U.S. Department of Energy

W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project

Final Environmental Impact Statement

Volume I

February 2013

DOE/EIS-0473

Office of Fossil Energy
National Energy Technology Laboratory

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Responsible Federal Agency: U.S. Department of Energy (DOE)
Title: W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project, **Final** Environmental Impact Statement (DOE/EIS-0473)
Location: Southeastern Texas, including Fort Bend, Wharton, and Jackson counties
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Abstract:

This **Final** Environmental Impact Statement (EIS) evaluates the potential impacts associated with the **U.S.** Department of Energy's **(DOE)** Proposed Action to provide financial assistance to NRG Energy, Inc. (NRG) and with NRG's proposed W.A. Parish Post-Combustion Carbon Dioxide (CO_2) Capture and Sequestration Project (Parish PCCS Project). DOE's Proposed Action would provide $167 million in cost-shared financial assistance to NRG under the Clean Coal Power Initiative (CCPI) Program to support construction and operation of NRG's Parish PCCS Project. The funding would be used for project design and development, procurement of capital equipment, construction, and CO_2 monitoring during the 35-month demonstration period of the integrated CO_2 capture and compression system.

NRG's proposed Parish PCCS Project would construct a CO_2 capture facility at its 4,880-acre W.A. Parish Plant in rural Fort Bend County near the small town of Thompsons, Texas. The capture facility would use an advanced amine-based carbon dioxide (CO_2) absorption technology to capture at least 90% of the CO_2 from a 250-megawatt equivalent (MWe) portion of the flue gas exhaust from Unit 8 at the W.A. Parish Plant. The project would be designed to capture approximately 1.6 million tons of CO_2 per year from the plant exhaust, which would otherwise be emitted to the atmosphere. The captured CO_2 would be compressed and transported via a new approximately **81**-mile-long, 12-inch-diameter underground pipeline to the existing West Ranch oil field in Jackson County, Texas. The CO_2 would be used for enhanced oil recovery (EOR) and ultimately sequestered in geologic formations approximately 5,000 to 6,300 feet below ground surface (bgs).

DOE is the lead federal agency responsible for preparation of this EIS. DOE prepared the EIS pursuant to the National Environmental Policy Act (NEPA) and in compliance with the Council on Environmental Quality (CEQ) implementing regulations for NEPA (40 Code of Federal Regulations [CFR] 1500 through 1508) and DOE NEPA procedures (10 CFR 1021). The EIS evaluates the potential environmental impacts of the Parish PCCS Project as part of DOE's decision-making process to determine whether to provide NRG with financial assistance for its proposed project. The EIS also analyzes the No-Action Alternative, under which DOE would not provide financial assistance for the proposed project.

In addition, the Final EIS provides the comments received on the Draft EIS, DOE's responses to those comments, revisions made in response to the comments, and changes made to the proposed project

between the preparation of the Draft EIS and Final EIS. Vertical lines in the left margins indicate where text from the Draft EIS has been revised or supplemented for this Final EIS. Revised text is also shown in boldface font (as in this paragraph). Appendix J in Volume II contains the public comments on the Draft EIS and DOE's responses.

Four written comments (letters) were received on the Draft EIS, two from representatives of federal agencies (U.S. Environmental Protection Agency and U.S. Department of the Interior), one from a representative of a state agency (Texas Parks and Wildlife Department), and one from a representative of a Native American tribe (Coushatta Tribe of Louisiana). In addition, one member of the general public made an oral comment at the public hearing. Detailed information on the nature of these comments, as well as DOE's responses, may be found in Table S-1, in Chapter 1 of Volume I of this document, and in Appendix J of Volume II of this document.

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ACRONYMS

Acronym	Definition
%	percent
°F	degrees Fahrenheit
µg/L	micrograms/liter
µg/m^3	micrograms/meter cubed
3D	three-dimensional
acfm	actual cubic feet per minute
ACGIH	American Conference of Governmental Industrial Hygienists
ACHP	Advisory Council on Historic Preservation
AEGL	Acute Exposure Guideline Level
AF	acre-feet
AF/yr	acre-feet per year
AIHA	American Industrial Hygiene Association
aka	also known as
amsl	above mean sea level
AOR	area of review
APE	area of potential effect
Approx.	Approximately
Ar	argon
AST	above-ground storage tank
ATWS	additional temporary work space
AZMI	above-zone monitoring interval
bbl	barrel
BEG	Texas Bureau of Economic Geology
bgs	below ground surface
BLM	Bureau of Land Management
BMP	best management practice
BNSF	Burlington Northern and Santa Fe
BOPD	barrels of oil production per day
BSR	Basin Summary Reports
BTC	buttress thread casing coupling
C	**Celsius**
C&D	construction and demolition
C.R.	County Road
ca.	circa
CAA	Clean Air Act

Acronym	Definition
Caltrans	California Department of Transportation
CCPI	Clean Coal Power Initiative
CCS	carbon capture and sequestration
CCTP	Climate Change Technology Program
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
COE	cost of electricity
CRP	Clean Rivers Program
CT	combustion turbine
CWA	Clean Water Act
dB	decibel
dBA	decibel, A-weighted
DCC	direct contact cooler
DEA	**diethanolamine**
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
e.g.	for example (Latin: exempli gratia)
EHS	Environmental, Health, and Safety
EIS	Environmental Impact Statement
EJ	environmental justice
EMIS	Environmental Management Information System
EMS	emergency medical service
EMT	emergency medical technician
EO	Executive Order
EOR	enhanced oil recovery
EPA	U.S. Environmental Protection Agency
EPAct05	Energy Policy Act of 2005
ERC	emission reduction credit
ERPG	Emergency Response Planning Guideline
ES&H	Environmental Safety and Health
ESA	Endangered Species Act
ESSS	Ecologically Significant Stream Segment
ETP	Energy Transfer Partners
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission

Acronym	Definition
FGCC	flue gas carbon capture
FGD	flue gas desulfurization
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FM	Farm-to-Market Road
FOA	funding opportunity announcement
FR	Federal Register
FTA	Federal Transit Administration
G	gravity
g/hp-hr	grams per horsepower-hour
GE	General Electric
GHG	greenhouse gas
GIS	geographic information system
GIWW	Gulf Intracoastal Waterway
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
GPS	global positioning system
H_2O	water
H_2S	hydrogen sulfide
H_2SO4	sulfuric acid
Hazmat	hazardous material
HCl	hydrochloric acid
HCM	Highway Capacity Manual
HDD	horizontal directional drilling
HEC	Hilcorp Energy Company
HF	hydrofluoric acid
HGAC	Houston-Galveston Area Council
HGB	Houston Galveston Brazoria
HGB MSA	Houston Galveston Brazoria Metropolitan Statistical Area
HHS	U.S. Department of Health and Human Services
hr	hour
HRB	heat recovery boiler
HRSG	heat recovery steam generator
HUD	U.S. Department of Housing and Urban Development
HVTL	high-voltage transmission line

Acronym	Definition
Hz	hertz
i.e.	that is (to say); in other words (Latin: id est)
IAH	Houston International Airport
IDLH	immediately-dangerous to life and health
kg/sec	kilograms per second
lb/ft^3	pounds per cubic foot;
lb/hr	pounds per hour
lbmol/hr	pound molar per hour
lbs	pounds
lbs/hour	pounds per hour
Ldn	day-night sound level
Leq	equivalent sound level
LOS	level of service
LWD	lost work day case
m/s	meters per second
MBTA	Migratory Bird Treaty Act
mcfd	thousand cubic feet per day
MCL	maximum contaminant level
mD	millidarcy(ies)
MDEA	**methyldiethanolamine**
MEA	monoethanolamine
MECT	Mass Emission Cap & Trade
mg/L	milligrams per liter
mgd	million gallons per day
MIT	mechanical integrity testing
MLV	main line valve
MMcf/hr	million cubic feet per hour
MMscf	million standard cubic feet
MMTA	million metric tons per annum
Mol. Wt.	molecular weight
MP	milepost
MPCA	Minnesota Pollution Control Agency
Mph	miles per hour
MSA	Metropolitan Statistical Area
MSDS	Material Safety Data Sheet
msl	mean sea level
MTA	metric tons per annum

Acronym	Definition
MW	megawatt
MWe	megawatt equivalent
N/A	not applicable
N_2	nitrogen
NA	(data) not available
NAAQS	National Ambient Air Quality Standards
NaOH	sodium hydroxide
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NGL	natural gas liquid
NH_3	ammonia
NHD	National Hydraulic Dataset
NHPA	National Historic Preservation Act of 1966
NIOSH	National Institute of Safety and Health
NIST	National Institute of Standards and Technology
NNSR	Nonattainment New Source Review
NO	nitrogen oxide
NO_2	nitrogen dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	U.S. National Resource Conservation Service
NRG	NRG Energy, Inc.
NRHP	National Register of Historic Places
NSR	New Source Review
NWI	National Wetland Inventory
NWIS	National Water Information System
NWP	Nationwide Permit
O_2	oxygen
O_3	ozone
OAQPS	EPA Office of Air Quality and Planning Standard
OPS	Office of Pipeline Safety
OSHA	U.S. Occupational Safety and Health Administration

Acronym	Definition
P&A	plugged and abandoned
PAC	Protective Action Criteria
Parish PCCS Project	W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project
PCCS	Post-Combustion CO_2 Capture and Sequestration
PEL	permissible exposure level
PFT	perfluorocarbon tracer
PHMSA	Pipeline and Hazardous Materials Safety Administration
PHT	peak hour traffic
PI	pipeline inflexion
PM	particulate matter
PM_{10}	particulate matter with a diameter of 10 microns or less
$PM_{2.5}$	particulate matter with a diameter of 2.5 microns or less
PPE	personnel protective equipment
ppm	parts per million
ppmv	parts per million by volume (1 ppmv = 0.0001%)
PPV	peak particle velocity
PSD	Prevention of Significant Deterioration
psia	pounds per square inch, absolute
RCRA	Resource Conservation and Recovery Act
RMP	Risk Management Plan
ROD	Record of Decision
ROI	region of influence
ROW	right-of-way
RRC	Railroad Commission of Texas
RWPG	Regional Water Planning Groups
SCAPA	Subcommittee on Consequence Actions and Protective Assessments
SCBA	self-contained breathing apparatus
scfm	standard cubic feet per minute
SCR	selective catalytic reduction (system)
SDWA	Safe Drinking Water Act
Sec	second
SHPO	State Historic Preservation Officer
SIL	Significant Impact Level
SIP	state implementation plan
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SOP	Standard Operating Procedures

Acronym	Definition
SPCC	Spill Prevention, Control, and Countermeasure
SPL	sound pressure level
STEC	South Texas Electric Cooperative
STEL	Short Term Exposure Limit
SWD	salt water disposal
SWI	salt water injection
SWPPP	Storm Water Pollution Prevention Plan
SWQS	surface water quality standards
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TCV	Texas Coastal Ventures LLC
TDS	total dissolved solids
TEEL	Temporary Emergency Exposure Limits
THC	Texas Historical Commission
THPO	Tribal Historic Preservation Office
tlv	threshold limit value
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
tpy	tons per day
TRB	Transportation Research Board
TRC	total recordable case
TSDF	treatment, storage, and disposal facility
TWA	time-weighted average
TWDB	Texas Water Development Board
TWQS	Texas Water Quality Standards
TXDOT	Texas Department of Transportation
TXNDD	Texas Natural Diversity Database
U.S.	United States
UIC	Underground Injection Control
UNFCC	United Nations Framework on Climate Change
USACE	U.S. Army Corps of Engineers
USBLS	U.S. Bureau of Labor Statistics
USC	United States Code
USDA	U.S. Department of Agriculture
USDW	underground source of drinking water
USFWS	U.S. Fish and Wildlife Service

Acronym	Definition
USGS	U.S. Geological Survey
VOC	volatile organic compound
VPD	vehicles per day
VSP	vertical seismic profiling
WCI	Western Climate Initiative
WFGD	wet flue gas desulfurization
WWTP	wastewater treatment plant

GLOSSARY

Term	Definition
"A-weighted" Scale	Assigns weight to sound frequencies that are related to how sensitive the human ear is to each sound frequency. Frequencies that are less sensitive to the human ear are weighted less than those for which the ear is more sensitive. A-weighted measurements indicate the potential damage a noise might cause to hearing.
100-year floodplain	Land that becomes or will become submerged by a flood that has a chance to occur every 100 years (1% annual chance of flooding).
500-year floodplain	Land that becomes or will become submerged by a flood that has a chance to occur every 500 years (0.2% annual chance of flooding).
Aesthetic	The perception of appearance of features in relation to one's sense of beauty.
Air quality	The cleanliness of the air as measured by the levels of pollutants relative to standards or guideline levels established to protect human health and welfare. Air quality is often expressed in terms of the pollutant for which concentrations are the highest percentage of a standard (e.g., air quality may be unacceptable if the level of one pollutant is 150 percent of its standard, even if levels of other pollutants are well below their respective standards).
Ambient noise level	Background noise associated with a given environment. Ambient noise is typically formed as a composite of sounds from many near and far sources, with no particular dominant sound.
Amines	A group of organic compounds of nitrogen, typically derived from ammonia, with one or more of the hydrogen atoms in ammonia replaced by one or more organic functional groups. Amines include amino acids and a wide range of primary, secondary, and tertiary amines used for dyes, pharmaceuticals, and gas treatment.
Aquatic	Characteristics of or pertaining to water.
Aquifer	Underground geologic formation composed of permeable layers of rock or sediment that holds and/or transmits water.
Archaeological resources	Material remains of past activity.
Area of potential effect	The geographic region that may be affected as a result of the construction and operation of the proposed project or alternatives.

Term	Definition
Atmospheric stability	Resistance of the atmosphere to vertical motion. Atmospheric stability may be affected by temperature changes, wind speed, surface characteristics, and other factors. The Pasquill atmospheric stability classes categorize the atmospheric turbulence into six stability classes named A, B, C, D, E, and F with class A being the most unstable or most turbulent class and class F representing calm, stable conditions.
Attainment	Those areas of the U.S. that meet NAAQS as determined by measurements of air pollutant levels.
Best Management Practice (BMP)	Method for preventing or reducing pollution impacts resulting from an activity. BMPs include non-regulatory methods designed to minimize harm to the environment.
Blowdown	Portion of circulating cooling tower water (or steam or water removed from a boiler) removed to maintain the amount of dissolved solids and other impurities at an acceptable level.
Boiler	A pressurized system in which water is vaporized to steam, the desired end product, by heat transferred from a source of higher temperature, usually the products of combustion from burning fuels.
Brackish	Water that is saltier than fresh water, but less than sea water. Salt content of brackish water is between 0.5 and 30 parts per thousand.
Brine	Highly salty and heavily mineralized groundwater that may contain heavy metal and organic contaminants.
Carbon dioxide (CO_2)	A common chemical compound, abbreviated as CO_2, composed of two oxygen atoms covalently bonded to a single carbon atom. CO_2 is a colorless, odorless, nonpoisonous, GHG created by combustion and emitted from natural and human activities, including the burning of fossil fuels to generate electricity and operate motor vehicles.
Carbon monoxide (CO)	A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.
Clean Water Act (CWA)	Primary federal law governing water pollution. The CWA's goals include eliminating toxic substance releases to water, eliminating additional water pollution, and ensuring that surface waters meet standards necessary to support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." (see National Pollutant Discharge Elimination System).
Confining unit	A body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers.
Cooling tower	A structure that cools heated condenser water by circulating the water along a series of louvers and baffles through which cool, outside air convects naturally or is forced by large fans.

