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:

- 7.2 Air Quality
- 7.3 Climate and Meteorology
- 7.4 Geology
- 7.5 Physiography and Soils
- 7.6 Groundwater
- 7.7 Surface Water
- 7.8 Wetlands and Floodplains
- 7.9 Biological Resources
- 7.10 Cultural Resources
- 7.11 Land Use
- 7.12 Aesthetics
- 7.13 Transportation and Traffic
- 7.14 Noise and Vibration
- 7.15 Utility Systems
- 7.16 Materials and Waste Management
- 7.17 Human Health, Safety, and Accidents
- 7.18 Community Services
- 7.19 Socioeconomics
- 7.20 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.

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 ***or possibly from the Colorado River Municipal Water District (CRMWD) (see Section S.4.3 and 2.4.5)***. 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 ***42,300*** 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. ***Additionally, after issuance of the Draft EIS, two additional and reasonable CO_2 pipeline options were submitted to DOE (see Section S.4.3). Option 1 would involve the construction and operation of a new, approximately 90-mile (145-kilometer) pipeline along existing ROWs; and Option 2 which would involve the use of existing pipeline and the construction of a new, approximately 30-mile (48-kilometer) pipeline and a separate sulfur removal plant***. 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.

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, and is about 60 miles (96.6 kilometers) south of the Midland-Odessa International Airport. ***The proposed injection site would be approximately 13 miles (21 kilometers) east of Fort Stockton, Texas.*** ***Proposed injection targets for this site include a lower interval (the Delaware Mountain Group sandstones) and an upper interval (the lower part of 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. ***The sequestration site contains an estimated 42,300 acres (17,118 hectares) of land.***
Utility Corridors	
Potable Water	Potable water would potentially be obtained through the same sources identified for process water.

Table 7.1-1. Odessa Site Features

Feature	Description
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. ***Since the issuance of the Draft EIS, the Site Proponents have provided another process water option. Odessa has offered to provide raw or treated water from the City of Odessa's water treatment plant using a new, approximately 17-mile (27.4-kilometer), process water pipeline (see Figure7.1-1). All but 1 mile (1.6 kilometers), approximately 5,000 feet (1,524 meters), of the distance of the new process water pipeline would either use existing public road ROWs (e.g., it would be installed under ground on the north side of 42nd Street) or be within the region of influence (ROI) analyzed in the Draft EIS for the Texland Great Plains water corridor. The new, less than 1-mile (1.6-kilometer) corridor requiring new ROW would traverse rangeland similar to that described for the Texland Great Plains water corridor.*** ***The water supply would be from the City of Odessa which receives its raw water from the Colorado River Municipal Water District (CRMWD). The CRMWD is the legislatively created entity whose mission is to provide water to several communities in this region of Texas. The CRMWD currently owns and utilizes three reservoirs and four active well fields (the groundwater is typically used only during summer months to meet peak demands) (City of Odessa, 2007).***
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.
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.

Table 7.1-1. Odessa Site Features

Feature	Description
CO_2 Pipeline	***As proposed in the Draft EIS,*** 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 ***CO_2 pipeline with varying diameter just east of the plant site operated by Kinder Morgan CO_2 Company (the Central Basin CO_2 pipeline). The CO_2 would then flow into one or two pipelines owned by PetroSource Inc. (the Comanche Creek Pipeline or the Val Verde Pipeline).*** Two miles (3.2 kilometers) of new CO_2 pipeline would connect the proposed power plant site to the existing ***Central Basin pipeline****,* and approximately 7 to 14 miles (11.3 to 22.5 kilometers) of new pipeline would connect the existing ***PetroSource pipelines*** to the proposed injection site. Because multiple injection wells would be used, intra-well piping would also be installed to connect the wells to the main pipelines. ***Since issuance of the Draft EIS, Alliance and DOE investigations have revealed that it would not be feasible at this time to transport CO_2 from the proposed power plant site at Odessa to the proposed injection well site using the PetroSource Val Verde CO_2 pipeline located east of the injection site, as originally stated in the Draft EIS. Therefore, Odessa has offered two additional CO_2 pipeline options:*** • ***Option 1- Construction and operation of a new, approximately 90-mile (145-kilometer) dedicated pipeline from the FutureGen plant to the injection site along existing rights-of-way; and*** • ***Option 2 – Use of existing pipeline owned by Kinder Morgan CO_2 Company and the construction and operation of a new, approximately 30-mile (48-kilometer) dedicated pipeline (ranging from 6 to 12 inches [15.2 to 30.5 cm] in diameter) from the end of the Kinder Morgan line (near McCamey, Texas) to the injection sites. Option 2 would require additional sulfur removal either at the FutureGen plant or in a separate sulfur removal plant operated by Kinder Morgan.*** ***The original option could be used to transport CO_2 to the sequestration site only through the PetroSource Inc. Comanche Creek Pipeline (it was learned that the Val Verde Pipeline flows the wrong direction). The Comanche Creek Pipeline is a 6-inch (15.2 cm) diameter pipeline that with upgrades, could carry only enough CO_2 to reach the goal of MMT/yr, but it could not deliver the maximum amount that could be captured by FutureGen's 2.8 MMT/yr.***
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 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).

