006 at http://www.illinoisvc.org/pages/faq/59.php

U.S. Bureau of Labor Statistics (USBLS). 2004. *News: United States Department of Labor (Civilian Labor Force and Unemployment by State and Selected Areas, Seasonally Adjusted).* Accessed December 1, 2006 at http://www.bls.gov/news.release/archives/laus_07202004.pdf

USBLS. 2006a. Illinois. *Data Series (Unemployment Statistics, July 2006).* Accessed December 3, 2006 at http://stats.bls.gov/eag/eag.il.htm

USBLS. 2006b. *Unemployment Rate (National Unemployment Rates 1996 to 2006).* Accessed December 3, 2006 at http://data.bls.gov/PDQ/servlet/SurveyOutputServlet?data_tool=latest_numbers&series_id=LNS14000000

U.S. Census Bureau (USCB). 2000a. *United States Census 2000. Demographic Profiles*. Accessed December 1, 2006 at http://censtats.census.gov/pub/Profiles.shtml (last updated September 2, 2004).

USCB. 2000b. *Projected Population of the United States, by Age and Sex: 2000 to 2050*. Accessed December 1, 2006 at http://www.census.gov/ipc/www/usinterimproj/natprojtab02a.pdf (last updated August 26, 2004).

USCB. 2000c. *Annual Estimates of the Population by Sex and Five-Year Age Groups for the United States: April 1, 2000 to July 1, 2005*. Accessed December 2, 2006 at http://www.census.gov/popest/national/asrh/NC-EST2005/NC-EST2005-01.xls (last updated June 8, 2006).

USCB. 2000d. *Median Age: 2000. Illinois by County*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF1_U&tm_name=DEC_2000_SF1_U_M00022&_dBy=050&geo_id=04000US17&_MapEvent=displayBy

USCB. 2000e. *Per Capita Income in 1999: 2000, Illinois by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=050&geo_id=04000US17&_MapEvent=displayBy

USCB. 2000f. *Per Capita Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000g. *Median Household Income in 1999: 2000, United States by State*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00024&_dBy=040&geo_id=01000US&_MapEvent=displayBy

USCB. 2000h. *Per Capita Income in 1999: 2000, Indiana by County*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?ds_name=DEC_2000_SF3_U&tm_name=DEC_2000_SF3_U_M00270&_dBy=050&geo_id=04000US18&_MapEvent=displayBy

USCB. 2005a. *Population Pyramids of Illinois*. Accessed December 1, 2006 at http://www.census.gov/population/projections/14PyrmdIL1.pdf (last updated April 20, 2005).

USCB. 2005b. *Illinois: Industry by Sex and Median Earnings in the Past 12 Months (in 2004 Inflation-Adjusted Dollars) for the Civilian Employed Population 16 Years and Over*. Accessed December 1, 2006 at http://factfinder.census.gov/servlet/STTable?_bm=y&-context=st&-qr_name=ACS_2004_EST_G00_S2403&-ds_name=ACS_2004_EST_G00_&-tree_id=304&-redoLog=true&-all_geo_types=N&-_caller=geoselect&-geo_id=04000US17&-format=&-_lang=en

USCB. 2005c. *Percent of Occupied Housing Units that are Owner-Occupied: 2005. United States by State*. Accessed December 2, 2006 at http://factfinder.census.gov/servlet/ThematicMapFramesetServlet?_bm=y&-geo_id=01000US&-tm_name=ACS_2005_EST_G00_M00621&-ds_name=ACS_2005_EST_G00_&-_MapEvent=displayBy&-_dBy=040#?388,250

5.20 Environmental Justice

59 *Federal Register* 7629. "Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." February 11, 1994. *Federal Register* [Volume 59, No. 32].

Council on Environmental Quality (CEQ). 1997. "Environmental Justice Guidance under the National Environmental Policy Act." Executive Office of the President. December 10, 1997. Washington, DC.

FutureGen Alliance (FG Alliance). 2006b. "Tuscola Site Environmental Information Volume."

U.S. Census Bureau (USCB). 2006. *American FactFinder*. Accessed November 12, 2006 at http://factfinder.census.gov

U.S. Department of Energy (DOE). 2006. *Environmental Justice Definition*. Accessed November 12, 2006 at http://www.lm.doe.gov/env_justice/definition.htm (last updated December 13, 2006).

5.3 CLIMATE AND METEOROLOGY

5.3.1 INTRODUCTION

This section addresses the region's climate and meteorology and the potential impacts on construction and operation of the proposed FutureGen Project.

5.3.1.1 Region of Influence

The ROI for climate and meteorology includes the proposed Tuscola Power Plant Site, sequestration site, and the utility and transportation corridors.

5.3.1.2 Method of Analysis

DOE reviewed the Tuscola EIV (FG Alliance, 2006b) report to assess the potential impacts of climate and meteorology on the proposed FutureGen Project. Factors identified in this section include normal and extreme temperatures, and severe weather events such as tornadoes and floods. There were no uncertainties identified in relation to climate and meteorology at the proposed Tuscola Site.

DOE assessed the potential for impacts based on the following criteria:

- Potential for aspects of the project to fail or cause safety hazards due to temperature variations and extremes; and
- Potential for aspects of the project to fail or cause safety hazards due to a high probability for severe weather events.

5.3.2 AFFECTED ENVIRONMENT

This section describes the climate of the central Illinois region and provides information on climate, meteorology, and severe weather events for Douglas County.

5.3.2.1 Local and Regional Climate

The proposed Tuscola Power Plant Site is located in Douglas County in the east-central region of Illinois near the city of Tuscola. This region has a moist, mid-latitude, humid continental climate consistent with the Köppen Climate Classification "Cfa." The Köppen Climate Classification System recognizes five major climate types based on annual and monthly temperature and precipitation averages. Each major type is designated by a capital letter A through E. The letter "C" refers to humid, mid-latitude climates where land/water differences play a large part. These climates have warm, dry summers and cool, wet winters. Further subgroups are designated by a second, lowercase letter that distinguishes seasonal temperature and precipitation characteristics. The letter "f" refers to moist climates with adequate precipitation in all months and no dry season. This letter usually accompanies A, C, and D climates. To further denote climate variations, a third letter was added to the code. The letter "a," found in C and D climates, refers to hot summers where the warmest month is over 72°F (22°C). Maximum

> The **Köppen Climate Classification System** is the most widely used system to classify world climates. Categories are based on the annual and monthly averages of temperature and precipitation. The Köppen System recognizes five major climatic types, and each type is designated by a capital letter (A through E). Additional information about this classification system is available at http://www.blueplanetbiomes.org/climate.htm (Blue Planet Biomes, 2006).

precipitation occurs in the summer and minimum precipitation occurs in the winter. Average annual rainfall is about 40 inches (102 centimeters), and measurable precipitation occurs about 100 days per year. Average winter snowfall is around 20 inches (51 centimeters); however, only one snowfall per year generally exceeds 6 inches (15 centimeters) (FG Alliance, 2006b).

Winters in the region are generally cold, and summers are generally hot. Average high and low January temperatures are around 34.4°F (1.3°C) and 18.0°F (-7.8°C), respectively. On average, the temperature falls below 0°F (-17.8°C) six days a year during the winter. In mid-summer, average high temperatures reach 88°F (31.1°C) and average low temperatures reach 66°F (18.9°C). High temperatures frequently reach 90°F (32.2°C) or more in the summer. Table 5.3-1 summarizes representative temperature, precipitation, and wind speed data. Climate data for this table were assembled from the National Climatic Data Center for the three nearest Illinois climate network stations (Arcola, Bondville, and Champaign) and are based on historical norms derived from 30 years of weather data from 1971 through 2000 (FG Alliance, 2006b).

Table 5.3-1. Seasonal Weather Data

Weather Parameter	Spring	Summer	Fall	Winter
Average Daily Temperature, °F (°C)	67.2 (19.6)	77 (25)	50.0 (10.0)	36.5 (2.5)
Precipitation, inches (centimeters)	11.6 (29.5)	11.8 (30.0)	9.7 (24.6)	7.5 (19.1)
Snow, inches (centimeters)	1.1 (2.8)	0.0 (0.0)	5.4 (13.7)	16.6 (42.2)
Average Wind Speed, miles per hour (kilometers per hour)	11.6 (18.7)	8.0 (12.9)	10.3 (16.6)	11.2 (18.0)

°F = degrees Fahrenheit; °C = degrees Celsius.
Source: FG Alliance, 2006b.

A wind rose is a graph created to show the directional frequencies of wind. Wind rose data from 1998 to 2006 are presented in Figure 5.3-1. The wind rose is representative of the percent of time that the wind blows at a particular speed and direction. The concentric circles on the wind rose represent percentage of time. The wind rose is based on climate data from University of Illinois Willard Airport located about 19 miles (31 kilometers) north of the proposed power plant site. As the wind rose indicates, the most common wind directions are from the south, the west, and the south-southwest (FG Alliance, 2006b). For the proposed FutureGen Project, the primary use of wind rose data is for evaluating potential hazardous material releases to estimate plume transport times and determine potential population exposure.

The average annual wind speed in the region is 10.5 mph (16.9 kmph), and winds from the south through southwest are most prevalent. Calm winds (below 1.5 mph [2.4 kmph]) prevail 4.6 percent of the time on an annual basis. In the winter, the average wind speed is 11.2 mph (18.0 kmph), and the most frequent wind speeds are between 8.0 and 19.6 mph (12.9 and 31.5 kmph). The most prevalent winter winds are from the south through southwest, with a milder spike of occurrences from the northwest. In the spring, the average wind speed is 11.6 mph (18.7 kmph), and the most frequent wind speeds are between 12.7 and to 19.6 mph (20.4 to 31.5 kmph). Winds from the south through southwest are most common in the spring, with no apparent secondary maximum from any other direction; however, winds from the northeast are rare. Winds are usually lighter in the summer with an average speed of 8.0 mph (12.9 kmph), and calm conditions occur around 6 percent of the time. The most prevalent wind directions in the summer are from the south through southwest. In the fall, the average wind speed is 10.3 mph (16.6 kmph), with the most prevalent winds from the south and south-southwest, although winds from the west-northwest are also common. Winds from the northeast are rare in the fall (FG Alliance, 2006b).

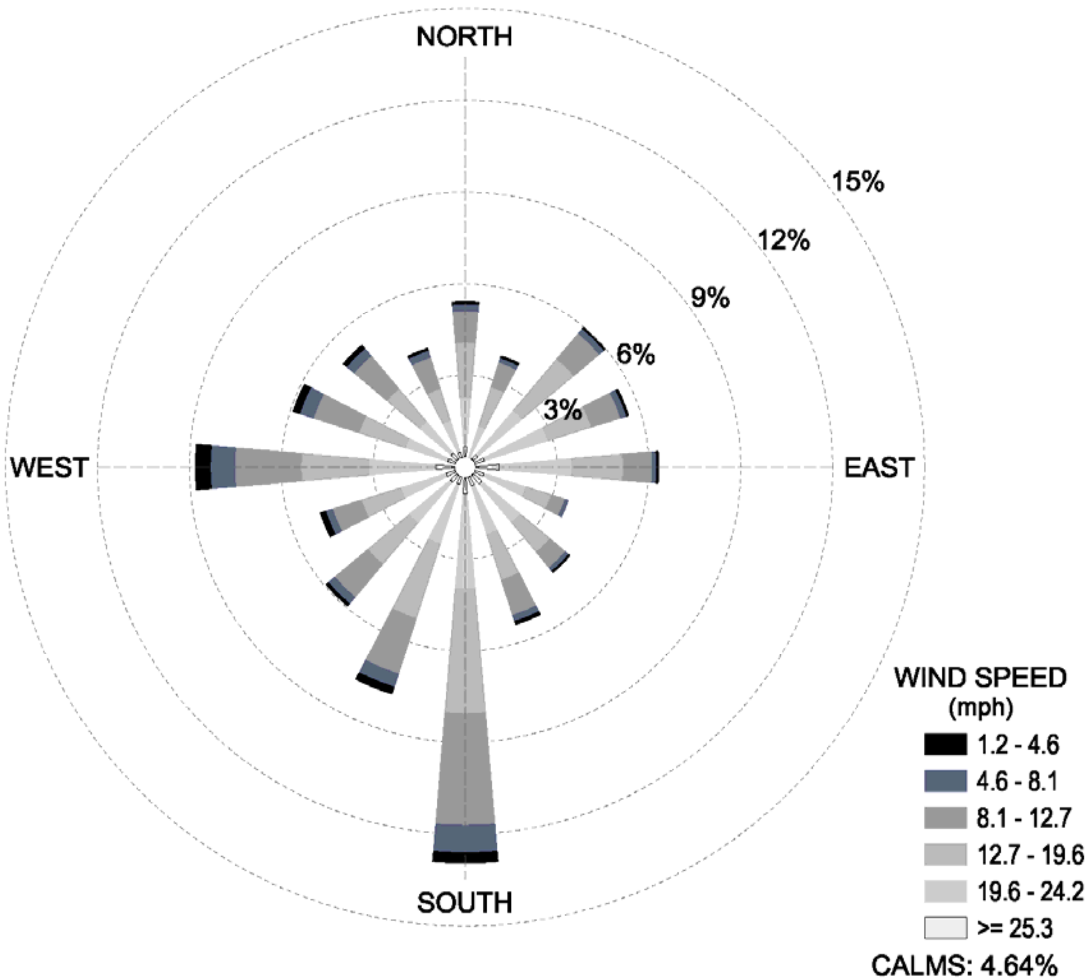


Figure 5.3-1. Wind Rose for the Tuscola Region

The proposed power plant site and sequestration site are located in the central plains region of Illinois, which historically experiences a full spectrum of weather phenomena, including extreme heat and cold, ice storms and blizzards, high winds and heavy rainfalls, thunderstorms, localized floods, and tornadoes. Based on historical norms, each year Douglas County can expect between 45 and 50 thunderstorms, between one and four tornadoes, and 4 or 5 days with winds that exceed 45 mph (72.4 kmph). Over a 10-year span, the region can expect about 25 hailstorms, 12 snowfalls of 6 inches (15 centimeters) or more, and 11 ice storms (FG Alliance, 2006b).

5.3.2.2 Severe Weather Events

Relevant severe weather events for the ROI include frozen precipitation (hail, snow, and ice), tornadoes, floods, and drought. The proposed project site is located hundreds of miles inland from both the Atlantic Coast and Gulf Coast. For this reason, coastal hurricanes do not occur within the region and have been excluded from discussion.

Hail, Snow, and Ice

On average, each year the Douglas County region receives an average of two or three hail storms, one snowfall of 6 inches (15.2 centimeters) or more, and one storm with icy precipitation that forms a glaze on road surfaces, trees, and power lines.

Tornadoes

The National Oceanic Atmospheric Administration (NOAA) documents tornado activity in the region. The Fujita Scale is a standard qualitative metric to characterize tornado intensity based on the damage caused. This scale ranges from F0 (weak) to F6 (violent). From 1950 to 2006, 25 tornados were reported in Douglas County, including 15 F0 tornadoes, four F1 tornadoes, five F2 tornadoes, and one F3 tornado (NOAA, 2006). Between one and four tornadoes greater than F1 intensity would be expected in Douglas County over a 50-year time interval (FG Alliance, 2006b).

The most common metric for tornado strength is the **Fujita Scale**. There are six categories on this scale. F0 and F1 are considered weak, F2 and F3 are strong, and F4 through F6 are violent. Each category represents a qualitative level of damage and an estimated range of sustained wind speed delivered by the tornado. Additional information about the Fujita Scale is available at http://www.tornadoproject.com/fscale/fscale.htm (The Tornado Project, 1999).

Floods

The city of Tuscola is located about 4.5 miles (7.2 kilometers) east of the Kaskaskia River and about 5.1 miles (8.2 kilometers) west of the Embarras River. During heavy rains, these rivers can overflow and cause localized flash floods. The NOAA database shows that, between 1999 to 2006, 11 floods have been reported in Douglas County. The most severe flood effects were generally localized near the Embarras and Kaskaskia rivers, although minor flood effects were sustained in Tuscola as well. The presence of these nearby rivers and the relative flat topography of the region contribute to the potential for flood events in the region (FG Alliance, 2006b). As noted in Section 5.8.2.2, the proposed power plant and sequestration sites are not in the 100-year or 500-year floodplains.

Drought

Illinois is located in the Ohio Valley area. This area has suffered notable periods of drought over the past 100 years with extended periods of severe to extreme drought in 1895 to 1896, 1900 to 1901, 1908, 1914, 1930, 1935 to 1937, 1940 to 1942, 1953 to 1954, 1963 to 1964, 1987, and 1996. A statewide network of data collection sites, operated by state and federal agencies, has been established to monitor drought conditions. These sites provide real-time climate, stream flow, aquifer, and reservoir information to water management professionals to develop drought mitigation and response plans. Additional information on the State of Illinois Drought Contingency Plan can be found at http://drought.unl.edu/plan/state%20plans/Illinois.pdf.

5.3.3 IMPACTS

5.3.3.1 Construction Impacts

Power Plant Site

Severe temperature or weather conditions may temporarily delay construction at the proposed power plant site. An ice glaze or snowstorm could prevent material deliveries to and from the site. A hail storm could cause minor damage to equipment at the construction site and extremely low temperatures could also damage equipment and delay construction progress, although such temperature extremes are relatively uncommon.

A flood could impact construction activities at the proposed power plant site; however, the chance for a flood would be very small because the proposed power plant site would be located entirely outside of the 500-year floodplain. A strong tornado could potentially impact construction activities at the proposed power plant site; however, the statistical probability for a tornado greater than F1 intensity in Douglas County is relatively low (between one and four occurrences every 50 years), and the proposed power plant site constitutes a small fraction of the county's size. The risks posed on construction safety by climate and severe weather events would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements (FG Alliance, 2006b).

Severe or extreme drought conditions could increase the potential for wildfires in the area. Drought conditions would also increase the number of water trucks needed to reduce fugitive dust emissions and to support other construction activities. In dry, hot weather, construction workers may need to wear a dust mask and work for shorter time intervals between breaks.

Sequestration Site

Construction impacts at the proposed sequestration site would be the same as those discussed for the power plant site.

Utility Corridors

Severe temperature or weather conditions could temporarily delay construction at the proposed utility corridors. The potential impacts from ice glaze, large snowfall, hail, or tornado would be comparable to those described for the proposed power plant site. The entire CO_2 corridor would be outside of the 100-year floodplain, so the potential for impact from flood would be low. Small portions of the proposed electrical transmission corridor would be within the 100-year floodplain; however, because this corridor would cross such a small portion of the 100-year floodplain and construction activities in the utility corridor would occur over such a limited time span, the potential for a flood to have direct or indirect impact on construction would be low.

Transportation Corridors

There are no proposed new transportation facilities. All transportation infrastructure corridors are existing and have previously been designed to handle predetermined flood conditions. Specific guidelines and flood frequency requirements would apply to any improvements to the existing transportation network such as roadways and bridges.

5.3.3.2 Operational Impacts

Power Plant Site

It is unlikely that operations at the proposed power plant site would be directly or indirectly affected by temperature extremes in the region. Although summer temperatures would be warm and winters generally bring cold temperatures and sizeable snowfalls, the proposed power plant site would be designed to operate under a wide range of weather conditions.

Because the land around the proposed power plant site is flat, land topography would not influence stack emissions downwash. However, water vaporization from cooling tower operation could potentially contribute to local fog conditions. Cooling tower "fogging" occurs when the condensed water vapor plume comes in contact with the ground for short time periods near the tower. Although this potential impact is referred to as fogging, cooling tower plume touchdown or fogging is usually a temporary event for only a few operational hours. Section 5.2 provides further discussion.

Hail, ice glaze, or large snowfall could disrupt material deliveries to and from the proposed power plant site and cause minor impacts on operations; however, these conditions would be largely mitigated by proper facility design and operational strategies.

The possibility of a strong tornado in the region poses the potential for both direct and indirect impacts on power plant operations. A strong tornado could directly impact plant operations if sufficient damage were incurred at the plant site. Indirect impacts could occur if a strong tornado struck nearby communities and affected the ability of workers or supplies to reach the site. However, the statistical probability of a tornado greater than F1 intensity in Douglas County is relatively low (between one and four occurrences every 50 years), and the size of the proposed power plant site is a small fraction of Douglas County's size; therefore, the chance for significant direct and indirect impacts from a tornado would be low (FG Alliance, 2006b).

It is very unlikely that a flood would cause a direct or indirect impact on operations at the proposed power plant site because the site would be located outside of the 500-year floodplain. The risks posed on operational safety would be mitigated through compliance with all applicable industry standards and with federal, state, and local regulatory requirements.

Severe or extreme drought conditions could increase the potential for wildfires in the area. Ready availability of water is crucial for both fire protection and daily power plant operations. Because severe to extreme drought conditions are likely over the planned life of the facility, contingency plans and design features must be established to address these conditions to ensure that the necessary water is always available.

Sequestration Site

Operations at the proposed sequestration site could be impacted by climate conditions in the region. Ice glaze, hail storms, or extremely cold temperatures could damage proposed sequestration site equipment; however, these conditions are not frequent and the equipment would be designed to operate under the anticipated weather conditions.