Term	Definition
Cooling water	Water that is heated as a result of being used to cool steam and condense it to water.
Cultural resources	Archaeological sites, historical sites (e.g., standing structures), Native American resources, and paleontological resources.
Cumulative effects	The impact to the environment that results from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.
Day-night noise level (Ldn)	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 p.m. and 7:00 a.m.
Decibel (dB)	Unit used to express the intensity of sound.
Density	Ratio of a substance's weight relative to its volume.
Dissolution	Process of dissolving a substance into a liquid.
Drawdown	The process by which the water table adjacent to a well is lowered after active pumping from an aquifer.
Ecosystem	A community and its environment treated together as a functional system of complementary relationships involving the transfer and circulation of energy and matter.
Effluent	Waste stream flowing into the atmosphere, surface water, groundwater, or soil.
Emergent	Erect, rooted herbaceous plants, such as cattails and bulrush, which dominate wetlands.
Emission	A material discharged into the atmosphere from a source operation or activity.
Endangered Species	Plants or animals that are in danger of extinction. A federal list of endangered species can be found in 50 CFR 17.11 (wildlife), 50 CFR 17.12 (plants), and 50 CFR 222.23(a) (marine organisms). Texas maintains its list of endangered species with the TPWD.

Term	Definition
Environmental justice	The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations.
Equivalent sound level (Leq)	Weighting imposed on the equivalent sound levels occurring during nighttime.
Erosion	The process by which particles of soils or other material are removed and transported by water, wind, and/or gravity to some other area.
Evaporation	A physical process by which a liquid is transformed into a gaseous state.
Fault	A subsurface fracture or discontinuity in geologic strata, across which there is observable displacement as a result of earth movement.
Floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding.
Flue gas	Residual gases after combustion that are vented to the atmosphere through a flue or chimney.
Formation	The primary unit associated with formal geological mapping of an area. Formations possess distinctive geological features and can be combined into “groups” or subdivided into “members” or “units”.
Fossil fuel	Coal, oil, or natural gas, formed from vegetation and animals under high pressure and temperatures during a past geological age.
Frequency	The number of cycles of completed occurrences per unit of time of a sound wave, most often measured in Hertz.
Fresh water	Water with bacteriological, physical, and chemical properties that make it suitable for beneficial use. (e.g., with TDS concentrations less than 1,000 mg/L).
Fugitive dust	Airborne particulate matter typically associated with disturbance of unpaved haul roads, wind erosion of exposed surfaces, and other activities in which soil is removed and redistributed.

Term	Definition
Geologic Sequestration	Process of injecting CO_2, captured from an industrial or energy-related source into deep subsurface geologic formations for long-term storage.
Global warming	The theory that certain gases such as CO_2, methane, and chlorofluorocarbon in the Earth's atmosphere effectively restrict radiation cooling, thus elevating the Earth's ambient temperatures or creating a greenhouse effect.
Greenhouse gas	Gas that contributes to the greenhouse effect by absorbing infrared radiation and ultimately warming the atmosphere. GHGs include water vapor, nitrous oxide, methane, CO_2, O_3, halogenated fluorocarbons, hydrofluorocarbons, and perfluorinated carbons.
Groundwater	Water obtained from an underground source (i.e., from an aquifer); may supply wells and/or springs.
Growth faults	Faults caused when sediment layers slump or subside at different rates. Growth faults are common along the Gulf of Mexico.
Habitat	The environment occupied by individuals of a particular species, population, or community.
Hazardous Air Pollutants (HAPs)	Air pollutants that are not covered by ambient air quality standards but that present, or may present, a threat of adverse health or environmental effects. These include an initial list of 189 chemicals designated by the U.S. Congress that is subject to revision by EPA.
Hazardous waste	Waste that exhibits at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity), or that is specifically listed by the EPA as a hazardous waste. Hazardous waste is regulated under RCRA Subtitle C.
Heavy metals	Natural trace elements, such as arsenic, cadmium, lead, mercury, and nickel, that are leachable and potentially toxic.
Historic Property	Prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places.
Historical site	A site that is more than 50 years old.
Hydric soils	Soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions within the major portion of the root zone.
Hydrology	A science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and the underlying rocks, and in the atmosphere.
Hydrophytic vegetation	Macrophytic plant life growing in water, soil, or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Term	Definition
Infiltration	The process of water entering the soil at the ground surface and the ensuing movement downward.
Intrusive (noise)	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the prevailing ambient noise level.
Irretrievable commitments	Resources that are lost for a period of time.
Landfill	Waste disposal method where waste material is stockpiled in a designated area until that area is full, at which time the material is buried and reclaimed in accordance with the applicable regulations for that type of landfill.
Laydown area	Material and equipment storage area during the construction phase of a project.
Level of service (LOS)	Measure of traffic operation effectiveness on a particular roadway facility type.
Lithic scatter	Concentration of waste flakes resulting from the manufacture of stone tools.
Loam	A soil composed of a mixture of clay, silt, sand, and organic matter.
Local roads	Public roads and streets not classified as arterials or collectors are classified as local roads. Local roads and streets are characterized by the many points of direct access to adjacent properties and the relatively minor value in accommodating mobility. Speeds and volumes are usually low and trip distances short.
Low income population	A community that has a proportion of low-income population greater than the respective average.
Major aquifers	Aquifers that produce large amounts of water over large areas.
Makeup water	Water feed needed to replace that which is lost by evaporation or leakage in a closed-circuit, recycle operation.
Mean sea level	Average ocean surface height at a particular location for all stages of the tide over a specified time interval (generally 19 years).
Megawatt (MW)	Unit of power equal to 1 million watts. A power plant with 1 MW of capacity operating continuously for one year could supply electricity to approximately 750 households.
Minor aquifers	Aquifers that produce minor amounts of water over large areas or large amounts of water over small areas.
Minority	Individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

Term	Definition
Minority population	Identified where either more than 50 percent of the population of the affected area is minority, or the affected area's minority population percentage is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
Miscible	Property of liquids that allows them to be mixed together and form a single homogeneous phase.
Mitigation	Efforts to lessen the severity or to reduce adverse impacts, including: avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree or magnitude of the action; repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation; and compensating for the impact by replacing or providing substitute resources or environments.
Monitoring	Periodic or continuous determination of the amount of substances present in the environment.
National Ambient Air Quality Standards (NAAQS)	Uniform, national air quality standards established by EPA that restrict ambient levels of certain pollutants to protect public health (primary standards) or public welfare (secondary standards). Standards have been set for CO, lead, NO_2, O_3, particulate matter, and SO_2.
National Environmental Policy Act (NEPA)	Signed into law on January 1, 1970, the National Environmental Policy Act (NEPA) declared a national policy to protect the environment and created the Council on Environmental Quality (CEQ) in the Executive Office of the President. To implement the national policy, NEPA requires that environmental factors be considered when federal agencies make decisions, and that a detailed statement of environmental impacts be prepared for all major federal actions significantly affecting the human environment.
National Pollutant Discharge Elimination System (NPDES)	Provision of the Clean Water Act that prohibits discharge of pollutants into U.S. waters unless a special permit is issued by EPA, a state, or where delegated, a tribal government on a Native American reservation, abbreviated NPDES.
Native species	Species normally indigenous to an area; not introduced by humans.
Nitrogen oxides (NO_x)	A product of combustion by mobile and stationary sources and a major contributor to the formation of O_3 in the troposphere.
Nonattainment	An area that does not meet air quality standards set by the Clean Air Act for specified localities and time periods; locations where pollutant concentrations are greater than the NAAQS.

Term	Definition
Notice of Intent (NOI)	Notice that an EIS will be prepared and considered. It is published in the *Federal Register* as soon as practicable after an agency knows that an EIS is required for a proposed action.
Ozone, (O_3)	A form of O_2 found naturally in the stratosphere and that provides a protective layer for shielding the Earth from ultraviolet radiation. O_3 occurring in the lower atmosphere is harmful and is classified as a criteria pollutant.
Palustrine	Living or thriving in a marshy environment.
Particulate matter (PM)	Small particles of solid or liquid materials that, when suspended in the atmosphere, constitute an atmospheric pollutant.
Peak particle velocity (PPV)	Measure of ground vibration. Peak particle velocity is the maximum speed (measured in inches per second or millimeters per second) at which a point on the ground moves relative to its static state.
Permeability	Rate at which fluids flow through the subsurface; reflects the degree to which pore space is connected.
pH	A measure of the acidity or alkalinity of a solution.
Pigging	The practice of using pipeline inspection devices or “pigs” to perform various operations on a pipeline without stopping the flow of the product in the pipeline. These operations include, but are not limited to, cleaning and inspection of the pipeline.
Plume	A flowing, often somewhat conical, trail of emissions from a continuous point source.
Point source	A stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, for example, a pipe, ditch, or stack.
Potable water	Water that is safe and satisfactory for drinking and cooking.
Prevention of Significant Deterioration (PSD)	An EPA program in which federal or state permits are required that are intended to restrict emissions for new or modified sources in places where air quality is already better than required to meet primary and secondary ambient air quality standards.
Prime farmland	Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion.
Produced water	Brine separated from produced oil or gas at an oil field. Produced water may also be called brine, salt water, or process water.

Term	Definition
Proposed Action	The activity proposed to accomplish a federal agency's purpose and need, often requiring an analysis of potential environmental impacts. A proposed action includes the project and its related support activities (pre-construction, construction, and operation, along with post-operational requirements).
Pulverized coal	Crushed coal used to fuel a coal power plant. Currently the principal electric generation technology in the U.S.
Qualitative	Analysis based on professional judgment of quality, generally lacking hard data.
Quantitative	Analysis based on hard data or numbers that can generally be repeated.
Recharge	The movement of water from an unsaturated zone to a saturated zone.
Record of Decision (ROD)	The concluding document of the NEPA process, which states the agency's decision, along with its rationale for its selection, including the major environmental reasons.
Region of influence (ROI)	The physical area that bounds the environmental, sociologic, economic, or cultural features of interest for the purpose of analysis.
Riparian	Pertaining to, situated, or dwelling on the bank of a river or other body of water.
Runoff	The portion of precipitation falling on the land that flows over the surface, rather than soaking into the surface.
Saline	Describes water with high concentrations of salts (typically more than 10,000 ppm dissolved solids), making it unsuitable for use.
Scoping meeting	An early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action.
Scrubber	A device that removes noxious gases (such as SO_2) from flue gases by using absorbents suspended in liquid solution.
Scrub-shrub	Woody vegetation less than 20 feet (6 meters) tall. Species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.
Sediment	Material that has been eroded, transported, and deposited by erosional processes, typically wind, water, and/or glaciers.
Sedimentation	The process or action of depositing sediment.
Seismic	Pertaining to, characteristic of, or produced by earthquakes or Earth vibrations.
Selective catalytic reduction (SCR)	A system to reduce NO_x emissions by injecting a reagent, such as NH_3, into exhaust gas to convert NO_x emissions to N_2 and water via a chemical reduction reaction.

Term	Definition
Sensitive receptor	As used in this analysis, any specific resource (i.e., population or facility) that would be more susceptible to the effects of the impact of implementing the proposed action than would otherwise be.
Sequestration	Process of injecting the CO_2 captured from an industrial or energy-related source into deep subsurface geologic formations for long-term storage.
Slipstream	The portion or percentage of the flue gas exhaust that is diverted to another location for alternative uses, including monitoring, research, or separate testing.
Solubility	Ability or tendency of one substance to dissolve into another at a given temperature and pressure.
Sound pressure level	Measure of a sound’s strength or intensity, expressed in dBA. The sound pressure level generated by a steady source of sound will usually vary with distance and direction from the source.
Spill Prevention Control And Countermeasure (SPCC) Plan	A plan that is implemented to protect resources from harmful quantities of petroleum discharges.
Stream	A continually, frequently, or infrequently flowing body of water that follows a defined course. The three classes of streams are: ephemeral—a channel that carries water only during and immediately following rainstorms; intermittent—a watercourse that flows in a well-defined channel during the wet seasons of the year, but not the entire year; and perennial—a watercourse that flows throughout the year or more than 90 percent of the time in a well-defined channel.
Subsidence	A sinking of a part of the surface topography.
Substation	An assemblage of equipment for the purposes of switching and/or changing or regulating the voltage of electricity.
Sulfur dioxide (SO_2)	A heavy, pungent, colorless, gaseous air pollutant formed primarily by the combustion of fossil fuels.
Supercritical CO_2	CO_2 usually behaves as a gas in air or as a solid known as dry ice. If the temperature and pressure are both increased (above its supercritical temperature of 88ºF [31.1ºC] and 73 atmospheres [1073 psi]), it can adopt properties midway between a gas and a liquid, such that it expands to fill its container like a gas, but has a density like that of a liquid.
Surface water	All bodies of water on the surface and open to the atmosphere, such as rivers, lakes, reservoirs, ponds, seas, or estuaries.
Threatened species	Plants or animals likely to become endangered species within the foreseeable future. A federal list of threatened species can be found in 50 CFR §17.12 (plants) and 50 CFR §227.4 (marine organisms). Texas maintains a list of threatened species with the TPWD.

Term	Definition
Topography	The configuration of a surface including its relief and position of the natural and manmade features.
Topsoil	The upper native soil layer; generally the layer that supports plant growth.
Traditional Cultural Property	District, site, building, structure, or object that is valued by a community for the role it plays in sustaining the community's cultural integrity.
Transmission corridor	Area used to provide separation between the transmission lines and the general public and to provide access to the transmission lines for construction and maintenance.
Turbidity	Capacity of material suspended in water to scatter light. Highly turbid water is often called muddy, although all manner of suspended particles contribute to turbidity.
Turbine	A machine for directly converting the kinetic energy and/or thermal energy of a flowing fluid (air, hot gas, steam, or water) into useful rotational energy.
Underground Source of Drinking Water (USDW)	Any aquifer or part of an aquifer that (1) supplies any public water system; or (2) contains a sufficient quantity of groundwater to supply a public water system, and currently supplies drinking water for human consumption or contains fewer than 10,000 milligrams per liter of total dissolved solids; and (3) is not an exempted aquifer.
Upset condition	An unpredictable failure of process components or subsystems which leads to an overall malfunction or temporary shutdown of system or facility.
Vibration	Force that oscillates about a specified reference point. Vibration is commonly expressed in terms of frequency, such as cycles per second, Hertz, cycles per minute, or strokes per minute.
Viewshed	A non-managed area with aesthetic value.
Viscosity	Measure of a fluid's resistance to flow.
Volatile organic compound (VOC)	A VOC is one of a group of carbon-containing compounds that evaporate readily at room temperature. As defined in 40 CFR 51.100(s), a VOC is any compound of carbon that participates in atmospheric photochemical reactions, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, and other organic compounds designated by EPA as having negligible reactivity.
Wastewater	A combination of liquid and water-carried wastes from residences, commercial buildings, and/or industrial facilities.
Watershed	A region or area bounded peripherally by a water-parting feature and draining ultimately to a particular watercourse or body of water.

Term	Definition
Wetland	An area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas and have the following general characteristics: (1) Vegetation typically adapted to inundated or saturated soil conditions; (2) Hydric soils or soils associated with low oxygen conditions; and (3) The area is inundated either permanently or periodically at mean water depths less than 6.6 feet, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.
Wetland hydrology	Permanent or periodic inundation or soil saturation for a significant period during the vegetative growing season.
Wind Rose	Circular diagram that illustrates the relative frequency of wind speeds for each compass direction based on a time interval.

1 PURPOSE AND NEED FOR AGENCY ACTION

1.1 INTRODUCTION

The United States (U.S.) Department of Energy (DOE) prepared this Environmental Impact Statement (EIS) to evaluate the potential environmental, cultural, and socioeconomic impacts associated with the DOE's Proposed Action of providing financial assistance for the W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project (Parish PCCS Project) under the Clean Coal Power Initiative (CCPI) Program. The EIS also evaluates the impacts associated with construction and operation of the proposed Parish PCCS Project, as submitted by NRG Energy, Inc. (NRG).