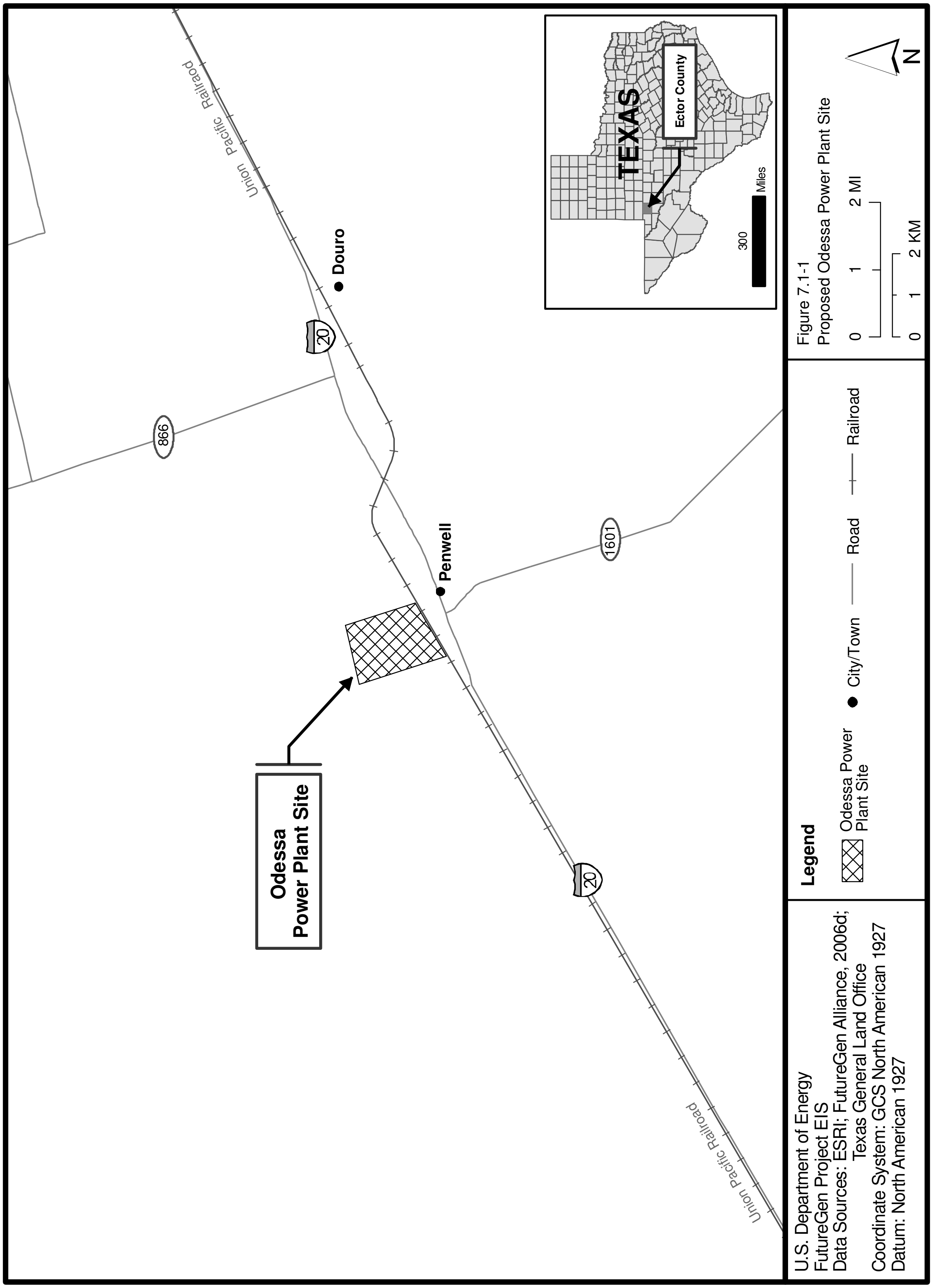

Figure 7.1-1
Proposed Odessa Power Plant Site

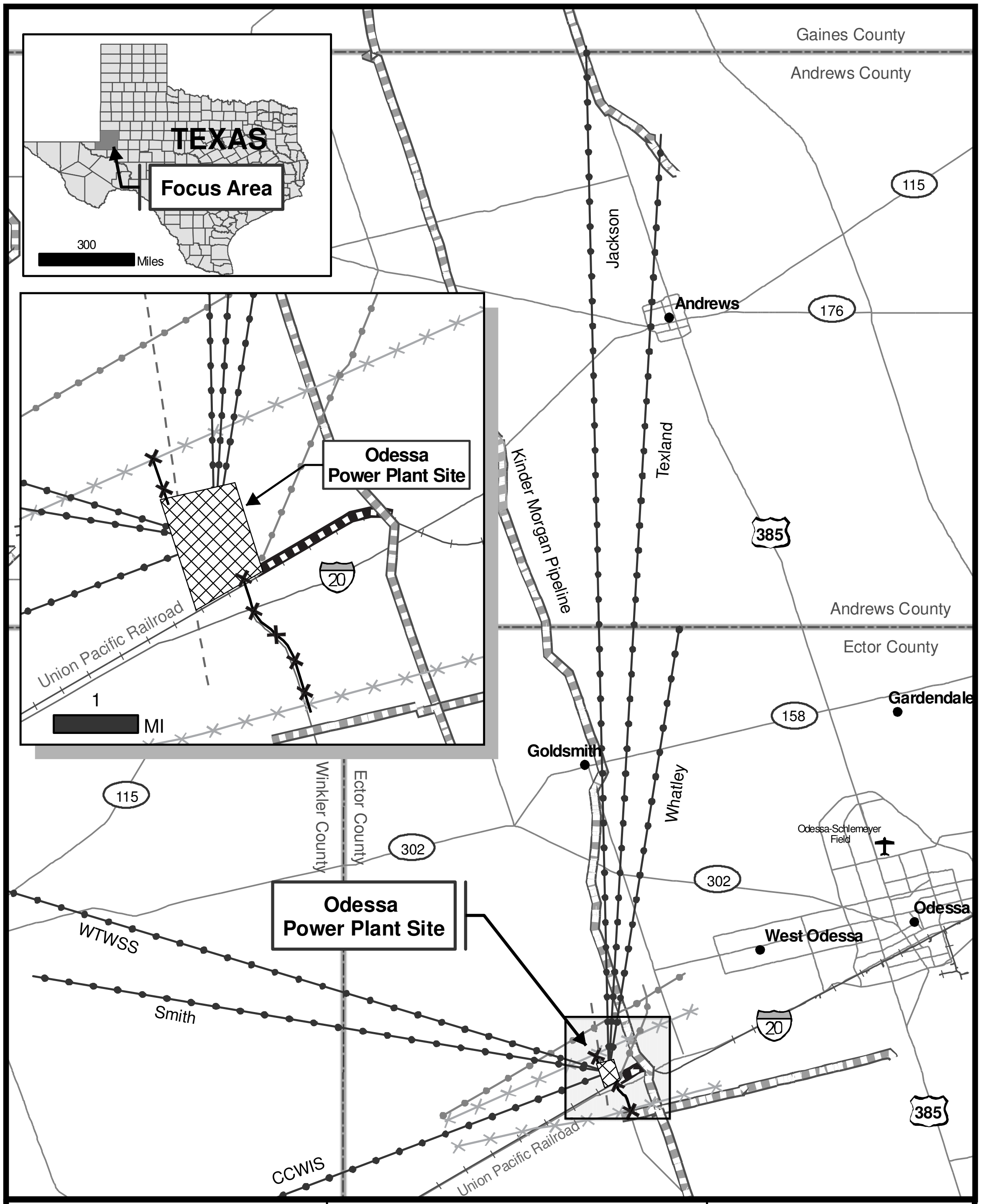

Figure 7.1-2
Proposed Utility Corridors for the Odessa Power Plant Site

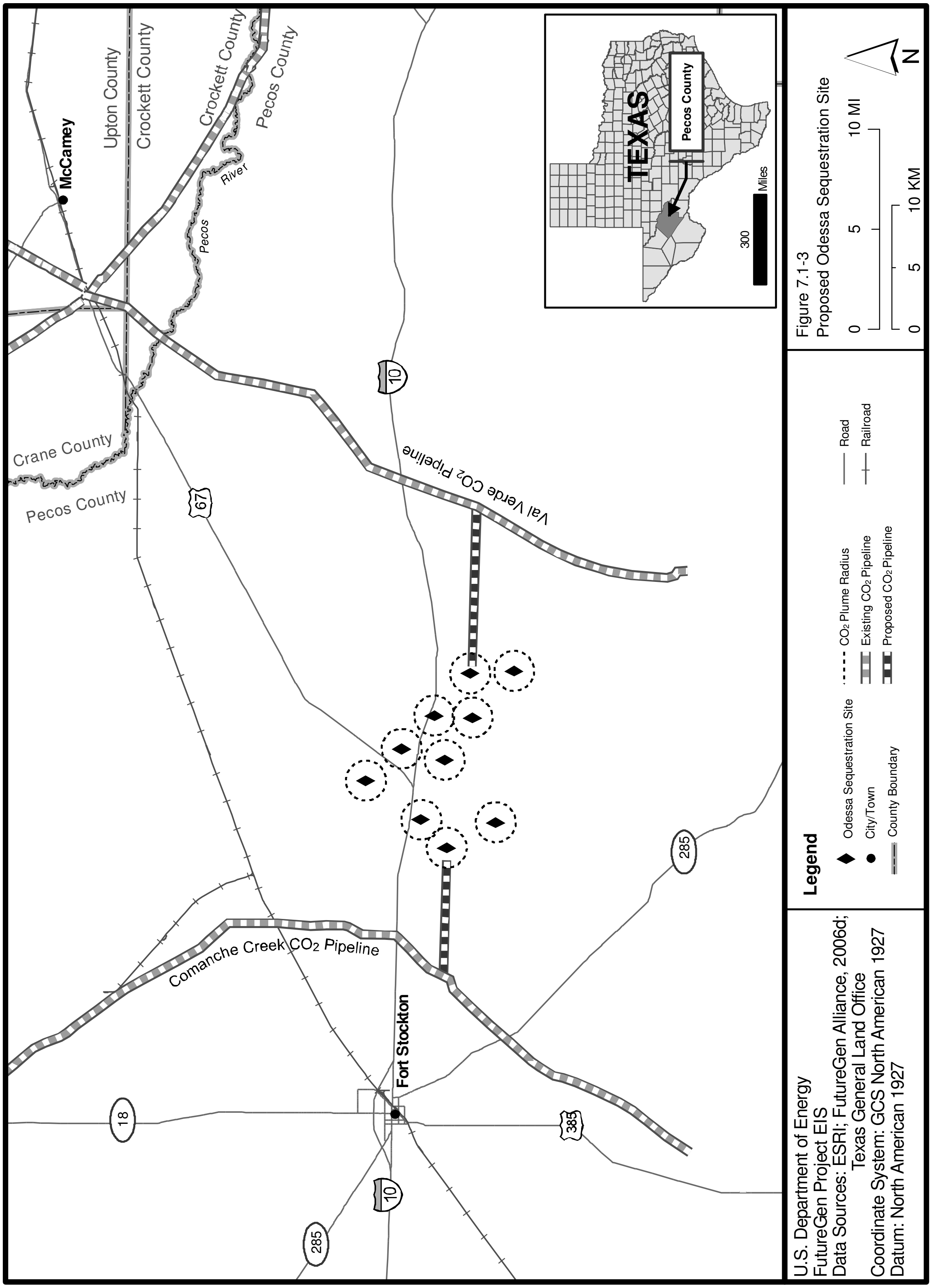

Figure 7.1-3
Proposed Odessa Sequestration Site

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). ***However, a power plant built with these conceptual designs, under normal steady-state operations, could meet the specified FutureGen Project Performance Targets (see Section 2.5.6).***

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*b*.

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. ***Appendix E provides additional detail.***

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. ***Appendix E provides additional details.*** 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)	***7.7*** ***20.3***	15 35
Hobbs, NM Lea County Pecos-Permian Basin Intrastate AQCR	75 (120)	O_3 (1-hour) O_3 (8-hour) PM_{10} (Annual)[2] PM_{10} (24-hour) NO_2 (Annual)	0.083 0.079 ***18*** ***51.3*** ***15.05***	0.12 0.08 150 ***100***
El Paso, TX El Paso County El Paso-Las Cruces-Alamogordo Interstate AQCR	245 (394)	O_3 (1-hour) O_3 (8-hour) CO (1-hour) CO (8-hour) SO_2 (Annual) SO_2 (24-hour) SO_2 (3-hour) Pb (Quarterly)	0.110 0.092 ***7,225.953,9*** ***02.01*** ***5.24*** ***13.09*** ***52.35*** 0.01	0.12 0.08 ***40,000*** ***10,000*** ***80*** ***365*** ***1,300*** 1.5

[1] Units for ***NO_2, SO_2,*** $PM_{2.5}$, PM_{10}, and Pb are in micrograms per cubic meter (µg/m³); units for O_3 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 ***generally*** 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 HAP in amounts greater than or equal to 25 tpy (22.7 mtpy). For sources that are not in one of the 28 categories ***defined by the PSD rule***, the threshold is 250 tpy (226.8 mtpy) of criteria pollutants (40 Code of Federal Regulations [CFR] 52.21, 2006). ***Because a fossil-fuel fired steam electric generating unit is one of the 28 categories defined by the PSD rule, the 100 tpy threshold applies.***

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.

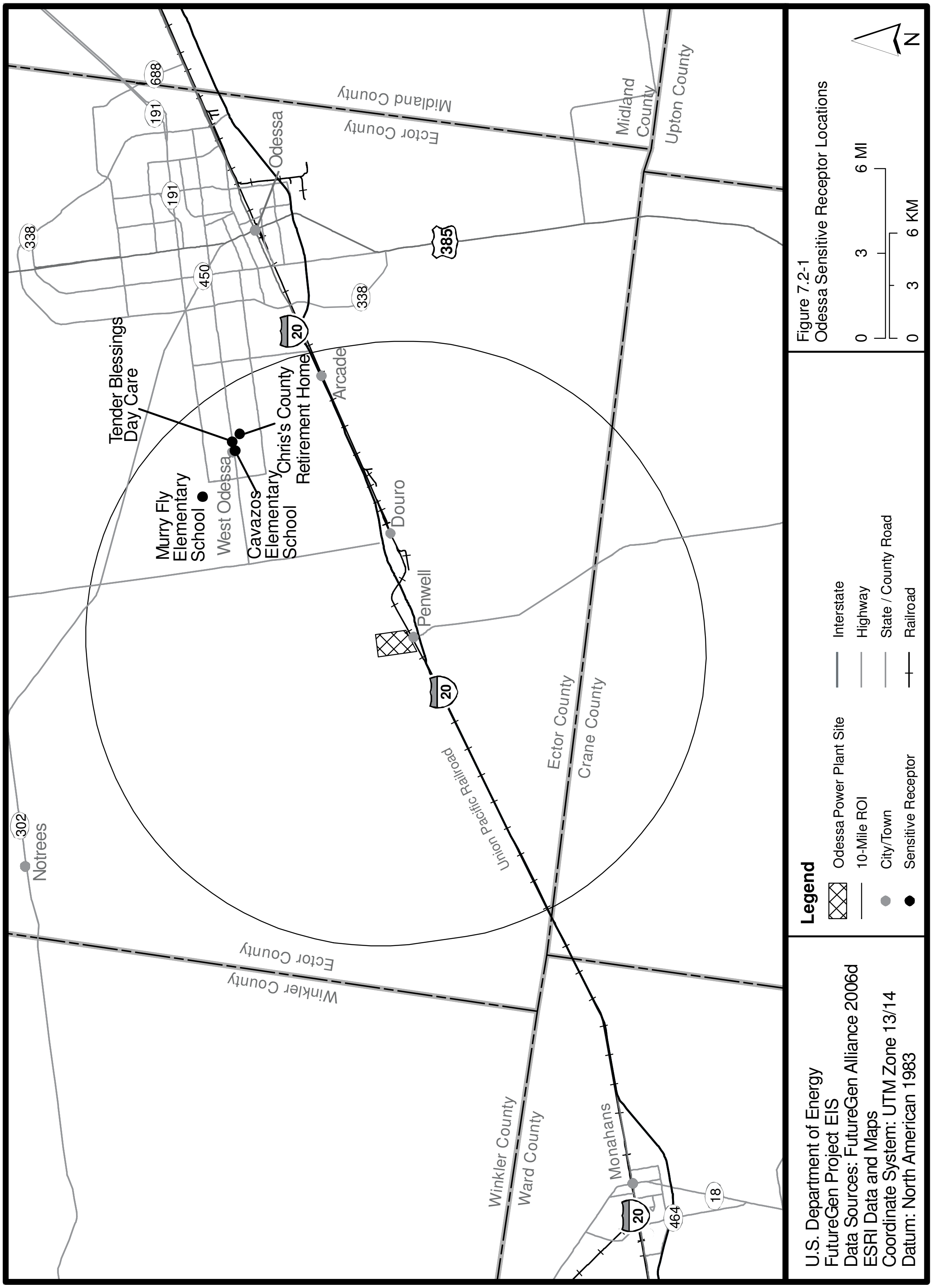

Figure 7.2-1
Odessa Sensitive Receptor Locations

Table 7.2-3. Allowable PSD Increments (µg/m³)

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/m³ = 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 ***PSD***. Health hazards and risks associated with these HAP emissions and other air toxins are discussed in Section 7.17.

Mercury

CAMR ***establishes "standards of performance" limiting mercury emissions from new and existing coal-fired power plants and creates a market-based cap-and-trade program that reduces nationwide utility emissions of mercury into two distinct phases. CAMR applies to units*** that produce more than 25-MW equivalent ***electrical*** output and that would sell ***more than one-third of their potential*** electric***al output***. ***Under CAMR, each State must submit a plan whereby the State will meet its mercury emissions budget under the nationwide cap; a State plan may deviate from the model rule developed by EPA but may not exceed its budget.***

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 ***the NSPS*** limit (TCEQ, 2006). ***The FutureGen Project would be subject to 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. Upon facility startup, the FutureGen Project would need to comply with the State plan for CAMR, as well as meet the Federal NSPS emission limits. Continuous monitoring for Hg would also***

be required. The AERMOD analysis predicted that a negligible annual concentration of Hg ($5.10x10^{-6}$ micrograms per cubic meter) would *result* within 0.55 mile (0.9 kilometer) of the proposed power plant site.

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 **unit's** 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).

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.

Radionuclides and Radon

Coal is largely composed of organic matter, but some trace elements in coal are naturally radioactive. These radioactive elements include uranium (U), thorium (Th), and their numerous decay products, including radium (Ra) and radon (Rn). During coal processing (e.g., gasification) most of the uranium, thorium and their decay products are released from the original coal matrix and are

distributed between the gas phase and the ash product. Almost all radon gas present in feed coal is transferred to the gas phase. In contrast, less volatile elements such as thorium, uranium, and the majority of their decay products are almost entirely retained in the solid ash or slag.

The concentration of uranium and thorium in coal is low. Analyses of Eastern and Western coals show that in the majority of samples, concentrations of uranium and thorium fall in the range from slightly below 1 to 4 parts per million (ppm). Similar uranium and thorium concentrations are found in a variety of common rocks and soils. For example, average thorium concentration in the earth's crust is approximately 10 ppm. Based on standards for hazardous pollutants, EPA determined that current levels of radionuclide emissions (both parent elements and various decay products) from coal-fired boilers represent a level of risk that protects the public health with an ample margin of safety. Therefore, since the FutureGen plant objective is to achieve near-zero emissions and will have greater particulate control, the risk from air emissions for the FutureGen plant is projected to be less than the plants represented in the EPA study.

The fate and transport of radionuclides in a coal combustion power plant is reasonably well understood, and most radionuclides (with the exception of radon, see below) will partition to the slag or ash. However, limited research to date has been conducted on gasification facilities. DOE sponsored testing and measurement of a number of trace substances, including radionuclides, at the Louisiana Gasification Technology, Inc., (LGTI) facility located within the Dow Chemical complex in Plaquemine, Louisiana. The objective was to characterize such emissions from an integrated gasification combined cycle power plant. Sampling and chemical analyses included samples from inlet streams (e.g., coal, makeup water, ambient air conditions) and outlet streams leaving the plant (e.g., slag, water, and exhaust streams). Limited data indicates that radionuclides behave in a similar manner to combustion facilities but the available data is insufficient to draw significant conclusions. As mentioned previously, FutureGen will have extremely high particulate control compared to conventional coal plants, a requirement for reliable operation of combustion turbines. In addition, FutureGen will have advanced highly efficient control equipment for removal of other syngas contaminants including mercury, sulfur and CO_2 ***beyond those that were included in the LGTI facility. These additional emission control devices provide added locations where radionuclides may be trapped, resulting in substantially lower emissions compared to existing facilities that use conventional technologies.***

Radon is a naturally occurring, inert gas that is formed from normal radioactive decay processes. Radon in the atmosphere comes largely from the natural release of radon from rock and soil close to the Earth's surface. Radon in coal will be present in the gas phase (e.g., gas bubbles within the coal). The source of the radon is from the decay over time of uranium 235 and 238 or thorium 232 that would have occurred in the coal seam. Some of the radon gas in the coal would be released during mining and coal preparation prior to arriving at the FutureGen plant. The radon released during the gasification process would be present in the syngas product leaving the gasifier. Various syngas cleaning and conditioning processes will be included in the FutureGen plant, likely including water and solvent scrubbing processes as well as absorbent/adsorbent systems. Since radon is soluble in water it is possible that a significant portion of the radon will be transferred to the water stream. Some radon will likely pass through the various scrubbing operations and will be emitted through the stack gas. Technology is currently available and commercially used to remove radon from water (e.g., granular activated carbon, aeration processes) and waste water treatment facilities will be designed to provide suitable control of regulated pollutants.