A flood could impact operations at the proposed sequestration site; however, the chance for a flood would be very small because much of the proposed sequestration site is outside of the 500-year floodplain. The potential for impact from a flood could be mitigated through selection of topographically favorable locations for injection equipment installation at the proposed sequestration site.

A strong tornado could impact operations at the proposed sequestration site; however, the probability of a tornado greater than F1 intensity in Douglas County is relatively low (between one and four occurrences every 50 years), and the proposed sequestration site constitutes a small fraction of the county's size. Therefore, the probability for impact from a tornado would be low (FG Alliance, 2006b).

Utility Corridors

Operation of the proposed underground utilities would not be affected by climate or severe weather because pipelines would be buried at appropriate depths to prevent weather-related damage, such as from freeze and thaw cycles. Operation of the proposed utility corridors could be impacted by climate or severe weather conditions in the region. The potential impacts from ice glaze, large snowfall, hail, or tornado would be comparable to those described for the proposed sequestration site. A significant ice glaze could down transmission lines and temporarily interrupt electrical service to the proposed power plant.

The entire CO_2 corridor would be outside of the 100-year floodplain, so the potential for impact from a flood would be low. Minor portions of the proposed electrical transmission corridor would cross small areas within the 100-year floodplain; however, the utility corridors would be designed to address the possibility of a flood. Therefore, the potential for direct or indirect impacts on operations due to a flood would be low.

Transportation Corridors

Operation of transportation routes to the site could be impacted by climate or severe weather conditions in the region. A significant ice glaze, snowfall, or tornado could interrupt the transport of workers or materials to and from the proposed power plant site.

Minor portions of the proposed transportation infrastructure corridors cross small areas within the 100-year floodplain; however, the corridors would be designed to address the possibility of a flood. Therefore, direct or indirect impacts on operations due to a flood would be low.

5.4 GEOLOGY

5.4.1 INTRODUCTION

The geologic resources of the proposed Tuscola Power Plant Site, sequestration site, and related corridors are described in this section, followed by a discussion of the potential impacts to these resources.

5.4.1.1 Region of Influence

There are three ROIs for geologic resources. The first ROI includes the land area on the surface that could be directly affected by construction and operation of the FutureGen Project at the proposed Tuscola Power Plant Site and Sequestration Site. The second ROI includes the subsurface geology related to the radius of the injected CO_2 plume. Numerical modeling indicates that the plume radius associated with injecting 1.1 million tons (1.0 MMT) of CO_2 per year for 50 years would be 1.1 miles (1.8 kilometers), equal to an area of 2,432 acres (984 hectares) (FG Alliance, 2006b). The plume radius and land area above the CO_2 plume are shown in Figure 5.4-1. The third ROI is a wider area (100 miles [160.9 kilometers]) that was evaluated to include potential effects from seismic activity.

5.4.1.2 Method of Analysis

The geologic setting includes the near-surface geology of the entire project and all deeper strata that make up the proposed sequestration reservoir. DOE evaluated the potential effects of the construction and operation of the proposed project on specific geologic attributes. In addition, DOE assessed the potential for impacts on the project due to geologic forces (e.g., earthquakes). The potential for impacts was based on the following criteria:

- Occurrence of local seismic destabilization (induced seismicity) and damage to structures;
- Occurrence of geologic-related events (e.g., earthquake, landslides, sinkholes);
- Destruction of high-value mineral resources or unique geologic formations or rendering them inaccessible;
- Alteration of geologic formations;
- Migration of sequestered CO_2 through faults, inadequate caprock or other pathways such as abandoned or unplugged wells;
- Human exposure to radon gas; and
- Noticeable ground heave or upward vertical displacement of the ground surface.

DOE based its evaluation on a review of reports from state geologic surveys and information provided in the Tuscola EIV (FG Alliance, 2006b).

DOE identified uncertainties in relation to geological resources at the Tuscola Site. These include the porosity and permeability of the target formation where CO_2 would be sequestered. Analog well data were analyzed; however, site-specific test well data were not collected. A 2D seismic line was shot across the proposed injection site location to provide information on formations at the sequestration site.

5.4.2 AFFECTED ENVIRONMENT

5.4.2.1 Geology

The proposed Tuscola Power Plant site is 345 acres (140 hectares) in size. The site is essentially flat with an average slope of approximately 0.5 percent. The elevation of the proposed site varies from a high of 686 feet (209 meters) above mean sea level (AMSL) in the center to a low of 679 feet (207 meters) AMSL along the eastern border.

Illinois is covered with glacial deposits that date from the Pleistocene and Holocene epochs of the Quaternary Period (up to approximately 2 million years before present). Beneath that recent veneer, Illinois is dominated by limestone and shale, which was deposited in shallow-water and coastal environments during the Paleozoic Era, beginning about 570 million years ago.

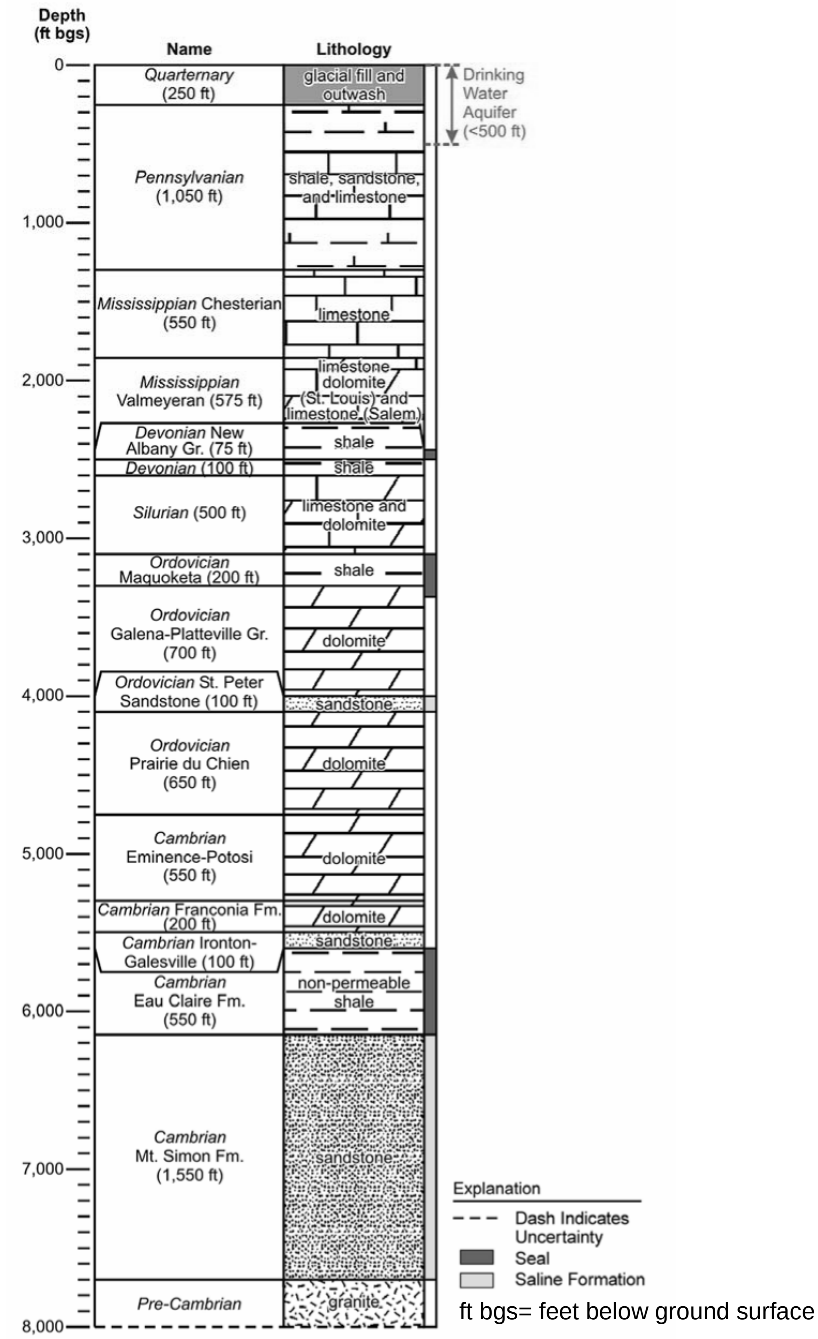
Figure 5.4-2 is a stratigraphic column of the geology beneath the proposed Tuscola sequestration site**.** The geology at the proposed plant site and other areas where construction would occur is similar. The surficial Quaternary glacial deposits are approximately 250 feet (76 meters) thick at the proposed injection site and these deposits are likely less than 100 feet (31 meters) thick at the proposed plant site, and vicinity. The glacial deposits are underlain by the Pennsylvanian age McLeansboro Group. This group includes coal seams over shale-limestone-shale formations. The McLeansboro Group is over 0.2 mile (0.3 kilometer) thick and is underlain by about 0.9 mile (1.4 kilometers) of shale, limestone, and dolomites with some interbedded sandstones.

Lying below these strata is the proposed target formation (or sequestration reservoir) for CO_2 injection, the Mt. Simon sandstone formation. This formation is brine saturated and is likely about 0.3 mile (0.5 kilometer) thick below the project site. The CO_2 injection target would occur at a depth of 1.2 to 1.5 miles (1.9 to 2.4 kilometers). It is the oldest formation of the Paleozoic Era rocks and rests on the pre-Cambrian igneous “basement” rocks. The Mt. Simon is composed of medium- to coarse-grained quartz sandstone, feldspar-bearing sandstone, and thin layers of micaceous shale near the top of the formation. The Mt. Simon is overlain by 500 to 700 feet (152 to 213 meters) of low permeability siltstones and shales of the Eau Claire formation, which would serve as the primary seal for the sequestration reservoir.

The Ordovician-age St. Peter sandstone is proposed as an optional target reservoir. It occurs at a depth of 0.9 mile (1.4 kilometers) below the earth’s surface, which is about 0.4 mile (0.6 kilometer) above the Mt. Simon formation (see Figure 5.4-2). At the Tuscola Site, the St. Peter is estimated to be over 200 feet (61 meters) thick with good lateral continuity and permeability. Both Mt. Simon and St. Peter reservoirs have been successfully used for natural gas storage in other parts of Illinois. In particular, the Mt. Simon supports 38 natural gas storage reservoirs in Illinois (FG Alliance, 2006b).

> An **anticline** is an upfolded strata in which layers slope away from the axis of the fold, or central ridge.

The dominant structural feature of Douglas County is the Tuscola Anticline. This fold, which extends northward into the southern portion of Champaign County, is 25 miles (40.2 kilometers) long by 10 miles (16.1 kilometers) wide, and has more than 700 feet (213.4 meters) of structural closure. The fold axis trends slightly west of north and the western flank is much steeper than the eastern. This anticline contains trapped oil reserves and is the source for six oil fields in the Tuscola area. The western flank of this anticline is present 3 to 4 miles (4.8 to 6.4 kilometers) east of the proposed Tuscola Sequestration Site. The western flank is known to have a steep dip, and it is likely that north-south trending faults and fracture zones are present there (FG Alliance, 2006b).



Source: FG Alliance, 2006b

Figure 5.4-2. Stratigraphy of the Tuscola Injection Area

The Tuscola Anticline is part of the greater La Salle Anticlinorium, the largest enclosed anticline in Illinois extending from west-south Indiana to north-central Illinois. The La Salle Anticlinorium is a compound anticline, consisting of a series of subordinate anticlines and synclines, the whole having the general contour of an arch. Although direct evidence is not available, the western limb of the Tuscola Anticline likely overlies a high-angle reverse fault in the pre-Cambrian igneous basement rocks. This faulting was a product of the Ancestral Rockies mountain-building event during late Paleozoic time. Faults probably extend upward from Precambrian into Paleozoic cover and may reach the bedrock surface. However, most fault locations are inferred because there is little surface expression of faults due to the surficial glacial deposits (FG Alliance, 2006b).

Because of the likelihood of faults associated with the Tuscola Anticline and the greater La Salle Anticlinorium, a regional geologic stress analysis was conducted to yield insight into the orientation of open fractures and possible transmissive faults. Throughout Illinois, the magnitude of the regional earth stresses and their direction are fairly consistent. The stress trend, or principal direction, is west-southwest to east-northeast. Stress values are dependent on depth, and maximum and intermediate horizontal stresses are greater than the vertical stress. The proposed injection site is in an overall compressional (mixed thrust and strike-slip fault) setting. Faults and fractures parallel to the greatest principal stress are more likely to be transmissive and faults or fractures not parallel to this direction are more likely to be sealing (FG Alliance, 2006b).

Geological Resources in the Tuscola Area

Aggregate or construction quality Silurian and Devonian carbonates (mostly dolomite) lie near the surface along the Tuscola Anticline. An active quarry, located about 4 miles (6.4 kilometers) east of the proposed Tuscola Power Plant Site and about 11 miles (17.7 kilometers) north of the proposed Tuscola sequestration site, currently mines these rocks for use in construction. The potential for mining carbonate aggregates diminishes away from the Tuscola Anticline to the east and west. At both the plant and sequestration sites, these rocks are buried too deeply to be commercially mined. Sand and gravel deposits are absent or are too thin or deeply buried in the immediate area to be economically mined. Thin sand and gravel deposits may be present along the Embarras River and elsewhere. These deposits would not be disturbed by the proposed project, and may provide small amounts of low-quality aggregate for local use, such as trench backfill or for road base and shoulder work on secondary roads (FG Alliance, 2006b).

Although coal is present throughout the area, only relatively small areas of Springfield and Herrin Coal are mineable. The Springfield and Herrin Coals occur at average depths of 800 to 900 feet (244 to 274 meters) in the Tuscola area.

Most factors known to cause subsidence are not present in the project area. Such factors include undermining for coal or other resources, and withdrawal of large quantities of water from aquifers. Subsidence has not been detected over areas in Illinois where oil has been extracted (FG Alliance, 2006b).

The proposed Tuscola Power Plant Site is located 330 feet (100.6 meters) east of Ficklin Field, a 70-acre (28-hectare) oil field that has produced 40,000 barrels of oil. Oil has been produced from the Mississippian Spar Mountain sandstone at a depth of approximately 0.3 mile (0.5 kilometer), and gas has been produced from one well completed in a Devonian sandstone at a depth of approximately 0.5 mile (0.8 kilometer). Records show that the field was discovered in 1969, and that all producing wells have been plugged and abandoned (FG Alliance, 2006b). Due to its location near the proposed power plant site, this oil field is not within the subsurface ROI related to the proposed sequestration site.

One oil and gas exploration well was drilled within the perimeter of the proposed plant site. In 1967, the Pflum No.1 well was drilled to a depth of 0.5 mile (0.8 kilometer) below the surface. The well was dry, and was therefore abandoned and plugged. An additional abandoned exploration well, the Scable Community No. 1, was drilled 330 feet (100.6 meters) south of the boundary of the plant site. This well was drilled in 1967 to a depth of 0.5 mile (0.8 kilometer) and has since been plugged.

The proposed injection site is located within the far northeastern portion of the Cooks Mills Consolidated Oil Field. This portion of the field was drilled and developed in 1956. Beginning in 1965, some of the dry wells were abandoned and plugged, with most of the wells in this portion of the field being abandoned by the mid 1970s. Plugging procedures during the 1960s through the 1970s were similar to present procedures. The surface facilities were removed, casing was cut off and capped at least 4 feet (1.2 meters) below ground surface, and cement plugs were set across the base of surface casings and across any open well intervals.

Records show that one active well is located 0.75 miles (1.2 kilometers) south of the proposed sequestration site, one is located 1.2 miles (1.9 kilometers) southwest of the site, and several are located over 2 miles (3 kilometers) southwest of the site. Wells in this field are reported to be shallow (FG Alliance, 2006b); they are seated several thousand feet above the proposed sequestration reservoir in the Mississippian age strata, and are likely no deeper than 0.4 mile (0.6 kilometer).

The Cooks Mills gas storage project is active and has three separate storage reservoirs in the area. These are located approximately 0.5 mile (0.8 kilometer), 1.25 miles (2.0 kilometers), and 2.3 miles (3.6 kilometers) from the proposed sequestration site boundary. The storage reservoirs for the Cooks Mills Project are the Mississippian Cypress sandstone at a depth of approximately 0.3 mile (0.5 kilometer) below ground surface.

5.4.2.2 Seismic Activity

The proposed Tuscola Power Plant Site is located roughly 60 to 70 miles (96.6 to 112.7 kilometers) northwest of an area of seismic activity known as the Wabash Valley Seismic Zone, which extends from southeastern Illinois into southwestern Indiana. The New Madrid Fault Zone is located roughly 230 miles (370 kilometers) south-southwest of the proposed site in the general area of the common borders of southern Illinois, western Kentucky and Tennessee, and southeastern Missouri. This area has spawned the most powerful earthquakes recorded in the continental United States (Richter magnitudes of 8.0). However, as discussed below, earthquakes centered in the area of the New Madrid Fault Zone have historically not caused damage in central Illinois.

The historical record of earthquakes having epicenters in Illinois begins on January 8, 1795. On that date, a mild earthquake occurred near Fort Kaskaskia on the Mississippi River in southwestern Illinois. During the 200 years since that event there have been about 200 other earthquakes in Illinois. Only nine of these quakes were strong enough to cause even minor damage. The largest Illinois quake ever recorded occurred in southeastern Illinois on November 9, 1968, and measured magnitude 5.4 on the Richter scale (ISGS, 1995a).

A search of the USGS database of historic earthquakes shows that since 1974, 30 earthquakes have occurred within 120 miles (193 kilometers) of the approximate midway point between the proposed power plant and sequestration site. The Richter magnitude of the earthquakes ranged from 2.4 to 5.1. The most recent seismic event, on December 6, 2006, was a 2.7 magnitude earthquake centered 101 miles (162.5 kilometers) from the midpoint between the power plant and sequestration site. The closest earthquake to the proposed power plant site was a magnitude 3.0 earthquake that occurred on April 24, 1990, approximately 12.4 miles (20 kilometers) from the plant-sequestration site midpoint (USGS, 2006).

As previously discussed, minor earthquakes are known to occur in Illinois, but damaging quakes are very infrequent. Minor damage (e.g., items falling from shelves) from Illinois earthquakes is reported about once every 20 years. Most recently, a Richter magnitude 5.0 earthquake shook southeastern Illinois in June 1987, causing minor structural damage in the Lawrenceville and Olney areas, approximately 80 miles (129 kilometers) south-southeast of the Tuscola Plant Site. Serious damage (i.e., major structural damage) from earthquakes occurs every 70 to 90 years. Devastating earthquakes (i.e., almost complete destruction over large areas) are very rare in the central U.S., occurring about once every 700 to 1,200 years. The last strong earthquake to strike the Midwest happened on October 31, 1895. The quake, centered just south of Illinois in Charleston, Missouri, had an estimated magnitude of 6.8 on the Richter scale. Although this quake was widely felt throughout the mid-continental U.S., it caused serious damage only in the immediate Charleston area (ISGS, 1995b).

5.4.2.3 Target Formation Properties

Characteristics

The thickest and most widespread saline reservoir in the Illinois Basin is the Cambrian-age Mt. Simon sandstone. It is overlain by the Eau Claire formation, a regional shale of very low permeability and is underlain by Precambrian igneous rocks that form the “basement.” The Mt. Simon is a regionally extensive formation, as document by several wells in central Illinois that indicate the depth and thickness of the Mt. Simon. It is anticipated that greater than 0.3 mile (0.5 kilometer) of Mt. Simon is present at the proposed Tuscola injection site. Drilling at the Weaber-Horn No.1 well, located 56 miles (90.1 kilometers) south of the Tuscola injection site, penetrated over 0.2 mile (0.3 kilometer) of Mt. Simon sandstone before reaching the Precambrian basement (FG Alliance, 2006b). Because of the structure of the Illinois Basin, the Mt. Simon likely thins to the south of the Tuscola sequestration site, indicating that the Mt. Simon at the Tuscola sequestration site is likely thicker than the Mt. Simon encountered at the Weaber-Horn No.1 well.

Depth

The top of the Mt Simon at the proposed Tuscola Sequestration Site is estimated to be between 1.0 and 1.2 miles (1.6 and 1.9 kilometers) below ground surface and the thickness is estimated to be about 0.3 mile (0.5 kilometer). Bottom hole temperature at the base of the Mt. Simon (1.6 miles [2.6 kilometers]) is estimated to be 145°F (62.8°C) and the bottom hole hydrostatic pressure is estimated to be 3,590 pounds per square inch (psi) (FG Alliance, 2006b). The injection zone would use the entire thickness of the Mt. Simon formation, although significant injection would occur primarily in the more permeable regions of the formation (those with greater effective porosity) as discussed below in *Storage Capacity*.

The St. Peter sandstone is proposed as an optional target reservoir at a depth of 0.9 mile (1.4 kilometers) above the Mt. Simon formation.