DOE prepared this EIS pursuant to the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [USC] 4321 et seq.), and in compliance with the Council on Environmental Quality (CEQ) implementing regulations for NEPA (40 Code of Federal Regulations [CFR] 1500 through 1508) and DOE's NEPA implementing procedures (10 CFR 1021). Chapter 1 of the EIS provides an overview of the Proposed Action and a description of the purpose and need for DOE action. This chapter also includes information on the NEPA process and the "scoping" efforts completed by DOE during planning and development of the EIS. "Scoping" refers to the public, tribal, and agency outreach efforts that DOE undertook early in the process to focus this NEPA analysis on the appropriate issues (please see 40 CFR 1501.7 and Section 1.6 of this EIS for more information).

1.2 CCPI PROGRAM

Congress established the CCPI Program to enable and accelerate the deployment of advanced technologies to promote clean, reliable, and affordable electricity for the U.S. The CCPI operates as a cost-shared partnership between government and industry to develop and demonstrate advanced coal-based power generation technology at the commercial scale. CCPI demonstrations address the reliability and affordability of the nation's electricity supply and further the objectives of the Energy Policy Act of 2005 (EPAct05). The overall goals of the CCPI are to: (1) increase investment in low-emissions, coal-based power generation technology, consistent with the EPAct05 (Public Law 109-58); and (2) accelerate the development and demonstration of advanced coal technologies for commercial use. By providing federal assistance, the inherent financial and technical risks (on the part of the commercial sector) associated with bringing advanced technology to the marketplace can be overcome more readily. In this manner, the CCPI accelerates the development of new coal technologies and facilitates the commercial acceptance of these emerging technologies.

The CCPI legislation specifically directs DOE to demonstrate coal-based technology advancements, thereby reducing barriers to the continued and expanded use of coal to generate electricity. When integrated with other DOE initiatives, the CCPI will help the nation successfully produce electricity at greater efficiencies, reduce air emissions, and produce cleaner fuels consistent with the EPAct05. By reducing emissions, the CCPI also directly supports the Climate Change Technology Program (CCTP) to reduce emissions of carbon dioxide (CO_2), a greenhouse gas (GHG). The CCTP provides planning and coordination assistance to the federal government to implement the President's National Climate Change Technology Initiative. Its purpose is to accelerate the development and

Carbon dioxide (CO_2) accounts for 83 percent of the total U.S. GHG emissions. As of 2008, the CO_2 emissions from U.S. electricity generation had grown 30 percent since 1990, while in comparison, total CO_2 emissions (from all reported U.S. sources) grew by only 16 percent. Electrical power generation contributes 41 percent of all CO_2 emissions in the U.S. In 2008, 82 percent of all CO_2 emissions from U.S. electricity generation were attributable to the use of coal (EIA, 2009b).

deployment of technologies that can reduce, avoid, or capture and store GHG emissions. The CCTP was established in 2002 with several participating federal agencies, including the U.S. Environmental Protection Agency (EPA) and DOE.

DOE selects CCPI projects for financial assistance through a competitive process following funding opportunity announcements (FOA) that solicit applications for federal cost-sharing of demonstration projects. To date, the CCPI Program has conducted three rounds of solicitations:

- *Round 1* sought projects that would demonstrate advanced technologies for power generation and improvements in plant efficiency, economics, and environmental performance.
- *Round 2* requested applications for projects that would demonstrate improved mercury controls and gasification technology.
- *Round 3*, which DOE conducted in two phases, sought projects that would demonstrate advanced coal-based electricity-generating technologies that capture and sequester (or put to beneficial use) CO_2 emissions.[1] The Round 3 solicitation was restricted to coal-based power generation.

NRG submitted an application for its proposed Parish PCCS Project in response to the CCPI Round 3 solicitation. As described in Section 1.6.4 and 2.2.2, DOE ultimately selected NRG's proposed project and four other applications for possible funding pending further, more detailed consideration. The DOE determined that these five projects would best meet CCPI's goals and objectives[1].

1.3 PROPOSED ACTION

1.3.1 Proposed Agency Action

DOE's Proposed Action is to provide limited financial assistance through a cooperative agreement with NRG for a new post-combustion CO_2 capture and compression system that would be added to the existing W.A. Parish power plant, with the captured CO_2 piped to an oil field for enhanced oil recovery (EOR). Under the original cooperative agreement, DOE agreed to provide approximately $167 million in cost-shared funding, or about 50% of the total estimated costs for a smaller project (approximately 60-megawatt equivalent [MWe]). However, during the initial stage of conceptual design NRG determined that it was necessary to increase the project size because the original 60-MWe program would be too small to meet project objectives (i.e., demonstrate significant oil production in most fields). As a result, NRG proposed in February 2011 that the technology be demonstrated at a larger size and requested an increase in DOE funding to be applied to the estimated $845 million cost of the revised project. DOE does not currently have additional funding available to increase its financial assistance for NRG's proposed project. Therefore, DOE's Proposed Action for the purposes

> The **Proposed Action** being considered by DOE is whether to provide cost-shared funding to the Parish PCCS Project. This project would capture CO_2 from an existing power plant and inject it into deep geologic formations for enhanced oil recovery (EOR) and ultimate sequestration.

[1] As stated in the Financial Assistance FOA for Round 3, "DOE's specific objective is to demonstrate advanced coal-based technologies that capture and sequester, or put to beneficial use, CO_2 emissions. DOE's goals are to demonstrate at commercial scale in a commercial setting, technologies that (1) can achieve a minimum of 50% CO_2 capture efficiency and make progress toward a target CO_2 capture efficiency of 90% in a gas stream containing at least 10% CO_2 by volume, (2) make progress toward capture and sequestration goal of less than 10% increase in the cost of electricity for gasification systems and less than 35% for combustion and oxycombustion systems all as compared to current (2008) practice, and (3) capture and sequester or put to beneficial use a minimum of 300,000 tons per year of CO_2 emissions using a 30-day running average to determine if the project successfully meets the CO_2 capture efficiency and the capture and sequestration or beneficial use rate requirements of this Announcement" (NETL 2009).

of this EIS is to provide approximately $167 million in cost-shared funding, or about 20% of the total estimated cost for NRG's proposed larger-scale project.

1.3.2 NRG's Proposed Project

NRG's proposed project would demonstrate the commercial feasibility of a retrofit, commercial-scale CO_2 capture and compression system, coupled with use of the captured CO_2 for EOR and ultimate sequestration. NRG would design and construct a system that would capture at least 90% of the CO_2 in an up to 250-MWe flue gas slipstream of the combustion exhaust gases from the existing 650-megawatt (MW) (gross) coal-fired Unit 8 at NRG's W.A. Parish Plant. The captured CO_2 (up to 5,475 tons per day) would be transported approximately 80 miles in a new pipeline to be constructed by NRG. The CO_2 would be used for EOR and ultimately sequestered at the existing West Ranch oil field in Jackson County, Texas. Additional details regarding the primary components of the proposed project are described below.

1.3.2.1 CO_2 Capture Facility

The proposed capture system would be constructed on NRG's 4,880-acre W.A. Parish Plant in rural Fort Bend County near the small town of Thompsons, Texas. The plant site includes four large power generating units fueled with pulverized coal, four smaller natural gas-fired units, and a 2,430-acre man-made lake used for cooling water. The proposed project would retrofit one of the coal-fueled units (Unit 8) with a post-combustion CO_2 capture system, using space available on the plant site immediately adjacent to the unit. The CO_2 capture system would use an advanced amine-based solvent technology. The project demonstration period may also include tests of other amine-based solvents. A new natural gas-fired cogeneration plant comprised of a combustion turbine with a heat recovery steam generator (CT/HRSG) would also be constructed as part of this project. The cogeneration plant would produce an estimated 80 MW equivalent of electric power which would be sufficient to drive the compressors and equipment of the capture system leaving excess power available for sale to the grid. The hot exhaust gases from the new combustion turbine would be used to produce steam in the HRSG, providing heat for the solvent regeneration process. **NRG plans to proceed with construction of the natural gas-fired cogeneration plant without DOE cost sharing and would begin operation in 2013. The initial operation of the electric generating plant would provide peaking power for other NRG needs unrelated to the Parish PCCS Project. At a later date, possibly 2015, the electric generating plant would provide the power needed for the carbon capture facility.**

1.3.2.2 CO_2 Pipeline

Captured CO_2 would be compressed and transported in a new, approximately **81**-mile-long, 12-inch-diameter pipeline from the proposed capture facility to injection sites at the West Ranch oil field. The pipeline route would traverse parts of Fort Bend, Wharton, and Jackson Counties. The anticipated route includes mostly sparsely-populated rural and agricultural lands. NRG evaluated potential pipeline routes and has proposed the pipeline to be collocated along or within existing mowed/maintained utility corridors for approximately **75**% of its length to avoid or minimize impacts to sensitive resources. Areas of currently maintained right-of-way (ROW) would be expanded, as necessary, to provide access for routine inspection and maintenance of the proposed pipeline.

1.3.2.3 Enhanced Oil Recovery

The proposed project would deliver up to 1.6 million tons of CO_2 per year to be used for EOR at the West Ranch oil field, located in Jackson County. The oil field has operated since 1938 and is well-characterized. However, CO_2 floods have not been previously demonstrated in this field. The portions of the West Ranch oil field in which EOR operations would be conducted are currently owned or leased by Texas Coastal Ventures, LLC (TCV), a joint venture between NRG and Hilcorp Energy Company (HEC). HEC has been contracted to conduct the EOR operations. A new CO_2 recycle facility would be constructed near the center of the approximately 5,500-acre area of EOR operations in an area that was previously occupied by a gas processing facility. As currently planned, the approximately 1.5-acre CO_2 recycle facility would include the following equipment:

- a single-stage separator to separate liquids out of the recycle gas stream;
- a membrane separation unit to remove CO_2 from the recycle gas stream;
- a glycol contactor to dehydrate the CO_2 recycle stream;
- a compressor to increase the pressure in the CO_2 recycle stream to the level required for injection;
- flow meters and other instrumentation;
- supply and distribution headers to connect the central CO_2 recycle facility to satellite collection areas; and
- a flare to control emissions in the event of an upset condition.

1.3.2.4 CO_2 Monitoring Program

NRG would implement a CO_2 monitoring program to monitor the injection and migration of CO_2 within the geologic formations. The CO_2 monitoring program must meet regulatory and CCPI program requirements and may consist of the following components:

- injection system monitoring;
- containment monitoring (via monitoring wells, mechanical integrity testing, and other means);
- CO_2 tracking via multiple techniques;
- modeling of CO_2, oil, and water behavior in the reservoir; and
- other experimental techniques yet to be developed.

1.4 PURPOSE AND NEED

1.4.1 DOE's Purpose and Need

The *purpose* of DOE's Proposed Action under the CCPI Program is to meet CCPI Program goals by providing cost-shared funding for this proposed project to demonstrate advanced coal-based technologies at a commercial scale that capture and geologically sequester CO_2 emissions.

> **The purpose of and need for DOE action** is to advance the CCPI Program by funding projects with the best chance of achieving the program's objectives as established by Congress: commercialization of clean coal technologies that advance efficiency, environmental performance, and cost competitiveness well beyond the level of technologies currently in commercial use.

The principal *need* addressed by DOE's Proposed Action is to satisfy the responsibility Congress imposed on DOE to demonstrate advanced coal-based technologies that can generate clean, reliable, and affordable electricity in the U.S. The CCPI Program selects projects with the best chance of achieving the program's objectives as established by Congress: commercialization of clean coal technologies that advance efficiency, environmental performance, and cost competitiveness well beyond the level of technologies currently in commercial service.

This proposed project would help DOE, through the CCPI Program, meet its congressionally mandated mission to support advanced clean-coal technology projects. This specifically includes those projects that have progressed beyond the research and development stage to a point of readiness for operation at a scale that, once demonstrated, can be readily implemented across the commercial sector. Post-combustion CO_2 capture offers the greatest near-term potential for reducing power sector CO_2 emissions because it can be used to retrofit existing coal-based power plants and can also be tuned for various levels of CO_2 capture, which may accelerate market acceptance (NETL 2010a). A successful commercial-scale demonstration of amine-based carbon capture technology at NRG's W.A. Parish Plant with beneficial use of the CO_2 at an existing oil field would also generate technical, environmental, and financial data from the design, construction, and operation of the CO_2 capture facility, pipeline, and EOR/ CO_2 monitoring facilities at the oil field. These data would be used to evaluate whether the deployed technologies could be effectively and economically implemented at a commercial scale.

1.4.2 NRG's Project Objectives

The purpose of NRG's proposed project is to advance a suite of integrated innovations in the field of carbon capture and sequestration (CCS) that are aimed at significantly lowering CCS implementation costs and ultimately limiting inflation in the cost of electricity (COE). Data generated by NRG's proposed project are intended to confirm that the deployed technologies can be effectively and economically implemented at a commercial scale. To accomplish this purpose, NRG has identified the following objectives for the Parish PCCS Project:

- Demonstration of an advanced amine-based CO_2 absorption technology;
- Integration of a custom-built cogeneration plant into the project to meet the specific power and steam requirements of the CO_2 capture system;
- Demonstration of EOR with CO_2 sequestration in a nearby oil field; and
- Demonstration of a CO_2 monitoring program.

NRG believes that the American energy industry is going to be increasingly impacted by the long-term societal trend towards sustainability. Moreover, the information technology-driven revolution which has enabled greater and easier personal choice in other sectors of the consumer economy will do the same in the American energy sector over the years to come. As a result, energy consumers will have increasing personal control over whom they buy their energy from, how that energy is generated and used, and what environmental impact these individual choices will have. NRG's initiatives in this area of future growth are focused on: (i) renewables, with a concentration in solar development; (ii) electric vehicle ecosystems; (iii) customer-facing energy products and services including smart grid services, nationwide retail green electricity, unique retail sales channels involving loyalty and affinity programs and custom design; and (iv) construction of other forms of on-site clean power generation.

NRG's business strategy is intended to maximize stockholder value through the production and sale of safe, reliable and affordable power to its customers in the markets served by NRG, while aggressively positioning itself to meet the market's increasing demand for sustainable and low carbon energy solutions. NRG's Parish PCCS Project uses EOR to turn carbon into a revenue stream to offset the cost of capturing it and aligns with the overall goal of providing reliable and affordable electricity while substantially reducing greenhouse gas emissions. This project enhances NRG's core business of competitive power generation while mitigating the risk of declining power prices. With this project and its other initiatives, NRG expects to become a leading provider of sustainable energy solutions that promotes national energy security, while using its retail business to complement and advance both initiatives. (NRG 2012c)

1.5 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA requires all federal agencies to include, in every recommendation or report on proposals for major federal actions that may significantly affect the quality of the human environment, a detailed statement by the responsible agency describing: (1) the potential environmental impacts of the Proposed Action; (2) any adverse environmental effects that cannot be avoided should the proposal be implemented; (3) alternatives to the Proposed Action, including the alternative of taking no action; (4) the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity; and (5) any irreversible and irretrievable commitments of resources that would be involved in the Proposed Action should it be implemented. NEPA also requires consultations with agencies that have jurisdiction or special expertise with respect to any environmental impact involved, and that the detailed statement along with the comments and views of consulted governmental agencies be made available to the public (42 USC 4332).

DOE developed a two-phased review process to comply with NEPA for the CCPI Program. During the first phase of the process, DOE solicited proposals for projects that would meet CCPI Program objectives by issuing an open solicitation which initiated a competitive selection process. The applications received in response to the solicitation that met the basic eligibility requirements set forth in the announcement constituted the range of reasonable alternatives for DOE consideration. Evaluation of the applications focused on the technical description of the proposed project, financial plans and budgets, potential environmental impacts, and other information that the applicants were requested to submit. To aid in the environmental evaluation, each applicant provided information on the site-specific environmental, health, safety, and socioeconomic aspects of its project. DOE documented the potential environmental consequences for each application in an environmental critique that was presented to the merit review board. The results are summarized in a publicly available environmental synopsis (see Appendix A), prepared in accordance with DOE's NEPA implementing regulations, which establish a specific procedure (10 CFR 1021.216) for reviewing projects seeking financial assistance prior to DOE deciding which ones to select.