DOE recognizes that radionuclides are present at detectable levels in coal throughout the U.S. While EPA has indicated that the risk of exposure from emissions from utilities is substantially lower than risks from background radiation, DOE acknowledges that there are research gaps related to the ultimate fate of radionuclides in advanced coal technologies. Characterization and monitoring of gaseous and solid effluents from the facility will be consistent with necessary requirements to ensure

compliance with required permits. As a research facility aimed to provide the pathway of achieving coal-based energy generation with zero emissions, FutureGen is a likely candidate location for advancing the understanding of the ultimate fate of trace substances in coal, including the ultimate fate of radionuclides.

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 **Program and Clean Air Interstate Rule** 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 ***CAA*** Title IV, ***generally*** requires electric generating units ***producing electricity for sale*** to obtain a Phase II Acid Rain Permit and meet the objectives of the program, which are achieved through a system of marketable **SO_2** allowances ***and through NO_X emission limitations***. 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 ***for*** volumetric gas flow and opacity, is ***generally required under*** the acid rain regulations, which ***also*** include ***other*** monitoring, recordkeeping, and reporting ***requirements***. ***CAIR, established under CAA section 110, expanded on the Acid Rain Program for 28 States in the eastern United States by lowering the cap for SO_2. CAIR also established a NO_X cap-and-trade program that broadens the geographic scope of the NO_X Budget Trading Program (NO_X SIP Call) and tightens the cap. CAIR has similar requirements for obtaining allowances and for monitoring, recordkeeping, and reporting.*** Upon facility startup, the FutureGen Project would need to ***hold*** SO_2 ***and NO_X emission*** allowances to ***cover*** actual SO_2 ***and NO_X*** 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. ***Evaporated water***

would be pure water, although water droplets carried with the exhaust air (called drift) would have the same concentration of impurities as the water entering and circulating through the tower. Water treatment additives could contain anti-corrosion, anti-scaling, anti-fouling and biocidal additives which can create emissions of VOCs, particulate matter, and toxic compounds. The drift is not expected to cause excessive pitting or corrosion of metal on nearby structures or equipment due to the relatively small amount of water released and the presence of trace amounts of anti-corrosion additives. Similarly, the treatment additives are not expected to cause noticeable adverse impacts to local biota due to the very small amounts released. 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. ***However, as a best management practice, the drift rate and associated deposition of solids could be reduced by employing baffle-like devices, called drift eliminators.*** 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, ***groundwater table***, 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.

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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 ***13*** inches (***33*** centimeters) (***at Penwell***), 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.

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)
Average Precipitation, inches (centimeters)	***3.1 (7.9)***	***4.3 (10.9)***	***4.2 (10.7)***	***1.6 (4.1)***
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.

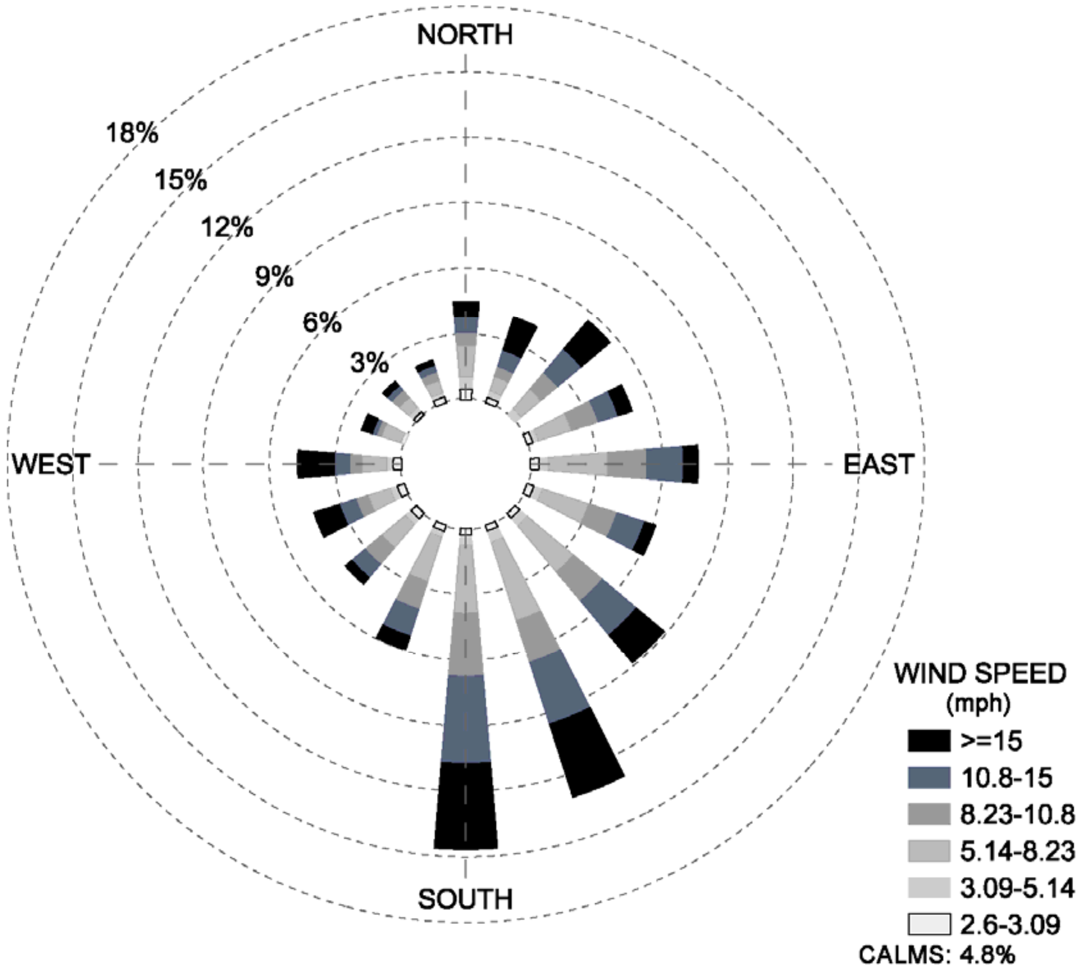

Figure 7.3-1. Wind Rose for the Odessa Region

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 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 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 ***2007***, 37 tornadoes were reported in the ***907*** square miles (2,333 square kilometers) of Ector County, including 30 F0 tornadoes, three F1 tornadoes, and four F2 tornadoes ***(NOAA, 2006)***. ***Based on historical tornado activity within Ector County, there could be 6 F1***

or greater tornadoes in the county (over 901 square miles [2,334 square kilometers]) over the possible 50 year lifespan of the FutureGen Project. For comparison purposes with the other candidate sites, using a nominal county size of 850 square miles (2,202 square kilometers), the tornado frequency would equate to approximately 6 F1 or greater tornadoes over 50 years. From 1950 to 2007, 61 tornadoes were reported in the 4,764 square miles (12,339 square kilometers) of Pecos County (location of the sequestration site), including 38 F0, 15 F1, six F2, one F3, and one F4. For Pecos County, for an 850 square mile (2,202 square kilometer) area, there could be 10 F1 or greater tornadoes over 50 years.

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. ***The tornado frequency is equivalent to approximately 6 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers). The probability of a tornado greater than F1 intensity across Ector County is approximately 1 every 8 years and the power plant site represents 0.04 percent of the combined land area of the counties. Therefore, the chance for significant direct and indirect impacts from a tornado 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. ***The tornado frequency for Pecos County is equivalent to approximately 10 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers).However, the probability of a tornado greater than F1 intensity within Pecos County is approximately 1 every 2 to 5 years and the sequestration site (assuming the entire University land area) represents 1.4 percent of the land area in count. Therefore,*** 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.

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. ***The tornado frequency is equivalent to approximately 6 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers). The probability of a tornado greater than F1 intensity across Ector County is approximately 1 every 8 years and the power plant site represents 0.04 percent of the land area of the counties. Therefore, the chance for significant direct and indirect impacts from a tornado during operations would be low.***

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. ***The tornado frequency is equivalent to approximately10 F1 or greater tornadoes over a 50 year period for an area of 850 square miles (2,202 square kilometers). The probability of a tornado greater than F1 intensity within Pecos County is approximately 1 every 2 to 5 years and the sequestration site (assuming the entire University land area) represents 1.4 percent of the land area in county; therefore,*** 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.

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.

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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).

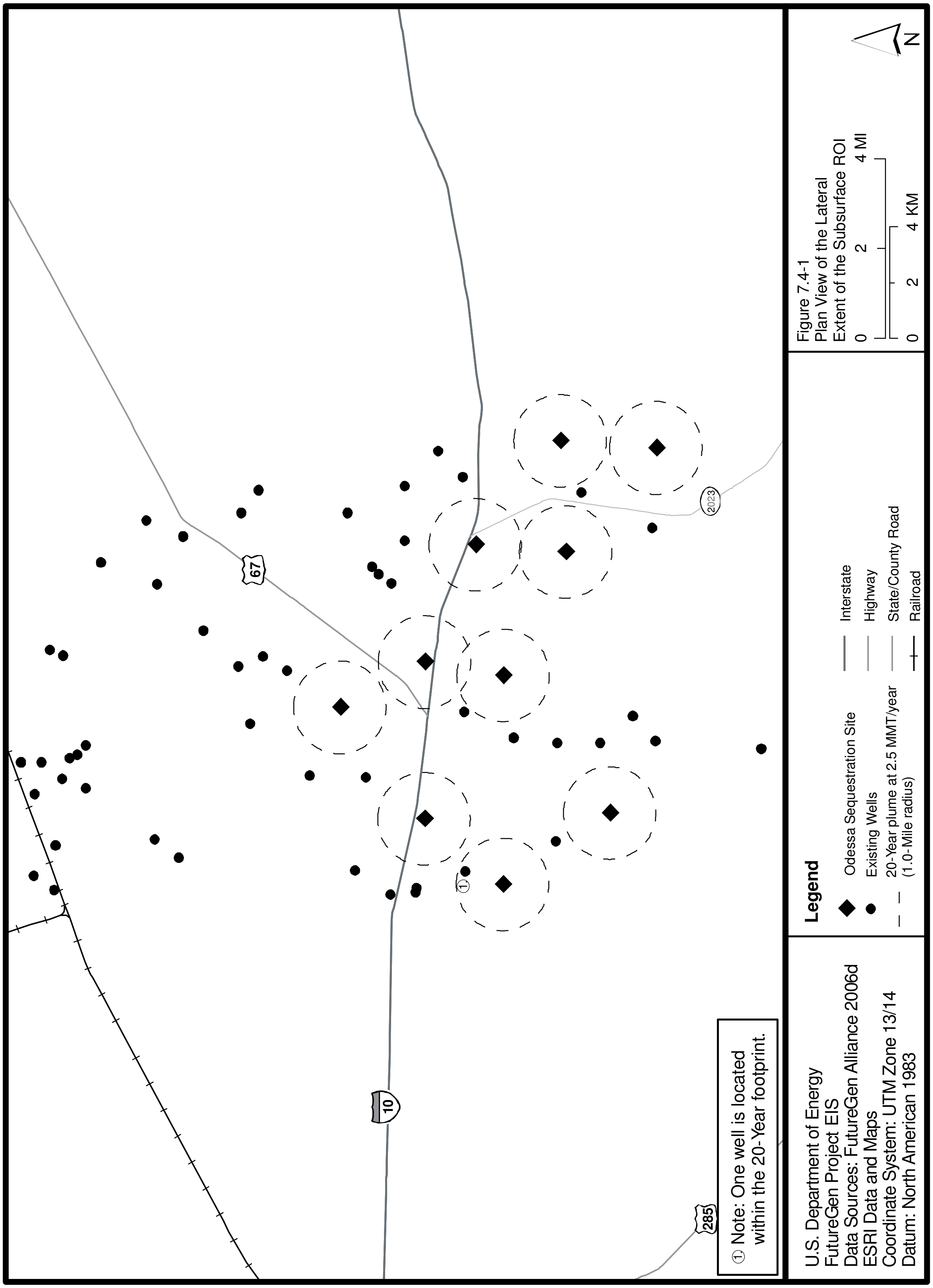


Figure 7.4-1
Plan View of the Lateral
Extent of the Subsurface ROI

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.