Injection Rate Capacity

Using the entire thickness of the Mt. Simon for injection and using analog data concerning porosity from the Weaber-Horn No.1 well discussed above, it was concluded that the required injection rate would likely be met using one CO_2 injection well. One well would be sufficient if the well’s injection rate was equivalent to the low end of injection rates for underground natural gas storage wells currently operating in the Illinois Basin (FutureGen Site Proposal [Tuscola, Illinois], 2006). Furthermore, reservoir modeling indicates that the proposed injection rate could be met using one injection well, even if permeabilities are an order of magnitude less than those of the gas storage reservoirs, and the thickness of porous sandstone is actually found to be as low as approximately 200 feet (61 meters) instead of the currently estimated 600 feet (182.9 meters) (FG Alliance, 2006b).

Storage Capacity

The storage capacity of a reservoir depends on its porosity, permeability, thickness and lateral extent. The uppermost Mt. Simon sandstone is composed of thin (10 to 20 feet [3.0 to 6.1 meters]) sandstone beds that are interbedded with thin (less than 1 foot [0.3 meters]) shale and siltstone beds. However, parts of the lowermost Mt. Simon have thick-bedded sandstone with some beds being greater than or equal to 100 feet (30.5 meters) in thickness. Permeability is measured in units of millidarcy (md) and values of 0.001 md or less are almost impermeable, 0.1 md is "tight" or of very low permeability, 1 to about 50 md is low permeability, and higher values are permeable.

The Mt. Simon has very large storage capacity because it is laterally extensive regionally and has numerous porous and permeable intervals. Regional well data indicate that the Mt. Simon should be porous at the proposed Tuscola sequestration site. The average porosity of the regional wells was 20.6 and 15.4 percent and the storability (sum of porosity-thickness product) was 102 and 59.7 pore-feet. The permeability to air was estimated for each interval that exceeded 12.6 percent porosity. The arithmetic average of permeability was 833 and 466 md, respectively.

At the Manlove anticline (located 33 miles [53.1 kilometers] north of the Tuscola sequestration site), the Mt. Simon is used for natural gas storage. One hundred-fifty billion cubic feet (4.2 billion cubic meters) of methane are stored in just the uppermost 200 feet (61 meters) of Mt. Simon sandstone. This is equivalent to approximately 25 million tons (22.7 MMT) of CO_2. The Mt. Simon sandstone likely contains 500 permeable feet (152 permeable meters) to inject and sequester CO_2 below the proposed Tuscola Site. The Tuscola Site would have a much larger volume of reservoir in which to inject CO_2 than what is found at the Manlove anticline.

Seals, Penetrations, and Faults

The Illinois Basin has the largest number of saline natural gas storage fields in the United States. These gas storage fields provide important analogs that can be used to analyze the potential for CO_2 sequestration. These analogs illustrate seal integrity, injection capability, storage capacity, and reservoir continuity in the north-central and central Illinois Basin. The long history, almost 50 years, of successful natural gas storage in the Mt. Simon sandstone is indicative of the containment quality of this saline reservoir.

Primary Seal

The regional geology of central Illinois has been well understood for decades. Regional cross-sectional diagrams of the rock strata in the central part of Illinois show that the Eau Claire formation is a laterally persistent low permeability shale layer above the Mt. Simon and that it is expected to provide a good seal. Gas storage projects in the Illinois Basin all confirm that the Eau Claire is an effective seal in the northern and central portions of the Basin. Analysis of rock cores from the Manlove Gas Storage Field, 33 miles (53.1 kilometers) to the north, shows that the Eau Claire shale has vertical and horizontal permeabilities of less than 0.1 md (FutureGen Site Proposal [Tuscola, Illinois], 2006).

The Weaber-Horn No.1 well, 56 miles (90 kilometers) to the south, penetrates over 500 feet (152.4 meters) of shale overlying the Mt. Simon. It is estimated that the Tuscola injection site has a minimum of 300 to 400 feet (91.4 to 121.9 meters) of shale that would serve as the primary seal (FutureGen Site Proposal [Tuscola, Illinois], 2006).

EPA's underground injection control (UIC) database of wells was also used to estimate seal qualities. In this database, the Eau Claire formation median permeability and porosity are 0.000026 md and 4.7 percent, respectively. Cores were obtained through 414 feet (126.2 meters) of the Eau Claire at the Ancona Gas Storage Field, located approximately 80 miles (129 kilometers) to the north of Tuscola, and 110 analyses were performed on the recovered core. Most vertical permeability analyses showed values of <0.001 to 0.001 md. Seventeen analyses were in the range of 0.002-0.009 md and 12 analyses were in the range of 0.010-0.099 md. Only five analyses were in the range of 0.100-0.871 md, the latter being the maximum value (FutureGen Site Proposal [Tuscola, Illinois], 2006). For comparison, 0.001 md is very low permeability, 0.1 md is "tight," or of low permeability, and 1 md is slightly permeable. Therefore, approximately 96.5 percent of the cores obtained were at least "tight" and it appears that the Eau Claire formation should be a good primary seal.

Secondary Seals

At least two other shale formations may act as secondary seals – the Maquoketa and New Albany Group Shales (see Figure 5.4-2). These formations are located between 0.5 and 0.6 mile (0.8 and 1.0 kilometer) below the ground surface in the project area and are likely between 100 and 200 feet (30.5 and 61.0 meters) thick.

In addition to the primary and secondary seals, there are numerous other fine-grained formations that would act as areas of low permeability, both within the estimated 0.3 mile (0.5 kilometer) of Mt. Simon rocks, and also in the estimated 1 mile (1.6 kilometers) between the top of the Mt. Simon and the ground surface. These seals are capable of retarding CO_2 vertical migration.

Relation of Primary Seal to Active or Transmissive Faults

As previously discussed, significant faulting and fracturing is likely to be present along and near the steep western flank of the Tuscola Anticline located about 3 to 4 miles (4.8 to 6.4 kilometers) east of the Tuscola Sequestration Site. However, the stable tectonic setting and compressive regional stress regime indicate that any fracture zones or faults that penetrate the seal are most likely to be sealing, and not transmissive (FG Alliance, 2006b). In addition, because Tuscola and the surrounding area are not seismically active and no major earthquakes have affected this area, it is not expected that seismic vibrations would activate existing faults.

Because of its location in relation to the La Salle Anticlinorium and Tuscola Anticline, the Tuscola Sequestration Site likely has some very distinctive tectonic elements, including potential fractures or faults. Vertical fractures are more likely at depth than horizontal ones, and fractures or faults trending roughly east-west, if present, may be transmissive. Thus, if such fractures are present in the Eau Claire formation within the injection site ROI, they could promote vertical migration of CO_2. However a recent 2D seismic line indicated no major faulting in the north-south direction at the injection site (Patrick Engineering, 2006).

5.4.2.4 Geologic Sequestration Studies, Characteristics and Risk Assessment

Currently, there are four CO_2 sequestration projects worldwide under detailed study. These are the Rangely, Weyburn, In Salah, and Sleipner projects. They are located in the U.S., Canada, Algeria, and Norway, respectively. Rangely and Weyburn involve enhanced oil recovery (EOR), In Salah involves enhanced gas recovery (EGR) and saline reservoir injection, and Sleipner is a storage project located off shore in the North Sea.

A database of these and other geologic storage facilities was created and used in conducting the human health risk assessment (Section 5.17). These studies of natural and industrial analogs for geologic storage of CO_2 (i.e., sites in similar geologic and hydraulic settings with similar human influences) provides support for the feasibility of geologic containment over the long term and for characterizing the nature of potential risks from surface leakage, should it occur. A more detailed description of these studies, their characteristics, and the state of risk assessment for geologic sequestration of CO_2 is provided in Section 5.17 and Appendix D.

5.4.3 IMPACTS

5.4.3.1 Construction Impacts

Power Plant Site

The surficial geology of the power plant site includes glacial deposits that are likely 40 to 250 feet (12.2 to 76.2 meters) thick. There are no geologic features present that would affect construction of the power plant infrastructure. Because there are no economically extractable geologic resources in the surface geology ROI, there would be no impact to the availability of such resources from construction of the power plant. However, aggregate and other geologic resources (e.g., sand) would be required to support construction activities, but these resources are abundant near the proposed plant site and the quantities required for construction of the power plant would not have a noticeable effect on their availability. Additional discussion of the availability of construction materials is addressed in Section 5.16.

The relatively flat surface topography of the power plant site precludes any potential impacts from landslides or other slope failures during construction. Similarly, because the area is not seismically active and most of the earthquakes in southern Illinois have a Richter magnitude below 3.0, it is not expected that seismic activity would affect construction of the power plant. The project area should not be affected by subsidence (sinking or lowering of the ground surface) because most factors known to cause subsidence are not present in the project area.

Sequestration Site

Potential impacts to geologic resources and impacts from geologic processes or features such as earthquakes or landslides would be the same for construction at the sequestration site as previously discussed for the power plant site. The injection well and backup well would penetrate over 1.3 mile (2.1 kilometers) of bedrock. It is believed that mineral resources would not be impacted by the installation of the injection well, backup well, or deep monitoring wells (these wells are discussed below).

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or landslides, would be the same for construction along the proposed transportation infrastructure corridors as discussed above for the power plant site.

5.4.3.2 Operational Impacts

Power Plant Site

During power plant operations, no additional impacts to geologic resources would be expected. The power plant site's relatively flat surface topography and lack of karst geology precludes any potential impacts from landslides, other slope failures, or sinkhole development during operation. Similarly, because the area is not seismically active and only minor earthquakes have been recorded for the project area, it is not expected that seismic activity would affect operation of the power plant.

Sequestration Site

The potential impacts to geologic resources and impacts to the sequestration site from geologic processes during operation are discussed below.

When CO_2 is injected into a deep brine-saturated (saline) permeable formation in a liquid-like (i.e., supercritical) dense phase, it is immiscible in, and less dense than, water. This would be the case at the proposed Tuscola Sequestration Site. The CO_2 would displace some of the brine. In addition to displacement of brine, CO_2 may dissolve in or mix with the brine, thereby causing a slight acidification of the water, react with the mineral grains, or be trapped in the pore spaces by capillary forces. Some combination of these processes is likely, depending on the specific conditions encountered in the reservoir.

Geochemical modeling of the potential pH changes was conducted for this EIS. The modeling showed that the pH of the brine in the Mt. Simon formation would be expected to drop from 6.5 to 3.3 over many years, creating acidic brine. However, the Mt. Simon is made up primarily of quartz-rich sedimentary rocks (primarily sandstone) that are extremely resistant to chemical changes. Therefore, this acidification of the brine solution would not be expected to substantially alter the Mt. Simon formation.

CO_2 emitted from the power plant would include some H_2S. Because of the significant expense required to separate these two elements, it is possible that the Alliance may conduct tests where greater concentrations of H_2S are included in the gas stream to be sequestered. Therefore, geochemical modeling of the potential changes that could occur to the Eau Claire shale (caprock) from the introduction of H_2S into the reservoir formation was conducted. It was concluded that, because of the mineralogy of the Eau Claire formation, there was no reaction mechanism that could serve as a major sink to decrease the concentration of injected H_2S. It was also noted that the chemical reactions would be unlikely to significantly change the dynamics of the injection behavior of the CO_2 and H_2S mixture, although H_2S can cause precipitation of minerals that would reduce the porosity of the formation (FG Alliance, 2006b).

Increases in pore pressure associated with the injection of CO_2 can decrease friction on existing faults and may cause the faults to become transmissive or to slip. Injection-induced seismicity at the Tuscola Sequestration Site is, however, unlikely for the following reasons:

- High injection pressures are dissipated within a short distance of the injection well where the injection zone is thick and has good porosity. As discussed above, the Mt. Simon has an estimated porous interval of up to 600 feet (183 meters) and it is laterally continuous for hundreds of miles.
- The general compressive tectonic regime of the Tuscola Site suggests that existing faults are not likely to slip as a result of normal field operations, especially if the maximum injection pressure is conservatively set at 85 percent of the fracture opening pressure currently required by Illinois UIC regulations.

Although injection-induced seismicity is unlikely, monitoring methods would further reduce the possibility of accidentally inducing seismicity on a scale larger than micro-scale (measuring -4 to 0 on the Richter scale).

The injection pressures that would cause new or existing fractures to open in the target reservoir and caprock are not known and would need to be determined as part of the permitting process. Requiring injection pressures to be substantially below the fracture opening and fracture closure pressures would greatly lower the risk of accidental overpressure and induced fracturing of the formation, the seal, or cements in wellbores, as well as lowering the risk of opening existing fractures. Site-specific injection pressure limits may be established as part of the permitting process.

Numerical modeling was conducted to estimate the potential CO_2 plume migration if an undetected transmissive fracture zone or fault was present that through-cuts the Eau Claire formation above the injection point in the Mt. Simon formation. This fracture zone or transmissive fault was assumed to have permeabilities well in excess of the permeability of the Eau Claire formation (four cases were modeled with permeabilities ranging from 0.01 to 1000 md). Only narrow faults were evaluated because fracture/fault zones larger than 33 feet (10 meters) wide could be detected and investigated before initiation of an injection program. Injection wells would be relocated, if necessary, to avoid such faults.

The results of the numerical modeling of the fault leakage scenario for the Tuscola Site indicate that, for permeabilities of 1 md and higher, the amount of CO_2 leakage through the fault is at least 2 percent of the total amount injected, as measured by the CO_2 flux rates, extent of the plume, and CO_2 gas pressure at the base of the overlying Maquoketa formation. If the fault was 321 feet (97.8 meters) long and had a permeability of 50 md, the steady-state flux rate for the first 60 years would be about 1.1 million tons (1 MMT) of CO_2 or 2 percent of the 55 million ton (50 MMT) per year injection rate. The maximum plume extent occurred for the higher permeability faults and was 2.5 miles (4 kilometers) at year 100 and was still expanding. The plume extent for the 1 and 0.01 md cases was essentially zero. Significant permeation of the Eau Claire shales is unlikely to occur at fault permeabilities less than 1 md (FG Alliance, 2006b).

The potential for leakage of CO_2 from the sequestration reservoir by means other than faults would also be a potential impact of concern. The injection and backup wells themselves (and any deep monitoring wells in the target formation) would be one of the likely paths for CO_2 migration from the reservoir, as by their nature they perforate all seals present. Unknown wells and improperly plugged wells within the ROI could potentially leak CO_2. The Tuscola Site subsurface ROI is surrounded by operating and abandoned petroleum exploration and production wells, with several hundred within 5 miles (8.0 kilometers) of the proposed injection site, and likely approaching 100 within 2 miles (3.2 kilometers). The primary oil-bearing formations are shallow, but one of these wells reportedly penetrates the New Albany secondary seal above the estimated Tuscola plume footprint. None of the known wells is deep enough to penetrate the primary seal, the Eau Claire. There are a number of wells in the area whose status is not known in the area, and there is a likelihood of improperly plugged oil wells existing within the subsurface ROI (FG Alliance, 2006b). However, as part of the site-specific assessment to be conducted on the selected site, geophysical surveys will be conducted to locate lost wells. If such wells were found to be improperly abandoned, they could be plugged and abandoned consistent with state regulations to prevent leakage. The risk assessment estimates the probability of leakage from such wells (Appendix D).

A search for wells deep enough to penetrate the primary seal (the Eau Claire formation) in an area with a radius of 15 miles (24.1 kilometers) around the proposed plant site was also conducted. Twenty wells were found that penetrated the primary seal; most were located approximately 5 miles (8 kilometers) north of the site and were primarily associated with the Tuscola Gas Storage project, although a few are exploratory wells. All of the wells that penetrate the Eau Claire formation have been plugged to the surface with the exception of the Lewis Shaw No. 1, which was plugged with drilling fluid and cement to a depth of 165 feet (50.3 meters) and was left open for use as a water well. This well is located less than 1 mile (1.6 kilometers) west of the proposed plant site and was reported to have penetrated 100 feet (30.5 meters) into the Mt. Simon formation (ISGS, 1968).

An earthquake has the potential to affect the injection well. If a fracture was penetrated by the well bore, the injection well's casing could be sheared if movement occurred on that fracture during a seismic event. However, vibrations from an earthquake would not likely cause faulting or affect the integrity of the well. Minor earthquakes do occur in central Illinois, but the project area is not seismically active. Central Illinois lies in a stable continental area where there is little risk of new faulting. In addition, earthquake epicenters in continental areas are typically deeper than the sedimentary strata that would be penetrated by the well (the depth of the shallowest earthquake recorded within 120 miles [193.1 kilometers] of Tuscola was 1.9 miles [3.1 kilometers]). Thus, it is unlikely that the well's casing would be sheared.

There are several sequestration features that indicate that CO_2 would be retained in the proposed injection formation, the Mt. Simon sandstone, including:

- The Mt. Simon formation likely has up to 700 feet (213 meters) of permeable sandstone (interbedded with less permeable layers) and extends laterally for hundreds of miles; therefore, more than adequate storage capacity exists in the proposed sequestration reservoir.
- The remaining interbedded sub-layers (totaling 0.2 mile [0.3 kilometer]) of the Mt. Simon formation that are less permeable should act as barriers to the upward migration of CO_2.
- The predominantly quartz mineralogy of the Mt. Simon formation would cause geochemical reactions to be primarily simple dissolution of the CO_2 in the brine formation water, although the presence of feldspar could cause some geochemical trapping of the CO_2 to occur as well.
- The primary seal, the Eau Claire formation, is a low-permeability shale with an estimated thickness of 500 to 700 feet (152 to 213 meters) in the subsurface ROI area.
- The natural gas industry has successfully stored natural gas in the Mt. Simon formation without fracturing the overlying the Eau Claire formation at 10 underground reservoirs in Illinois at depths shallower than the proposed injection zone (ranging from 0.3 to 0.7 mile [0.5 to 1.1 kilometers]).
- The IEPA has stated that the Tuscola Sequestration Site is located in a part of the state where the regional geology is well known and that the area is "well suited for Class I injection activities." In addition, the IEPA stated that no current or former injection wells penetrate either the proposed injection or confining zones near the Tuscola Sequestration Site (FG Alliance, 2006b).

There are many variables that affect the potential to increase pore pressure enough to cause vertical displacement. Collection of site-specific data, including porosity, permeability, and mean effective stress would allow for future modeling of the predicted pressure increases and subsequent potential for ground heave at the Tuscola Sequestration Site and surrounding area. If a potential problem is identified, injection pressures could be maintained below the levels that would cause heaving.

The EPA has mapped Douglas County as an area with a high potential for radon to exceed their recommended upper limit for air concentrations within buildings. Thus, if CO_2 were to escape the sequestration reservoir and increase pore pressures in the vadose zone (near surface unsaturated soils above the water table), it could potentially displace radon, forcing it into buildings. As discussed above, several sequestration features indicate that CO_2 should be retained in the sequestration reservoir. If CO_2 were to leak, however, radon transport induced by CO_2 leakage would be highly localized over the point of CO_2 leakage. The risk assessment conducted for this EIS addressed the potential for adverse impacts from radon displacement (Appendix D). Data concerning potential existing radon levels from state and local sources were used as the baseline. Using conservative assumptions on increases of radon via displacement by CO_2, it was concluded that the situation with respect to radon would remain unchanged as to whether EPA-established action levels would be exceeded. This indicates that there would be no incremental risks above background from radon at the Tuscola Site.

An option for 10 acres (4 hectares) for subsurface and mineral rights has been agreed upon. Complete title searches for subsurface rights at the injection site and surrounding area have not been performed. Searches will be conducted if the site is selected. All necessary mineral rights will be negotiated.

The project area should not be affected by subsidence (sinking or lowering of the ground surface) because most factors known to cause subsidence are not present in the project area.

Utility Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed utility corridors as discussed above for the power plant site.

Transportation Corridors

Potential impacts to geologic resources, and impacts from geologic processes or features such as earthquakes or karst geology, would be the same for operation of the proposed transportation infrastructure corridors as discussed above for the power plant site.

5.4.3.3 Fate and Transport of Injected/Sequestered CO_2

As previously mentioned, in saline formations, supercritical CO_2 is less dense than water, which creates strong buoyancy forces that drive CO_2 upwards. After reaching the top of the reservoir formation, CO_2 would continue to migrate as a separate phase until it is trapped as residual CO_2 saturation or in local structural or stratigraphic traps within the sealing formation. In the longer term, significant quantities of CO_2 (up to 30 percent) would dissolve in the formation water and then migrate with the groundwater. Reservoir studies and simulations for the Sleipner Project have shown that CO_2 saturated brine will eventually become denser and sink, thereby eliminating the potential for long-term leakage. These reactions, however, may take hundreds to thousands of years (IPCC, 2005).

Numerical modeling indicates that the plume radius from injecting 1.1 million tons (1.0 MMT) of CO_2 per year for 50 years would be 1.1 miles (1.8 kilometers), equal to an area of 2,432 acres (984 hectares). A plan view of the projected extent of the plume is shown in Figure 5.4-1.

Geological characteristics of the area (simple sedimentary structure with a low rate of dip; no known transmissive faults or fractures, and compressive stress regime; deep reservoir zones in a formation consisting mainly of quartz-rich sandstone with up to 600 feet (182.9 meters) of high porosity and permeability sub-layers overlain by up to 600 feet (182.9 meters) of low permeability shale; and over 1.1 miles (1.8 kilometers) of overlying mostly fine grained carbonate rock that also includes many sequences of more and less permeable zones) indicate that it would be unlikely that CO_2 would migrate vertically for any significant distance.