Following separate reviews by technical, environmental, and financial panels, and a comprehensive assessment by a merit review board, DOE officials selected projects for potential funding that would best meet the programmatic purposes and needs for DOE action, with appropriate consideration of the environmental impacts associated with each eligible proposal.

In the second phase of the NEPA process, DOE focused on the individual selected projects. DOE determined that providing financial assistance for the construction and operation of the Parish PCCS Project would constitute a major federal action that could significantly affect the quality of the human environment and, therefore, would require an EIS. DOE prepared this EIS to inform the public of its decision-making with respect to providing financial assistance to NRG for support of the Parish PCCS Project. To prepare this EIS, DOE used information provided by NRG and other project team members, as well as information provided by state and federal government agencies, and subject matter experts. DOE prepared this EIS in accordance with Section 102(2)(C) of NEPA, as implemented under regulations promulgated by CEQ (40 CFR 1500 through 1508), and DOE's NEPA implementing procedures (10 CFR 1021). This EIS is organized according to CEQ recommendations (40 CFR 1502.10).

Figure 1-1 illustrates the steps involved in the EIS process. To formally initiate the NEPA process, DOE published a Notice of Intent (NOI) to prepare an EIS in the *Federal Register* (FR) on November 14, 2011, under Docket ID No. FR Doc. 2011–29333; (76 FR 70429). After issuing the NOI, DOE conducted a scoping process that included public scoping meetings and consultation with various interested governmental agencies and stakeholders. Information related to the public scoping meetings is described

below and in Appendix B and consultation-related correspondence is provided in Appendix C. Results of these scoping efforts were used by DOE to define the scope and areas of emphasis (or focus) of this EIS.

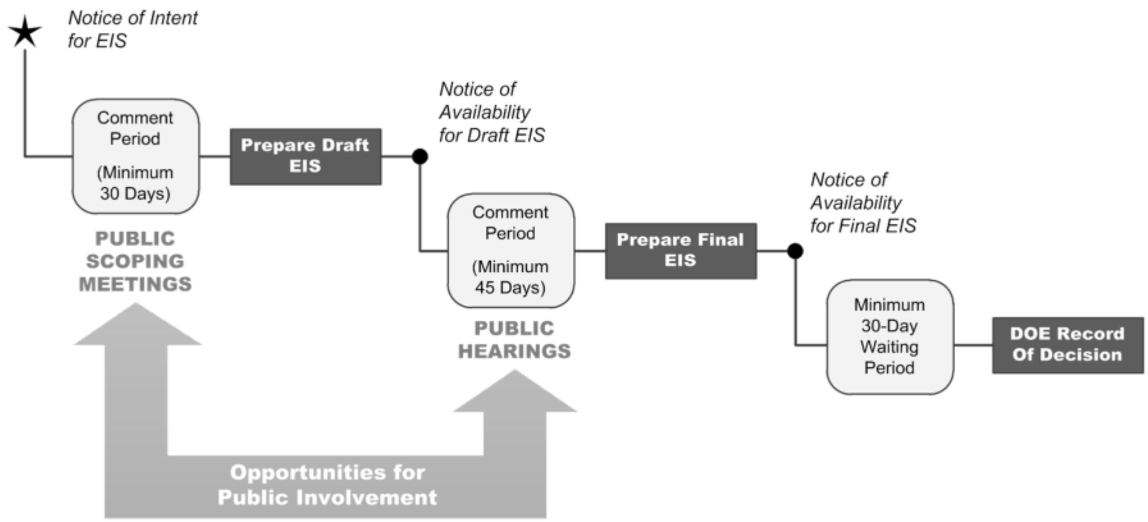


Figure 1-1. Steps in the NEPA Process

1.6 SCOPE OF THE ENVIRONMENTAL IMPACT STATEMENT

1.6.1 NEPA Scoping Process

This EIS assesses the potential environmental impacts of the Proposed Action and the No-Action Alternative. DOE determined the scope of this EIS based on internal planning and analysis, consultation with federal and state agencies, and involvement of the public.

During the public scoping period, DOE solicited public input to ensure that: (1) significant issues were identified early and properly analyzed; (2) issues of minimal significance would not consume excessive time and effort; and (3) the EIS would be thorough and balanced, in accordance with applicable regulations and guidance (see Section 1.1).

DOE held public scoping meetings on November 30, 2011, at the Needville High School in Needville, Texas, and December 1, 2011, at the Jackson County Services Building in Edna, Texas. DOE published notices in the following local newspapers announcing the meetings: *Jackson County Herald-Tribune* on November 16 and 30, 2011; *El Campo Leader-News* on November 16 and 26, 2011; *Fort Bend Herald* on November 16 and 27, 2011; and *La Subasta* (Southwest edition – Spanish) on November 17 and 24, 2011. DOE also announced the meetings in its NOI published in the *Federal Register* on November 14, 2011. These meetings were attended by ten members of the public, including two elected officials, along with project staff from DOE, NRG, and other project partners.

Both scoping meetings began with an informal open house from 5:00 p.m. to 7:00 p.m. During this time, attendees were able to view project-related posters and handouts, and ask questions of DOE and NRG representatives. The informal open house was followed by a formal project presentation and public oral comment session, which were transcribed by a court reporter. The public scoping period ended on December 15, 2011 after a 30-day opportunity to submit comments. During this time, DOE accepted comments by telephone, facsimile, U.S. mail, and electronic mail. Appendix B provides additional information on the public scoping process for this project.

1.6.2 Issues Identified Prior to the Scoping Process

DOE initially identified the following environmental resource areas for consideration in the EIS. These resource areas were identified in early planning efforts and listed in the NOI. This list was neither intended to be all-inclusive, nor a predetermined set of resources to be assessed for potential environmental impacts:

- Air quality resources
- Water resources
- Infrastructure and land use
- Visual resources
- Solid wastes
- Ecological resources, including threatened and endangered species and species of special concern
- Floodplains and wetlands
- Traffic
- Historic and cultural resources, including historic structures and properties, sites of religious and cultural significance to tribes, and archaeological resources
- Geology
- Fate and transport of CO_2 being sequestered by its use for EOR
- Health and safety
- Socioeconomics
- Environmental Justice, including disproportionately high and adverse impacts on minority and low-income populations
- Noise and light
- Connected actions
- Cumulative effects
- Compliance with regulatory and environmental permitting requirements

1.6.3 Issues Identified During the Scoping Period

DOE received four scoping comments at the Public Scoping Meetings. These comments were delivered verbally at the November 30, 2011 meeting. One commenter had a question about ownership of the pipeline and use of eminent domain to obtain property for the pipeline. Another asked if a certified payroll would be available for inspection (i.e., to report prevailing wages according to the requirements of the Davis-Bacon Act) and how much DOE funding would be provided for the project. A third commenter asked about any additional water that might be required for the CO_2 capture system at the W.A. Parish Plant. The fourth commenter asked if the project would have any impact on consumers' electricity bills.

This EIS addresses potential impacts to the areas identified during both internal planning and public scoping for the proposed project.

1.6.4 Agency Decision-Making Process

DOE's alternatives to its Proposed Action for CCPI Round 3 consist of the other eligible applications received in response to the FOA. DOE received 36 applications that met the minimum eligibility requirements. These applications provided DOE with the range of reasonable alternatives for meeting the objectives of Round 3 of the CCPI. DOE reviewed each application to evaluate potential environmental consequences associated with each proposed project and made preliminary determinations regarding the level of NEPA review required for each.

During the review process, DOE considered both potential environmental consequences and the ability of each proposed project to meet DOE's purpose of and need for action. DOE uses the procedures established in its NEPA regulations, specifically those in 10 CFR 1021.216, to identify and consider the potential environmental impacts of the eligible projects in making its selections as described in Section 1.5.1. The preliminary NEPA determinations and environmental reviews were provided to the selecting official for consideration during the selection process.

Based on the results of the review process, the DOE selecting official determined that the proposed Parish PCCS Project and four other applications would best meet the goals and objectives of the CCPI Program. For each of the selected projects, DOE must complete a project-specific NEPA analysis before making a final decision on its proposed actions.

This EIS identifies and analyzes the potential impacts of the Parish PCCS Project at the proposed locations in Fort Bend, Wharton, and Jackson Counties (please see Chapter 3). No alternative CCS sites are being analyzed in this EIS, as DOE's Proposed Action is to provide NRG with financial assistance based on the project attributes as described in NRG's Round 3 CCPI application. However, this EIS analyzes NRG's siting options for various components of the Parish PCCS Project (e.g., CO_2 pipeline corridors, injection sites, etc.). Chapter 2 discusses all aspects of the project in detail.

Evaluations of potential impacts included in this EIS are intended to assist the DOE in deciding whether to provide CCPI cost-shared funding to NRG for the Parish PCCS Project. If DOE decides to provide financial assistance for the project, DOE may also specify measures to mitigate potential impacts. NRG would be required to implement the measures specified in the ROD as a condition to continue receiving DOE funds for the project. In the absence of DOE cost-shared funding (the No-Action Alternative), NRG might elect to construct and operate the Parish PCCS Project using alternative funding mechanisms. However, for purposes of analysis in this EIS, the No-Action Alternative is defined as a "no-build" scenario under which it is assumed that the project would not be constructed in the absence of DOE funding (see Section 2.2.2.1).

No sooner than 30 days after publication of EPA's NOA of the Final EIS in the *Federal Register*, DOE will announce in a ROD the selection of either the Proposed Action or the No-Action Alternative. If DOE selects the Proposed Action, the ROD will also summarize measures that may be required during implementation of NRG's proposed Parish PCCS Project, as applicable, to avoid, minimize, or mitigate potential impacts to the environment.

1.7 COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

Comments received on the Draft EIS and DOE responses are presented in Appendix J. DOE addressed these comments in the Final EIS, as appropriate. A summary of the major comments from the Draft EIS and revisions in the Final EIS is provided in the following sections.

1.7.1 Public Hearing and Opportunities to Comment

DOE distributed the Draft EIS on September 13, 2012 to the elected officials, agencies, Native American tribes, organizations, and members of the public identified in the distribution list found in Chapter 10. DOE filed the Draft EIS with EPA, and EPA's Notice of Availability was published in the Federal Register on September 21, 2012 (77 Federal Register 58539). EPA's notice started the 45-day comment period on the Draft EIS, which ran from September 21, 2012 to November 5, 2012.

On September 21, 2012, DOE published its own Notice of Availability of the Draft EIS (77 Federal Register 58533) and announced its plans for two public hearings. Public hearings were held in two locations: Thompsons, Fort Bend County, Texas, on October 10, 2012 and Edna, Jackson County, Texas, on October 11, 2012. These hearing locations were selected based on their proximity to the project, venue size, and venue availability.

DOE published advertisements for the Draft EIS public hearings and comment period in several local newspapers in both English and Spanish. The English version was published in the *Jackson County Herald-Tribune* on September 26 and October 3, 2012; *El Campo Leader-News* on September 26 and October 6, 2012; *Fort Bend Herald* on September 25 and October 8, 2012; and in the *Houston Chronicle – Southwest Edition* on September 27 and October 4, 2012. The Spanish version was published in *La Subasta* (Southwest edition – Spanish) on September 27 and October 4, 2012.

Both versions of the advertisement provided the following information:

- **Hearing times, dates, locations, and meeting agenda**
- **Brief project description**
- **Physical locations (libraries) in Wharton, Texas (Wharton County), Needville, Texas (Fort Bend County), Richmond, Texas (Fort Bend County), and Edna, Texas (Jackson County) where interested parties could view a hard copy of the Draft EIS**
- **Process for registering to submit verbal comments during the hearings**
- **Alternative methods of comment submittal (e.g., toll-free telephone number, fax, email, U.S. Postal Service mail)**
- **Comment deadline.**

This same information was contained in letters sent on September 19, 2012, to 190 property owners in the vicinity of the project.

Both hearings began with an informal open house from 5 p.m. to 7 p.m. During this time, attendees were given information packets about the project and were able to view project-related exhibits. DOE personnel and support staff were on hand to greet attendees; outline the meeting agenda; answer questions about the Draft EIS, NEPA process, and project status; and invite all attendees to provide comments, either written or verbal on the proposed project. NRG personnel also were available at displays illustrating various features of the proposed project.

Individuals who wished to speak during the formal hearing portion of the meeting (7 p.m. to 8 p.m.) were given an opportunity to register. Individuals could also record a verbal comment with the court reporter at the meeting. Anyone who wished to provide comments in writing was invited to do so by completing a comment form and giving it to a DOE team member at the public hearing or mailing it at a later date. The comment form provided information about all alternative methods of submitting comments as well as the comment deadline. Individuals were also given an opportunity to receive a copy of the executive summary of the Draft EIS at the public meeting or request a copy of the Draft EIS and/or the Final EIS (either a hard copy of the entire EIS or a hard copy of the Summary plus a compact disk containing the entire EIS).

The informal open house was followed by presentations and the formal public hearing, which was held from 7 p.m. to 8 p.m. DOE led the discussion and presided over the hearing. The presentation included an overview of the DOE CCPI program, NRG's proposed project, and the NEPA process. DOE presented information about alternative methods of submitting comments and the comment

deadline. A court reporter was present during the entire hearing to record all verbal comments. One individual presented a verbal comment at the hearings. Collectively, 18 members of the public attended the public hearings in the two locations.

At the public hearing on October 10, 2012, when no individuals expressed a desire to provide oral comments, DOE opened the floor to more questions. Several individuals asked clarifying questions about the diameter, location, and depth of the proposed pipeline; the need to take additional rights-of-way; the number of rivers the pipeline would cross; whether other oil fields might benefit from the proposed project in the future; the size of the oil reservoir at the West Ranch Oil Field; and any potential hazards associated with the pressure of the CO_2 in the proposed pipeline. Similar questions came up during both informal sessions as well. Many people at the October 11, 2012 public hearing were landowners previously contacted by NRG or its contractors. Many were wondering what the next steps would be for negotiating the pipeline right-of-way.

During preparation of the Final EIS, DOE considered all comments received on the Draft EIS individually and collectively. An identification number was assigned to each originator of comments, including those at the public hearing. A total of five individuals, tribes, and agencies provided comments on the Draft EIS as follows:

- **Two representatives of federal agencies (EPA, U.S. Department of the Interior)**
- **One representative of a state agency (Texas Parks and Wildlife Department [TPWD])**
- **One representative of a Native American Tribe (Coushatta Tribe of Louisiana)**
- **One representative of the general public (verbal testimony).**

After reviewing the comments received, a list of issues was developed (Table 1-1). Appendix J of the Final EIS provides a complete summary of the public hearing for this proposed project as well as DOE's methodology for responding to public comments, copies of the transcripts from the public hearings, original comment documents in their entirety, and DOE's response to each comment.

Table 1-1 General Comments Received During the Draft EIS Public Comment Period

Issues	Description
Use of coal as fuel	Comment expressed concern about emissions from coal burning.
Use of NO_2 emission credits to offset VOC emission	Commenter concurred with use of credits and indicated that Texas Commission on Environmental Quality (TCEQ) approval is needed.
Use of Horizontal Directional Drilling (HDD) to cross under waterways	Commenter recommended use of HDD to cross under perennial waterways with unique characteristics.
Mitigation of wetlands impact	Commenter recommended verification of extent of Traditional Navigable Waters and provision of compensatory mitigation for permanent impacts to 7.4 acres of wetlands. Also recommended use of approved wetland functional assessment models to determine wetland types and extent of mitigation required to restore unavoidable adverse impacts to Waters of the U.S.