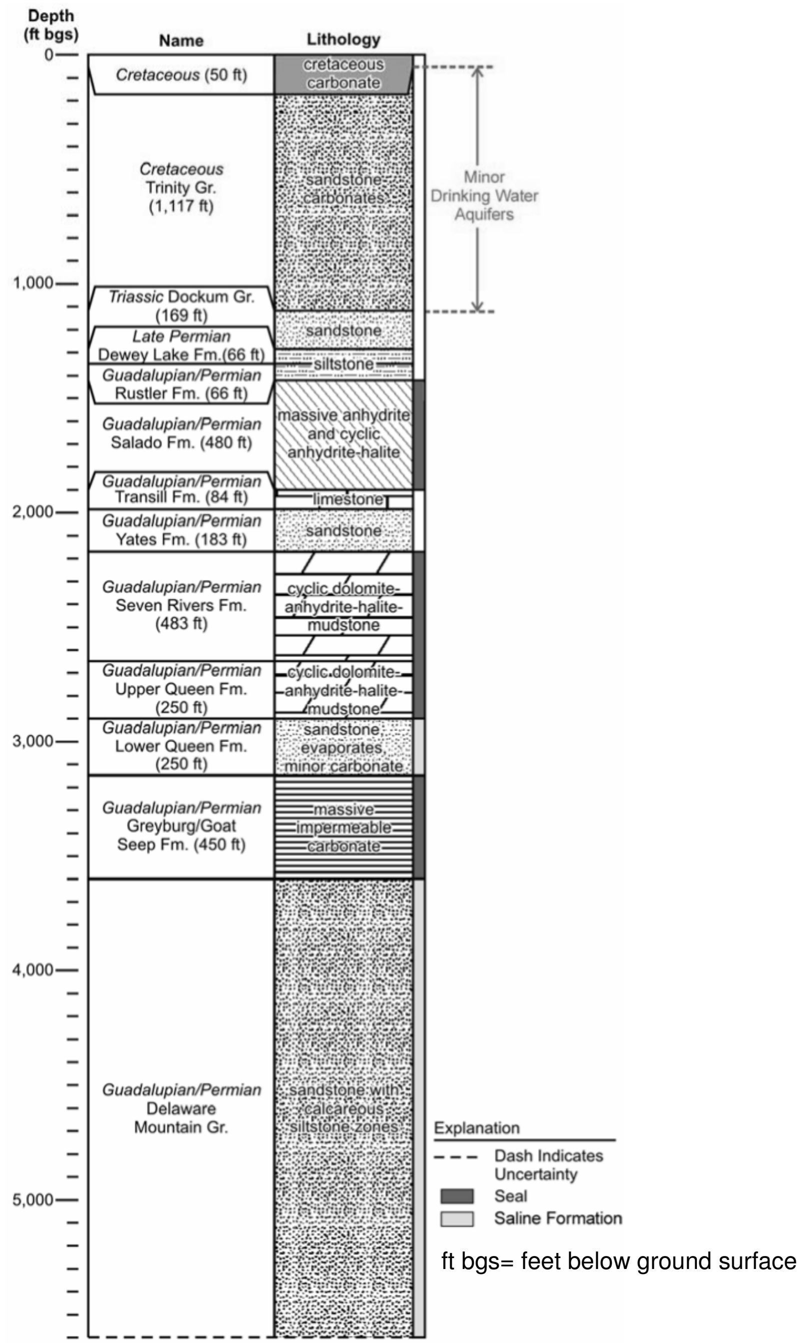
Early to middle Paleozoic rocks in Texas are typically carbonates deposited in ancient seas located inland of the continental margin. Permian-aged rocks are the most well-known of the Texas Paleozoic, likely because these strata are also oil-rich where buried in west Texas, such as in the Midland and 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 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.

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 ***a minimum of three wells would be required to support the proposed injection rate for the lower injection rate and a minimum of eight 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 in Section 2.5.2.2 would alert the operator of pressure build-up that could lead to induced seismicity, where appropriate remediation strategies could be employed to prevent or minimize adverse impacts.

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 drainage ways 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, Occasionally 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.
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.

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
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.
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.

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
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.
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.

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
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.
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.

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
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.
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.

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
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.
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.

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 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.

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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***n underground source of drinking water*** 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 (7.4×10^9 cubic meters) per year in 2010 to 3,534,124 acre-feet (4.4×10^9 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 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 (7.1×10^8 cubic meters) per year in 2010 and 572,517 acre-feet (7.1×10^8 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 1.07×10^{12} gallons (4.1×10^{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 SIO_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; SIO_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)	44,008 (5.4×10^7)
Livestock	23,060 (2.8×10^7)	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 (***FG Alliance, 2006d*** 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. ***Unlike other major water uses in the area (municipal and irrigation), water used in the FutureGen power plant would be discharged in the form of water vapor from the cooling towers and would not provide local recharge to aquifers (through direct or indirect discharge to groundwater). This may result in the loss of 4,000 acre-feet ($4.9x10^6$ cubic meters) per year of groundwater in the region.*** 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: 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 ***USDW*** 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 ***USDW*** 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 ***USDW*** 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).

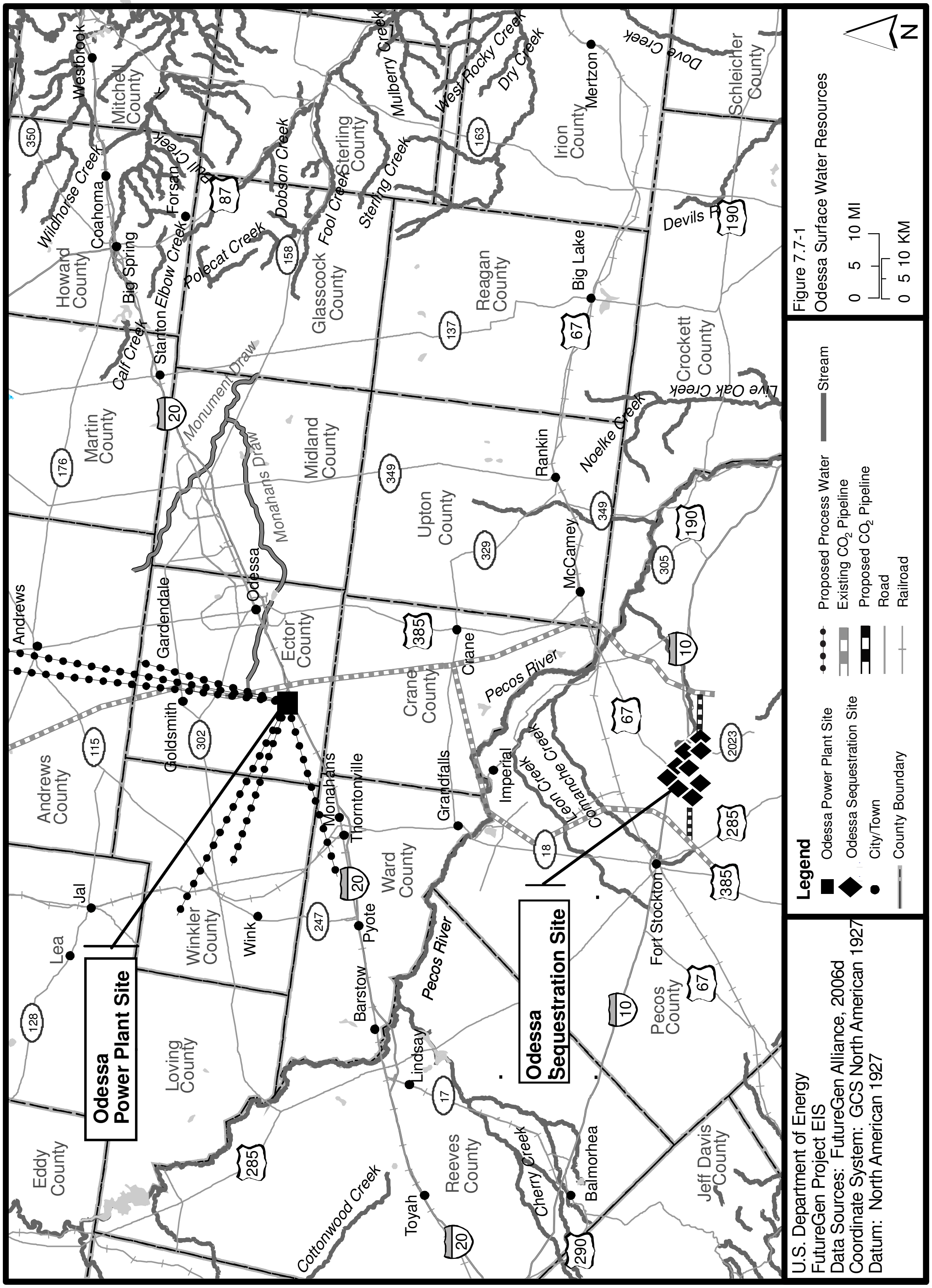

Figure 7.7-1
Odessa Surface Water Resources

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 (***FG Alliance, 2006d***) 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 (***Damen et al., 2003***). 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). 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.

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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

Executive Order 11990 requires federal agencies to avoid short and long-term impacts to wetlands if no practicable alternative exists. In addition, 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 ***federally*** jurisdictional, or regulated by ***the United States Army Corps of Engineers (USACE)***. 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 ***(those that have no apparent regulatory connection to Section 404 resources)*** are not jurisdictional unless protected under a bylaw ***discussed below***.

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 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 wetlands or Waters of the U.S. are located within the proposed power plant site. However, several wetland areas 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 (***FG Alliance, 2006d***) (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) ***within the sequestration site*** (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***, including any isolated wetlands***.

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 ***if any wetlands or channels are present***.

Several ***channels*** 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***, including any isolated wetlands***.

No areas potentially subject to Section 404 jurisdiction are located within the CO_2 pipeline corridor east of the proposed power plant site ***that would connect to the existing CO_2 pipeline***. 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.

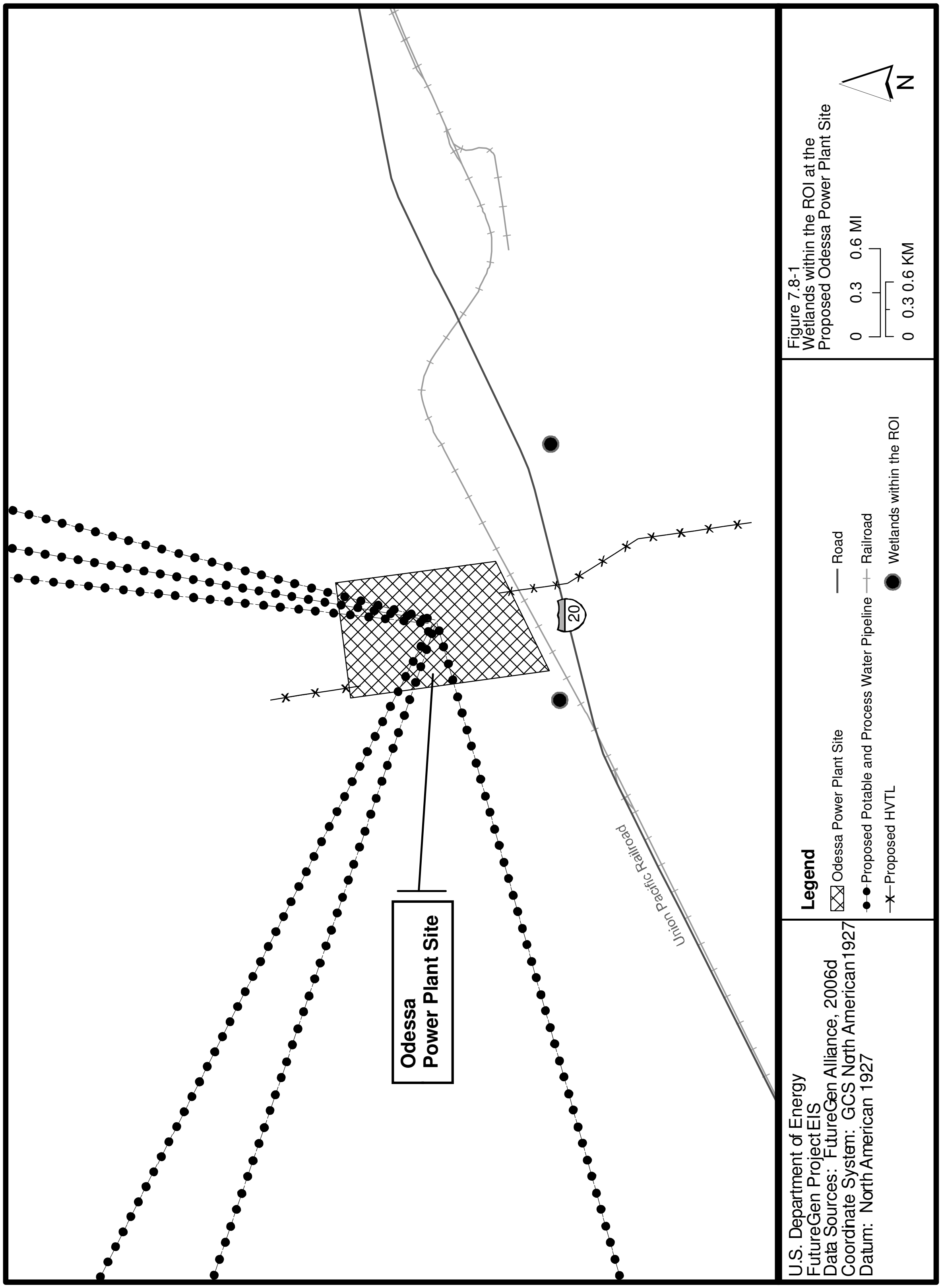

Figure 7.8-1
Wetlands within the ROI at the
Proposed Odessa Power Plant Site

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 (***FG Alliance, 2006d***) (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 (***FG Alliance, 2006d***) and Ward County (***FG Alliance, 2006d***) 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).