However, if a transmissive fracture was present in the subsurface ROI, CO_2 could migrate along its path. Horizontal open fractures within the Mt. Simon would cause the CO_2 to migrate farther laterally than the modeling predicts. Vertical open fractures are more likely at depth than horizontal ones, and fractures or faults trending roughly east-west, if present, may be transmissive. Thus, if such fractures are present in the Eau Claire formation within the ROI, they could promote vertical migration of CO_2. In order for the CO_2 to reach shallow potable groundwater or the biosphere, such fractures would need to penetrate and be open through, or connect in networks through, over 6,000 feet (1,829 meters) of various types of rock. It is unlikely that such fractures exist in the project area due to the presence of significant oil reserves (i.e., trapped fluids); however, further site-specific geologic investigations would be necessary to verify this before initiating injection of CO_2. See Section 5.17 for a detailed discussion of CO_2 transport assumptions and potential associated risks.

5.5 PHYSIOGRAPHY AND SOILS

5.5.1 INTRODUCTION

This section addresses the physiography and soils associated with the Tuscola Power Plant Site, sequestration site, and related corridors.

5.5.1.1 Region of Influence

The ROI for physiography and soils is defined as a 1-mile (1.6-kilometer) radius around the proposed power plant site, the sequestration site, reservoir, and utility corridors.

5.5.1.2 Method of Analysis

DOE reviewed reports from the U.S. Department of Agriculture (USDA), information provided in the Tuscola EIV (FG Alliance, 2006b), and other available public data to assess the potential impacts of the proposed FutureGen Project on physiographic and soil resources. DOE assessed the potential for impacts based on the following criteria:

- Potential for permanent and temporary soil removal;
- Potential for soil erosion and compaction;
- Potential for soil contamination due to spills of hazardous materials; and
- Potential to change soil characteristics and composition.

Some uncertainties were identified in relation to soil resources at the proposed Tuscola Site, such as the porosity and permeability of the various soils where the project infrastructure would be located. Uncertainties, based on the absence of site-specific data, are discussed as appropriate in the following analysis. Prime farmland is discussed in Section 5.11.

5.5.2 AFFECTED ENVIRONMENT

5.5.2.1 Physiography

The proposed Tuscola Power Plant Site and sequestration site are located in Douglas County and lie entirely within the Bloomington Ridged Plain of the Central Lowland physiographic province. Proposed transmission corridors are also located within the Bloomington Ridged Plain. The Bloomington Ridged Plain is part of the Wisconsinan Till Plain that is characterized by a series of end moraines and ground moraines (USDA, 2006).

> **Moraines** are glacial deposits.
>
> **End moraines** are irregular ridges of glacial sediments that form at the margin or edge of the ice sheet.
>
> **Ground moraines** are rolling to flat landscapes that form under the ice sheet.

Douglas County was covered by glaciers during the Pleistocene age. Most of the present surface materials and landforms are the result of glacial ice and running water, resulting in nearly level and gently sloping, broad uplands. The greatest change in relief occurs in areas along major drainageways, where stream downcutting has caused 50- to 65-foot (15- to 20-meter) drops in elevation from the adjacent uplands (USDA, 2006). The elevation in the county ranges from about 600 feet (183 meters) to about 720 feet (220 meters) above mean sea level with the highest elevation located near the village of Newman on the West Ridge Moraine. The lowest elevation is where the Embarras River exits the county southwest of Oakland.

The floodplains along the Kaskaskia and Embarras rivers and their tributaries are generally flooded annually, and the soils in these areas often have a high seasonal water table. Because Douglas County has such low relief, ponding occurs on many soils (USDA, 2006).

Most areas are sufficiently drained for commonly grown crops. Subsurface tile drains have been installed in most of the fields, and an extensive system of drainage ditches supplements the natural drainage and windblown deposits of the most recent glacial stage, the Wisconsinan. The central part of Douglas County is surrounded by glacial moraines from different ice advances and retreats. The Arcola Moraine lies to the south and west, and the Pesotum and West Ridge Moraines are to the north. A large part of Douglas County was covered by a glacial lake between these moraines (USDA, 2006).

The presence of a series of end moraines in Douglas County represents successive advances and retreats of the glacial ice front. The end moraines have slopes that are quite variable, commonly ranging from gently sloping to very steep. Ground moraines of the Wisconsinan Stage, which occur between the end moraines, generally consist of broad, nearly level to gently sloping interfluves. The relief on ground moraines is less variable than the relief on end moraines, and the loess deposits are thicker. Catlin and Flanagan soils are found on ground moraines (USDA, 2006).

5.5.2.2 Soils

The following section describes the different predominant soils at the proposed power plant site, sequestration site, and utility and transportation corridors. Descriptions of the soil type characteristics and uses are found in Table 5.5-1.

The soils found within the ROI are agricultural, which is indicative of favorable characteristics for growing vegetation. Seven different soil types occur within the proposed power plant site and five different types on the proposed sequestration site. These soils found on the proposed power plant site are Drummer-Milford silty clay loams, Flanagan silt loam, Elburn silt loam, Harpster silty clay loam, Catlin silt loam, Peotone silty clay loam, and Blackberry silt loam (FG Alliance, 2006b). The five soils found on the proposed sequestration site are Drummer, Milford, Elburn, Blackberry, Harpster, and Brenton. The soils found in the proposed utility corridors are: Drummer-Milford silty clay loams, Flanagan silt loam, Elburn silt loam, Harpster silty clay loam, Catlin silt loam, Peotone silty clay loam, and Blackberry silt loam (FG Alliance, 2006b).

Table 5.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Blackberry	• Moderately well drained soils formed in loess and other silty sediments and the underlying loam materials on till plains, outwash plains and stream terraces. Slopes range from 0 to 5 percent, potential for runoff is low, and permeability is moderate. Surface soil located from 0 to 16 inches (0 to 41 centimeters) deep is very dark grayish brown and dark brown, neutral, silt loam.	• Most area is prime farmland.

Table 5.5-1. Predominant Soil Types, Characteristics, and Uses in the Proposed Power Plant and Sequestration Sites and Related Corridors

Soil Type	Characteristics	Uses
Brenton	• Somewhat poorly drained soils formed in loess or silty sediments and in the underlying loamy stratified outwash on outwash plains and stream terraces. Slopes range from 0 to 5 percent, potential runoff is negligible to medium, and permeability is moderate.	• Most areas are used for cropland.
Catlin	• Moderately well drained soils formed in loess or other silty material on till plains. Slopes range from 0 to 15 percent, potential for surface runoff is low to medium, and permeability is moderate. Surface soil located from 0 to 11 inches (0 to 28 centimeters) deep is very dark brown, neutral, silt loam.	• Most areas are used for cropland.
Drummer	• Poorly drained soils formed in loess and over loamy stratified outwash sediments on nearly level or depressional outwash plains, stream terraces, and till plains. The slope ranges from 0 to 2 percent and the potential for surface runoff is negligible to low. Permeability is moderate and water ponds occur for brief periods of time in the spring.	• Cropland is the main use for this soil type.
Elburn	• Some what poorly drained soils formed in loess over loamy stratified outwash on outwash plains, till plains, and stream terraces. Slopes range from 0 to 5 percent, surface runoff is negligible to low, and permeability is moderate in the loess and moderate to moderately rapid in the outwash. Surface soil located from 0 to 16 inches (0 to 41 centimeters) deep is very dark grayish brown, lightly acid to neutral, silt loam.	• Most areas are cultivated.
Flanagan	• Somewhat poorly drained soils formed in loess over glacial till on uplands. Slopes range from 0 to 7 percent, potential for runoff is low to high, and permeability is moderately slow. Surface soil located from 0 to 18 inches (0 to 46 centimeters) deep is characterized by very dark gray, very dark brown, and very dark grayish brown, slightly acidic, silt loam.	• Most areas are used for cultivated crops.
Harpster	• Poorly drained soils formed in silty material derived from calcareous loess or glacial drift on nearly level or depressional outwash plains, till plains, or stream terraces. Slopes range from 0 to 2 percent, potential for surface runoff is negligible, and permeability is moderate surface soil located 0 to 18 inches (0 to 46 centimeters) deep is characterized by black and very dark gray, moderately alkaline, silty clay loam.	• Most areas are used for cropland.
Milford	• Poorly and very poorly drained soils formed in lacustrine sediments on glacial lake plains. Slopes range from 0 to 2 percent, the potential for runoff is negligible to low, and permeability is moderately slow.	• Most areas are used for cultivated crops.
Peotone	• Very poorly drained soils formed in colluvial sediments in depressions on till plains. Slopes are less than 2 percent, potential for surface runoff is negligible, and permeability is moderately slow. Surface soil located from 0 to 13 inches (0 to 33 centimeters) deep is black, neutral, silty clay loam.	• Areas are used for cropland when drained and idle when undrained.

Source: FG Alliance, 2006b and NRCS, 2006a.

5.5.3 IMPACTS

5.5.3.1 Construction Impacts

Direct impacts that could be caused during construction of the proposed power plant facility include removal of soil, soil-blowing and erosion due to wind and motion of equipment, soil compaction, and change in soil composition. Soil removal disturbs soil properties such as permeability and horizon structure, and disturbs vegetation. Soil-blowing could cause the movement of soil, making it unstable as well as unsuitable for vegetation growth. Soil compaction could cause changes in soil characteristics such as permeability, water capacity, surface runoff, root penetration, and water capacity. Indirectly, impacts to soils could result in soil erosion due to runoff and wind, potential decline in nearby surface water quality due to increased sedimentation, potential soil contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. BMPs would be used to minimize impacts (see Section 3.1.5).

Generally moderately permeable soils coupled with a water table ranging from 10 to 20 feet (3 to 6 meters) makes the chances of groundwater contamination due to spills low.

Power Plant Site

Construction at the proposed power plant site would impact up to 200 acres (81 hectares) of soil. Soil impacts would result from construction of the proposed power plant, storage areas, associated processing facilities, research facilities, parking areas, access roads, and the on-site railroad loop. During construction, soil would be removed from areas where the foundations of the structures would be sited. This soil would be placed on a temporary storage site protected from erosion and runoff for reuse as topsoil replacement or as fill. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 200-acre (81-hectare) power plant footprint. Soils impacts would be permanent for areas converted into impervious surface areas (e.g., structure, pads, and parking). Temporary soil compaction would occur in areas of temporary road construction and heavy equipment storage, soil–blowing, and localized erosion would be likely during construction from equipment movement. Construction-related impacts to soils in areas not converted to impervious surfaces would be temporary and these areas would be restored after construction is completed.

Chemical spills could potentially affect up to a 200-acre (81-hectare) area of on-site soil. Chemicals commonly used during construction include oils, paints, solvents, lubricants, and cement. The quantities of these chemicals expected on-site during construction are small. The use of segregation, storage, labeling, and adequate handling, as well as secondary containment and other spill prevention techniques, could minimize the potential for a spill to occur. Should a spill occur, it would be contained and would not be expected to permanently impact soil characteristics such as pH, porosity, humidity, and texture. Soils present at the proposed site are abundant throughout the region; therefore, overall impacts would not be adverse. The potential for impacts to prime farmland soil is discussed in Section 5.11.

Sequestration Site

The construction of the injection wells at the proposed sequestration site would result in the removal of up to 10 acres (4 hectares) of soil. Direct impacts would include the removal of soil, soil-blowing, and compaction. Indirect impacts would include some soil erosion due to runoff and wind. After completion of drilling, soil would be replaced using BMPs as discussed in Section 3.1.5 or would be disposed of off site. Removing and replacing these soils would likely result in changes to soil composition and characteristics, such as infiltration rate, within the proposed 10-acre (4-hectare) footprint. The impacts expected at the proposed sequestration site would be similar to those on the proposed power plant site, but at a much smaller scale (duration and magnitude).

Utility Corridors

The direct and indirect impacts to soil from the construction of the proposed utility corridors would be similar to those described for the proposed power plant site, though at a lesser duration and magnitude. The aerial extent of direct and indirect impacts due to the construction of towers for the proposed transmission line corridors would depend on the number of towers built. Regardless, the overall permanent impacts would occur only at the actual footprint of the tower where a relatively small amount of soil would have to be removed and compacted to set the structure.

The proposed transmission line would be up to approximately 17 miles (27.4 kilometers) long with all but up to 3 miles (5 kilometers) on existing ROW. The amount of soil disrupted would depend on the interval of the towers to be constructed. The proposed process water pipeline would be approximately 1.5 miles (2.4 kilometers) long and it is estimated that a disturbance width of 20 feet (6 meters) would be required (FG Alliance, 2006b). This would require the removal of up to 3.6 acres (1.5 hectares) of soil during construction. The proposed wastewater line would be 0.9 mile (1.4 kilometers) long and 20 feet (6 meters) wide that would impact up to 2.1 acres (0.8 hectare) of soil. This pipeline would most likely be constructed adjacent to the water supply line; therefore, no additional impacts to the soils would occur above the estimate for the water supply pipeline. Construction of the proposed CO_2 pipeline would cause direct impacts to 26.7 acres (10.8 hectares) of soil due to soil removal or compaction. Indirect impacts include soil erosion due to runoff and wind, a decline in nearby surface water quality due to increased sedimentation, contamination due to spills, and a decrease in biodiversity due to changing soil characteristics. Impacts would be temporary (during construction) and areas would be restored after construction. Up to 32.4 acres (13.1 hectares) of disturbed land could be susceptible to removal, erosion, or compaction of soils due construction of utility corridors.

Impacts to soil from construction of the proposed utility corridors are expected to be small in terms of area and magnitude, because the soil removed could be stored and used later to grade other areas such as temporary access roads.

Transportation Corridors

The direct and indirect impacts due to the construction of the proposed transportation corridors would be relatively minor, consisting of the same types of impacts described for the proposed power plant site. If road upgrades are needed, impacts would be minimal due to the current road system in place in the area of the proposed site. The rail loop track and main track connections for the rail would require 1.1 miles (1.7 kilometers) of 50-foot (15-meter) wide track construction (approximately 6.7 acres [2.7 hectares]). Construction of temporary access roads would result in soil compaction. These areas could be returned to near pre-existing conditions after construction is complete or, if needed, these roads would remain in use during operations.

5.5.3.2 Operational Impacts

Direct impacts that could occur from operations include soil contamination due to leaks and spills, increased CO_2 concentration in soils due to CO_2 pipeline failures, and soil erosion due to wind and movement of machinery. Indirect impacts include disruption of plant growth and subsurface organisms, and groundwater contamination. It is expected that the impacts during operations would remain at a minimum due to the limited extent and current vegetative status of the site. Generally moderately permeable soils coupled with a water table ranging from 10 to 20 feet (3 to 6 meters) below ground surface greatly lowers the potential for groundwater contamination due to spills. It is anticipated that any spills could be identified and addressed before reaching groundwater sources. The BMPs that would be put in place during operation, such as revegetation, could also improve the state of the soil in those areas that are not directly impacted by construction.

Power Plant Site

During the operation of the proposed plant and associated facilities no new soil disturbance or removal would occur beyond what was described for construction. Storage of hazardous materials, ash, and coal piles could cause soil contamination if in direct contact with the soil. Revegetation of disturbed areas during operations would minimize the potential for erosion.

Sequestration Site

During operations at the proposed sequestration site, soil would not be disturbed; therefore, there would be no environmental impacts associated with operations. Potential impacts due to a pipeline, surface equipment, or well failure are to be minimal as risk abatement and safety procedures would be in place. Though it is highly unlikely, because of the high volatility of CO_2 at atmospheric pressure, an increase of CO_2 concentration in the soil due to leaks can lower pH, which could in turn cause a disruption in plant growth and occurrence of subsurface organisms (Damen et al., 2003) (e.g., microbes occurring approximately 0.9 mile (1.4 kilometers) underground; see Section 5.9). Some levels of ground subsidence and heave have been known to be caused by petroleum production/injection operations, disposal well operations, and natural gas storage operations. Since the CO_2 injection at the proposed Tuscola Site would be at great depth and into very well consolidated rocks, the risks of any ground movement are small. Furthermore, since differential heave occurs most commonly when the underlying strata are tilted, faulted, or discontinuous, and the underlying strata at the proposed Tuscola Site are horizontal, un-faulted, and continuous, there is a very low potential for differential settlement. Thus, if a small amount of ground heave occurred, it would likely have a negligible impact on soils.

Utility Corridors

During operations the soil would not be disturbed around the utility corridors; therefore, there would be no environmental impacts associated with operations or maintenance of vegetation around the utilities during operation. Access within the utility corridors would occur through existing access roads or through access points constructed and maintained for any new corridors.

Transportation Corridors

During operations there would be minimal indirect and direct impact to the soil due to transportation corridor use and maintenance. Impacts could include soil contamination due to spills, soil-blowing, soil compaction, and soil removal.

5.6 GROUNDWATER

5.6.1 INTRODUCTION

This section addresses groundwater resources that may be affected by the construction and operation of the proposed FutureGen Project at the proposed Tuscola Power Plant Site, sequestration site, and related corridors.

5.6.1.1 Region of Influence

The ROI for groundwater resources includes aquifers that underlie the proposed power plant site, sequestration site, and aquifers that may be used to obtain water for construction and operations support. The horizontal extent varies, depending on the particular aspects of the groundwater resource, as follows:

- A distance of 1 mile (1.6 kilometers) from the proposed power plant site defines the general vicinity that could be affected (but to a lesser degree) by changes in groundwater quantity or quality due to the power plant footprint.
- During drought conditions, a limited quantity of groundwater could be used to supplement the power plant's water supply. The distance affected by pumping would depend on specific aquifer properties of the formations being used and well design. Because a specific aquifer has not been identified, the distance affected by pumping for the plant has not yet been determined.
- A distance of 1.1 miles (1.7 kilometers) from each sequestration injection well defines the area that could be affected by potential leaks of CO_2 from the target reservoir to overlying aquifers. This distance is based on modeling that indicates that CO_2 could migrate up to 1.1 miles (1.7 kilometers) from the site of each injection well.
- The facility footprint (including utility and transportation corridors) defines where construction or other land disturbances could take place. These areas could be susceptible to changes in groundwater infiltration, discharge, or quality. Damage to, or loss of use of, an existing well (including the potential need for well abandonment) could also occur within the facility footprint.

5.6.1.2 Method of Analysis

DOE reviewed reports from state water authorities and information in the Tuscola EIV (FG Alliance, 2006b) to assess the potential impacts of the proposed FutureGen Project on groundwater resources.

Uncertainties identified in relation to groundwater resources at the Tuscola Site include the porosity, brine saturation, and permeability of the target formation where CO_2 would be sequestered. Analog well data were analyzed; however, site-specific test well data were not collected. Uncertainty also exists concerning the presence of transmissive faults or improperly abandoned wells in the area.

Because neither the specific aquifer to be used for the water supply nor well locations have yet been selected, the analysis addresses a number of aquifers that could be used.

DOE assessed the potential for impacts based on the following criteria:

- Depletion of groundwater supplies on a scale that would affect available capacity of a groundwater source for use by existing water rights holders, interference with groundwater recharge, or reductions in discharge rate to existing springs or seeps;
- Relationship to established water rights, allotments, or regulations protecting groundwater for future beneficial uses;

- Potential to contaminate a public water supply aquifer through acidification of the aquifer due to migration of CO_2; toxic metal dissolution and mobilization; displacement of groundwater with brine due to CO_2 injection; and contamination of aquifers due to chemical spills, well drilling, or well completion failures; and
- Conformance with regional or local aquifer management plans or goals of governmental water authorities.

5.6.2 AFFECTED ENVIRONMENT

This section describes groundwater resources in the project area. In general, this description applies to all proposed project areas, although site-specific data are presented where available and applicable.

5.6.2.1 Groundwater Quality and Uses

Groundwater resources in the project area are available in limited quantities from the sand and gravel deposits that are contained in the unconsolidated glacial material above the bedrock surface and from some shallow bedrock aquifers. An existing surface reservoir located at the Lyondell-Equistar Chemicals facility would provide the plant's process water. The Kaskaskia River is the primary source of water for this reservoir, but the reservoir is supplemented by groundwater from the Mahomet aquifer, from wells located near Bondville, Illinois, during low-flow conditions.

Private well logs obtained from the Illinois State Water Service's (ISWS) online well database show that the sand and gravel deposits in the vicinity of the proposed power plant site range in depth from approximately 70 to 100 feet (21 to 31 meters) below the ground surface. These sand and gravel deposits are sufficient groundwater resources for domestic and agricultural uses with an average withdrawal rate of up to approximately 10 gallons (38 liters) per minute. Data from a well located just over 1 mile (1.6 kilometers) from the proposed power plant site show the water table to be about 10 to 20 feet (3 to 6 meters) below the ground surface (FG Alliance, 2006b). No sole source aquifers have been designated in the vicinity of the proposed project area (EPA, 2006).

Eight wells were identified within approximately 1 mile (1.6 kilometers) of the proposed power plant site. These are all private wells that were identified by the ISGS and all are classified as domestic- and agricultural-use wells.

Several private and commercial/industrial wells receive groundwater from the shallow Pennsylvanian and Mississippian bedrock. These units consist primarily of thin, interbedded sandstones and limestones, which provide up to approximately 10 gallons (38 liters) per minute (FG Alliance, 2006b). Below depths of several hundred feet, the groundwater is brine and is not suitable for most applications.