Table 1-1 General Comments Received During the Draft EIS Public Comment Period

Issues	Description
Impacts on state or global rare plant communities	Commenter recommended use of TPWD's Rare Plant Communities List to identify rare plant communities and contacting TPWD to discuss mitigation if impacts are identified.
Environmental Justice Analysis	Commenter noted that environmental justice applicability analysis in Draft EIS appears to be flawed and/or misleading, and recommended that environmental justice impact be properly addressed by following the Council on Environmental Quality's environmental justice guidelines and Executive Order 12898.
Mitigation measures for construction-related emissions	Commenter recommended use of mitigation measures to reduce impacts of NO_x, CO, PM, SO_2, and other pollutants from construction activities. Measures include dust source controls, mobile and stationary source controls, and administrative controls.
Threatened and Endangered Species	Commenter recommended that Threatened and Endangered Species information be in compliance with U.S. Fish and Wildlife Service Consultation Handbook.
Whooping cranes in Fort Bend and Wharton counties, Texas	Commenter noted that lack of documented sightings of whooping cranes within the region of influence is not sufficient data to predict where whooping cranes may be found in the future.
Bald eagle nests	Commenter recommended conducting additional surveys for bald eagle nests.
Protection of fresh water mussel species	Commenter recommended use of silt fences and filter fabric to reduce sedimentation in the Colorado River and tributaries, review of Best Management Practices, and coordination with the U.S. Fish and Wildlife Service's Clear Lake Ecological Services Field Office.
Impacts on migratory birds	Commenter recommended consultation with U.S. Fish and Wildlife Service's Region 2 Migratory Bird Program for specific nesting seasons, and avoidance of habitat alteration, removal, or destruction during nesting system. Also recommended use of surveys to determine presence of migratory birds prior to construction, down-shielding of bright lighting, use of alternative routes and directional drilling, and adherence to pipeline conditions from the USACE.

1.8 SUMMARY OF CHANGES IN THE ENVIRONMENTAL IMPACT STATEMENT

Since publication of the Draft EIS in September 2012, NRG has made some refinements to its Proposed Action and provided supplemental information. These refinements are reflected in the analysis as in the EIS text and tables and highlighted with vertical lines in the left margin of the page.

1.8.1 Early Construction of the Cogeneration Plant

At its option, NRG plans to proceed with construction of a natural gas-fired cogeneration plant without DOE cost sharing and would begin operation in 2013. The initial operation of the electric generating plant would provide peaking power for other NRG needs unrelated to the Parish PCCS Project. At a later date, possibly 2015, the electric generating plant would provide the power needed for the carbon capture facility. The potential environmental impacts of the construction and operation of the electric generating plant have not been separated from the other components of NRG's Proposed Action to retain a conservative upper estimate of environmental impacts. However, Section 3.2.4, Direct and Indirect Impacts of the No-Action Alternative does address the air quality impacts associated with the construction and operation of a natural gas-fired cogeneration plant without the other components of the Parish PCCS Project.

1.8.2 Interim Actions

The Draft EIS listed construction of a **new warehouse and ductwork integration in Section 2.2.3 as potential interim actions, as defined by DOE's NEPA implementing regulations at 10 CFR 1021.104. During the development of this EIS, NRG decided to not pursue these two actions at the W.A. Parish Plant related to the Proposed Action as interim actions as previously planned. Instead, NRG may commence on these actions earlier than scheduled and prior to issuing a Record of Decision (ROD). These actions would be funded by NRG "at-risk", and if the proposed project is funded by DOE, then DOE would reimburse NRG per the cooperative agreement. If the proposed project is not funded by DOE, then NRG would not be reimbursed for any costs associated with these actions. Details of these proposed activities are provided in Section 2.2.3 and Section 2.3.2.2.**

1.8.3 CO_2 Pipeline Corridor

Pipeline Realignments: NRG has made minor realignments to its proposed pipeline route to accommodate landowner concerns or to allow for better access for horizontal directional drilling to place the proposed pipeline under an existing paved road. The proposed route was modified to accommodate landowner concerns in two notable areas; between milepost 33 and milepost 38; and, between milepost 47 and milepost 49. As a result of the realignments, the proposed route is now approximately 81 miles long, an increase of approximately 1 mile. The realignments are illustrated in a set of maps in Appendix D-4. These minor realignments account for many of the changes to the acreage of potential impacts within the pipeline ROI in Chapters 3 to 7 compared to the values presented in the Draft EIS.

Other notable revisions related to the pipeline corridor include:

- **Access Roads: NRG increased the length of access roads that they expect to use and potentially improve from approximately 40 miles to 43 miles.**

- **Overall Pipeline Footprint: As a result of NRG's changes in the pipeline alignment and access roads, the approximate overall amount of land that would be included in the pipeline ROW and access roads would increase from 1,028 to 1,197 acres.**

Biological (including wetlands) and cultural resources surveys were completed of the areas within the proposed revised construction corridor. Biological surveys were completed for the entire area of the revised corridor, and one area of less than one acre remains to be surveyed for cultural resources.

1.8.4 Freshwater Mussel Field Surveys

Additional field surveys were conducted to identify occurrences of freshwater mussels in waterways that would be crossed by the pipeline as requested by the TPWD. The methodology and results of the mussel investigations are described in Section 3.9.2.1.3 and Section 3.9.3.1.2.

1.8.5 Cultural Resources Subsurface Testing

Trenching investigations were conducted to identify subsurface cultural resource features at river and stream crossings where HDD techniques would be used, as requested by the Texas Historical Commission. The trenching methodology and results are described in Section 3.10, Cultural Resources.

1.8.6 Recalculation of Human Health Risk

The realigned pipeline corridor was evaluated for changes in risk to human health due to an unlikely sudden release of CO_2. The updated results and figures are included in Appendix F, Risk Evaluation and in Section 3.15, Human Health and Safety.

1.8.7 Cumulative Impacts

Revisions to the cumulative effects analysis were made to include the potential for impacts to freshwater mussels identified after publication of the Draft EIS (see Section 5, Cumulative Impacts).

1.8.8 Public Hearings Summaries

A description of the public hearings held in October 2012 is provided in Section 1.7 and in Appendix J of Volume II.

1.8.9 Comments and Responses on the Draft Environmental Impact Statement

Appendix J of Volume II provides a description of the public hearings, DOE's methodology for responding to public comments, a copy of the transcripts from the public hearings and original comment documents in their entirety, and DOE's response to each comment.

2 PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

This chapter describes DOE's Proposed Action and the alternatives considered, including the No-Action Alternative, in Section 2.2. Section 2.3 describes NRG's proposed Parish PCCS Project and includes detailed descriptions of the following project components:

- CO_2 capture facility,
- CO_2 pipeline,
- EOR operations,
- CO_2 monitoring program,
- Decommissioning, and
- Measures to reduce potential impacts.

This chapter also presents project implementation options that NRG is currently considering and the manner in which these options are analyzed within this EIS. For the remainder of this EIS, the term "CO_2 capture facility" refers to all of the equipment at the W.A. Parish Plant that relates to the Parish PCCS Project including the CO_2 capture system, the CT/HRSG (aka, the cogeneration plant), the cooling tower, the emergency generator, and associated equipment.

2.2 PROPOSED AGENCY ACTION AND ALTERNATIVES CONSIDERED

2.2.1 DOE Proposed Action

DOE's Proposed Action is to provide limited financial assistance through a cooperative agreement with NRG for a new post-combustion CO_2 capture and compression system that would be added to the existing W.A. Parish Plant, with the captured CO_2 piped to an oil field for EOR. Under the cooperative agreement, DOE would provide approximately $167 million in cost-shared funding for NRG's proposed project. Section 1.3.1 of this EIS provides additional details regarding DOE's Proposed Action. As discussed further in Section 2.3 of this EIS, NRG's proposed project would capture CO_2 from a 250-MWe flue gas slipstream taken from Unit 8 at the W.A. Parish Plant. The CO_2 would be compressed and transported via an approximately **81-**mile-long pipeline to the West Ranch oil field where it would be used for EOR and ultimately sequestered.

2.2.2 Alternatives Considered by DOE

Section 102 of NEPA requires that agencies discuss the reasonable alternatives to the Proposed Action in an EIS. The term "reasonable alternatives" is not self-defining, but rather must be determined in the context of the purpose expressed by the underlying legislation. The purpose and need for a federal action determines the reasonable alternatives for the NEPA process.

Any reasonable alternative to the Proposed Action must be capable of satisfying the purpose and need of the CCPI Program. As described in Section 1.2 of this EIS, Congress established the CCPI Program with a specific goal — to accelerate the commercial deployment of advanced coal-based technologies that can generate clean, reliable, and affordable electricity in the U.S. The CCPI legislation directs DOE to demonstrate coal-based technology advancements, thereby reducing the barriers to continued and expanded use of coal to generate electricity.

Alternatives considered by DOE are limited to the applications submitted to DOE in response to requirements specified in CCPI solicitations. DOE considered all the applications that met the mandatory eligibility requirements as expressed in the funding opportunity announcement. In this competitive process, DOE cannot consider site or technology combinations other than those included in the applications received. The applicant provides at least a 50–50 cost share and bears the responsibility for designing and executing the project. DOE's action concerning these applications is to decide which projects would receive DOE financial assistance from among the eligible applications submitted. Unlike a project owned by DOE, when projects are selected in a competitive process in response to a funding opportunity announcement, DOE does not make decisions concerning the location, layout, design, or other features of the project. In other words, DOE must select among the eligible projects submitted to DOE by the applicants. DOE cannot re-write any applicant's proposal and thereby compromise an open, fair, and competitive funding opportunity. Nor can DOE compel a private entity to implement DOE's preferred design. DOE's decision is to either accept or reject the project as proposed by the proponent, including its proposed technology and selected sites. However, DOE may specify mitigation measures that would be required as part of the proposed project.

DOE's Proposed Action is therefore limited to providing financial assistance in cost-sharing arrangements to projects submitted by applicants in response to a competitive funding opportunity. Consequently, DOE's consideration of reasonable alternatives is also limited to the technically acceptable applications and the No-Action Alternative for each selected project.

2.2.2.1 Alternative Project Applications Considered During the CCPI Selection Process

DOE's alternatives for CCPI – Round 3 consisted of the other eligible applications received in response to FOA DE-FOA-0000042, *Clean Coal Power Initiative - Round 3, Amendments 005 and 006*. DOE received 38 applications, of which 25 met the minimum eligibility requirements listed in the FOA under Round 3 of the CCPI. These applications provided DOE with a range of options for meeting the objectives of Round 3 of the CCPI. DOE reviewed each of the 25 applications that met minimum eligibility requirements to evaluate potential environmental consequences and made preliminary determinations regarding the level of NEPA review required. DOE documented the potential environmental consequences for each application in an environmental critique that was considered by the selection official. The environmental critique was summarized in a publicly available environmental synopsis (see Appendix A). DOE prepared this synopsis in accordance with DOE's NEPA implementing regulations (10 CFR 1021.216). DOE also reviewed each eligible application for technical and financial merit. Through this review process, DOE considered both potential environmental consequences and the ability of each application to meet DOE's purpose and need.

Considering technical and financial merit along with the potential environmental impacts associated with each application's proposal, DOE ultimately determined that the proposed Parish PCCS Project and five other applications would best meet the goals and objectives of the CCPI Program. After selection, DOE must complete a project-specific NEPA analysis for each selected project before making a final decision. Although each of these projects is eligible for cost-shared funding under CCPI, no other relationship exists among them. The selection and potential execution of each standalone project has no effect or bearing on the other projects. The status of the six projects selected in Round 3 is summarized in Table 2-1 below.

Table 2-1. Status of CCPI Round 3 Projects

Applicant	Project Title	Status
American Electric Power Company, Inc., Columbus, OH	Mountaineer Commercial Scale Carbon Capture and Storage Project	Withdrawn by applicant - Draft EIS published in February 2011
Basin Electric Power Cooperative, Beulah, ND	Antelope Valley Station Post Combustion CO_2 Capture Project	Withdrawn by applicant
Hydrogen Energy California LLC , Kern County, CA	Hydrogen Energy California Project: Commercial Demonstration of Advanced IGCC with Full Carbon Capture	On-going - NEPA review in process
NRG Energy, Inc. Princeton, NJ	W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project	On-going - This EIS analyzes NRG's proposed project
Southern Company Services, Inc., Birmingham, AL	Southern Company Carbon Capture and Sequestration Demonstration	Withdrawn by applicant
Summit Texas Clean Energy, LLC, Bainbridge Island, WA	Texas Clean Energy Project: Pre-Combustion CO_2 Capture and Sequestration	On-going - ROD published August 2011

2.2.2.2 No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the proposed Parish PCCS Project. In the absence of DOE cost-shared funding, NRG could still elect to construct and operate the proposed project; therefore, the DOE No-Action Alternative could result in one of **three** potential scenarios:

- The proposed Parish PCCS Project would not be built.
- The proposed Parish PCCS Project would be built by NRG without benefit of DOE cost-shared funding.
- **NRG plans to construct a natural gas-fired cogeneration plant without the benefit of DOE cost-shared funding, either as a stand-alone project or as part of the Parish PCCS Project.**

DOE assumes that if NRG proceeded with project development in the absence of DOE cost-shared funding, the project would include the features, attributes, and impacts as described for the proposed project. However, without DOE participation, it is possible that the project would be canceled. Therefore, for the purposes of analysis in this EIS, the DOE No-Action Alternative is defined as the No-Build Alternative. This means that the project would not be built and environmental conditions would not change from the current baseline (i.e., no new construction, resource use, or CO_2 capture and storage would occur).

Therefore, under the No-Action Alternative, the project technologies (i.e., large-scale CO_2 capture and geologic storage) may not be implemented in the near term. Consequently, timely commercialization of these technologies for large-scale, coal-fired electric generation facilities would be postponed and may not be realized. This scenario would not contribute to the CCPI goals to invest in the demonstration of advanced coal-based power generation technologies that capture and sequester, or put to beneficial use, CO_2 emissions. While the No-Action Alternative would not satisfy the purpose and need for the Proposed Action, this alternative was retained for comparison to the effects of the proposed project, as required under CEQ Regulations (40 CFR 15012.14). The No-Action Alternative reflects the current baseline condition and serves as a benchmark against which the effects of the Proposed Action can be evaluated.

NRG plans to proceed with construction and operation of individual project components such as a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. The construction of the natural-gas cogeneration plant would not be part of the cooperative agreement with DOE. This plant would begin operation in 2013. The initial operation of the electric generating plant would be to provide peaking power for other NRG needs unrelated to the Parish PCCS Project. At a later date, possibly 2015, the electric generating plant would be used to power the compressors of the carbon capture facility. This would result in a variation of the No-Action Alternative that would have low environmental impacts, primarily in the area of air quality. A discussion of potential air quality impacts is provided in Section 3.2.4, Direct and Indirect Impacts of the No-Action Alternative.

2.2.3 Interim Actions at the W.A. Parish Plant

Interim actions, as defined by DOE's NEPA implementing regulations at 10 CFR 1021.104, are actions that DOE proposes to take before issuing a ROD and that are permissible under 40 CFR 1506.1 (Limitations on actions during the NEPA process). Such action must not have adverse environmental impacts or limit the choice of reasonable alternatives.

During the development of this EIS, NRG decided not to pursue DOE's approval for the two interim actions discussed in the Draft EIS - warehouse construction and ductwork integration. Instead, NRG may commence on these activities earlier than scheduled and prior to DOE issuing a ROD, but would do so at its own risk. If pursued prior to the ROD, these activities, now described in Section 2.3.2.2, would be funded and completed solely by NRG. If DOE decides in the ROD to fund the proposed project, DOE would likely reimburse NRG per the terms of the cooperative agreement. If the proposed project is not funded by DOE, NRG would not be reimbursed for any costs associated with these activities.