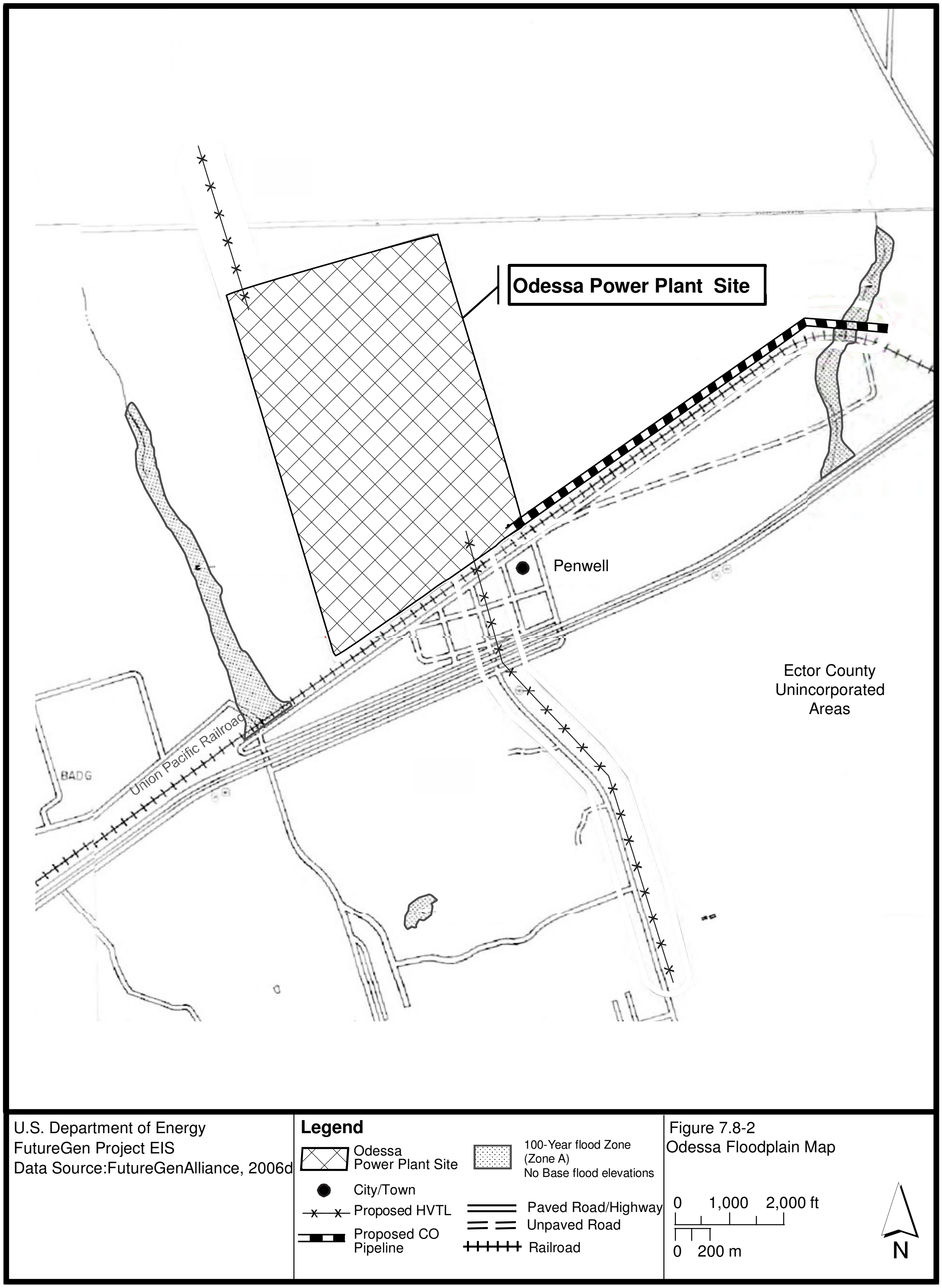

Figure 7.8-2
Odessa Floodplain Map

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. ***Tables 3-13 and 3-14 in Section 3.4 provide potential mitigation measures and best management practices to avoid, minimize, and offset impacts to wetlands.***

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 ***including migratory birds*** 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.

Coordination with the FWS and TPWD did not identify any migratory bird populations that could be affected by the project. However, habitat (i.e., wetlands and riparian corridors) for these populations is present. Therefore, migratory birds could use habitat within the area as stopovers during migration.

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.

Construction of the utility corridors could result in temporary impacts to migratory bird habitat. This loss of habitat would have a minimal impact to migratory bird populations as comparable habitat is abundant and available in the overall region.

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 ***and animals*** 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). ***If there were upward migration of the sequestered gas, the H_2S within the gas would diffuse in the subsurface and react with the rock formations, which would minimize or eliminate its release to the atmosphere. Therefore, migration of H_2S into shallow soils at concentrations harmful to burrowing animals and other ecological receptors is not likely.***

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, ***200***6) 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.

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).

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 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 (***Miller and Yost, 2006***), 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; ***Miller and Yost, 2006***). 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 (***Miller and Yost, 2006***) 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.

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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 13 miles (21 kilometers) east of Fort Stockton, Texas***. 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

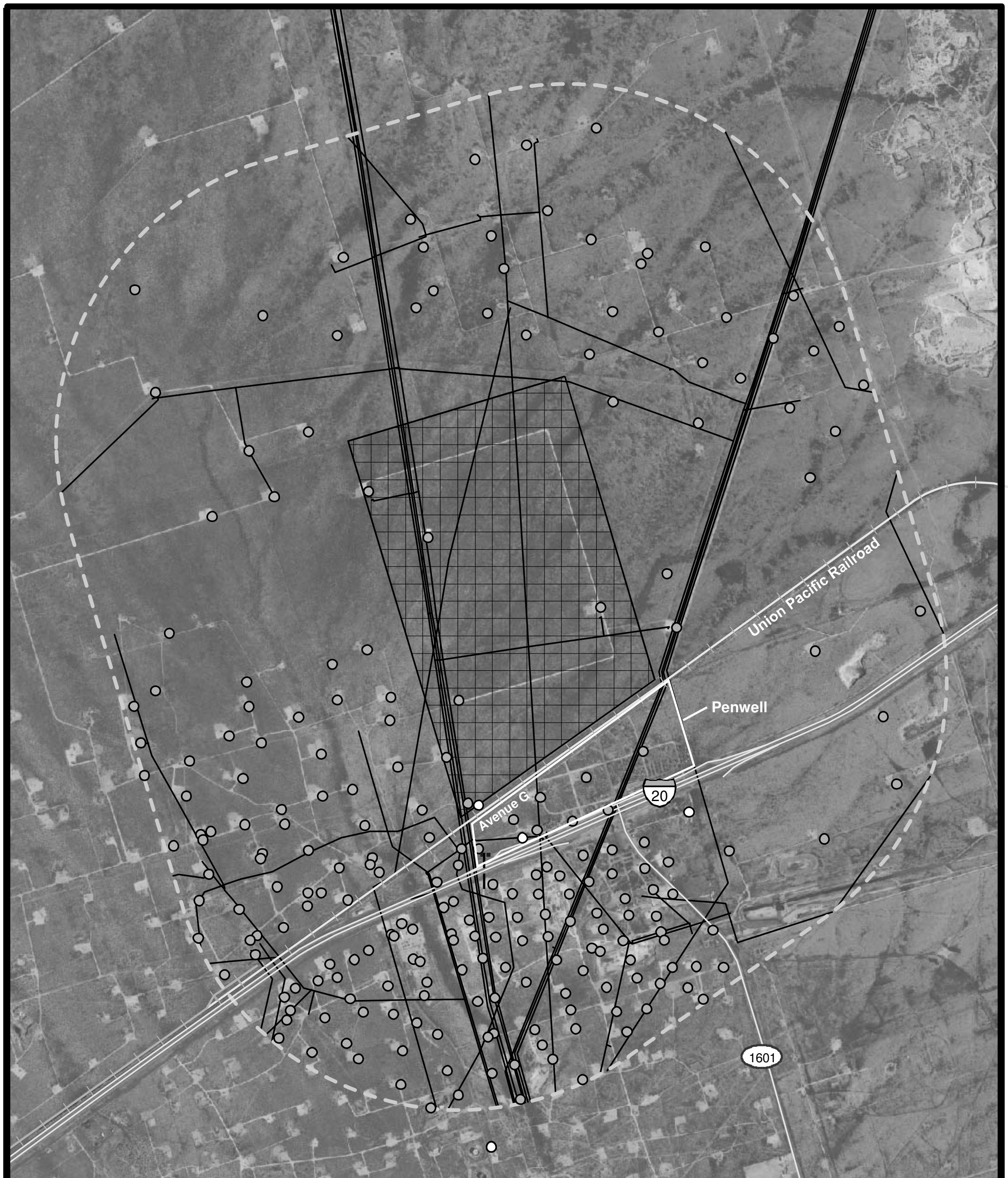
As noted above, the proposed 600-acre (243-hectare) Odessa Power Plant Site is located in a rural area where land use has been dominated historically by ranching and oil and gas activities. The site contains unimproved roads and structures related to oil and gas well activities. Several pipelines and 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.



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

Legend

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

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

0 0.25 0.5 MI
0 0.25 0.5 KM
N

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. 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 (***FG Alliance, 2006d***).

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

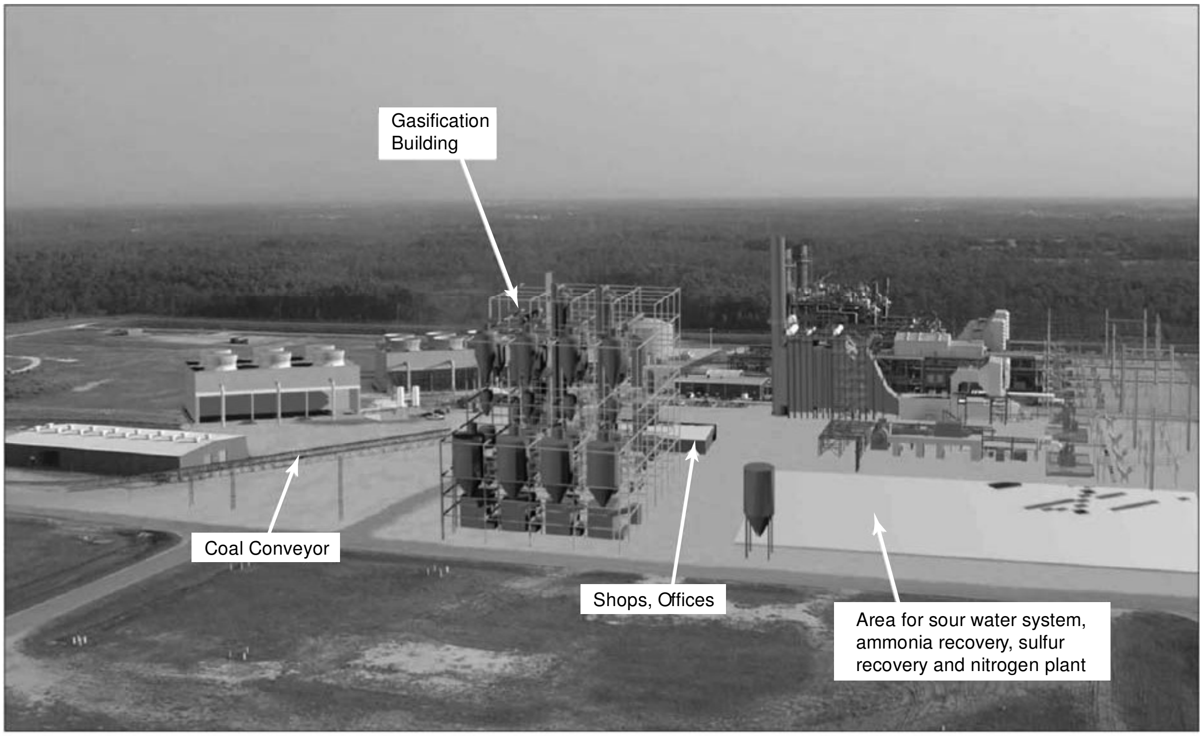
Major equipment for the power plant would include the gasifier and turbines, a 250-foot (76-meter) tall HRSG stack, a 250-foot (76-meter) tall flare stack, synthesis gas cleanup facilities, coal conveyance and storage systems, and particulate filtration systems. Additionally, the project would include 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.



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

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).

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.

> **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 7.13-1 defines each LOS category for Class I and II two-lane highways.