ISWS personnel estimated that recharge capacity in the vicinity of the proposed power plant site is likely equal to or less than 1 inch (2.5 centimeters) per year, and that wells installed in the sand and gravel units have specific capacities ranging from 1 to 2 gallons per day per foot (12.4 to 24.8 liters per day per meter) of drawdown, equating to estimated transmissivity values of 1,440 to 2,880 gallons per day per foot (17,884 to 35,768 liters per day per meter). Transmissivity is low because water is found in thin sand and gravel layers (averaging 10 to 20 feet [3.0 to 6.1 meters] thick) within unconsolidated glacial till. The specific capacities of wells installed in the bedrock ranged from 1 to 6 gallons per minute per foot, giving transmissivity values of 1,915 to 11,490 gallons per day per foot (23,783 to 164,668 liters per day per meter) (FG Alliance, 2006b).

> **Recharge capacity and transmissivity** are numerical factors that estimate the capacity of an aquifer to recharge with new water and transmit water, respectively.

No water quality data were available for the shallow aquifer, although since it is used for domestic/agricultural and commercial purposes, the aquifer's quality is likely fair to good at a minimum. In addition, no data were discovered that indicated the potential for existing contamination at the proposed power plant site (FG Alliance, 2006b).

No data were available on the annual amount withdrawn from either the sand and gravel or bedrock aquifers in the vicinity of the proposed power plant site. A report published by Southern Illinois University at Carbondale provides current and projected annual total water usage for Douglas County, Illinois. The report shows that, in 2000, Douglas County used a total of 0.47 million gallons (1.78 million liters) per day, with a projected water usage of 2.04 million gallons (7.72 million liters) per day in 2025 (FG Alliance, 2006b).

Tuscola receives its public water solely from the Champaign Division of Illinois-American Water Company (IAWC). The source of supply for the Champaign County District is groundwater, primarily from wells screened in the Mahomet aquifer in the Champaign area about 20 miles (32 kilometers) north of Tuscola. This aquifer is present under much of central Illinois and is the major groundwater resource for east-central Illinois. The aquifer underlies 1.26 million acres (509,903 hectares), of land and spans 15 counties. The Mahomet aquifer ranges from 4 to 15 miles (6.8 to 30.5 kilometers) wide and 50 to 200 feet (15.2 to 61.0 meters) thick, although the average thickness is 100 feet (30.5 meters). The aquifer is confined over much of its extent. Over its entire area, the aquifer is thought to have many millions of gallons per day of additional capacity, but local depletion is a concern in the Champaign area, as water levels have dropped over the past several decades.

Twenty-one wells deliver potable water to two municipal water treatment plants located about 20 miles (32 kilometers) north of Tuscola: the East Plant located in Urbana, and the West Plant located in Champaign. The wells are primarily located in two areas. The north wellfield taps the Glasford aquifer and consists of eight wells that supply the East Plant. The west wellfield consists of 13 wells that draw from the Mahomet aquifer and supply water to both the East and West Plants. The wells range from 150 to 366 feet (45.7 to 111.6 meters) in depth (City of Tuscola, 2003).

As proposed, the FutureGen plant would draw about 4.3 million gallons (16.3 million liters) per day of process water from an existing 80-acre (32-hectare), 150-million-gallon (568-million-liter) raw water holding pond located 1.5 miles (2.4 kilometers) west of the site at the Lyondell-Equistar Chemical Company. Lyondell-Equistar Chemicals currently draws its raw water supply from an existing intake structure along the Kaskaskia River, and supplements its water supply during low-flow conditions by pumping water from wells near Bondville, Illinois, which are screened in the Mahomet aquifer. This supplemental water is conveyed to the intake structure at Lyondell-Equistar Chemicals via the Kaskaskia River.

Total water usage from the Mahomet aquifer in the Champaign area is reported to be 30 million gallons (113.6 million liters) per day and the additional capacity of the area is estimated by the ISWS to be 16 to 17 million gallons (60.6 to 64.4 million liters) per day (The News Gazette, 2006).

The target formation for CO_2 sequestration is the Mt. Simon formation. In northern Illinois (within about 80 miles [129 kilometers] of the Wisconsin border, and about 200 miles [322 kilometers] north of Tuscola), the Mt. Simon formation is a freshwater aquifer. The surface recharge area of the Mt. Simon formation lies to the north in Wisconsin where the formation outcrops. Near Tuscola, it is a saline formation that lies beneath several hundred feet of caprock (e.g., the Eau Claire shale and siltstone).

The aquifers that lay beneath the injection site would not fit EPA's definition (EPA, 2006) of an Underground Source of Drinking Water (USDW), which includes any aquifer or part of an aquifer that:

- Supplies any public water system, or contains a sufficient quantity of groundwater to supply a public water system and currently supplies drinking water for human consumption or contains fewer than 10,000 milligrams per liter of total dissolved solids (TDS); and
- Is not an exempted aquifer.

Following EPA's definition above, the shallow aquifers near the sequestration site cannot be classified as USDW because they do not supply any public water system or have the quantity of water to do so. Furthermore, there are no water quality data to support any claim about the concentration of TDS in the water. The deeper aquifers are salty and not suitable for human consumption.

5.6.3 IMPACTS

5.6.3.1 Construction Impacts

Power Plant Site

Construction activities would not be expected to disturb the groundwater resources beneath the plant or other facilities. While construction of impervious areas would hinder aquifer recharge in the immediate vicinity of the power plant site, this effect would be minimal, as the size of the aquifer recharge area is much larger than the area of impervious surface that would be created. Water for construction activities would be trucked to the site, so groundwater withdrawals would be unnecessary.

There would be no direct on-site discharge of wastewater to the subsurface. Appropriate Spill Prevention, Control, and Countermeasure (SPCC) plans would be employed to minimize the potential for spills of petroleum, oils, lubricants, or other materials used during construction and to ensure that waste materials are properly disposed of. In the event of a spill, it is unlikely that these materials would reach groundwater sources before cleanup (based on an estimated depth to groundwater of 10 to 20 feet [3 to 6 meters]). Section 5.5 provides further details regarding soil properties, including permeability. In general, no impact on groundwater availability or quality would be anticipated due to construction of the proposed power plant.

Sequestration Site

The above discussion for the power plant site also applies to the sequestration site, located 11 miles (18 kilometers) south of the plant site, although considerably less impervious cover would be associated with CO_2 injection wells and equipment. One injection well and one backup well would be drilled to a depth of between 1.2 and 1.5 miles (1.9 and 2.4 kilometers) to reach the target injection formation, the Mt. Simon formation. Injection well drilling would use a series of conductor casings to protect shallow groundwater.

Utility and Transportation Corridors

Potential construction impacts are similar to those discussed for construction of the proposed power plant site, with the exception that considerably less impervious area would be created in the corridors.

5.6.3.2 Operational Impacts

Power Plant Site

During operation of the power plant, petroleum, oils, lubricants, and other hazardous materials could be spilled onto the ground surface and potentially impact groundwater resources. However, appropriate SPCC plans would be employed to minimize the potential for such materials used during operation to be released to the surface or subsurface and to ensure that waste materials are properly disposed of. Section 5.5 provides further detail regarding soil properties, including permeability.

At the proposed power plant site, groundwater would only be used as a source for process water during drought conditions, when the intake from the surface reservoir would be supplemented with groundwater from the Mahomet aquifer. Total water usage from the Mahomet aquifer in the Champaign area is reported to be 30 million gallons (113.6 million liters) per day and the additional capacity is estimated by the ISWS to be 16 to 17 million gallons (60.6 to 64.4 million liters) per day. The FutureGen Project's estimated needs of almost 4.3 million gallons (16.3 million liters) per day would account for about 26 percent of this capacity if all of the plant's water were obtained from the Mahomet aquifer. Only in severe drought conditions would the Mahomet aquifer supply 100 percent of the necessary process water. Therefore, operations would have a minor impact on groundwater levels and availability for other uses. Severe drought conditions are regional events that could affect the overall water supply for users in the area, but, since these events are foreseeable, their impact would be minimized through planning.

Sequestration Site

The potential impacts associated with CO_2 sequestration in geologic formations are largely associated with the possibility of leakage. The potential for leaks to occur would depend upon caprock integrity and the reliability of well capping methods and, in the longer term, the degree to which the CO_2 eventually dissolves in formation waters or reacts with formation minerals to form carbonates. The mechanisms that could allow leakage of the injected CO_2 into shallower aquifers are:

- CO_2 exceeds capillary pressure and passes through the caprock;
- CO_2 leaks into the upper aquifer via a transmissive fault;
- CO_2 escapes through a fracture or more permeable zone in the caprock into a shallower aquifer;
- Injected CO_2 migrates up dip, and increases reservoir pressure and permeability of an existing fault; or
- CO_2 escapes via improperly abandoned or unknown wells.

CO_2 would be injected into the Mt. Simon formation at a depth of 1.2 to 1.5 miles (1.9 to 2.4 kilometers) below the ground surface. Subsequently, it would mix with the saline groundwater in the formation. Because CO_2 is less dense than the surrounding groundwater, its buoyancy would cause it to move vertically into lower pressure zones until it reached less permeable strata that would act as a seal (e.g., caprock layer). Over time, the CO_2 would dissolve in the formation water and begin to move laterally with the groundwater flow, unless it found a more permeable conduit, such as a transmissive fault or an improperly abandoned well.

However, vertical migration of CO_2 to near-surface freshwater aquifers would be highly unlikely due to:

- The depth of the injection zone in the Mt. Simon formation;
- The substantial primary seal provided by the Eau Claire shale (500 to 700 feet [152.4 to 213.4 meters] thick);

- The presence of at least two secondary seals; and
- A total of over 0.9 mile (1.4 kilometers) of various strata (much of it being fine grained) between the injection zone and any potable water aquifers in the project area.

Each series of less permeable and more permeable sedimentary layers within the 0.9 mile (1.4 kilometers) between the top of the Mt. Simon formation and the deepest potable aquifers in the project area would be a barrier to upward migration of CO_2. Pressure would force the CO_2 through each layer with lower permeability, then dissipate due to lateral flow of CO_2 in each layer with higher permeability. There are hundreds of these series and, as a result, extensive vertical movement to potable aquifers would not be likely.

Based on data from the nearest deep well with a geologic log (about 30 miles [48 kilometers] away), significant fractures are not identified or suspected. If any fractures are present, due to the compressive stress within the formation, only vertical fractures are likely to be transmissive and they would have to penetrate and be open through 0.9 mile (1.4 kilometers) of various types of rock to allow CO_2 migration to shallow potable water aquifers. A recent 2D seismic survey line shows relatively flat, parallel reflectors in the Eau Claire/Mt. Simon interval below the "Base of Knox" horizon and above the Precambrian. This strongly suggests a lack of major north-south trending vertical faults at the proposed Tuscola Sequestration Site (Patrick Engineering, 2006). DOE considers it unlikely that such fractures exist in the project area.

Reservoir modeling indicates that the largest plume radius would be approximately 1.2 miles (1.9 kilometers) over 50 years of injection at a rate of 1.1 million tons (1 MMT) per year. CO_2 movement would be expected to be primarily horizontal, with very little upward migration out of the injection zone due to trapping beneath the caprock seal provided by the Eau Clare shale and siltstone. Brine in the Mt. Simon formation would be displaced horizontally (and vertically) for an unknown lateral distance. However, given that the areas where the Mt. Simon formation contains potable water are about 200 miles (322 kilometers) from the injection ROI, and the brine groundwater in the Mt. Simon formation likely moves at no more than a few centimeters per year, it is very unlikely that the potable parts of this aquifer would be affected.

In addition to displacing brine, CO_2 would also dissolve into the brine over time. In formations like the Mt. Simon with slowly flowing water, reservoir-scale modeling for similar projects shows that, over tens of years, up to 30 percent of the CO_2 would dissolve (IPCC, 2005). Once CO_2 dissolves in the brine groundwater, it could be transported out of the injection site by regional scale circulation or upward migration, but the time scales of such transport are millions of years and are thus not considered an impact for this assessment (IPCC, 2005).

Reactions between the CO_2 and brine would produce carbonic acid, a weak acid that would react with the Mt. Simon formation. This formation is quartz-rich and reacts with minerals very slowly, taking hundreds to thousands of years (IPCC, 2005). Toxic metal displacement and dissolution could be a concern in those areas where injected CO_2 reacts with brine if anomalous concentrations of heavy metals were in the pathway of the brine. These dissolved metals could travel over time and be assimilated by groundwater, causing an incremental increase in the concentration of heavy metals in the water. However, in the ROI, there are no known anomalous concentrations of metals that could pose a risk to the aquifer.

Acidification of the aquifer due to dissolution of CO_2 into water would slightly lower the pH of the groundwater. At the Tuscola Site, acidification of shallower groundwater sources would be very unlikely due to the hundreds of feet of separation between the injection target formation and these aquifers, as well as the limited pathways for CO_2 to travel upward and mix with groundwater. Similarly, it would be unlikely that the CO_2 injection would contaminate overlying aquifers by displacing brine, because this would require pathways, such as faults or deep wells that penetrate the primary seal. Such faults are not believed to exist at the proposed site.

Any eventual CO_2 and brine contamination of any of the small, surficial groundwater reservoirs in the Tuscola region would be limited to individual cases because this resource is of limited extent in the area, and not used for any public water system.

However, monitoring methods could help detect CO_2 leaks before they migrate into an aquifer, and mitigation measures could minimize such impacts should they occur (see Section 3.4).

Utility Corridors

The above discussion for the power plant site also applies to the proposed utility corridors, but to a lesser extent as hazardous materials would not be expected to be on site in the utility corridors unless maintenance activities were occurring.

Transportation Corridors

Traffic accidents could result in hazardous materials spills. The spill response measures discussed for the proposed power plant site would be executed to ensure rapid control and cleanup of any hazardous material spill from a traffic accident.

5.7 SURFACE WATER

5.7.1 INTRODUCTION

Surface water is an important resource in Illinois from which communities receive much of their drinking water. Ready access to an abundant supply for water is an important consideration in siting power plants, as water is necessary for steam generation and process water. Drinking water would also be required for the employees at the proposed power plant and sanitary wastewater would be generated by restrooms, sinks, and shower facilities. The proposed FutureGen Power Plant would not discharge any industrial wastewater, as all process wastewater would be treated by the zero liquid discharge (ZLD) system and recycled back to the power plant. The following analysis examined short-term impacts from construction and long-term impacts from operations to surface water resources from the proposed FutureGen Project.

5.7.1.1 Region of Influence

The ROI consists of the proposed power plant site, sequestration site, areas within 1 mile (1.6 kilometers) of all related areas of new construction, and any surface water body above the sequestration reservoir.

The ROI for the greatest potential for impacts to surface water resources is limited in most cases to the proposed power plant and sequestration site and related utility corridors. Because of the types of land disturbing activities that would occur during construction of the proposed power plant, this area would be susceptible to erosion and changes in surface water flow patterns. This is also an area that could be affected by spills associated with construction or operations.

The ROI for surface water extends beyond the power plant property. Construction and operation activities would impact a larger area in cases where flow patterns were modified or contamination was carried downstream by surface water drainages.

5.7.1.2 Method of Analysis

DOE reviewed public data, research, and studies compiled in the Tuscola EIV (FG Alliance, 2006b) to characterize the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Alter stormwater discharges, which could affect drainage patterns, flooding, erosion, and sedimentation;
- Alter infiltration rates, which could affect (substantially increase or decrease) the volume of surface water that flows downstream;
- Conflict with applicable stormwater management plans or ordinances;
- Contaminate public water supplies and other surface waters exceeding water quality criteria or standards established in accordance with the Clean Water Act (CWA), state regulations, or permits;
- Conflict with regional water quality management plans or goals;
- Affect capacity of available surface water resources;
- Conflict with established water rights or regulations protecting surface water resources for future beneficial uses;

- Alter a floodway or floodplain or otherwise impede or redirect flows such that human health, the environment or personal property is impacted; or
- Conflict with applicable flood management plans or ordinances.

DOE reviewed reports from USGS, U.S. EPA, and IEPA, and reviewed information provided in the Tuscola EIV (FG Alliance, 2006b) to assess the potential impacts of the proposed FutureGen Project on surface water resources. Surface water data analysis was limited to locations that had the potential for permanent impacts (i.e., power plant and sequestration site). Site-specific surface water data for these areas were not collected. Data were evaluated from area discharge points and sample locations monitored by the agencies previously mentioned. Best professional judgment was applied to determine the likelihood of surface water impairments in the area. Uncertainties and unavailable data are discussed as appropriate in the following analysis.

To avoid or limit adverse impacts, emphasis is placed on adhering to applicable laws, regulations, policies, standards, directives, and BMPs. Most importantly, careful pre-planning of construction and operational activities would allow potential impacts to be minimized before they occur.

5.7.2 AFFECTED ENVIRONMENT

The proposed plant site consists of 345 acres (140 hectares) located 1.5 miles (2.4 kilometers) west of Tuscola, Illinois. Figure 5.7-1 shows the proposed power plant site, sequestration site, proposed utility corridors, and surface water resources in the area. The nearest water body to the proposed power plant site is Scattering Fork Creek, located approximately 0.6 mile (1 kilometer) to the east of the site. Scattering Fork Creek flows eastward into the Embarras River watershed. To the west of the site is the Upper Kaskaskia River watershed and the Kaskaskia River is located about 2 miles (3.2 kilometers) west of the proposed site.

Tuscola receives 40 inches (102 centimeters) of precipitation annually and local storms have been known to produce flash floods and torrential rainfall, resulting in decreased infiltration and increased surface water runoff (ISWS, 2002 and NOAA, 2005).

As noted in Section 5.5, there are seven different soil types on the proposed power plant site. These soils are Drummer-Milford silty clay loams, Flanagan silt loam, Elburn silt loam, Harpster silty clay loam, Catlin silt loam, Peotone silty clay loam, and Blackberry silt loam (ISWS, 2004). In general, these soils are poorly drained to moderately wet, having the affinity to retain moisture. Soils are discussed in further detail in Section 5.5, but are mentioned briefly here to facilitate the discussion of surface water impacts (e.g., erosion).

Power Plant Site

The proposed power plant site lies within the Embarras River watershed, east of the Embarras/Kaskaskia River watershed divide (Figure 5.7-1). This boundary also serves as the watershed divide between the Upper Mississippi and Ohio River basins. Surface runoff from the proposed power plant site drains to the Embarras River via overland flow, roadside ditches, and Scattering Fork Creek. The majority of the surface water runoff from the proposed power plant site, including the proposed electricity corridor, ultimately drains to the Embarras River, with the exception of the proposed process water line corridor and proposed injection line corridor, which drains to the Kaskaskia River.

Sequestration Site

The proposed sequestration site lies in the Upper Kaskaskia watershed. Figure 5.7-1 details the watershed boundaries and sequestration sites.

Utility Corridors

The proposed 345-kV transmission would be located near three surface water bodies: the Hayes and Hackett Branches of the Embarras River, and the Embarras River itself. The Hayes Branch supports aquatic life, whereas the Hackett Branch is listed as impaired for total phosphorus and dissolved oxygen, attributed to municipal point sources, urban runoff/storm sewers, and non-irrigated crop production (IEPA, 2006). There are no lakes, ponds, or surface reservoirs along the proposed corridor.

The proposed CO_2 pipeline would be located within the Kaskaskia River watershed, with a small length of the line south of the site within the Embarras River watershed. Surface water resources located near the proposed transmission line include the Tuscola No. 4 drainage ditch and one unnamed tributary, drainage ditch No. 5 drainage, Scattering Fork Creek, and three unnamed tributaries to the Kaskaskia River. There are no lakes, ponds, or surface reservoirs along the proposed corridor.

The proposed process water supply line would be located within the Kaskaskia River watershed, with an additional one-third located within the Embarras River watershed. Surface water resources located near the proposed process water supply line are existing roadside ditches.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected surface waters. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

5.7.2.1 Surface Water Quality

There are limited water quality and quantity monitoring data for surface waters within the ROI of the site because many of the surface waters have intermittent flows. Surface water quality and quantity data were not collected on the roadside ditches and unnamed tributaries within the ROI. Scattering Fork Creek, the nearest surface water to the proposed plant site, has been assessed by the IEPA and has been determined to meet its designated use (e.g., not impaired) to be impaired due to stream alterations and nutrients (IEPA, 2006). Other surface waters near the proposed Tuscola site that are on the IEPA's list of impaired waters are presented in Table 5.7-1 (IEPA, 2006). IEPA assigns a category (Cat.) for each water body, based on the level of support for each designated use and the causes of impairment. Applicable categories listed in Table 5.7-1 are defined as follows (IEPA, 2006):

- Category 2. Attaining some of the designated uses; no use is threatened; and insufficient or no data and information is available to determine if the remaining uses are attained or threatened.
- Category 5. The water quality standard is not attained.