2.3 DESCRIPTION OF NRG'S PROPOSED PROJECT

2.3.1 Introduction

The Parish PCCS Project would demonstrate the operation of an integrated PCCS project at commercial scale on a coal-fired power plant. As part of the proposed project, NRG would design, construct, and operate a commercial-scale CO_2 capture facility at its existing W.A. Parish Plant (Figure 2-1) and deliver the CO_2 via a new approximately **81**-mile-long pipeline to the West Ranch oil field in Jackson County, Texas (see Figure 2-2). The Parish PCCS Project would use an advanced amine-based absorption technology to capture at least 90% (approximately 1.6 million tons) of CO_2 annually from a 250-MWe flue gas slipstream taken from the 650-MW Unit 8 at the W.A. Parish Plant. Up to 5,475 tons per day of captured CO_2 would be dried, compressed, and transported via pipeline to the West Ranch oil field where it would be used in EOR operations. The four primary components of the project include the following:

1. *CO_2 Capture Facility:* The proposed project would retrofit one of the W.A. Parish Plant's existing coal-fueled units (Unit 8) with a post-combustion CO_2 capture system that would be constructed within the existing 4,880-acre W.A. Parish Plant site. A new natural gas-fired cogeneration plant

(also mentioned in Section 2.2.2.2), estimated to be 80 MW in size, would also be constructed within the plant property to produce the auxiliary electricity and steam needed by the proposed CO_2 capture system.

2. *CO_2 Pipeline:* Captured CO_2 would be transported via a new, approximately **81**-mile-long, 12-inch-diameter[1] pipeline to the West Ranch oil field, located near the city of Vanderbilt in Jackson County, Texas. The anticipated pipeline route includes mostly rural and sparsely-developed agricultural lands in Fort Bend, Wharton, and Jackson Counties. NRG plans to use existing mowed and maintained utility ROWs to the extent practicable to minimize environmental impacts and avoid sensitive resources. As proposed, NRG's pipeline would be collocated along or within existing mowed and maintained utility ROWs for approximately **75**% of the route. A joint venture between NRG and HEC, known as Texas Coastal Ventures LLC (TCV), would operate the pipeline.
3. *EOR Operations:* The Parish PCCS Project would deliver up to 1.6 million tons of CO_2 per year to the West Ranch oil field, where the CO_2 would be injected into the 98-A, 41-A, Glasscock, and Greta sand units of the Frio Formation, which lie approximately 5,000 to 6,300 feet below ground surface (bgs). The portions of the West Ranch oil field in which EOR operations would be conducted are currently owned or leased by TCV. HEC has been contracted to conduct the EOR operations. TCV plans to invest hundreds of millions of dollars outside of the DOE funded program to modernize and prepare the West Ranch oil field to safely accept CO_2 injection, but it is included in this project description because it is integrated into the project concept and is considered a connected action.
4. *CO_2 Monitoring Program:* TCV would implement a program to monitor the injection and migration of CO_2 within the geologic formations at the EOR site based on a CO_2 Monitoring Plan developed in cooperation with the Texas Bureau of Economic Geology (BEG). This CO_2 monitoring program would be established and operated in accordance with requirements of the CCPI program as well as Railroad Commission of Texas (RRC) regulations for certification of CO_2 storage related to EOR operations (i.e., as specified in 16 TAC 5.305) and the provisions of underground injection control (UIC) permits for injection wells at the West Ranch oil field (i.e., existing permits for existing injection wells and new permits that would be required for newly installed injection wells).

[1] 12-inch-diameter pipe has an outer diameter of 12.75 inches and inner diameter between approximately 11.9 and 12.1 inches, depending on the thickness of the pipe wall.

Figure 2-1. W.A. Parish Plant

Figure 2-2 shows the general location of the proposed project components. Figure 2-3 presents an overall schematic of the proposed CO_2 capture system, CO_2 pipeline, and EOR operations. Additional details regarding each of the primary project components are provided in Table 2-2.

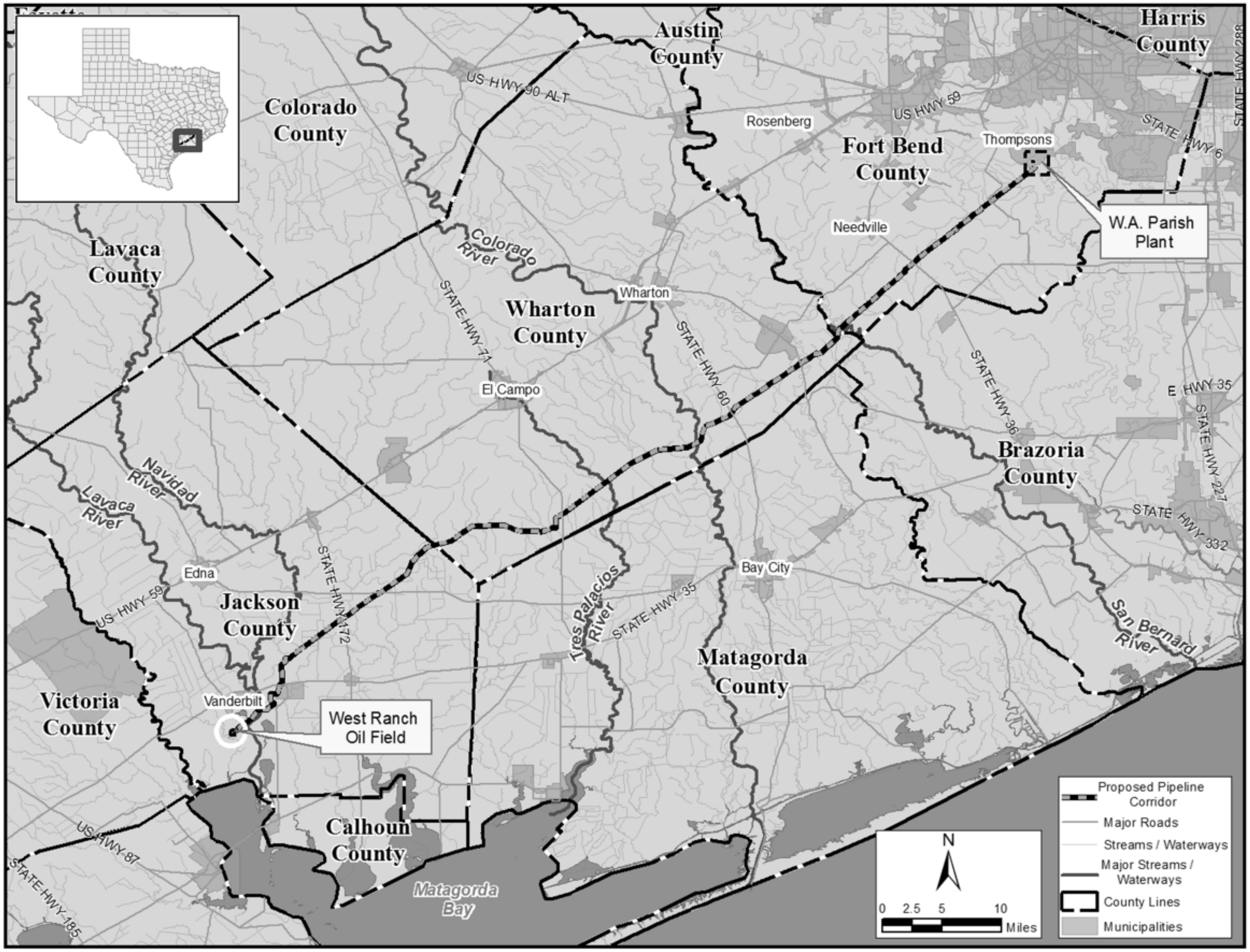


Figure 2-2. Map of Project Area

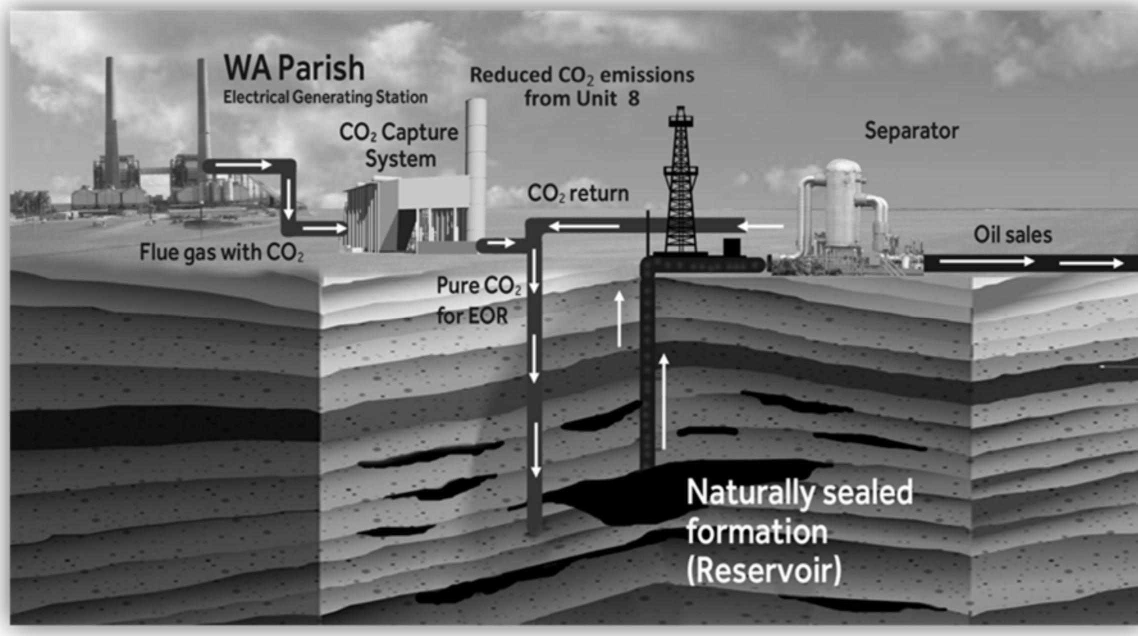


Figure 2-3. Schematic of the PCCS Concept

Table 2-2. Proposed Parish PCCS Project Features

Project Component	Description
CO_2 Capture Facility	A CO_2 capture facility would be constructed at NRG's W.A. Parish Plant. The facility would use an advanced amine-based absorption technology to capture CO_2 from a 250-MWe flue gas slipstream at the plant's 650-MW Unit 8 pulverized coal-fired electric generating unit. As discussed in this EIS, the CO_2 capture facility includes the following components, which occupy an area of approximately 29 acres: *CO_2 Capture System area*: Approximately 400 feet by 400 feet (3.3 acres); *Combustion Turbine/Heat Recovery Steam Generator (CT/HRSG) area (aka, Cogeneration Plant)*: Approximately 100 feet by 200 feet (0.44 acres); *Two Laydown Areas*: Approximately 22 acres total; and *Other project areas:* Relocated warehouse, relocated road, rail unloading area, CO_2 compressor, pipe rack, flue tank and pump, switchyard, and surface water intake (3.2 acres total). (See Figure 2-4 for details. The location of the new water intake is shown in Figure 2-6.)
CO_2 Pipeline	A new, 12-inch-diameter, approximately **81**-mile-long pipeline to transport CO_2 from the W.A. Parish Plant to the West Ranch oil field would be collocated along or within existing mowed and maintained utility ROWs (i.e., high-voltage transmission line [HVTL] and pipeline ROWs) for approximately **75**% of its length. TCV would own, operate, and maintain the CO_2 pipeline. *Construction ROW Width*: Generally 100 feet, although ROW width may be reduced to 75 feet in some areas to minimize impacts to wetlands. *Permanent ROW Width*: 30 feet *Meter Stations*: One meter station would be located within the W.A. Parish Plant. The second meter station would occupy an area of approximately 0.25 acres (i.e., 100 feet by 100 feet) within a five-acre parcel along the pipeline ROW near milepost (MP) **77**. (See Figure 2-7 and Appendix D-1 for additional details.)

Table 2-2. Proposed Parish PCCS Project Features

Project Component	Description
EOR Operations	The approximately 5,500-acre EOR area would be located within the portion of the West Ranch oil field that is currently owned/leased by TCV. A central CO_2 recycle facility would be constructed near the center of the EOR area in a disturbed area previously occupied by a gas processing facility. TCV estimates that approximately 9 injection wells and 16 production wells would be used initially for EOR operations. As many as 130 injection wells and 130 production wells would be used over the 20-year span of the proposed project. Existing wells would be used (i.e., refurbished or deepened as needed) to the extent practicable to minimize the number of new production wells that would be needed. New injection wells would be drilled if the existing wells cannot be reworked for injection. All new injection wells would require UIC permits and TCV would install the new injection wells in accordance with the design standards specified by the RRC UIC Program. New wells would be installed on existing well pads to the extent practicable. These wells would be arranged in 5-spot patterns, as described in Section 2.3.4.2.2. Each 5-spot pattern would consist of one production well surrounded by four injection wells and would occupy an approximately 40-acre area. The EOR system would be configured to allow multiple injection and extraction wells to be operated concurrently. Each injection well would be installed to a sufficient depth that it could be used for injection into the 98-A, 41-A, Glasscock, and Greta sand units. *Construction Area*: Approximately 0.5 to 2.0 acres per well site *Well Depth*: Approximately 5,000 to 6,300 feet bgs *Operational Area*: Approximately 0.01 to 0.5 acres per well site, depending on configuration *CO_2 recycle facility*: Approximately 250 feet by 250 feet (1.5 acres) (See Figure 2-10 and Figure 2-11 for additional details.)
CO_2 Monitoring Program	A combination of existing wells (where practicable) and new wells would be used as monitoring wells for the CO_2 monitoring program. New wells would be installed on existing well pads to the extent practicable. TCV anticipates that approximately 10 to 13 monitoring wells would be used in the CO_2 monitoring program (i.e., one monitoring well for each 10 to 15 injection wells), including some monitoring wells screened above the injection zones and some monitoring wells screened within the injection zones. Each monitoring well would be located within approximately 1,500 to 3,000 feet of an injection well. Details would be defined in the final UIC permit and the monitoring plan. *Construction Area*: Approximately 0.5 to 2.0 acres per well site *Well Depth*: 100 to 6,300 feet bgs *Operational Area*: 0.01 to approximately 0.5 acres per site, depending on configuration (usually collocated with injection well sites)
Access Roads	*W.A. Parish Plant:* As shown in Figure 2-4, one road (approximately 1,000 feet long, which is included in the 29-acre area discussed above) would be relocated within the W.A. Parish Plant as part of the Parish PCCS Project. *CO_2 Pipeline*: Approximately **43** miles of existing roads would be used to access the construction ROW. Some access roads may be upgraded (i.e., resurfaced and/or widened) to make them suitable for use by construction equipment. The total length of access roads to be upgraded would be determined during the detailed design. *West Ranch oil field*: Existing access roads would be used to the extent practicable to access EOR and CO_2 monitoring areas within the West Ranch oil field. No new road construction is anticipated. *Construction Width*: Approximately 30 feet *Permanent Width*: Approximately 20 feet

2.3.2 CO_2 Capture Facility

The proposed project would retrofit one of the existing coal-fueled units (Unit 8) at NRG's W.A. Parish Plant with a post-combustion CO_2 capture system using space available on the plant site immediately adjacent to Units 7 and 8. The CO_2 capture system would use an advanced amine-based absorption technology, with monoethanolamine (MEA) or other amine compounds with similar characteristics as the primary basis for the solvent. The project demonstration period may also include tests of other amine-based solvents, depending on compatibility with the final design of the capture system. A new natural gas-fired cogeneration plant (aka, the CT/HRSG), estimated to be 80 MW in size, would be constructed to produce the steam and electricity needed to operate the capture system. Exhaust heat from the combustion turbine would be used in combination with supplemental duct firing within a new HRSG to provide the necessary thermal energy, in the form of steam, for the solvent regeneration process.