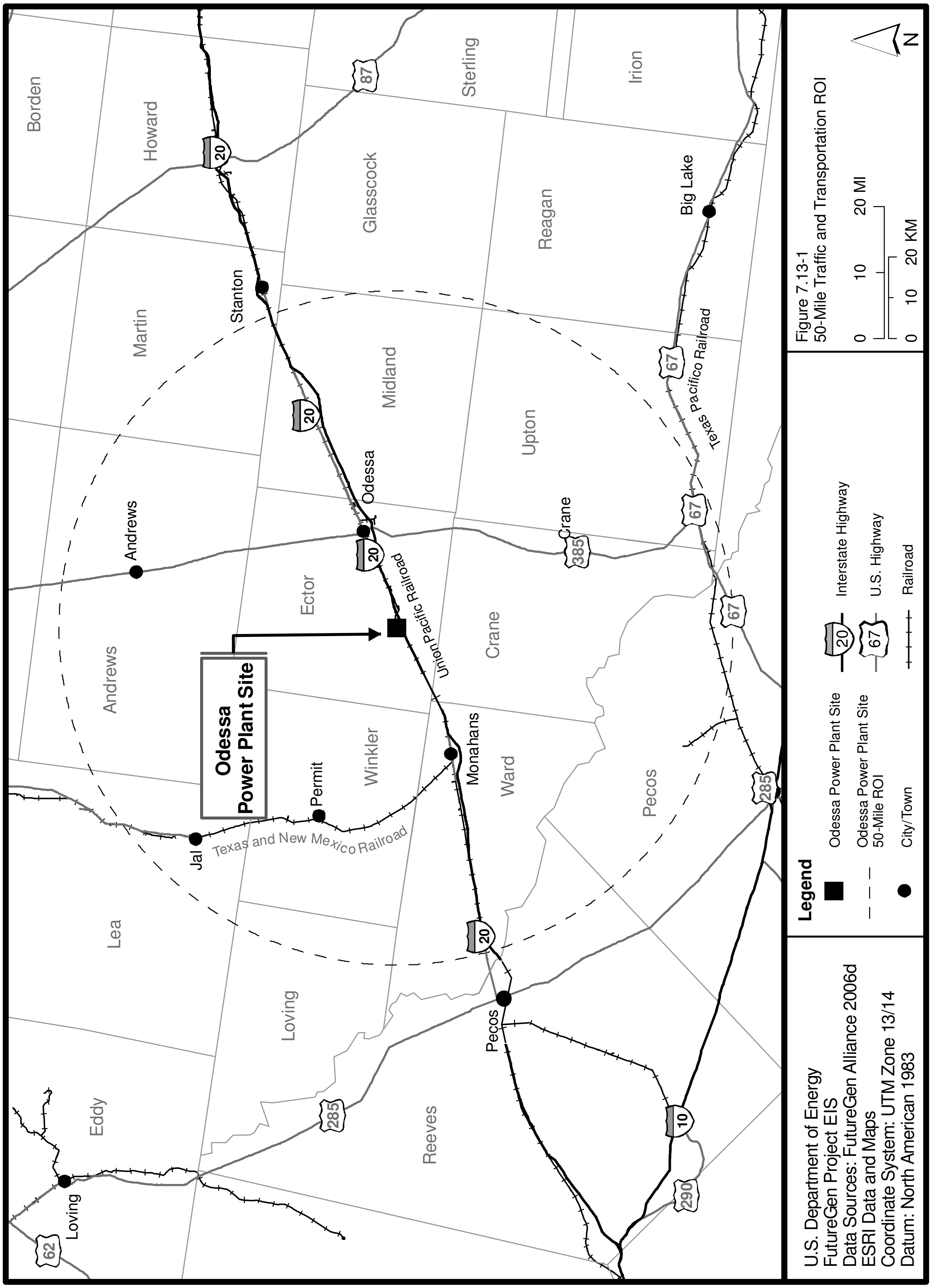


Figure 7.13-1
50-Mile Traffic and Transportation ROI

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, and about 60 miles (96.6 kilometers) south of the Midland-Odessa International Airport. ***The proposed injection site would be approximately 13 miles (21 kilometers) east of Fort Stockton, Texas.*** Access to the site would be via I-10.

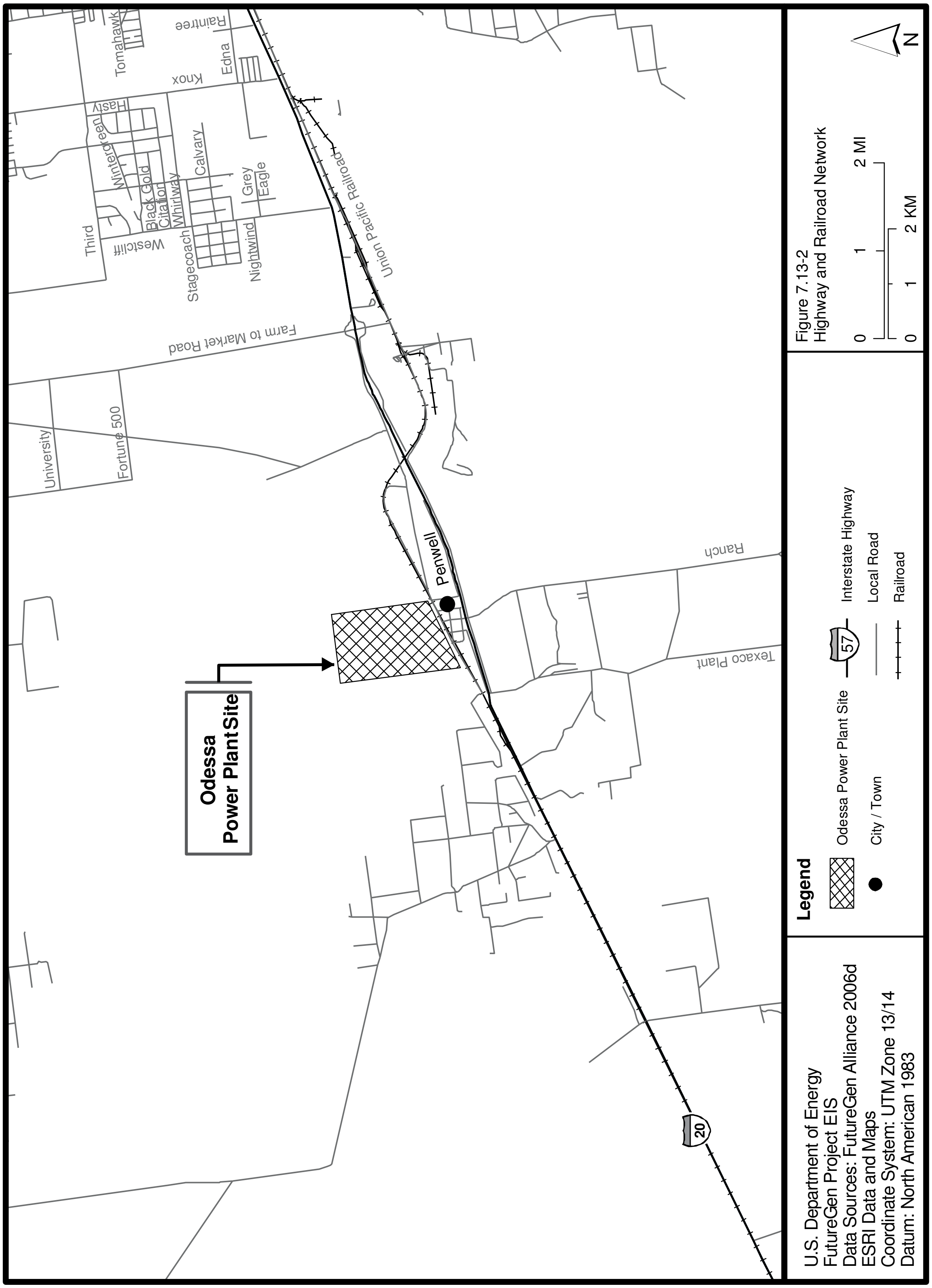


Figure 7.13-2
Highway and Railroad Network

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.

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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 (***MTA, 2004***) 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:

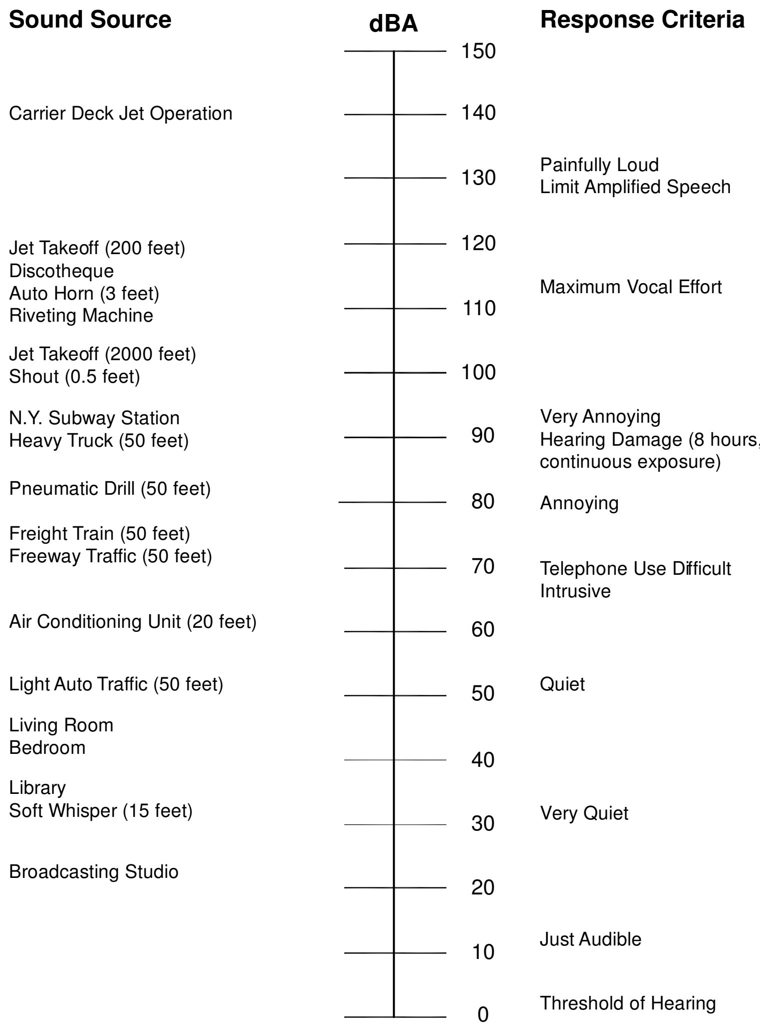
- A L_{eq} is the continuous equivalent sound level. The sound energy from fluctuating SPLs is averaged over time to create a single number to describe the mean energy or intensity level. Because L_{eq} values are logarithmic expressions, they cannot be added, subtracted, or compared as a ratio unless 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: ***NYSDEC, 2000***

Figure 7.14-1. SPL Values of Common Noise Sources

For mobile sources, DOE estimated noise levels using traffic noise screening ***and analysis*** 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***. DOE then used FHWA's Traffic Noise Model, Version 2.5 (TNM), which considers roadway geometry, vehicle speed, and traffic direction,*** to ***predict the increase in noise generated by project-related traffic and*** 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. Sensitive receptor locations near the proposed Odessa Power Plant are shown in Figure 7.14-2.

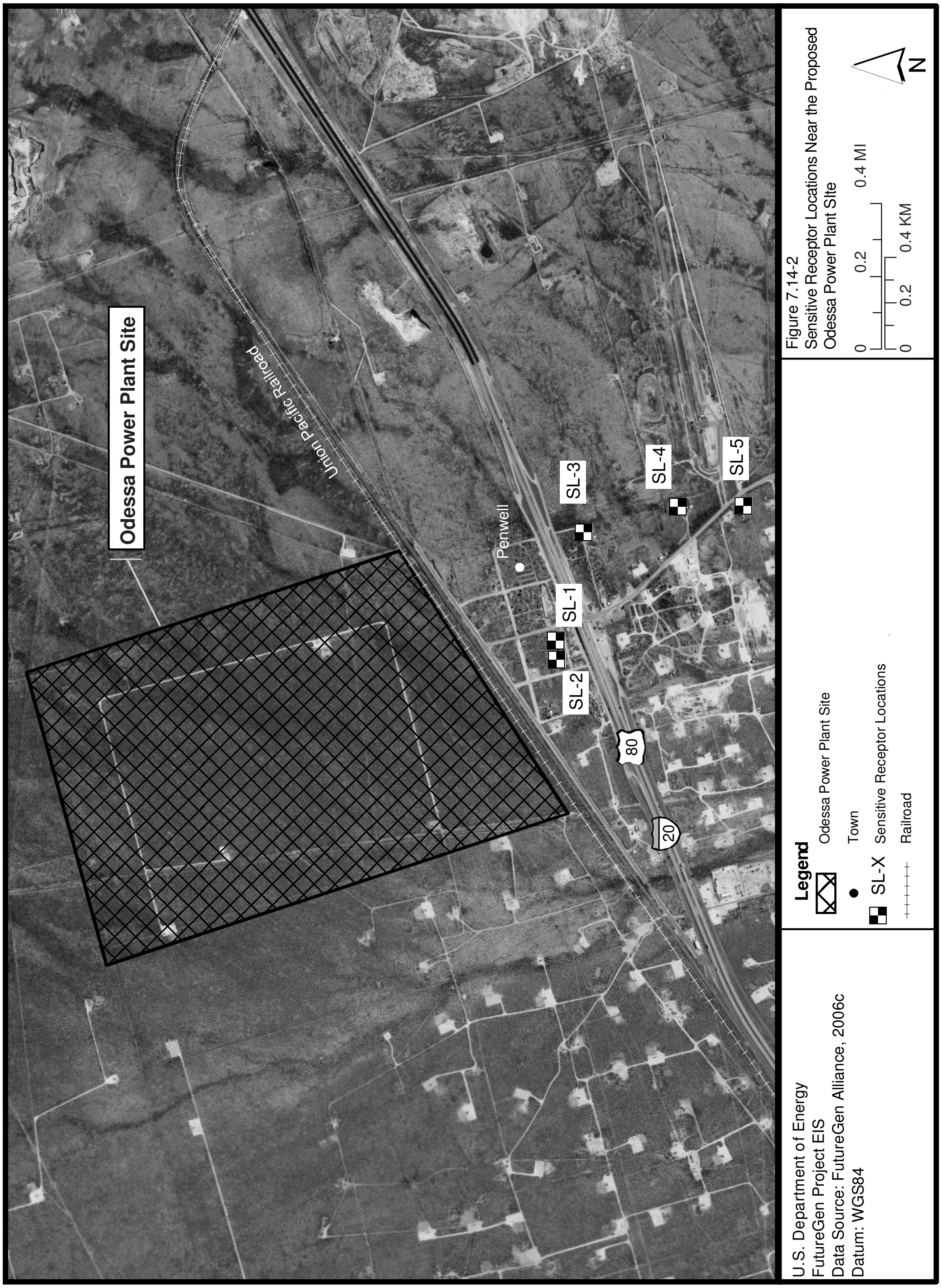


Figure 7.14-2
Sensitive Receptor Locations Near the Proposed
Odessa Power Plant Site