Table 5.7-1. Water Resources Near the Proposed Power Plant Site Listed on State of Illinois 2006 303(d) List[1]

Segment Name	Assessment Unit ID	Cat.	Segment Length (miles [kilometers])	Designated Use	Cause(s) of Impairment	Source(s) of Impairment
Scattering Fork Creek	IL_BER-01	5	13.4 (21.5)	Aquatic Life, Fish Consumption, Primary and Secondary Contact, Aesthetic Quality	Alteration in stream-side or littoral vegetative covers, Nitrogen (total), Phosphorous (total)	Animal Feeding Operations (nonpoint source), Channelization, Crop Production
Kaskaskia River	IL_O-08	5	23.0 (37.0)	Aquatic Life, Fish Consumption, Primary and Secondary Contact, Aesthetic Quality	Fecal coliform	Source Unknown
	IL_O-10	2	8.7 (13.9)		n/a	n/a
	IL_O-32	2	6.6 (10.6)		n/a	n/a

[1] Portions of the Kaskaskia River are not impaired. All other water resource segments exhibit some level of impairment.
n/a = not applicable.
Source: IEPA, 2006.

5.7.2.2 Process Water Supply and Quality

The proposed power plant would require 3,000 gallons per minute (11,356 liters per minute) or 4.3 million gallons per day (MGD) (16.4 million liters per day [MLD]). The proposed site would draw about 4.3 MGD (16.4 MLD) of process water from an existing 80-acre (32.4-hectare), 150-million-gallon (567.8-million-liter) raw water holding pond located 1.5 miles (2.4 kilometers) west of the proposed site at the Lyondell-Equistar Chemical Company (see Figure 5.7-2). Lyondell-Equistar is proposing to provide the process water for the proposed plant site from their on-site wastewater facilities and reservoir. All surface water runoff from the Lyondell-Equistar plant is collected and routed to Lyondell-Equistar's main fresh water reservoir. The raw water supply for this reservoir is from an existing intake structure along the Kaskaskia River.

Lyondell-Equistar Chemical currently draws its raw water supply from an existing intake structure along the Kaskaskia River, and supplements its water supply during low-flow conditions by pumping water from the Mahomet aquifer wells near Bondville, Illinois. This supplemental water is conveyed to the intake structure at Lyondell-Equistar Chemical via the Kaskaskia River. The primary purpose of supplemental pumping at Bondville is based on Lyondell-Equistar's existing NPDES permit. Under the current permit, Lyondell-Equistar can only discharge their treated effluent at a rate of 1 to 5. They currently discharge at a rate of approximately 1 million gallons (3.8 million liters) a day, thus the river must be flowing at a minimum of 5 million gallons (19 million liters) a day. Lyondell-Equistar is considering the option of becoming a zero discharge facility; with this option the need to supplement the river to meet a discharge requirement (by permit) would be eliminated. The main advantages of this change would be a reduced consumption of raw river water by the Equistar plant, and increased availability of water within its current holding ponds. This would increase the available process water for the proposed FutureGen Power Plant by up to 2 MGD (7.5 MLD). There would still potentially be a need to extract from the Mahomet aquifer if the zero discharge option is exercised; however, it would be as a result of water needed for the industrial processes, not at part of a discharge requirement. Also, a zero discharge concept at Lyondell-Equistar would equate into a total reservoir capacity of approximately 290 million gallons (1.1 billion liters). This would be obtained by using the treatment lagoons as additional reservoir capacity.

Water quality data are available downstream of the site at a current USGS gage station at Cooks Mills, Illinois (USGS, 2006). These data include data collected from the USGS National Water Information System Web Interface, and data collected from U.S. EPA's STORET Web Interface. Zinc levels in the holding ponds at the Lyondell-Equistar Plant measure 0.013 milligrams per liter (Behl, 2006). Table 5.7-2 summarizes water quality data available for the proposed process water sources.

Table 5.7-2. Water Quality Data Summary

Constituent	Formula	Units	Design Value	Urbana Champaign SD SW Effluent (E1), NPDES Discharge ID001901		Lyondell-Equistar Chemical Plant	Kaskaskia River at Cooks Mills, USGS Gage 05591200[1]
				1997	2004		
Calcium	Ca	mg/L	75	31	-	ND	70
Magnesium	Mg	mg/L	16	16	-	ND	31
Potassium	K	mg/L	3	9.5	-	ND	2
Sodium	Na	mg/L	20	67	-	ND	22
Bicarbonates	HCO_3	mg/L	240	0.002	-	ND	238
Chlorides	Cl	mg/L	25	-	-	ND	34
Silica	SiO_2	mg/L	4	-	-	ND	-
Sulfates	SO_4	mg/L	58	-	-	ND	52
Nitrate	NO_3	mg/L	7	-	-	ND	-
TDS	TDS	mg/L	460	-	-	ND	211
TOC	TOC	mg/L	3		-	ND	5
Temperature	-	°F	60	21.0	21.5	ND	57
pH	pH	-	8.0	7.5	8.0	ND	7.4

[1] Values shown are averages for period of record; Period of Record 01-01-1990 to 09-30-2006.
mg/L = milligrams per liter; °F = degrees Fahrenheit; ND = no data.
Source: IEPA, 1997, 2004; USGS, 2006.

Average and Low-Flow Water Volume

Table 5.7-3 lists 2003-2005 flow data for the Kaskaskia River near the intake for the 150-million-gallon (567.8-million-liter) holding pond. The data include river flow at the intake and return/consumption discharge rates by Equistar Chemical (Behl, 2006). On average, 1.3 to 1.7 MGD (5.1 to 6.6 MLD) of process water is available from the Lyondell-Equistar Chemical plant.

During normal river flows, water is pumped into the holding pond from the Kaskaskia River on a regular basis. Equistar Chemical currently does not typically pump water into the 150-million-gallon (567.8-million-liter) holding pond during low-flow periods. Its typical practice is to draw water from the holding pond, then pump from the river once flow has increased. Equistar Chemical can currently use water from the holding pond without pumping from the river for approximately 30 to 45 days. When needed, the plant would supplement its flows by pumping from the Mahomet aquifer.

Table 5.7-3. Discharge Data at Equistar Chemical Intake

	2003 MGD	2004 MGD	2005 MGD
River Flow			
Maximum	345	477	487
Minimum	4.0	5.0	3.0
Average	19	36.59	8.85
Return Discharge			
Maximum	5.81	5.62	8.54
Minimum	0.39	0.44	0.3
Average	1.56	1.73	1.34
Consumption Rate			
Maximum	3.0	3.01	2.6
Minimum	1.83	1.69	1.71
Average	2.19	2.01	1.96

MGD = million gallons per day.
Source: L. Behl, 2006.

Hydrologically-based design flow methods have been developed to answer questions relating to water quality and stream flows. Most states currently recognize hydrologically-based design flow methods, such as the 7Q10 flow, as acceptable methods. The 7Q10 is the lowest 7-day average flow that occurs (on average) once every 10 years. From 7Q10 low-flow maps provided by the ISWS, the Kaskaskia River has a 7Q10 low-flow of 3.3 MGD (12.5 MLD) near the existing intake for Equistar Chemical (Figure 5.7-2). Flows in the Kaskaskia River are sustained by wastewater effluents from the Urbana-Champaign Sanitary District treatment plant (SDTP), located approximately 23 miles (37 kilometers) upstream along Copper Slough, a tributary to the Kaskaskia River.

Due to increased development in the area, the SDTP has been expanded in the last year to accommodate increased wastewater flows. The current average daily discharge from the Urbana-Champaign SDTP is approximately 6 MGD (22.7 MLD), with an available maximum daily treatment capacity of over 27 MGD (102.2 MLD) (FG Alliance, 2006b). The Kaskaskia River flow is also supplemented by wastewater effluent flows from the villages of Tolono and Sadorus. Based on conversation with the City of Tolono, their current average daily effluent discharge is 0.17 MGD (0.64 MLD), with a design capacity of 0.59 MGD (2.2 MLD) (FG Alliance, 2006b).

5.7.3 IMPACTS

5.7.3.1 Construction Impacts

Water would be required during construction for dust suppression and equipment washdown and would most likely be trucked to the site; no water would be withdrawn from surface waters. BMPs would be used to contain water used for dust suppression and equipment washdown, minimizing the impacts to surface waters to the extent practicable. This activity would be addressed in the NPDES Permit. Proposed grades in paved areas and for building first floor elevations would be close to existing grade as feasible to minimize side slopes, limiting potential erosion. All temporarily disturbed areas would be seeded to re-establish vegetative cover after construction.

Because there would be over 1 acre (0.4 hectare) of disturbance, the construction contractor would need to apply for a general NPDES Permit No. ILR10 from the IEPA, which requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP). The general NPDES permit includes erosion control and pollution prevention requirements and refers to the IEPA Urban Manual for specific construction standards, material specifications, planning principles and procedures. The plans are required to include site-specific BMPs. Operating stormwater pollution prevention restrictions and BMPs would be dictated by the NPDES permit.

> A **Storm Water Pollution Prevention Plan** consists of a series of phases and activities to characterize the site and then select and carry out actions to prevent pollution of surface water drainages.

Impacts due to construction activities would likely include erosion due to equipment moving, surfacing and leveling activities, and alteration of surface structures resulting in effects to local hydrology. In addition, Section 404 of the CWA (hereafter referred to as Section 404) requires permits for jurisdictional waterbody (wetland) crossings, which would be implemented before construction. Section 404 permits require the use of BMPs during and after construction and often times include mitigation measures for unavoidable impacts.

Power Plant Site

Scattering Fork Creek is the nearest water body to the proposed power plant, approximately 0.6 mile (1 kilometer) east of the site and drains east to the Embarras watershed. Once constructed, increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation. Presently, area soils have low to moderate surface water runoff due to soil permeability and slopes (ISWS, 2004). Implementation of BMPs to address, mitigate, and control stormwater runoff would reduce the impacts to downstream surface water resources.

Sequestration Site

The proposed sequestration site is an 80-acre (32.4-hectare) site. Up to 10 acres (4 hectares) of the site would be required for placement of the injection wells. The proposed sequestration site is approximately 11 miles (17.7 kilometers) directly south of the proposed plant site (see Figure 5.7-1). The area above the site is rural, consisting primarily of agricultural land with row crops. The radius is expected to be 1.1 miles (1.8 kilometers) from the injection point. The area of the sequestration plume is estimated to be 2,432 acres (985 hectares).

The sequestration site does not have any lakes, ponds or surface reservoirs within the ROI. An existing unnamed tributary to the Kaskaskia River runs west through the site directly to the Kaskaskia River. The nearest major water body is the Kaskaskia River estimated at 1.4 miles (2.3 kilometers). Surface runoff from the site is conveyed to the Kaskaskia River via overland flow and the existing unnamed tributary. No surface water quality data are available for the sequestration site, and there are no other current surface water uses for the unnamed tributary. It is expected that no process and potable water would be needed for the site. No effects upon surface water resources would be anticipated from construction of the injection area.

Utility Corridors

The construction of new utility lines would potentially create temporary impacts to surface waters. The probability of these impacts to occur would increase the closer construction activities are located to surface water resources. The maximum extent of impacts would occur when the utilities cross one of these surface water resources. Temporary impacts to surface waters for utility line crossings using trenching methods would include stream diversion/piping flows around the crossing, increased turbidity and sedimentation during construction, streambed disturbance, and removal of streambank vegetation. Directional drilling of utility lines would avoid these impacts. Construction conducted near surface water resources could indirectly create sedimentation from runoff and turbidity of waters. BMPs required through Section 404 permitting would be implemented both during and after construction. The BMPs would reduce temporary impacts by controlling sedimentation and turbidity, restoring stream crossings to their original grade, and to stabilize streambanks post-construction. Potential surface water resources which may be affected by these activities are further discussed below.

The proposed site would include a 500-foot-wide (150-meter-wide) corridor to co-locate utilities, in an effort to reduce environmental impacts. This width has been determined to be of adequate size for the ensuing discussion. Utilities would be buried whenever possible.

The construction of new pipelines along the utility corridors would require hydrostatic testing of the lines to certify the material integrity before use. These tests consist of pressurizing the pipelines with water and checking for pressure losses due to pipeline leakage. Hydrostatic testing would be performed in accordance with U.S. Department of Transportation (DOT) pipeline safety regulations. Withdrawal of hydrostatic test water could temporarily affect downstream users and aquatic organisms (primarily fish) if the diversion constitutes a large percentage of the source's total flow or volume. Potential impacts include temporary disruption of surface water supplies, temporary loss of habitat for aquatic species, increased water temperatures, depletion of dissolved oxygen levels, and temporary disruption of spawning, depending on the time of withdrawal and current downstream users. These impacts would be minimized by obtaining hydrostatic test water from bodies of water with sufficient flow or volume to supply required test volumes without significantly affecting downstream flow.

Although no source has been specified, the water for the hydrostatic test could be provided by the intake on the Upper Kaskaskia River or by Lyondell-Equistar. Both of these sources have sufficient capacity to enable this test. The amount of water required to complete these tests on all newly constructed pipelines is unknown until preliminary designs for the proposed power plant, including the sequestration site, and utilities have been completed to scale the appropriate size pipe.

Water used for hydrostatic testing is required to be pumped to a lined on-site pit or leak free above ground container. No hydrostatic testing or well testing water may be discharged to the surface (62 IAC 240.530). No chemical additives would be introduced to the water used to hydrostatically test the new pipeline, and no chemicals would be used to dry the pipeline after the hydrostatic testing. Hydrostatic testing would be conducted in accordance with applicable permits.

Process Water Supply Line

The proposed process water supply line would run east approximately 1.5 miles (2.4 kilometers) to the proposed site from an existing 150-million-gallon (567.8-million-liter) surface water storage facility operated by Lyondell-Equistar. The existing surface water facility is located to the west of the site along the Kaskaskia River. Lyondell-Equistar currently receives water from an intake structure located along the river, west of the storage facility. All surface runoff from Lyondell-Equistar is routed to the storage facility. Surface runoff within the Kaskaskia River watershed drains to the river via overland flow, existing roadside ditches, and via Lyondell-Equistar's surface runoff conveyance system. Surface runoff within the Embarras River watershed drains via overland flow, existing roadside ditches, and the Scattering Fork Creek to the Embarras River. The Kaskaskia River, the 150 million-gallon (567.8 million-liter) surface water facility (from which the actual supply water would be drawn), and several wastewater and settling ponds are within the ROI of the proposed water supply line.

Approximately two-thirds of the proposed process water supply line corridor lies within the Kaskaskia River watershed; the remaining line, approximately one-third, lies within the Embarras River watershed. The proposed process water supply line, in general, would follow the existing roadway, which does not cross any surface reservoirs, lakes or ponds. Efforts to reduce or avoid impacts to surface water bodies would be evaluated during the engineering and design phase. Mitigating actions may include directional drilling where appropriate.

Power Transmission Corridor

The proposed 345-kilovolt (kV) transmission line would run north, then east of the site along an existing transmission line corridor, where it would connect with another existing transmission line east of Murdock, Illinois. The line would total approximately 17 miles (27.4 kilometers), of which 14 miles (22.5 kilometers) are existing corridors. The proposed transmission line would cross three surface water bodies: the Hayes and Hackett Branches of the Embarras River, and the Embarras River itself. The Hayes Branch supports aquatic life, whereas the Hackett Branch is listed as impaired for total phosphorous and dissolved oxygen, attributed to municipal point sources, urban runoff/storm sewers, and nonirrigated crop production (IEPA, 2006). There are no lakes, ponds, or surface reservoirs along the proposed corridor.

An option to establish adequate power to the proposed site would include the construction of a new interconnection facility (substation) approximately 0.5 mile (0.8 kilometer) north of the proposed power plant site (FG Alliance, 2006b).

CO_2 Pipeline

The proposed CO_2 pipeline would run south from the proposed site to the proposed sequestration reservoir southwest of Arcola, Illinois. The majority of the transmission line would be located within the Kaskaskia River watershed, with a small length of the line south of the site within the Embarras River watershed. Surface runoff along the proposed corridor within the Embarras River watershed drains to the river via roadside ditches, the Tuscola No. 4 and No. 5 drainage ditches, and the Scattering Fork Creek. The proposed CO_2 pipeline would cross four surface water bodies: one unnamed tributary to the Tuscola No. 4 drainage ditch, and three unnamed tributaries to the Kaskaskia River. There are no lakes, ponds, or surface reservoirs along the proposed corridor.

Transportation Corridors

No new transportation corridors are proposed; however, upgrades to existing roads and new transportation spurs within the proposed power plant footprint could occur. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

5.7.3.2 Operational Impacts

Potential operational impacts would largely consist of surface water runoff from the proposed power plant site and potential spills (i.e., fuel, chemicals, grease, etc.). Mitigation of runoff, recycling of materials, and pollution prevention measures would reduce or eliminate the potential for operational impacts to surface water. A pollution prevention program would be implemented to reduce site spills (i.e., fuel, paint, chemicals, etc.). Adherence to applicable laws, regulations, policies, standards, directives, and BMPs would avoid or limit potential adverse operational impacts to surface waters.

Stormwater runoff from the proposed power plant site would be expected to have minimal impact on surface water resources. Stormwater could be collected and recycled into the process water to support the operations of the proposed power plant. The following discussion details the impacts specific to the location of operations.

Power Plant Site

The State of Illinois operates under a common law water rights system. There are no allocated water rights associated for this project. The proposed power plant would use 3,000 gallons per minute (11,356 liters per minute) or 4.3 MGD (16.4 MLD) of process water during normal operations. Process water would be supplied by Lyondell via a newly constructed water line along a corridor from the pump station at Lyondell’s 150-million-gallon (567.8 million-liter) reservoir. Water within the pond is drawn from the Kaskaskia River and is supplemented during low flow (drought) conditions by pumping water from the Mahomet aquifer. Normal operations and stream flow conditions would not affect surface water resources. In addition, treated water (including water from any pretreatment) could also be used to supplement periods of lower flows. Increased development within the region has caused expansion of the existing wastewater treatment plants to accommodate increased effluent discharges; avoiding any impacts on Kaskaskia River flows during drought conditions.

Potentially, the site could discharge sanitary sewer waste. The method of on-site waste systems has not been determined (see discussion in Section 5.15). Appropriate permits would be secured before any discharges. Discharge frequency, quantity and quality would be subject to permit requirements.

During operations, slag and coal piles would be stored on site. Although, the actual configuration has yet to be determined, for the purposes of this analysis, it is presumed that these storage areas would be stored in open air, lined areas. Implementation of BMPs and a stormwater management system would capture the runoff from the coal piles, and direct it to the ZLD system for on-site treatment. Further mitigation could include covering the slag and coal pile areas to prevent contact with precipitation and eliminate stormwater runoff. Minimal effects to downstream surface water resources would be anticipated because the proposed power plant would be a zero emissions facility.

Increases in impervious surfaces would decrease the available surface area to allow infiltration from precipitation. Runoff from the site due to industrial activities would require implementing a stormwater management program to reduce or eliminate any potential surface water quality impacts. The general NPDES permit would include erosion control and pollution prevention requirements. Operating stormwater pollution prevention restrictions and BMPs would be dictated by the NPDES permit.

Sequestration Site

The sequestration site does not have any lakes, ponds or surface reservoirs. However, there are drainages on the lower-western radial quadrant of the injection plume. These drainages flow into the Kaskaskia River to the west of the site. There are five different soil types associated with the sequestration site: Drummer-Milford silty clay loam, Elburn silt loam, Blackberry silt loam, Brenton silt loam, and Harpster silty clay loam. These soils range in permeability from very to moderately poor, which tend to abate infiltration of surface waters.

The construction of injection wells would disturb minor amounts of land, which could cause temporary indirect impacts to adjacent surface waters such as sedimentation and surface water turbidity from runoff. These impacts would be minimized or avoided through the use of BMPs.

In surface waters lacking buffering capacity, such as freshwater and stably stratified waterbodies, the pH could be significantly altered by increases in CO_2 (Benson et al., 2002). The persistence and amount of CO_2 being leaked are primary factors which determine the severity of the impacts from increased CO_2 in the soil and surface water (Damen et al., 2003). The risk of a CO_2 leak from the sequestration reservoir is dependent upon the reservoir and other site-specific variables, such as the integrity of the well and cap rock and the CO_2 trapping mechanism (Reichle et al., 1999). CO_2 sequestration is maintained via a sealed caprock, which can be compromised by rapid release of CO_2 through natural events or unplugged wells, or slow leaks of CO_2 through rock fractures and fissures. These are influenced by the characteristics (e.g., porosity) of the caprock material. As discussed in Section 5.4, the potential for CO_2 leakage from the proposed Tuscola Sequestration Reservoir is small, but it could occur. A risk analysis was completed to assess the likelihood of such failures occurring, as discussed in Section 5.17 (Tetra Tech, 2007).

Although the risk of a CO_2 leak is minimal, a leak from the pipeline transporting the CO_2 to the injection site can increase concentration of CO_2 in the soil, which would lower the pH and negatively affect the mineral resources in the affected soil (Holloway, 1996). This, in turn would lower the pH of the surface waters in the affected area, potentially resulting in calcium dissolution and altering the concentration of trace elements in the surface water (Damen et al., 2003; Benson et al., 2002; Holloway, 1996). A monitoring program would be implemented to monitor CO_2 to detect a leak, should one occur. Seepage of sequestered gases from the reservoir would not affect surface water because the solubility of the CO_2 in water would keep the concentration of CO_2 less than 0.2 percent (Tetra Tech, 2007).