2.3.2.1 Location and Background

The W.A. Parish Plant, shown in Figure 2-4, is located on 4,880 acres in rural Fort Bend County within the incorporated area of the town of Thompsons, Texas. The W.A. Parish Plant consists of four gas-fired utility boilers and four coal/gas-fired utility boilers (Units 1 through 8) which produce steam for the generation of electricity. An auxiliary boiler provides steam for startup of Units 1, 2, and 4. The plant also includes a gas turbine, which supplies electricity in emergency situations. Other equipment at the plant includes coal, limestone, and material loading, unloading, and handling equipment, tanks, cooling towers, pollution control equipment, degreasers, engines, and oil-water separators. Smithers Lake, which is located on the north side of the plant, is a 2,430-acre man-made water body used for plant cooling water.

The W.A. Parish Plant occupies an industrial area located next to relatively undeveloped lands. An electric substation for Calpine's Brazos Valley Power Plant is located immediately east of the W.A. Parish Plant. Scattered ranches and residences are located to the east and southwest; and Smithers Lake is located to the north. Highway access to the W.A. Parish Plant from the west is via Farm-to-Market Road 762 (FM 762) and Smithers Lake Road. Access from the east is via FM 2759/North Thompson Road and Y U Jones Road. The BNSF Railway utilizes the W.A. Parish Plant rail lines to deliver coal to the storage yard on the west side of the plant. The proposed CO_2 capture facility would have a footprint of approximately 400 feet by 400 feet (3.3 acres) within the existing W.A. Parish Plant, as shown in Figure 2-4. Including the CO_2 capture facility, the CT/HRSG area, two large laydown areas, and other project areas, a total of approximately 29 acres within the existing plant boundaries would be used during construction.

2.3.2.2 CO_2 Capture System Component Overview

The proposed CO_2 capture facility would consist of a CO_2 capture system; a new, 80-MW natural gas-fired cogeneration plant that would primarily serve to supply the steam and electricity needed to operate the CO_2 capture system; and associated equipment (Figure 2-5). The Parish PCCS Project would treat a slipstream that accounts for approximately 250 MWe of flue gas extracted from the existing Unit 8 duct work, upstream of the stack and downstream of the existing selective catalytic reduction system (SCR), which is used for removal of nitrogen oxides (NO_x); baghouse filtration, which is used for particulate matter (PM) reduction; and wet flue gas desulfurization (WFGD) system, where a bulk portion of the sulfur is removed. Therefore, the extracted flue gas would be treated, filtered and scrubbed to significantly reduce NO_x, PM, and sulfur dioxide (SO_2) by the existing air quality control systems installed on Unit 8 prior to entering the CO_2 capture system. The CO_2 capture system would only be online while Unit 8 is operational.

Figure 2-4. CO_2 Capture Facility Plot Plan

CO_2 = carbon dioxide; HDD = horizontal directional drill; kV = kilovolt

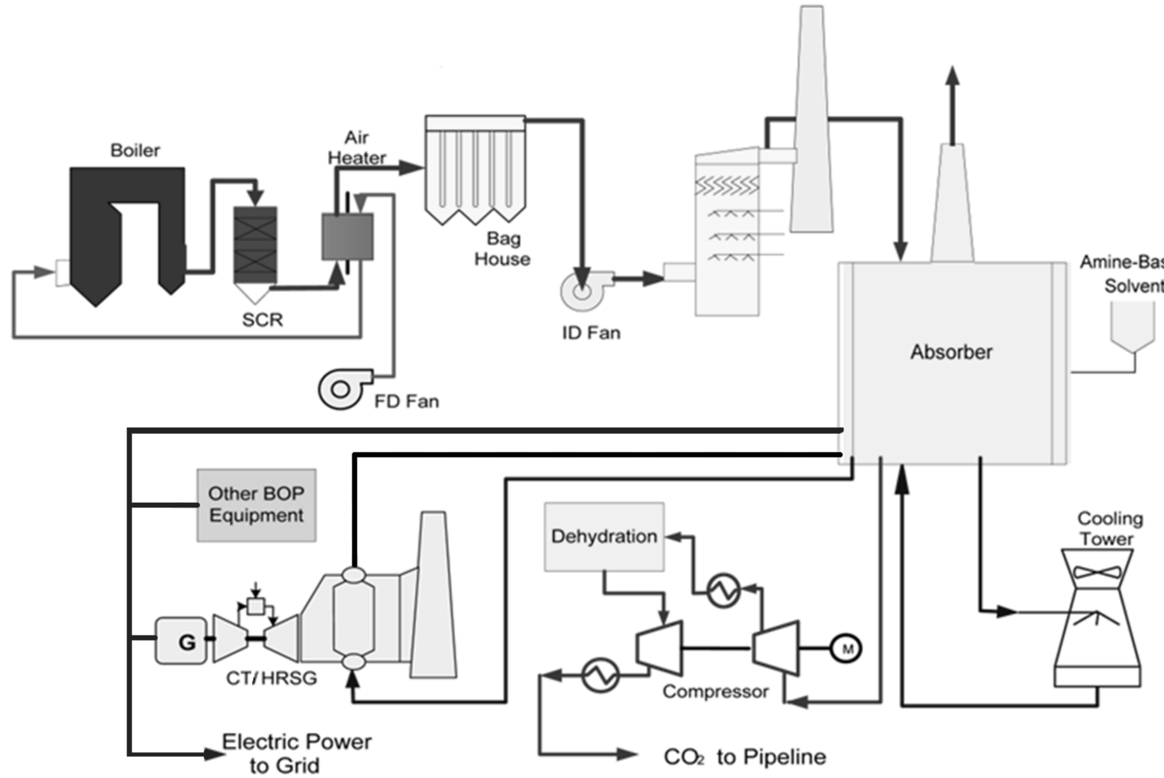


Figure 2-5. Block Flow Diagram of CO_2 Capture Facility

BOP = balance of plant; CO_2 = carbon dioxide; CT = combustion turbine; FD = forced draft; ID = induced draft; HRSG = heat recovery steam generator; SCR = selective catalytic reduction (system)

Emissions of carbon monoxide (CO), NO_x, SO_2, hydrogen fluoride (HF), hydrogen chloride (HCl), and particulate matter (PM, PM_{10}, and $PM_{2.5}$) in the Unit 8 flue gas are currently authorized under existing air permits issued by the Texas Commission on Environmental Quality (TCEQ) for the W.A. Parish Plant. In August 2012, NRG applied for an alteration to TCEQ Permit No. 7704, which currently authorizes the Unit 8 boiler, to indicate that the Unit 8 boiler and the new CO_2 capture system would operate in a dual stack configuration (i.e., some current emissions from Unit 8 would be emitted through the CO_2 capture system vent instead of the existing Unit 8 emission point). Permit alterations are used to update a permit in cases where there is no increase in emission limits. The duration of the TCEQ review and approval process for a permit alteration is approximately 45 days and no public notice is required. In cases where emission limits are increasing, the TCEQ requires a permit amendment, which is a lengthier process (i.e., approximately 9 to 12 months for review and approval) that generally requires public notice.

NRG's New Source Review (NSR) permit application for the Parish PCCS Project, which was submitted to the TCEQ on September 16, 2011, only addresses new emissions associated with the CO_2 capture facility (i.e., the CO_2 capture system, CT/HRSG, cooling tower, emergency generator, and associated equipment) and does not request reauthorization of the Unit 8 Boiler pass-through emissions. NRG's NSR permit application, which is discussed further detail in Section 3.2 of this EIS (Air Quality and Climate), is currently being reviewed by the TCEQ.

The proposed CO_2 capture system would use an advanced amine-based absorption technology. The main components of Unit 8 are shown in the upper left of Figure 2-5. Flue gas from Unit 8 would be diverted from the existing stack through new duct work into the CO_2 capture system, which is represented by the absorber on the right side of Figure 2-5. The CO_2 capture system consists of three main elements: a direct contact cooler (DCC), where the flue gas is further conditioned (i.e., since initial flue gas conditioning occurred in the SCR, baghouse, and WFGD system, as discussed above) and prepared for the absorption process; an absorber, where CO_2 is absorbed into the amine-based solvent through a chemical reaction; and a regenerator (or stripper), where the concentrated CO_2 is released and the original solvent is recovered and recycled back through the process. When entering the CO_2 capture system, the flue gas is first routed to the DCC, which is located within the absorber process island, for flue gas conditioning (i.e., cooling, dehydration, and trim acid gas removal). The flue gas is cooled in the DCC because the absorption reaction is affected by the temperature of the flue gas (i.e., absorption of CO_2 in the solvent is an exothermic process that favors lower temperatures). The flue gas cooling is done in the quench section of the DCC by circulating water. During this process, over half of the water content of the slipstream is removed in the DCC. The cooled flue gas from the quench section of the DCC then contacts a circulating sodium hydroxide (NaOH) scrubbing solution for trim (i.e., polishing) SO_2 removal to minimize formation of heat-stable salts in the downstream absorber-regenerator loop. Over 98% of the incoming SO_2 would be removed in the DCC. This is because SO_X has a stronger acid strength than the CO_2 acid gas, making it the preferred reaction which removes the amine's ability to react with the CO_2 if not removed from the gas stream (i.e., it inhibits regeneration since this stronger compound cannot be disassociated in the presence of heat).

In the CO_2 stripping section, the CO_2 would be liberated from the solvent using steam, producing a low-pressure CO_2 product stream and regenerating the solvent for additional CO_2 capture use. The CO_2 rich solvent leaves the bottom of the absorber and is pumped to the solvent regeneration section of the plant. This is the section where the weakly bonded compound is broken down with the application of heat to liberate the CO_2 and leave reusable solvent behind. The rich solvent from the absorber is first heated in a heat exchanger and then enters the stripper where the rich solvent flows down the stripper through the packed beds counter current to the stripping steam which removes the CO_2 from the rich solvent. The solvent collects on the bottom chimney tray and is sent to the reboiler where low-pressure steam, which is extracted from the cogeneration plant, is used to heat the loaded solvent. The resulting vapor at the top of the stripper contains CO_2 saturated with water. In the stripper, the CO_2 is separated from most of the moisture, yielding a rich CO_2 stream that is sent to the CO_2 product compressor. The lean solvent (i.e., with CO_2 removed) is routed back to the absorber via the rich/lean heat exchanger.

A slipstream of the lean solvent would be periodically treated in a solvent reclaiming section to remove contaminant byproducts that can gradually build up in the circulation loop. The presence of acid gas impurities in the flue gas leads to the formation of heat-stable salts in the sorbent stream, which cannot be dissociated even on application of heat. To avoid accumulation of these salts in the solvent stream and to recover some of this lost solvent, a slip stream of hot lean solvent from the bottom of the stripper is removed through a semi-continuous reclaiming operation and sent for proper disposal. The rate at which this reclaimer effluent waste stream is generated varies according to the capacity and running conditions of the CO_2 capture system. The reclaimer effluent is comprised of heat-stable salts, non-volatile solvent degradation products, unrecovered solvent, and a small amount of water. Typical disposal measures for this type of waste are incineration and landfilling. It is anticipated that this reclaimer effluent waste would be disposed of at a licensed, off-site hazardous waste treatment, storage, and disposal facility (TSDF).

As shown in Figure 2-5, the low-pressure captured CO_2 would be compressed in an electric compressor, which would be located in an approximately 0.2-acre area adjacent to the CO_2 capture system (Figure 2-4), up to the pipeline pressure (i.e., 2,115 pounds per square inch absolute [psia]). The compressed CO_2

would be a supercritical fluid, resembling a liquid but expanding to fill space like a gas, and would have a density heavier than air and a very low viscosity (i.e., flows readily). To minimize pipeline corrosion, the water content of the CO_2 would be reduced during compression to 632 parts per million by volume (ppmv) or less[2], as indicated in Table 2-4 **in Section 2.3.2.4.3.1**. The dehydration would occur first via compression and cooling to remove liquid water, followed by a second stage of dehydration in a desiccant bed dryer. After compression, the CO_2 product stream would exit the CO_2 capture facility and enter the CO_2 pipeline.

DOE and NRG anticipate that the CO_2 capture system would normally operate at full capacity, except during startup and testing of the equipment. The CO_2 capture system may also be designed to operate at a turndown rate of 50% of its rated capacity, which would be equivalent to approximately 120 MWe of flue gas. Operation of the CO_2 capture system under turndown conditions may be necessary if Unit 8 needs to operate at reduced loads. As previously stated, the cogeneration plant would be operational whenever the CO_2 capture facility is operating to provide the necessary energy requirements to run the capture facility. It is expected that the cogeneration plant would have a maximum electrical output of 80 MW. The auxiliary power used for the CO_2 capture system under full load conditions would be approximately 50 MW. Therefore, under normal operating conditions, approximately 50 MW would be used by the CO_2 capture system and nearly 30 MW would be placed into the electricity grid for sale.

A General Electric (GE) Frame 7EA generator (or a similar unit) would be installed as the combustion turbine in the 80-MW natural gas-fired cogeneration plant for the W.A. Parish PCCS Project. An SCR system would be installed in the HRSG to further reduce NO_x emissions from the gas turbine. The HRSG would be equipped with duct burners and an oxidation catalyst to reduce CO and volatile organic compound (VOC) emissions from the combustion turbine. An SCR catalyst bed and an ammonia injection grid would be located in the HRSG to reduce NO_x emissions. Ammonia for the SCR would be provided from existing on-site storage tanks, with no increase in the existing storage capacity anticipated. No change in the delivery schedule of aqueous ammonia would be required because the additional amount of aqueous ammonia required for operation of the CO_2 capture facility would be negligible in comparison to the volume currently in use at the W.A. Parish Plant.

The proposed project would include a cooling tower for non-contact cooling water. The cooling tower would be designed to efficiently evaporate water, which absorbs heat, causing the remaining water to become colder. Water not lost to evaporation in the cooling tower would be used for non-contact cooling. This water would contain total dissolved solids (TDS), which tend to concentrate in the water that remains circulating within the cooling tower as the evaporated water is emitted. To improve the evaporation rate, cooling towers are typically designed to induce a flow of fresh air across a large wetted surface area. This induced airflow, however, entrains some of the fine water droplets that carry out of the tower, which is referred to as drift. These fine droplets subsequently evaporate in the ambient air, liberating the dissolved solids that were formerly in solution as PM, PM_{10}, or $PM_{2.5}$ emissions. These particulate matter emissions would be controlled by high efficiency drift eliminators located within the tower to remove and coalesce fine water droplets before they can be emitted to the atmosphere. High efficiency drift eliminators typically consist of overlapping layers of plastic fins or blades, commonly with a chevron-shaped profile.

The proposed CO_2 capture facility would be constructed in an area currently occupied by an existing warehouse. To support the proposed project schedule, a new warehouse must be constructed so that equipment can be relocated and operations transitioned to the new warehouse.

[2] As noted in Table 2-4, NRG anticipates that the water content of the compressed CO_2 product would be approximately 100 ppmv under normal process conditions.

The new warehouse would be located in the northern portion of the W.A. Parish Plant, adjacent to the existing administration building and surrounded by previously developed areas. Construction and operations associated with the proposed warehouse would occur within the footprint of the existing plant and contribute only minor impacts due to the permanent loss of some undeveloped property within the existing plant site. Construction of the warehouse would involve minor excavation in previously disturbed soils to install the footings and foundation for the building and any required utility connections (e.g., water, sewer, electrical, and telephone).

The Unit 8 flue gas ductwork must be modified to create a tie-in point for the CO_2 capture facility. The tie-in point not only requires modifications to the existing Unit 8 ductwork, but also requires reinforcement of the existing support structure to preserve the structural integrity of the ductwork in the new configuration. During these tie-in activities, Unit 8 must be temporarily removed from service, so this work would likely be completed over one or more scheduled plant outage.

The work would include modifying the existing chimney inlet duct and local support steel. The chimney inlet duct modification would include modification and reinforcement of the existing duct for a new take-off point. The duct and support steel to be modified do not contain environmentally sensitive materials, such as lead based paint or asbestos.