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 site visit**s** on November 29, 2006 ***and June 19, 2007***, DOE personnel observed t***hree*** residences on the south side of I-20 (SL-***3, SL-4,*** and SL-***5***) and ***two*** on the north side of I-20 (SL-1 ***and SL-2***) within the 1-mile (1.6-kilometer) ROI. The closest noise-sensitive recepto***rs are two*** occupied residence***s along Avenue J*** on the north side of I-20 (SL-1 ***and SL-2***) ***and*** approximately 0.***2***5 mile (0.***4*** kilometer) from the southern boundary of the proposed ***Odessa Power Plant S***ite. Figure 7.14-2 ***shows the location of all five receptors.***

During the June 19, 2007 site visit, DOE measured the ambient noise environment near the SL-1 sensitive receptor location and recorded a noise level of 62 dBA. DOE used a Quest Model 2900, Type II sound level meter that was equipped with a windscreen and mounted on a tripod approximately 4 feet (1.2 meters) above ground level, away from any reflective surface. To be conservative, measurements were taken at night during the early morning hours which was considered the quietest period where the maximum project-related noise impacts would most probably occur because the existing background levels are low. DOE field calibrated the sound level meter and noted the weather conditions (e.g., temperature, wind) before sampling the ambient noise environment at SL-1. Broadband noise levels were collected over a 10-minute sampling period.

The ambient noise levels at the receptors on Avenue J are greatly influenced by existing vehicle traffic on the Interstate highway, which is approximately 300 feet (0.09 kilometers) to the south of I-20. As such, periodic increases in the ambient noise levels may occur at the***se*** residential receptors***, especially during the daytime hours.*** Based on the posted speed of 70 miles per hour (113 kilometers per hour), traffic noise levels would exceed 55 dBA 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

One residence ***along Avenue J is*** located ***approximately 300 feet (91.4 meters) west of FM 1601*****,** the local access route leading to the proposed Odessa Power Plant Site**.** ***No sensitive receptors are*** 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 ***one of*** the two residential sensitive receptors located ***n**o**r***th 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***, Beranek, and Newman***, 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 ***relative*** distances ***from the site boundary to the following two noise-sensitive receptors:***

- ***SL-1: Along Avenue J and west of FM 1601, approximately 0.25 mile (0.4 kilometer)***
- ***SL-3: South of I-20, approximately 0.5 mile (0.8 kilometer)***

The existing ambient and distance-attenuated noise levels were then logarithmically summed to predict ***estimated noise levels at the nearest receptor relative to the proposed site on the north and south sides of the I-20,*** 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 with the ambient noise level ***at SL-1 and SL-3*** shows that the change in ambient noise levels due to construction of the proposed Odessa Power Plant would be ***noticeable only to receptors on the north side of I-20 (SL-1 and SL-2), which would experience an incremental change from existing conditions equaling 5.8 dBA.*** The ***three*** residences within the ROI ***south of the I-20 (SL-3, SL-4, and SL-5) would experience little to no impacts because the incremental change from existing conditions would be just 1.6 dBA. As noted earlier, a noise level increase of 5 dBA would be expected to be readily noticeable to the human ear, while an increase of less than 3 dBA would not be.***

Table 7.14-2. 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)	62	93	64.6	67.8	+5.8
SL-3	0.50 (0.8)	62	93	58.5	63.6	+1.6

Combined equipment noise level is 93 dBA at 50 feet (15 meters) from source.
The ambient noise level at SL-3 was assumed to be the same as measured for SL-1 because both are located near I-20.
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 67 dBA at the property boundary and 6*4* dBA at the closest sensitive receptor. Adding the predicted construction noise contribution to the ***existing*** ambient ***noise*** level of 62 dBA, the resultant noise level would increase by ***up to 4.1*** dBA. ***At SL-3, the blowdown noise would attenuate to 61 dBA and when added to the existing ambient noise 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 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.

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.

To obtain more specific information on the potential impacts that construction traffic may have on receptors adjacent to FM 1601, DOE took a morning peak hour ambient noise measurement and conducted a detailed TNM analysis. Measurements were taken at a representative location along the FM 1601 noise study segment using the same methods described in Section 7.14.1.2. The sound level meter was placed off the side of the road approximately 10 feet (3 meters) east from the edge of the FM1601 northbound roadway for a 30-minute noise measurement period and three-way vehicle classification (i.e., passenger car, medium or heavy trucks) traffic counts were taken simultaneously. Next, DOE multiplied by two the vehicle classification data collected during the noise measurement to compute the hourly traffic flow. The resulting vehicle mix data and traffic speed were then input into TNM along with the configuration of the roadway segment and distance between the noise meter and the roadway's centerline using a three-dimensional coordinate system. DOE then compared the measured L_{eq} value of 68.7 dBA with the TNM predicted L_{eq} value of 63.8 dBA to calibrate the modeling program. The results of this comparative analysis showed that ambient noise in this area is influenced by other noise sources in addition to those generated by vehicular traffic on FM 1601.

Finally, DOE used TNM to compute the incremental change in the ambient sound level that would occur due to the additional vehicular noise generated by construction traffic for the proposed power plant. For these runs, DOE input the proposed 2009 Build and No-Build traffic volume data using the same roadway configuration and including receptor SL-1 on Avenue J, located approximately 300 feet (91.4 meters) west of FM 1601. TNM file predicted an incremental change of 5.3 dBA. Therefore, 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 receptor 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.

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 mile (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 mile (0.8 kilometer) from ***the*** center of ***the*** 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***s*** is ***51*** dBA. The noise contribution of the power plant ***would not be noticeable because the existing ambient noise level of 62 dBA is much louder than 51 dBA and thus no net increase to the ambient noise environment within the ROI is expected.***

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***s*** (SL-1 ***and SL-2***).

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, and 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 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 ***and FM 1601*** during normal plant operations because the predicted change in the ambient noise level would ***generally be*** less than 3 dBA (Table 7.14-4).

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-***8*** in Section 7.13.
dBA = A-weighted decibels.

On June 19, 2007, DOE performed additional analyses to obtain more specific information on the potential impacts that operational traffic may have on receptors adjacent to FM 1601. The TNM results predicted an incremental change of 2.7 dBA. Operational traffic would not be noticeable at the SL-1 receptor on Avenue J because the predicted noise level increase would be less than 3 dBA.

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 dBA 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 mile (0.8 kilometer) from the Union Pacific Railroad.

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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 injection site would be approximately 13 miles (21 kilometers) east of Fort Stockton, Texas. 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.