The persistence and amount of CO_2 being leaked are primary factors that determine the severity of the impacts from increased CO_2 in the soil and surface water (Damen et al., 2003). In the unlikely event of a major CO_2 pipeline rupture above a waterbody, the extent of impact would be limited to a minimal and localized decrease in pH of the affected waterbody. Mitigation measures would be implemented immediately to reduce the likelihood of adverse impacts to surface water bodies.

None of the area resources is presently impaired for pH (IEPA, 2006).

Utility Corridors

Normal operations of the power transmission corridors and pipelines for the proposed site would not affect surface water resources. Occasional maintenance may require access to buried portions of the utilities; however, BMPs would be used to avoid any indirect impacts (e.g., sedimentation and turbidity) to adjacent surface waters.

Transportation Corridors

Operation of the power plant would use existing transportation corridors, and therefore, would have no impact on surface water resources. Any upgrades to existing corridors would require a separate analysis.

5.8 WETLANDS AND FLOODPLAINS

5.8.1 INTRODUCTION

This section discusses wetlands and floodplains identified in the affected environment that may be affected by the construction and operation of the proposed FutureGen Project at the Tuscola Power Plant Site, sequestration site, and related corridors. This section also provides the required floodplain and wetland assessment for compliance with 10 CFR Part 1022, “Compliance with Floodplain and Wetland Environmental Review Requirements,” and Executive Orders 11988, “Floodplain Management,” and 11990, “Protection of Wetlands (May 24, 1977).”

5.8.1.1 Region of Influence

The ROI for wetlands and floodplains for the proposed Tuscola Power Plant includes the proposed power plant site and the area within 1 mile (1.6 kilometers) of the boundaries of the proposed power plant site, sequestration site, and utility and transportation corridors.

5.8.1.2 Method of Analysis

DOE reviewed research and studies in the Tuscola EIV (FG Alliance, 2006b) to characterize the affected environment. Additionally, DOE received correspondence from the Illinois Department of Natural Resources (IDNR) (IDNR, 2006) which provided site-specific information regarding wetlands and potential mitigation measures (see Appendix A). DOE also conducted site visits in August 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause construction of facilities in, or otherwise impede or redirect flood flows in, the 100- or 500-year floodplain or other flood hazard areas;
- Conflict with applicable flood management plans or ordinances; and
- Cause filling of wetlands or otherwise alter drainage patterns that would affect wetlands.

5.8.2 AFFECTED ENVIRONMENT

5.8.2.1 Wetlands

All tributaries to Waters of the U.S., as well as wetlands contiguous to and adjacent to those tributaries, are subject to federal jurisdiction and potential permitting constraints under Section 404. These resources are referred to as jurisdictional, or regulated by federal and state agencies. To be contiguous or tributary, there must be a continuous surface water connection between the surface water bodies. This surface water connection can be either surface flowing water at regular intervals of time, or a continuum of wetlands between the two areas. Open water features (e.g., upland stock ponds) within the Federal Emergency Management Agency (FEMA) designated 100-year floodplain that have associated emergent vegetation fringe are also jurisdictional Waters of the U.S. Isolated wetlands are not jurisdictional unless protected under a local bylaw.

IDNR has the authority to regulate wetlands under the Interagency Wetland Policy Act of 1989 (IWPA) for projects that receive funding or technical assistance from the state. The IWPA defines federal money that passes through a state agency as state funding. Isolated, farmed, and U.S. Army Corps of Engineers (USACE) jurisdictional wetlands are state jurisdictional wetlands under the IWPA. IDNR accepts the procedures outlined in the 1987 USACE Wetland Delineation Manual for delineating wetlands. The IWPA requires mitigation for all adverse impacts regardless of the size of the impacted area or the wetland quality.

The local USACE Regulatory Branch makes jurisdictional determinations. Activities such as mechanized land clearing, grading, leveling, ditching, and redistribution of material require a permit from the USACE to discharge dredged or fill material into wetlands. Permit applicants must demonstrate that the activity avoided wetlands and minimized the adverse effects of the project to the extent practicable. Compensation is generally required to mitigate most impacts that are not avoided or minimized.

Hey and Associates conducted surveys to identify jurisdictional wetlands and Waters of the U.S. from August 23 to 25, 2006, using procedures outlined in the 1987 USACE Wetland Delineation Manual (USACE, 1987). IDNR conducted a detailed review based on additional site-specific information for the wetlands in the project area. IDNR has the authority to regulate jurisdictional wetlands through Section 404 and the IWPA. IDNR also has peripheral authority through the Illinois Rivers, Lakes, and Streams Act.

The study area included the land for the proposed power plant, a 350-foot (107-meter) wide corridor along the proposed 345-kV line, a 300-foot (90-meter) wide corridor along the proposed water line, a 300-foot (90-meter) wide corridor along the proposed CO_2 line, and a 1.1-mile (1.8-kilometer) radius surrounding the sequestration site.

Available maps and related data sources, such as National Wetland Inventory (NWI) maps and Natural Resources Conservation Service (NRCS) Swampbuster maps, were reviewed before the wetland delineations. The USGS Hydrologic Atlas indicated the presence of intermittent streams with a possible hydrologic connection to the Embarras and Kaskaskia rivers, which are Waters of the U.S. that fall under USACE jurisdiction. A total of 19 wetland areas were delineated within the project area using the Cowardin et al. classification scheme (Cowardin et al., 1979) (Table 5.8-1). Wetlands encountered during field surveys were listed by size, NWI classification, vegetation community, quality, and jurisdiction, and are discussed below. Figure 5.8-1 shows the general location of mapped wetlands identified using the Cowardin et al. classification scheme (Cowardin et al., 1979).

Power Plant Site

Wetland delineations did not identify any federal or state jurisdictional wetlands in the vicinity of the proposed Tuscola Power Plant Site. No evidence of wetland hydrology or vegetation was observed during field verification surveys. The proposed site consists entirely of agricultural land (e.g., soybeans and corn).

Sequestration Site

Field surveys performed by Hey and Associates confirm that the proposed sequestration site consists of land developed for agricultural use. However, approximately 5 acres (2 hectares) of Wetland Areas 16 to 19 were identified on the land above the proposed sequestration reservoir. The areas consist mainly of an excavated pond, drainage swales, and floodplain terraces and woods along intermittent creeks that are Kaskaskia River tributaries. The dominant vegetation is silver maple (*Acer saccharinum*), reed canary grass (*Phalaris arundinacea*), pinkweed (*Polygonum pensylvanicum*), and eastern cottonwood (*Populus deltoides*). The seasonally dry creek beds are dominated by clearweed (*Pilea pumila*) and white grass (*Leersia virginica*) (FG Alliance, 2006b).

Utility Corridors

A total of 12 wetland areas (1 to 12) were identified along the 345-kV transmission corridor. The wetlands consist of constructed drainage swales, bermed ponds, two creeks, and the Embarras River. Only Wetland Area 15 consisted of an excavated drainage swale along the CO_2 pipeline corridor. The dominant vegetation in these areas is reed canary grass. The agricultural grassed waterways are broad constructed swales planted with upland vegetation that are used to prevent erosion in agricultural fields. They are designed to convey runoff during storm events and do not meet the wetland criteria.

The proposed process water line extends west from the proposed power plant across an agricultural field and the existing Lyondell-Equistar Plant to a holding pond adjacent to the Kaskaskia River. The Lyondell-Equistar Plant, Wetland Area 13, contains numerous bermed ponds, excavated ponds, settling basins, and constructed drainage swales that are used for industrial applications and local stormwater management. The dominant vegetation found in these areas is common reed (*Phragmites australis*), cattail (*Typha* spp.), and reed canary grass. Because these water features are constructed and are used for industrial applications, they would not likely fall under USACE jurisdiction.

Wetland Area 14 consists of the intake and outfall channels to the Kaskaskia River, the Kaskaskia River itself, and a pond. Water is drawn from the Kaskaskia River through a channel and pumped into the holding pond at the Lyondell-Equistar plant. Industrial wastewater and runoff is released back into the river through a channel south of the intake channel. The dominant vegetation in these areas is reed canary grass, a thin band of honey locust (*Gleditsia triacanthos*), and eastern cottonwood, with hackberry (*Celtis occidentalis*) along the shoreline.

Transportation Corridors

Because no new transportation corridors are proposed outside of the proposed power plant site, this EIS does not provide further description of wetlands. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

5.8.2.2 Floodplains

A review of FEMA flood insurance rate maps for Douglas and Coles counties indicates no portion of the proposed Tuscola Power Plant Site is within the 100- or 500-year floodplains (Figure 5.8-2) (FEMA, 2006a, 2006b). In addition, no portion of the proposed process water pipeline or the proposed wastewater force main is within the 100- or 500-year floodplains.

No portion of the proposed injection site property and associated corridor is within the 100-year floodplain. There are two locations in the west and southwest portion of the ROI that are within the 100-year floodplain, as identified by FEMA. These locations are associated with Kaskaskia River tributaries and have a drainage area of less than 10 square miles (26 square kilometers). One location along the CO_2 pipeline would cross an existing drainage ditch, and three locations along the proposed 345-kV transmission line corridor would cross a 100-year floodplain.

5.8.3 IMPACTS

5.8.3.1 Construction Impacts

Direct impacts to wetland habitats would be related to heavy equipment and construction activities, and could include soil disturbance and compaction, dust, vegetation disturbance and removal, root damage, erosion, and introduction and spread of non-native species. The addition of silt, resuspension of sediment, or introduction of pollutants (e.g., fuels and lubricants) related to, and in the immediate vicinity of, construction activities could degrade the quality of native wetlands.

The proposed FutureGen Project could result in localized, direct, and adverse construction impacts to wetlands. Filling or modifying portions of wetlands, if avoidance is not feasible, would permanently alter hydrologic function and wetland vegetation, and result in direct habitat loss. Potential habitat degradation of wetlands and waters downstream could also occur if flow into adjacent areas is reduced. Construction impacts would be mitigated by minimizing the areas disturbed and preventing runoff from entering wetlands during construction. Section 404 jurisdiction would also be required for permit approval.

The amount of mitigation required for the proposed power plant site and other project components (e.g., utility corridors) is not known at this time. Ratios have been established by the USACE regarding mitigation. For example, a 2:1 ratio would require 2.0 acres (0.8 hectare) of wetland creation for every acre (0.4 hectare) of wetland loss. Typical mitigation ratios for unavoidable impacts to wetlands would be 1:1 for open water and emergent wetlands, 1:5 for shrub wetlands, and up to 2:1 for forested wetlands. The appropriate type and ratio of mitigation would be determined through the Section 404 permitting process.

Power Plant Site

The wetland delineation and NWI map review did not identify any state jurisdictional wetlands in the vicinity of the proposed Tuscola Power Plant Site. Additionally, the proposed power plant site is not within the 100-year floodplain.

Sequestration Site

Four state jurisdictional Wetland Areas (16, 17, 18, and 19) totaling approximately 5 acres (2 hectares) were identified within the ROI associated with the proposed injection site. Injection wells would be constructed outside these wetland areas and; therefore, no direct impacts to these resources are anticipated. The proposed injection well locations are classified as cropland; therefore, no direct impacts are anticipated.

The proposed sequestration site is not located within the 100-year floodplain. Direct and indirect impacts to mapped floodplain areas near the proposed sequestration site would not be anticipated because there would be no need to construct a building or permanent structure within the mapped floodplain areas. Permits with the Illinois Office of Water Resources and Douglas County would therefore not be required. In addition, any required sequestration plume monitoring wells and equipment would be located outside of the existing mapped floodplain areas.

Utility Corridors

Twelve state jurisdictional Wetland Areas (1 to 12) were identified within the transmission line corridor. Construction of the proposed 345-kV line corridor could directly impact up to 4.2 acres

(1.7 hectares) of wetlands by removing vegetation and causing potential soil erosion and sedimentation. During construction, wetland and other vegetation communities within the transmission line corridor would be altered. Because tall-growing vegetation would be cut and kept at a height low enough to prevent interference with the conductors, forest cover habitats would be reduced and shrub or other low-growing vegetation would eventually dominate the corridor. Overall, any potential impacts with wetlands could be minimized by locating any proposed facilities outside of identified impact locations. This effect would be minimized by limiting the areas disturbed if, based upon the results of the MISO study, it is determined that existing transmission lines are adequate or that existing corridors could be used to parallel or upgrade existing lines. Potential impacts to wetlands located along the corridor that could not be avoided by use of existing corridors could be mitigated in-place, in-kind by replacing soil and planting appropriate vegetation at a ratio consistent with USACE and IWPA requirements. The permanent conversion of forested wetlands to emergent wetlands would require a mitigation ratio consistent with federal and state requirements.

One transmission line corridor alternative would use the existing corridor, which would result in no direct or indirect impact to Wetland Areas 1, 2, 4, 6, 7, 8, 9, 10, 11, and 12. If an upgrade is required, the utility poles would be either replaced or reused; thus, the direct impact would be minimal. In areas where utility poles could not be replaced or reused, the placement of new utility poles would avoid wetland areas to the extent feasible. The IDNR would be consulted regarding the appropriate mitigation if a utility pole must be sited in one or more wetland areas. The state-recommended mitigation ratio required for the removal of any trees in the vicinity of Wetland Area 3 would be between 1.5:1 and 3.0:1. The mitigation ratio required for impacts to forested Wetland Area 5 would be between 2.5:1 and 5.5:1. These wetland areas would be avoided by using directional boring pipeline construction techniques. Every effort would be made to not disturb this area.

One state jurisdictional wetland (Wetland Area 15) was identified within the CO_2 corridor. It is likely that the CO_2 corridor would also use existing ROWs for much of its length, minimizing the amount of wetlands to be disturbed. Impacts to this wetland (0.1 acre [0.04 hectare]) would consist of vegetation and soil disturbance and would be mitigated at a 1.0:1 ratio.

Two state jurisdictional wetlands were identified in the vicinity of the Lyondell-Equistar Plant (Wetland Area 13) and the water intake (Wetland Area 14). Temporary impacts to holding ponds in Wetland Area 13, such as vegetation and soil disturbance, could occur during construction of the process water pipeline and would be avoided as feasible. If direct impacts to Wetland Area 13 could not be avoided, disturbed areas would be restored to their original condition at a 1.0:1 mitigation ratio after piping has been installed. There would be no direct or indirect project-related impacts to Wetland Area 14 during construction.

The location where the CO_2 pipeline would cross an existing drainage ditch would be constructed using directional boring equipment and in accordance with the IDNR Office of Water Management's "State Wide Permit #8-Underground Pipelines and Utility Crossings," to reduce direct impacts to mapped floodplain areas. The locations where the proposed electric corridor would cross a mapped 100-year floodplain would be regulated under the IDNR Office of Water Resources, and covered under a statewide permit.

Temporarily adding or excavating fill during construction within the floodplain would have no permanent impact on the lateral extent, depth, or duration of flooding in the floodplain areas traversed. Construction within floodplain areas would not result in increases of the 100-year flood elevation by any measurable amount because the floodway is unconstrained and there are no barriers to floodflow passage.

Depending upon final site design and construction activities, other federal, state, and local authorities may have jurisdiction over dredging, filling, grading, paving, excavating, or drilling in the floodplain that would require permits. The USACE has authority to regulate the discharge of dredged or fill materials into waterways and adjacent wetlands through Section 404. The IEPA provides water quality certification as required by Section 401 of the CWA. Concurrent with its review of the proposed FutureGen Project to determine appropriate National Environmental Policy Act (NEPA) requirements, DOE would also determine the applicability of the floodplain management and wetlands protection requirements contained within 10 CFR Part 1022.

Transportation Corridors

No new transportation corridors are proposed outside of the proposed power plant site footprint. As such, the potential impacts from project construction are discussed under the proposed power plant site. Any unforeseen upgrades or new transportation corridors would require a separate analysis.

5.8.3.2 Operational Impacts

Power Plant Site

No jurisdictional wetland areas occur within the proposed power plant site; however, Wetland Area 13 (Equistar Pond) would be affected through water withdrawals required for process water. The resulting impact would be water level fluctuation in the pond. This impact would be minimal because Lyondell-Equistar operations cause these fluctuations and the wetland is of low value due to the existing industrial use of the pond. Studies have shown that water supply within the pond would be adequate during normal conditions (see Section 5.7).

Activities would be located outside of the 100-year floodplain; therefore, no impacts are anticipated.

Sequestration Site

Operations at the proposed sequestration site would have no impact on wetlands or floodplains. All activities would occur outside of wetland and floodplain areas.

Utility Corridors

The proposed 345-kV transmission line corridor would be maintained without trees to provide maintenance access and safety. Conversion of less than 2 acres (0.8 hectare) of forested wetlands to emergent wetlands may occur. The resulting wetland and other vegetation communities in the corridor would be similar to those on other transmission line ROWs in the vicinity. Maintenance would likely be conducted using mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in proximity to streams and wetlands could be a damaging indirect effect on vegetation and aquatic resources. Following approved herbicide usage instructions, however, would likely reduce this concern. The proposed CO_2 corridor would be allowed to revegetate, and there would be no additional impacts to wetlands or floodplains. Herbicides would be used to address invasive and noxious weed species.

Transportation Corridors

Operation of the proposed power plant would use existing transportation corridors, and therefore, would have no impact on wetlands or floodplains. Any upgrades to existing corridors would require a separate analysis.

5.9 BIOLOGICAL RESOURCES

5.9.1 INTRODUCTION

This section discusses both aquatic and terrestrial vegetation and habitat, as well as threatened, endangered, and protected species identified in the affected environment that may be impacted by the construction and operation of the proposed FutureGen Project.

5.9.1.1 Region of Influence

The ROI for biological resources is defined as 5 miles (8 kilometers) surrounding the proposed power plant site, sequestration site, and utility corridors.

5.9.1.2 Method of Analysis

DOE reviewed the results of research and studies compiled in the Tuscola EIV (FG Alliance, 2006b) to characterize the affected environment. This information included data on wetland, aquatic, and threatened and endangered species. DOE also conducted site visits in August 2006, which provided additional information related to the affected environment.

DOE assessed the potential for impacts based on whether the proposed FutureGen Project would:

- Cause displacement of terrestrial communities or loss of habitat;
- Diminish the value of habitat for wildlife or plants;
- Cause a decline in native wildlife population;
- Interfere with the movement of any native resident or migratory wildlife species;
- Conflict with applicable management plans for wildlife and habitat;
- Cause the introduction of noxious or invasive plant species;
- Alter drainage patterns causing the displacement of fish species;
- Diminish the value of habitat for fish species;
- Cause a decline in native fish populations;
- Interfere with the movement of any native resident or migratory fish species;
- Conflict with applicable management plans for aquatic biota and habitat;
- Cause loss of a wetland habitat;
- Cause the introduction of non-native wetland plant species;
- Affect or displace special status species; and
- Cause encroachment on or affect a designated critical habitat.

5.9.2 AFFECTED ENVIRONMENT

5.9.2.1 Vegetation

Aquatic

Power Plant Site

There are no surface water or wetlands within the proposed Tuscola Power Plant Site boundaries. The only aquatic macrophytes observed during field work were in industrial ponds located within the ROI

(FG Alliance, 2006b). These species include coontail (*Ceratophyllum demersum*) and milfoil (*Myriophyllum* sp.).

Sequestration Site

The only aquatic habitat located on the sequestration site is a small section of the Kaskaskia River, its associated floodplain, and several intermittent drainages. In this reach, the vegetated riparian corridor is wide with seasonal overbank flooding into the floodplain terrace.

Utility Corridors

Aquatic vegetation within the transmission line corridor, which includes both the 138-kV and the 345-kV options, occurs predominantly within the Embarras River watershed. The final route of the proposed 345-kV transmission line has not been determined at this time. The corridor could cross several streams, including upper tributary reaches of Scattered Fork, Hayes Branch, and Hackett Creek, which are all intermittent streams. The corridor could also cross the Embarras River. No information was available, and neither DOE nor the Alliance conducted surveys regarding the presence of in-stream aquatic vegetation; however, DOE did not observe any aquatic plants in any of these streams during an August 2006 site visit. Wetlands found within the transmission line and CO_2 pipeline corridors are discussed in Section 5.8.

Vegetation on the east side of the Kaskaskia River, which would provide the water source for the proposed Tuscola Power Plant Site via the Lyondell-Equistar Chemicals LP water reservoir west of Tuscola, consists of common floodplain trees, including silver maple (*Acer saccharinum*) and box elder (*Acer negundo*), along with common herbaceous species such as reed canary grass (*Phalaris arundinacea*). On the west side of the river, the same tree species line the riverbank, and the adjacent land is planted with soybeans. There is little in the way of aquatic or upland habitat in the area of the water intake. No known aquatic plant and animal management plans exist for the project area.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

Power Plant Site

The proposed power plant site consists entirely of an agricultural monoculture of corn row crops. Because the property is maintained as a monoculture, non-agricultural plant species are not present.

Sequestration Site

The proposed sequestration site also consists predominantly of monotypic agricultural cropland with several homesteads and grassed waterways. Additionally, there are areas of woodland near the southwest corner of the sequestration site containing typical upland species such as oak (*Quercus* spp.), hickory (*Carya* spp.), and white ash.

Utility Corridors

> **Riparian** areas are those located on the banks of a natural course of water (i.e., adjacent to a river or stream).

Because both a natural gas and potable water pipeline currently exist adjacent to the plant site and the vegetation in the area is predominantly a monoculture of row crops, vegetation would be the same as that described for the power plant site. The terrestrial habitat along the proposed transmission line corridor and the proposed CO_2 pipeline corridor also consists predominantly of monotypic stands of row crops. Occasional grassed waterways are constructed to drain water quickly from the cropland and are planted with non-native vegetation. The riparian corridor associated with the Embarras River contains some native tree and herbaceous species such as white ash (*Fraxinus americanus*), black walnut (*Juglans nigra*), common hackberry (*Celtis occidentalis*), clearweed (*Pilea pumila*), marshpepper knotweed (*Polygonum hydropiper*), and Virginia wild rye (*Elymus virginicus*), which may provide habitat for a variety of animal species. However, due to the intensive agricultural history of the region, these areas are ecologically degraded. The riparian corridor is limited to a narrow band of non-agricultural vegetation, which can only support a limited number of species. Additional terrestrial habitat within the proposed transmission line and CO_2 pipeline corridors includes a golf course and homesteads with landscaped lawns.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected terrestrial environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

5.9.2.2 Habitats

Aquatic

Power Plant Site

Because no permanent aquatic habitats occur within the proposed power plant site, the site does not contain fish or aquatic invertebrates.

Sequestration Site

The only aquatic habitat at the sequestration site consists of a small section of the Kaskaskia River, its associated floodplain, and several intermittent drainages. Fish and macroinvertebrates found within this stretch of the river are expected to be similar to those found during surveys conducted in the river by the Illinois Environmental Protection Agency (IEPA) in the summer of 2002; 4 miles (6.4 kilometers) west of Hayes, Illinois (see Tables 5.9-1 and 5.9-2).

Table 5.9-1. Fishery Sampling Data, Upper Kaskaskia River, IEPA Site 0-31 (Electric Seine)[1]

Specific Fish Species Survey Results		
Common Name	**Scientific Name**	**Kaskaskia Ditch (no. of individuals)**
Gizzard shad	***Dorosoma cepedianum***	3
Carp	***Cyprinus carpio***	4
Hornyhead chub	***Nocomis biguttatus***	1
Striped shiner	***Luxilus chrysocephalus***	42
Red shiner	***Cyprinella lutrensis***	87
Bluntnose minnow	***Pimephales notatus***	247
Bullhead minnow	***Pimephales vigilax***	3
Sand shriner	***Notropis ludibundus***	129
Silverjaw minnow	***Notropis buccatus***	19
Quillback	***Carpiodes cyprinus***	12
River carpsucker	***Carpiodes carpio***	1
Highfin carpsucker	***Carpiodes velifer***	25
Golden redhorse	***Moxostoma erythrurum***	1
Channel catfish	***Ictalurus punctatus***	6
Yellow bullhead	***Ameiurus natalis***	7
Tadpole madtom	***Noturus gyrinus***	8
Freckled madtom	***Noturus nocturnus***	1
Blackstripe topminnow	***Fundulus notatus***	3
Longear sunfish	***Lepomis megalotis***	12
Johnny darter	***Etheostoma nigrum***	1
Overall Aquatic Community Results		
Total fish		612
Total species		20
Electrode minutes		28
Kilograms of fish		16.1
Native fish species		19
Native minnow species		7
Native sucker species		4
Native sunfish species		1
Benthic invertivore species		4
Intolerant species		2
Prop. specialist benthic invertivores		0.02
Prop. geneneralist feeders		1.0

Table 5.9-1. Fishery Sampling Data, Upper Kaskaskia River, IEPA Site 0-31 (Electric Seine)[1]

Specific Fish Species Survey Results		
Common Name	**Scientific Name**	**Kaskaskia Ditch (no. of individuals)**
Prop. mineral-substrate spawners		0.07
Prop. tolerant species		0.2
Extrapolated IBI		40

[1] Data collected 07/09/02.
Source: IEPA, 2002; FG Alliance, 2006b.

Table 5.9-2. Macroinvertebrate Sampling Data, Upper Kaskaskia River, IEPA Site 0-31[1]

Scientific Name	Kaskaskia Ditch (no. of individuals)
Argia sp.	2
Baetis propinquus	2
Caenis sp.	5
Chironomus sp.	2
Corbicula sp.	1
Cricotopus bicinctus	25
Cricotopus sylvestris	4
Cricotopus trifascia	1
Cryptochironomus sp.	2
Dicrotendipes sp.	2
Dubiraphia sp.	154
Enallagma sp.	8
Gomphus sp.	3
Hemerodromia sp.	1
Hetaerina sp.	1
Hexagenia limbata	1
Hyalella azteca	1
Hydroptila sp.	1
Labiobaetis sp.	1
Oligochaeta	1
Orthocladiinae	5
Paratanytarsus sp.	63
Pentaneura sp.	1

Table 5.9-2. Macroinvertebrate Sampling Data, Upper Kaskaskia River, IEPA Site 0-31[1]

Scientific Name	Kaskaskia Ditch (no. of individuals)
Pisidiidae	1
Polypedilum convictum	2
Polypedilum illinoense	19
Procladius sp.	3
Rheotanytarsus sp.	2
Sialis sp.	1
Stenonema pulchellum	1
Tanytarsini	2
Tanytarsus sp.	1
Tricorythodes sp.	33
Count	33
MBI	5.7
%EPT	3.1%
%Midge	38.1%
Sum	352
Count Genus	30
Count EPT Genus	6
Count Midge Genus	12

[1] Data collected 7/09/02.
Source: IEPA, 2002; FG Alliance, 2006b.

Utility Corridors

Aquatic habitat at the water intake area at the Lyondell-Equistar Plant consists of an excavated channel approximately 75 feet (22.9 meters) wide leading from the Kaskaskia River to the pump intake at the plant. From there, water is pumped to a series of excavated reservoirs on the plant site. Return water is released back into the river just downstream of the intake. During the field investigations, the return water from the plant was noticeably clearer than the turbid water flowing in the Kaskaskia River.

Ten mussel species were previously reported in the Chicken Bristle segment of the Kaskaskia River, a Natural Area from the Douglas-Champaign County line to the Lyondell-Equistar intake, classifying this segment as a High Mussel Diversity Area (FG Alliance, 2006b). IDNR conducted a mussel survey in August 2006 to verify the current status of this classification and determine whether any other listed mussel species might be present. The survey found very few mussels, none of which were listed. IDNR has stated that this segment of the river is unlikely to maintain its status as a Natural Area, and potential impacts to listed mussels in this reach are no longer a concern (FG Alliance, 2006b). Causes for the decrease in mussel diversity in this reach are unknown.

IEPA conducted fish and macroinvertebrate surveys in the Kaskaskia River in summer 2002, 4 miles (6.4 kilometers) west of Hayes, Illinois, and north of Chicken Bristle. Tables 5.9-1 and 5.9-2 list the results of these surveys. As part of the fisheries survey, IEPA calculated an Index of Biotic Integrity of 40, indicating a low "B-rated" stream segment, which is classified as a Moderate Aquatic Resource. The calculated Macroinvertebrate Biotic Index for this reach was 5, which indicates an overall healthy macroinvertebrate community.

As previously discussed, the proposed transmission line would potentially cross several intermittent streams, including upper tributary reaches of Scattering Fork, Hayes Branch, and Hackett Creek, as well as the Embarras River. Actual stream crossings depend upon the final route and configuration of the line and would be determined following completion of the current MISO study. Despite seasonal low flows and the agriculturally dominant land use in the watershed, the Critical Trends Assessment Program identified the entire length of the Embarras River as a Resource Rich Area (RRA) (FG Alliance, 2006b). Species diversity and richness are high in the Embarras River, which offers a variety of habitats including gravel bars, gravel and sand raceways, sandbars, riffles, and deep pools. Two sections of the river (112.5 miles [181.1 kilometers]) are rated as Biologically Significant Streams. One section begins just downstream of the transmission line corridor crossing at US 36 (4 miles [6.4 kilometers] east of Tuscola) and continues downstream to the confluence with the Little Embarras River in Coles County upstream of the City of Charleston (INHS, 1996). This reach of the river is naturalized and 25 to 50 feet (7.6 to 15.2 meters) wide, with substrate consisting of sand and gravel with some bedrock, cobble, and silt. Mussel diversity is high.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs.

Terrestrial

The proposed power plant site, sequestration site, transmission line corridor, and CO_2 pipeline corridor all consist of predominantly monotypic agricultural croplands. As such, with the exception of riparian corridors along the Kaskaskia and Embarras rivers and their tributaries, wildlife found within the proposed project areas would be limited to common species such as raccoons (*Procyon lotor*), white-tailed deer (*Odoceilus virginianus*), skunks (*Mephitus mephitus*), and various rodents. The riparian corridors contain upland tree species such as white oak (*Quercus alba*), white ash, basswood (*Tillia americana*), honey locust (*Gleditsia triacanthos*), and hickory with floodplain species such as red maple (*Acer rubrum*), silver maple, and cottonwood (*Populus deltoides*) in lower areas adjacent to the river. There is also a small woodland area near the southwest corner of the sequestration site that contains similar upland species. This area could support additional common wildlife species, such as downy woodpeckers (*Picoides pubescens*), blue jays (*Cyanocitta cristata*), black-capped chickadees (*Poecile atricapilla*), chipmunks (*Tamias minimus*), and eastern gray squirrels (*Sciurus carolinensis)*; however, no critical or unique habitat has been identified there by the IDNR or during site investigations.

5.9.2.3 Federally Listed Threatened and Endangered Species

According to the FWS (FWS, 2006) the only federally listed species that may occur within the proposed project vicinity is the endangered Indiana bat (*Myotis sodalis*). This species occupies caves and abandoned mines during the winter and uses trees and cavities for roosting the remainder of the year. Potential habitat within the project area for the Indiana bat is limited to wooded riparian habitat and the woodland area in the southwest corner of the sequestration site. Pursuant to consultation between IDNR and the site proponent, the Indiana bat is not expected to occur within the proposed power plant site, sequestration site, or utility corridors.

5.9.2.4 Other Protected Species

The state-listed threatened Kirtland's snake (*Clonophis kirtlandii*) has been found 1 mile (1.6 kilometers) from the proposed transmission line corridor near Spring Lake. Kirtland's snake occurs in damp habitats, such as wet meadows and wet prairies, near water bodies. Because most of the project area consists of cropland, the only potential habitat occurs within riparian areas along the proposed transmission line corridor.

5.9.3 IMPACTS

5.9.3.1 Construction Impacts

Power Plant Site

Because no permanent streams or ponds are located at the proposed power plant site, no direct impacts on aquatic resources would occur. Standard stormwater management practices for construction activities (e.g., placement of silt fencing around disturbed areas), would prevent indirect impacts, such as sedimentation to off-site surface waters.

Project construction could require the removal of up to 200 acres (81 hectares) of cropland to accommodate the power plant envelope (plant buildings and associated structures), depending upon final site design. Because this cropland does not provide high-quality wildlife habitat and similar agricultural habitat is prevalent in the area, effects on wildlife and displacement of terrestrial communities would be minimal. Some small, less mobile species that inhabit the cropland, such as rodents, could be lost during construction; however, these species are plentiful and the loss of a few individuals would have no effect on the overall population. The proposed power plant site does not contain habitat for any federally or state-listed rare, threatened, or endangered species. Additionally, construction at the proposed power plant site is unlikely to cause a proliferation of noxious weeds because the disturbed area would become an industrial facility with little vegetation.

Sequestration Site

A small section of the Kaskaskia River is the only permanent stream located on the sequestration site; however, because construction of the proposed injection wells would be localized and sited to avoid this stream, direct impacts to aquatic resources would not occur. Standard stormwater management practices, as described for the impacts at the power plant site, would prevent indirect impacts to this stream and off-site surface waters.

Up to 10 acres (4 hectares) of land could be permanently lost as a result of the construction of the injection wells. The sequestration site is predominantly monotypic agricultural cropland and land disturbance associated with well construction would remove existing cropland habitat. However, because this cropland does not provide high-quality wildlife habitat and similar agricultural habitat is prevalent in the area, effects on wildlife and displacement of terrestrial communities would be minimal. Furthermore, revegetation of disturbed areas that are not used for injection wells with native plant species would limit the proliferation of noxious weeds. Temporary impacts to vegetation would result from truck access during the required seismic surveys of the sequestration site, before injection well construction. No known federally or state-listed rare, threatened, or endangered species are present at the sequestration site.

Utility Corridors

Removal of vegetation during construction of the proposed utility corridors could affect riparian habitat by increasing the potential for soil erosion in newly disturbed areas. The potential for this impact would be related to the corridor lengths, the habitat that they traverse, and the type of utility (i.e., aboveground versus belowground). Generally, the use of existing ROWs would reduce the potential for these impacts. The vegetation within the corridor would require periodic trimming for corridor maintenance, thereby permanently removing areas of forest within the corridor. Tree cover loss would be minimized by paralleling existing utility lines, upgrading existing utility lines, or using existing maintained ROWs.

The length of the electric transmission line corridor would vary between 0.5 and 17 miles (0.8 and 27.4 kilometers) for the 138-kV line (Option 1) or 345-kV line (Option 2), respectively. The results of ongoing studies by MISO, the regional transmission authority, would determine the selection of electric transmission options. Option 1 would require 0.5 mile (0.8 kilometer) of new ROW. Option 2 would require approximately 14 miles (22.5 kilometers) of construction within an existing ROW and 3 miles (4.8 kilometers) of construction within a new ROW. The vegetation within the corridor would require periodic trimming for corridor maintenance, thereby permanently removing areas of forest within the corridor. Tree cover loss would be minimized by paralleling existing transmission lines, upgrading existing transmission lines, or using existing maintained ROWs. Direct impacts to aquatic communities, including streams and wetlands, would be avoided. Transmission lines would be above ground, limiting earth disturbance and fill activities to the pole locations. Poles supporting the transmission lines would also be located outside of sensitive habitats such as streams and wetlands. Indirect impacts, such as increased stream temperatures due to loss of riparian tree canopy, could result from clearing of trees along the stream within the electric transmission line corridor; however, this impact would be considered minimal as the majority of the corridors are located in agricultural areas with limited stream shading.

The 11-mile (17.7-kilometer) long CO_2 pipeline corridor would also use existing ROWs for much of its length. The proposed process water pipeline would be 1.5 miles (2.4 kilometers) long and would occur in agricultural land and within an existing road ROW. The proposed sanitary water pipeline under Option 2 would parallel the process water pipeline for its 0.9-mile (1.4-kilometer) length. Construction of these underground utilities would disturb habitats in primarily agricultural lands along with some riparian habitats at stream crossings. No critical habitats are located within the corridors. These pipelines would be built using standard pipeline construction techniques and directional drilling under sensitive areas such as wetlands, streams, and rivers. After construction, the land above these pipelines would be revegetated with native species, maintaining wildlife habitat similar to current conditions and limiting the proliferation of noxious weeds. Overall, due to the small amount of vegetation expected to be disturbed, impacts would be minimal.

Construction activities would temporarily displace wildlife species using these corridors. The plant community in the transmission corridor would be permanently maintained in an early-successional stage with no trees. As such, tree cover in riparian areas within any new 345-kV transmission line corridor would be permanently lost.

No known federally listed threatened or endangered species occur in any of the utility corridors. The state-listed Kirtland's snake occurs in riparian areas within the proposed transmission line corridor and could be affected during construction in the absence of appropriate protection and mitigation measures. To minimize potential impacts to Kirtland's snake, IDNR recommends that the following measures would be incorporated into construction plans: (1) construction crews would be educated to identify the snake and relocate any encountered individuals to appropriate off-site habitat; (2) trenches would be backfilled immediately after piping is installed, if possible; (3) if trenches must be left open, they would be covered with plywood or similar material at the end of the day and covered with enough dirt to keep snakes from entering; and (4) trenches that have not been backfilled would be inspected for the snake at the beginning of each day, and an IDNR biologist would be contacted to capture and release any snakes trapped in the open trench. These measures would minimize the potential for impacts to Kirtland's snake. Should Tuscola host the FutureGen Project, consultation with IDNR would ensure that proper protection measures are in place before construction.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected aquatic environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

5.9.3.2 Operational Impacts

Power Plant Site

Process water for the proposed power plant would come from the existing Lyondell-Equistar Chemical Company's 150 million-gallon (568 million-liter) raw water holding pond which obtains water from an intake structure on the Kaskaskia River. During low flow conditions, Lyondell-Equistar either draws water from the holding pond and begins pumping from the river once moderate to heavy rains have increased its flow, or it pumps water from the Mahomet aquifer wells near Bondville, Illinois, to supplement water needs (see Section 5.7 for further details on proposed water use and impacts to surface water). In either case, pumping water from the chemical plant's holding pond for the FutureGen Project is expected to have minimal impacts to aquatic resources in the Kaskaskia River because of increased discharge upstream. Because of increased development upstream of the intake structure, low flow in the river has been sustained by increased effluents from the Urbana-Champaign Sanitary District WWTP. The current average daily discharge from the Urbana-Champaign WWTP is approximately 6 million gallons (23 million liters) per day (FG Alliance, 2006b). As proposed, the FutureGen plant would draw about 4.3 million gallons (16.3 million liters) per day of process water from an existing 80-acre (32-hectare), 150 million-gallon (568 million-liter) raw water holding pond located 1.5 miles (2.4 kilometers) west of the site at Lyondell-Equistar Chemical Company. This supplemental water is conveyed to the intake structure at Lyondell-Equistar Chemicals via the Kaskaskia River. Water withdrawals from the Kaskaskia River would not be expected to have an adverse impact on the aquatic habitat in the river because upstream discharges from community wastewater systems have increased by amounts greater than the projected FutureGen Project demand. As noted in the affected environment discussion, listed mussels are not present near the existing intake structure, thus impacts to listed mussels in this area are not a concern (FG Alliance, 2006b).

Operating the proposed power plant, injection wells, and utilities would have minimal effect on biological resources. Noise during proposed project operations would be slightly elevated in the absence of mitigation (see Section 5.14). However, wildlife species that are found near the proposed power plant site, such as white-tailed deer, skunks, and raccoons, are adapted to the noise found in areas of human development. Air emissions due to routine operation would result in small increases in ground-level pollutant concentrations (see Section 5.2) that should be below levels known to be harmful to wildlife and vegetation or affect ecosystems through bio-uptake and biomagnification in the food chain. Because there are no high-quality or sensitive aquatic or wildlife receptors near the proposed power plant site, air emissions would not impact biological communities.

Sequestration Site

A limited number of site characterization seismic surveys would be required during operation of the sequestration site, resulting in temporary impacts to vegetation due to truck access within the survey plots.

Microbes occurring approximately 0.9 mile (1.4 kilometers) under ground within the sequestration reservoir could be affected by sequestration. Microbes are likely to exist in almost every environment, including the proposed sequestration reservoirs, unless conditions prevent their presence. CO_2 sequestration has the potential to destroy these localized microbial communities by altering the pH of the underground environment. However, it is also possible that CO_2 sequestration would not harm microbial communities (IPCC, 2005). The potential loss of localized microbial populations within the sequestration reservoir would not constitute an appreciable difference to the world's total microbial population.

No additional impacts are anticipated during normal operations. Should released gas from the sequestration reservoir reach surface water, impacts to aquatic biota would be unlikely because the concentration of CO_2 in the surface water would be less than the 2 percent level at which effects to aquatic biota could occur (see Section 5.17). Plants are not predicted to be impacted by gradual CO_2 releases from the reservoir, although effects in the immediate vicinity of the injection wells could result from a rapid CO_2 release (see Section, 5.17).

Utility Corridors

The proposed transmission line are process water supply corridors would be maintained without trees to provide maintenance access and for safety reasons. Corridor maintenance would likely use both mechanical (e.g., cutting and mowing) and chemical (e.g., herbicides) means. Applying certain herbicides in close proximity to streams and wetlands could be potentially damaging. Following approved herbicide usage instructions would eliminate this concern. The proposed CO_2 pipeline corridor would be allowed to revegetate once construction is complete; therefore, no impacts would be likely during operations.

If a leak or rupture in the CO_2 pipeline occurred, respiratory effects to biota due to atmospheric CO_2 concentrations would be limited to the immediate vicinity along the pipeline where the leak or rupture occurred. While heat generated from the supercritical fluid in the CO_2 pipeline could potentially affect surface vegetation, pipeline construction techniques that would contain the heat through insulation and installation depth would prevent this impact. Soil gas concentrations vary, depending on soil type; therefore, effects on soil invertebrates or plant roots could occur close to the segment of the pipeline that ruptured or leaked (see Section 5.17).

The proposed transmission line could potentially affect raptors and waterfowl located near the line due to collision or electrocution. Designing the line in accordance with current guidelines (APLIC et al., 1996) would minimize the potential for these effects.

Transportation Corridors

Because no new transportation corridors are proposed outside of the power plant site, this section does not include a description of the affected environment. Any potential upgrades to existing transportation corridors are anticipated to occur in existing maintained ROWs. Any unforeseen major upgrades or new transportation corridors would require a separate analysis.

INTENTIONALLY LEFT BLANK