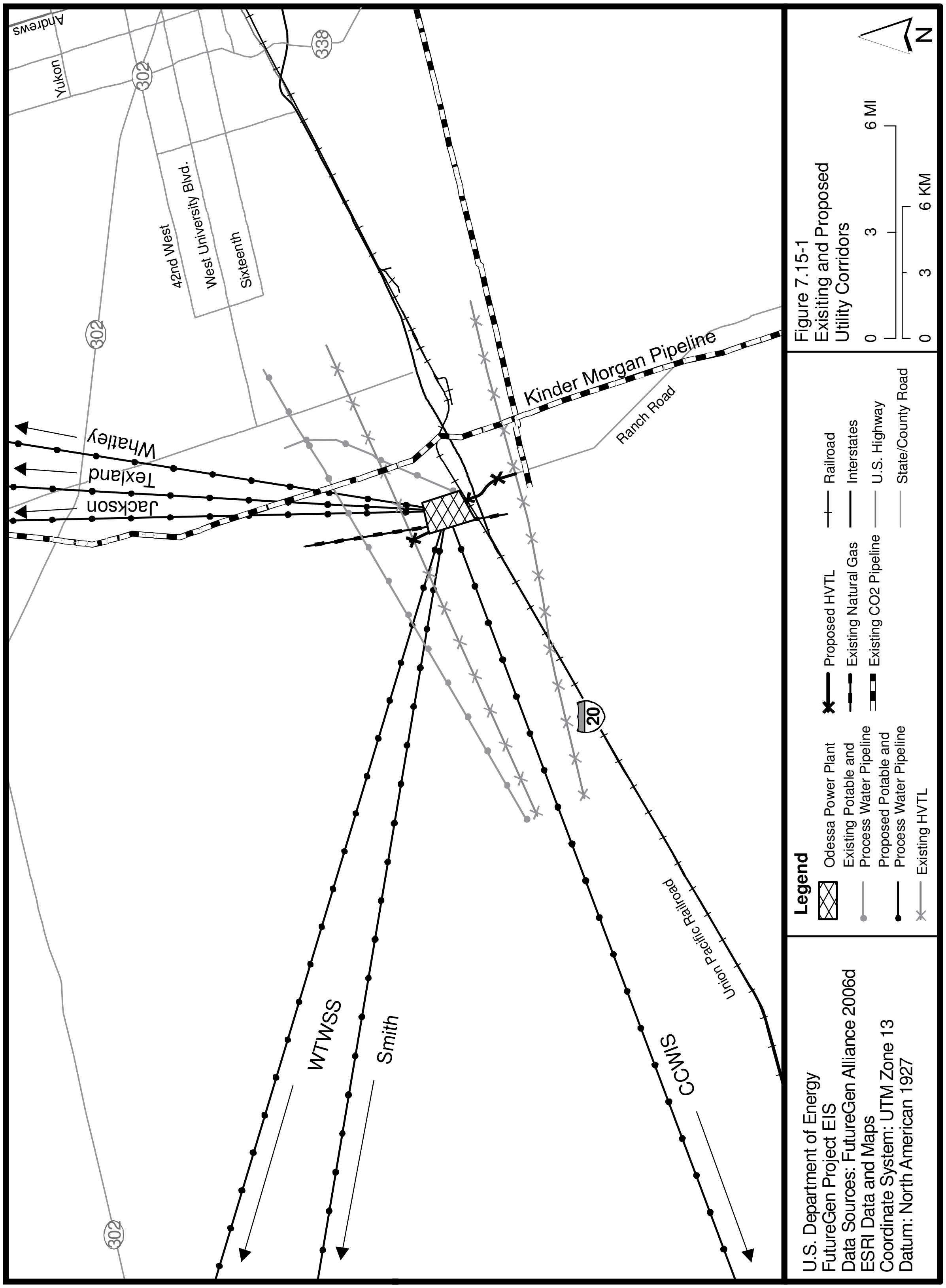


Figure 7.15-1
Exisiting and Proposed Utility Corridors

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

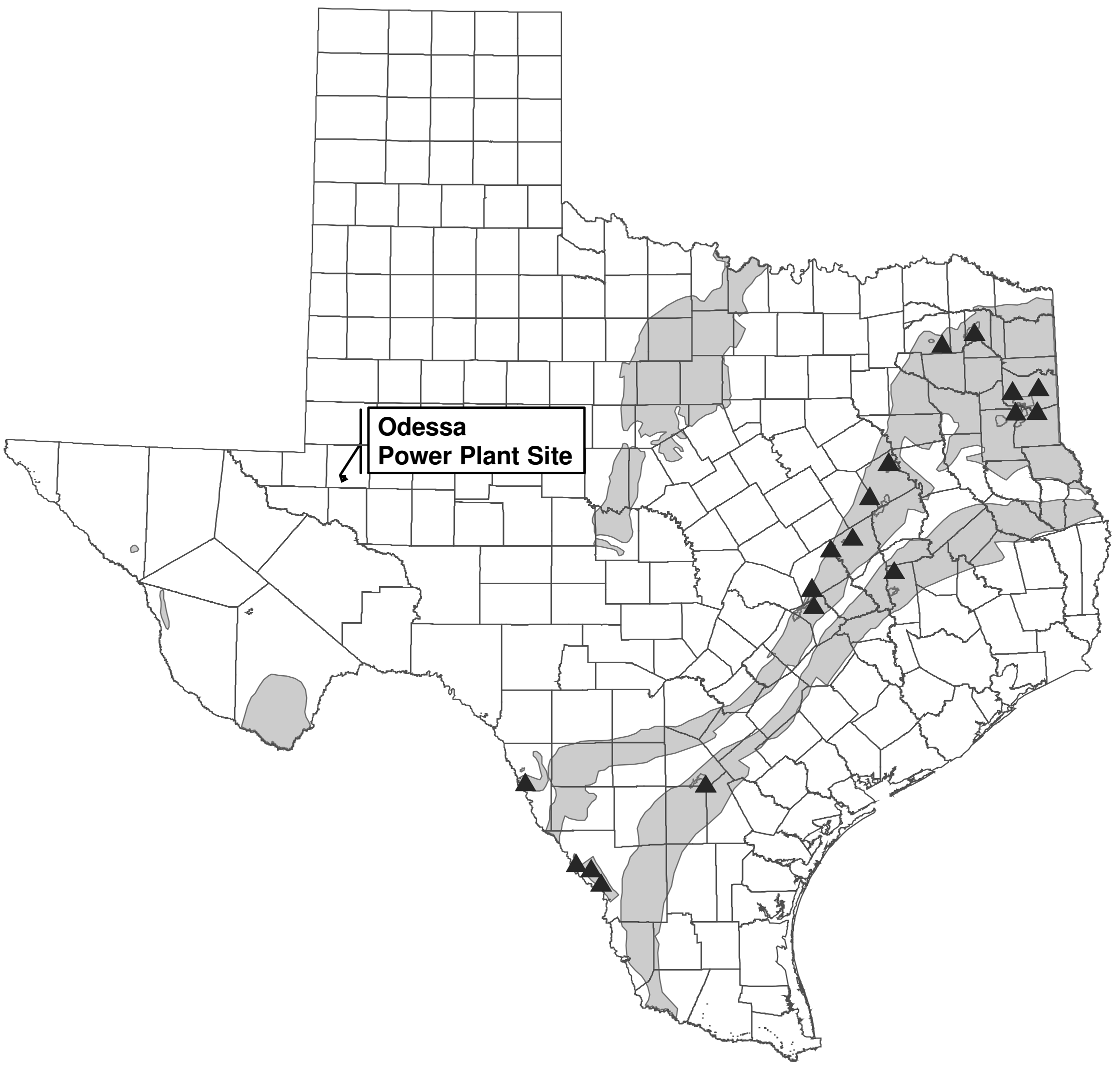
The availability of low cost Texas Lignite, PRB coal, and Gulf Coast Petroleum Coke would provide the FutureGen facility with several fuel options.

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.



U.S. Department of Energy
FutureGen Project EIS
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

Table 7.16-1. Coal Price Projections

Coal Type	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.

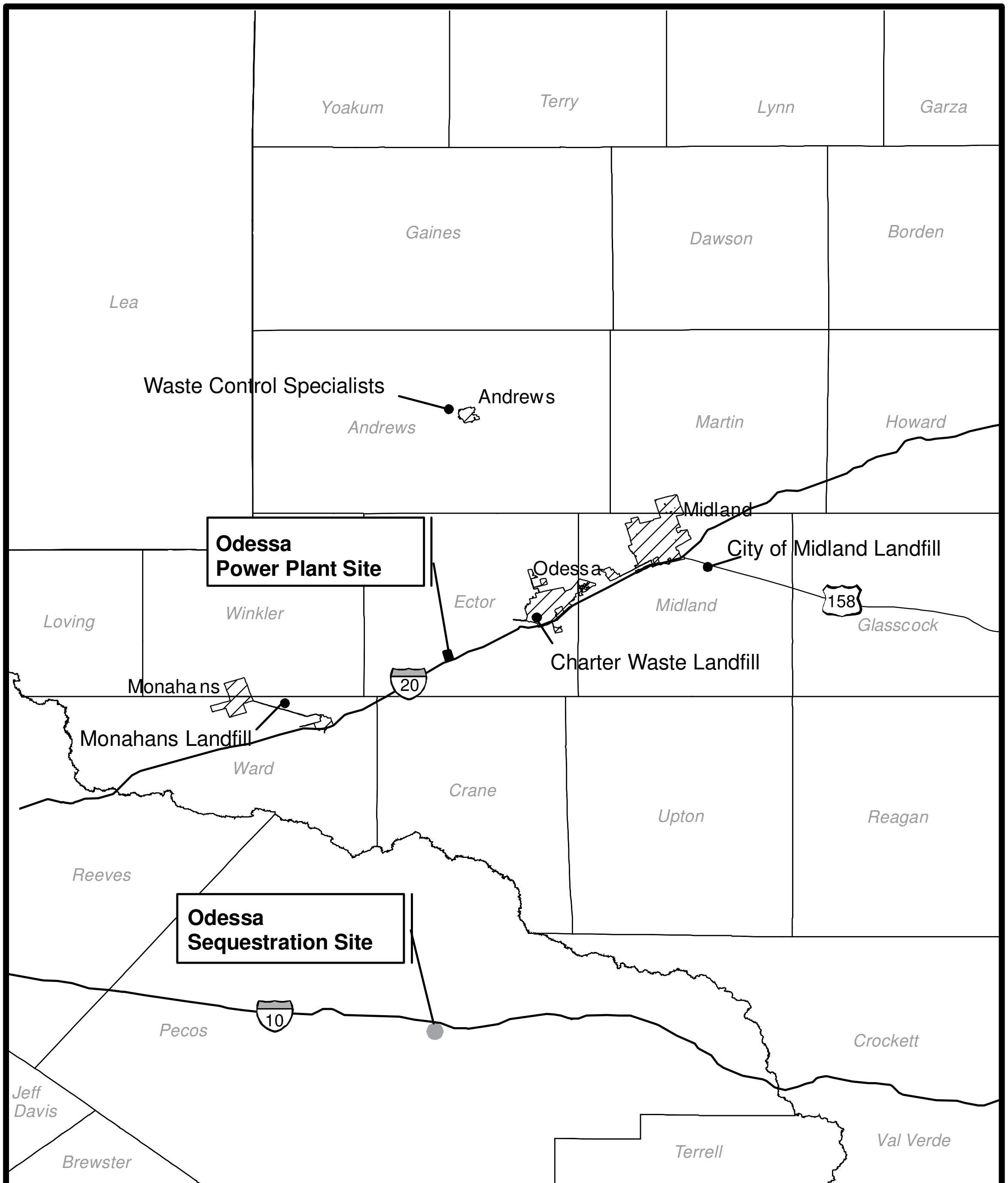
Sanitary waste planning in Texas is the responsibility of 24 Councils of Governments. The Odessa Power Plant Site is located within the Permian Basin Regional Planning Commission, which according to TCEQ has approximately 177 years of sanitary landfill capacity remaining (TCEQ, 2006b).

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.



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

Legend

- Odessa Power Plant Site
- Odessa Sequestration Site
- Waste Management Facility
- City Boundaries
- County Boundary

Figure 7.16-2
Waste Management Facilities

0 10 20 20 MI
0 5 10 20 KM
N

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***b***) 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***b***.

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***b***.

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***b***) 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***b***). 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***b***, 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.

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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 7.17-4. 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.

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°F (41.1 °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 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 (2,000)
		Life threatening effects	2,277 (694)
NH_3 tank rupture (104,355 pounds, 19 percent solution)	NH_3	Adverse Effects	9,186 (2,800)
		Irreversible adverse effects	3,281 (1,000)
		Life threatening effects	1,132 (345)

[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]		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	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 **Concentration**.
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.

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.

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 over the two non-consecutive one-week test periods, 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. Because these tests would occur for a very short period of time (a total of two weeks), it would be very unlikely that an accidental release would occur during co-sequestration testing. Nevertheless, additional model simulations of pipeline ruptures or punctures to represent releases during the co-sequestration experiment were conducted, as discussed in Section 4.5.5 of the Final Risk Assessment Report. These results show that the distance downwind where the public could be exposed to H_2S at levels that could result in adverse effects are significantly greater than for the base case, and thus more people could be exposed, if a release occurred during an experiment. While the distances where adverse effects occur, as listed in the Risk Assessment, are quite high (tens of miles), they are likely greatly overestimated in the model, as it assumes that the wind would be maintained at the same stability class, wind speed and direction over a substantial amount of time (e.g., 19 hours for Jewett). Although short-term testing of co-sequestration (CO_2 with H_2S) may be considered for two weeks during the DOE-sponsored phase of the proposed project, no decision has been made yet to pursue the co-sequestration testing, and further NEPA review may be required before such tests could be conducted. If co-sequestration would be considered for a longer period of time under DOE funding, further NEPA review would be required. To minimize the potential for releases during the co-sequestration experiments, additional protective measures could be implemented, including inspection of the pipeline before and after the tests and not allowing any excavation along the pipeline route during the tests.

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 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 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]).

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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;

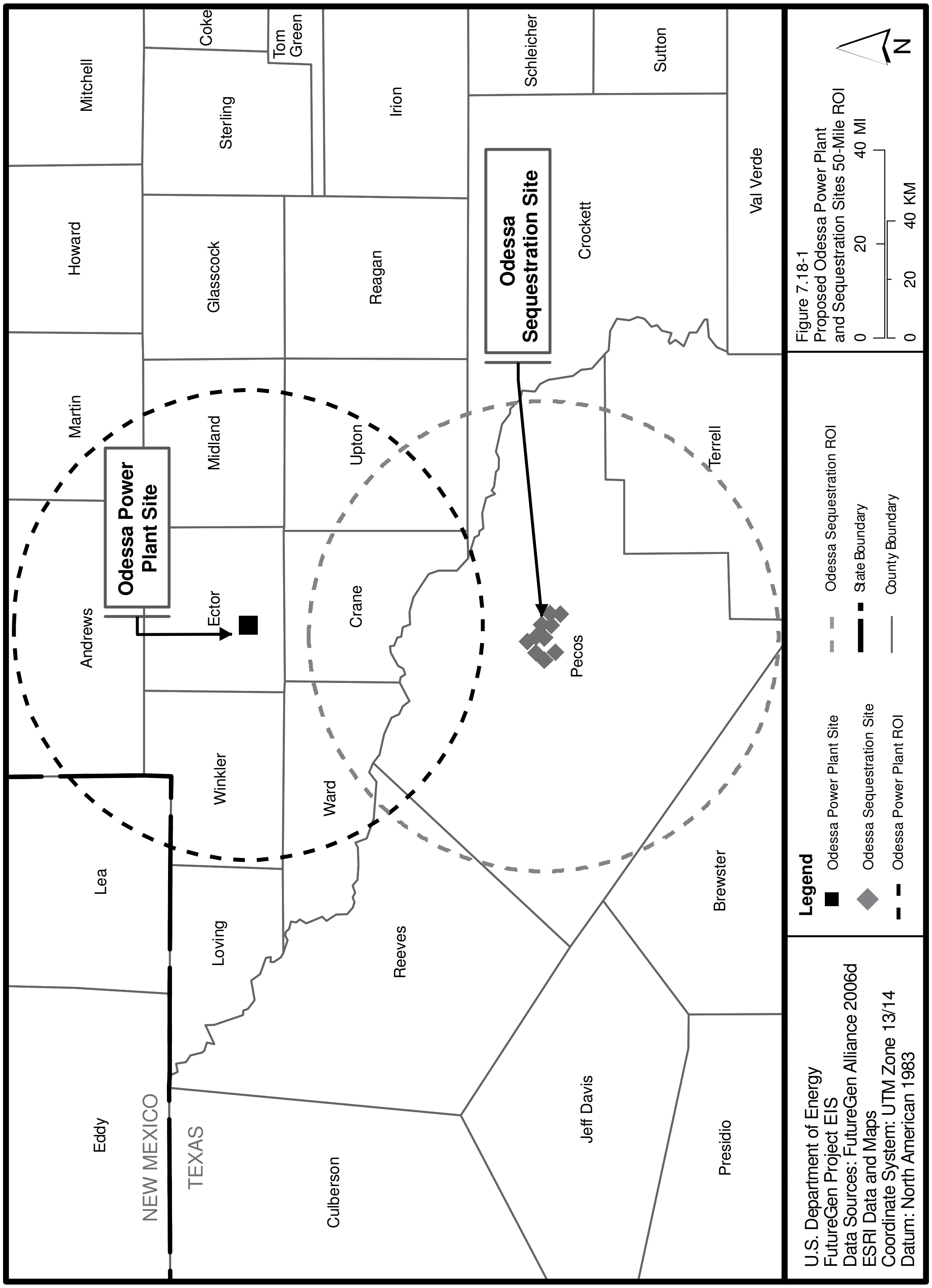

Figure 7.18-1
Proposed Odessa Power Plant and Sequestration Sites 50-Mile ROI

- 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.

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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.

The properties potentially being acquired for the proposed FutureGen Project would receive tax abatements on property tax revenues for a period of 10 years. This would result in a loss of revenue to the taxing bodies associated with the County, including: Ector County, Odessa College, Ector County Independent School District, and Ector County Hospital District. The total loss of revenue would be $2,799 per year based on current tax structures.

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.

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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.

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