During a 28-day planned outage in November 2012, insulation and lagging was removed from the outside of the stack inlet duct and the external duct stiffeners were modified in preparation for the final tie-in work. All of the work was to the external structure of the duct (the internal duct plate was not modified) and when the structural work was complete, the insulation and lagging were replaced.

2.3.2.3 Construction Phase

NRG plans to begin construction of the proposed project in **mid-2013**, at the earliest, and construction would take approximately 24 months to complete. Construction would be followed by a three- to six-month commissioning and start-up period to verify that all process systems function properly and achieve project requirements. Conventional construction methods would be used to build the project. Site preparation activities would begin with grading of the site. Following site preparation, other phases of construction would include the erection of administrative facilities, installation of piles and foundations, assembly of structural steel and building enclosures, and installation of mechanical and electrical systems.

Within the existing W.A. Parish Plant property, up to 22 acres of land would be required for two temporary construction staging and laydown areas for storage of materials and equipment, as shown in Figure 2-4. Construction materials and equipment would be delivered by trucks and rail. Construction truck traffic would access the plant site from the west via FM 762 and Smithers Lake Road or from the east via FM 2759/North Thompson Road and Y U Jones Road. These paved roads currently provide access to the plant and would not require any upgrades. A small section of a gravel road within the plant site would be rerouted due to the construction.

NRG estimates that site preparation and foundation construction would generate an average of 10 trucks per day, with the most frequent truck trips occurring from **January** to **April** of **2014**. Building fabrication and aboveground work would generate between five and 12 trucks per day, with the most frequent truck trips occurring from **February** to **August** of **2014**. Approximately 10 to 12 pieces of construction-related equipment and components would be delivered by heavy haul truck or rail during construction of the CO_2 capture facility.

The number of construction workers would vary during the two-year construction period, ranging from 250 to 600 persons during the various phases of construction and averaging approximately **300** personnel. The largest demand for construction workers would likely occur approximately six months after the start of construction, when approximately 600 construction workers would be on site to construct the mechanical and electrical systems. Construction water needs would be supplied by the existing W.A. Parish Plant water system. Electricity would be provided by on-site maintenance power sources or via new metered service from a local retail service provider. During the construction phase, NRG or its contractor would provide potable water, portable toilets, and hand-wash stations for construction workers. In the later months of the construction phase, potable water and wastewater needs for construction of the CO_2 capture facility may be incorporated into the proposed project infrastructure.

Potential construction-related environmental impacts would be typical of those associated with a large industrial construction project and would primarily be related to air emissions, construction traffic, fugitive dust emissions from site disturbance, and storm water runoff from construction areas. Best management practices (BMPs) would be implemented and all necessary permits would be obtained to minimize potential impacts and to comply with regulatory requirements during construction. NRG would receive the delivery of larger equipment via rail or truck traffic during construction of the CO_2 capture facility. The existing rail spur, as shown in Figure 2-4, is primarily used for delivery of the coal for the coal-fired electric generator units. Construction-related rail traffic would be minimized to reduce the potential for disruption of coal deliveries.

2.3.2.3.1 Construction Safety Policy and Program

Emergency services during construction would be coordinated with the local fire departments, police departments, paramedics, and hospitals. A first aid office would be provided on site for minor incidents. Personnel would be on site to respond to and coordinate in the event of an emergency. All temporary facilities would have fire extinguishers and fire protection would be provided in work areas where welding work would be performed. In addition, other existing NRG Environmental, Health, and Safety (EHS) plans and policies would be updated as necessary to accommodate the proposed project.

2.3.2.3.2 Construction Waste

Construction of the proposed project would generate typical construction wastes. The predominant waste streams would include soils and debris from site clearing, used lube oils, surplus materials, and empty containers. Surplus, scrap, and waste materials and used lube oils would be recycled or reused to the extent practicable. Solid wastes (i.e., garbage and rubbish) would be collected for disposal in a licensed, off-site disposal facility. NRG's Texas Waste Management Guidance Manual identifies preferred providers, with whom NRG has existing contracts for waste management services related to a variety of construction and operations wastes. Temporary sanitary facilities (i.e., portable toilets and hand-wash stations) would be placed in appropriate locations at the construction sites for use by construction workers. These self-contained, portable units would be serviced regularly and the wastes collected and hauled to a permitted sewage treatment facilities by licensed waste transporters.

NRG would ultimately be responsible for the proper handling and disposal of construction wastes; however, NRG's construction contractors would be responsible for minimizing the amount of waste produced by construction activities. These contractors would be contractually required to fully cooperate with project procedures and regulatory requirements for waste minimization and the proper handling, storage, and disposal of hazardous and non-hazardous wastes.

2.3.2.4 Operation Phase

The demonstration phase of the proposed project is currently scheduled to last for 35 months, according to the terms and conditions of the cooperative agreement between DOE and NRG. NRG would ultimately determine how long to continue running the CO_2 capture system following the demonstration phase based on a variety of factors, including potential future CO_2 legislation and regulations, process performance, and overall economics. For the purposes of this EIS, DOE assumes the CO_2 capture system would continue to operate for 20 years.

2.3.2.4.1 Operational Labor

The existing W.A. Parish Plant currently employs 385 workers and operates 24 hours per day, seven days per week, with employees working in shifts. The CO_2 capture facility and associated equipment installed as part of the Parish PCCS Project would require an increase of approximately 15 full-time personnel divided among shifts (i.e., an increase of approximately 4% over current conditions). It is expected that one control room operator and one field technician would be required per shift. It is estimated that five shift crews would be required to cover a work week for 10 total new positions. Also, an additional operations supervisor, chemist, system engineer, and/or maintenance technician(s) (i.e., mechanical, instrument & controls, or other) may be required for up to five additional new positions. All new staff would be based at the W.A. Parish Plant.

2.3.2.4.2 Health and Safety Policies and Programs

NRG’s existing Environmental and Safety Policies direct all persons and entities operating and maintaining the W.A. Parish Plant on its behalf to act in a manner protective of human health and safety, the environment, and property while complying with all applicable laws and regulations. These policies would apply to the facilities and personnel associated with the project. NRG would update its existing Environmental Management Information System (EMIS) at the W.A. Parish Plant to include the proposed project. The EMIS implements the EHS Policy within the context of federal, state, and local laws and regulations, along with specific permits and agreements that define NRG’s environmental requirements. The goal of the EMIS is to efficiently execute all plant activities with no deficiencies in environmental compliance.

The storage and handling of toxic or flammable materials would be conducted in compliance with EPA and Occupational Safety and Health Administration (OSHA) regulations and the National Fire Protection Association’s “Guide on Hazardous Materials” (NFPA 2010). The plant’s Spill Prevention, Control, and Countermeasures (SPCC) Plan would be updated to encompass the proposed project in compliance with federal and state regulations. Existing worker safety programs would continue to educate plant personnel regarding spill containment procedures and related EHS policies.

2.3.2.4.3 Resource Requirements (Process Inputs)

2.3.2.4.3.1 Process Chemicals

During operation of the project, process-related chemicals would be transported to the W.A. Parish Plant either by truck or rail. The amount of chemicals stored at the W.A. Parish Plant would be determined by the rates of consumption, customary delivery volumes available from suppliers, and the reliability of supply. In addition to regulatory requirements, NRG would follow the chemical suppliers’ recommendations and procedures in storing and handling all chemicals.

The CO_2 capture system would require the use and storage of an advanced amine-based solvent as the main component. The project demonstration period may also include tests of other amine-based solvents, which would also be used and stored at the facility. Ammonia would be used in the SCR for NO_x reduction at the proposed new 80-MW cogeneration plant. However, ammonia for the SCR would be provided from existing on-site storage tanks and there would be no increase in the existing storage capacity. The CO_2 capture facility would also use caustic solution for trim sulfur scrubbing of the flue gas and for solvent reclaiming, and may use sulfuric acid for VOC emission control (i.e., to treat amine solvent slip). Other chemicals similar to those already used at the W.A. Parish Plant would be needed for circulating (cooling) water chemical treatment, steam conditioning, and make-up water treatment. These would include hypochlorite, sulfuric acid, coagulant, and sodium bisulfate for circulating (cooling) water chemical treatment, and aqueous ammonia and 10% carbohydrazide for steam conditioning and treatment. Chemicals that would be used by and stored at the W.A. Parish Plant to support the proposed project are discussed in Section 3.14 of this EIS (Materials and Waste Management).

NRG would design and engineer the chemical feed storage systems to include adequate valving, interlocks, and safety systems (e.g., fogging, foaming, secondary containment, berms, spill prevention, instrumentation, ambient monitoring systems, alarms) for the safe operation, maintenance, and reliability of the equipment for the life of its use. NRG would also complete a preliminary hazard analysis early in the design process to review the conceptual design prior to the development of detailed engineering and design. Based on a review of hazards and in accordance with all regulatory requirements, NRG would implement the following precautions:

- Install tanks/vessels on concrete foundations.
- Locate storage tanks outdoors with secondary containment for spills around the tank and in defined unloading areas.
- Provide nearby safety showers and eyewash stations.
- Design and install process fluid tanks/vessels and associated equipment (e.g., pumps, piping, valves) per industry standards and codes.
- Include process drains, sumps, etc., to capture spills, leaks, and washdown of the area and equipment, consistent with applicable state or federal rule or standard pertaining to spill prevention.
- Operate the CO_2 capture facility in a manner that maintains compliance with the Texas Pollutant Discharge Elimination System (TPDES) permit for the facility.

Currently, each year the W.A. Parish Plant receives approximately 23,000 deliveries by large trucks and semi-trailers and approximately 1,000 deliveries by rail. Implementation of the project would generate additional traffic to the facility during operation. Chemicals delivered to the CO_2 capture facility and waste shipments from the facility would primarily be transported by truck. To reduce the potential for disruption of coal deliveries, which are made by rail, NRG does not plan to transport materials or wastes related to the operation of the CO_2 capture facility by rail. Table 2-3 presents the estimated annual truck shipments for the various chemicals proposed for use at the CO_2 capture facility at the W.A. Parish Plant.

Table 2-3. Estimated Material and Waste Transportation

Chemical	Approximate Number of Truck Shipments
Materials	
Advanced amine-based solvent	24 per year
10% carbohydrazide	2 per year
Ferric chloride coagulant	20 per year
Polymer	2 per year
Caustic	2 per year
Sulfuric Acid	50 per year
Hypochlorite	50 per year
Sodium bisulfate	2 per year
Wastes or By-Products	
Reclaimer effluent	24 per year

2.3.2.4.3.2 Plant Flue Gas (CO_2 Capture Facility Input)

Characteristics of the flue gas that would be treated in the CO_2 capture system are presented in Table 2-4. This table also summarizes the characteristics of the flue gas that would be emitted to the atmosphere after treatment in the CO_2 capture system (i.e., treated flue gas) and the characteristics of the compressed CO_2 product stream that would be sent to the CO_2 pipeline.

Table 2-4. Nominal Characteristics of Existing Unit 8 Flue Gas (CO_2 Capture Facility Input), Emissions to Atmosphere, and Compressed CO_2 Product

Stream Description		Flue Gas Feed to CO_2 Capture Facility		Treated Flue Gas Vent to Atmosphere		Compressed CO_2 Product	
Temperature, ºF		165		114		102	
Pressure, psia		14.6		14.7		2,115	
Component Flows	Mol. Wt.	Flow Rate (lb/hr)	Concen-tration	Flow Rate (lb/hr)	Concen-tration	Flow Rate (lb/hr)	Concen-tration
H_2O	18.02	311,456	18.0%	135,201	9.8%	18	100 ppmv
CO_2	44.01	487,493	11.5%	48,711	1.4%	438,701	>99.96%
N_2	28.01	1,760,810	65.4%	1,760,734	82.3%	63	226 ppmv
Ar	39.95	29,961	0.8%	29,962	1.0%	2	5 ppmv
O_2	32.00	133,841	4.3%	133,862	5.5%	<3.2	<10 ppmv
SO_2	64.06	373	60.6 ppmv	0	0.0 ppmv	0	**0.0 ppmv**
SO_3	80.06	9	1.2 ppmv	9	1.5 ppmv	0	**0.0 ppmv**
NO	30.01	75	26.0 ppmv	75	32.7 ppmv	0	**0.0 ppmv**

Table 2-4. Nominal Characteristics of Existing Unit 8 Flue Gas (CO_2 Capture Facility Input), Emissions to Atmosphere, and Compressed CO_2 Product

Stream Description		Flue Gas Feed to CO_2 Capture Facility		Treated Flue Gas Vent to Atmosphere		Compressed CO_2 Product	
NO_2	46.01	6	1.4 ppmv	0	0.1 ppmv	0	**0.0 ppmv**
HCl	36.46	8	2.2 ppmv	0	0.0 ppmv	0	**0.0 ppmv**
HF	20.01	1	0.6 ppmv	0	0.0 ppmv	0	**0.0 ppmv**
NH_3	17.03	2	1.3 ppmv	<1.4	<1 ppmv	0	**0.0 ppmv**
Amine Solvent	61.08	0	0.0 ppmv	<4.9	<1 ppmv	0	**0.0 ppmv**
Acet-aldehyde	44.06	0	0.0 ppmv	7	2.1 ppmv	0	**0.0 ppmv**
Total Flow, lb/hr[a]		2,723,940		2,108,470		438,780	
Molecular Weight		28.3		27.6		44.0	
Density, lb/ft^3		0.062		0.066		46.7	
Liquid Flow, gpm		-		-		2,122	
Actual Vapor Flow, acfm		736,259		530,077		Not applicable	
Std. Vapor Flow, scfm		608,181		483,194		Not applicable	

Source: NRG 2012g
[a]Due to rounding, total may be slightly more or less than the sum of individual emissions.
°F = degrees Fahrenheit; acfm = actual cubic feet per minute; Ar = argon; CO_2 = carbon dioxide; gpm = gallons per minute; H_2O = water; HCl = hydrochloric acid; HF = hydrofluoric acid; lb/ft^3 = pounds per cubic foot; lb/hr = pounds per hour; Mol. Wt. = molecular weight; N_2 = nitrogen; NH_3 = ammonia; NO = nitrogen oxide; NO_2 = nitrogen dioxide; O_2 = oxygen; ppmv = parts per million by volume (1 ppmv = 0.0001%); psia = pounds per square inch, absolute; scfm = standard cubic feet per minute; SO_2 = sulfur dioxide; SO_3 = sulfur trioxide

During normal operation, the CO_2 capture system vent would emit the treated flue gas. The bulk composition of the treated flue gas would differ from the incoming flue gas primarily in reduced CO_2 and water emissions. Furthermore, the CO_2 capture system would perform trim SO_2 removal, as discussed above, and would also remove some ammonia, HCl, and HF, plus part of the particulates and a portion of the NO_X. Primary treatment of the Unit 8 flue gas is performed upstream of the CO_2 capture system by the SCR, baghouse, and WFGD system. The incoming flue gas contains NO_X as nitrogen oxide (NO) and nitrogen dioxide (NO_2). The majority of the NO would pass directly through the CO_2 capture system. Approximately 95% of the NO_2 would be absorbed either in the DCC or in the CO_2 capture system. The CO_2 capture system would not generate additional NO_X components. The CO_2 capture system would add trace amounts of solvent, ammonia, and other VOC into the flue gas. The incoming flue gas contains SO_X as SO_2 and sulfur trioxide (SO_3). Over 98% of the incoming SO_2 would be removed in the DCC. The remaining SO_2 in the flue gas would react with the amine-based solvent in the CO_2 capture system; therefore, the vent gas would be effectively free of SO_2. All of the incoming SO_3 would be emitted with the CO_2 capture system vent. The CO_2 capture system would not generate hydrocarbons or CO. Any hydrocarbons or CO present in the incoming flue gas would be vented out through the CO_2 capture system stack. When the CO_2 capture system is not operating, the Unit 8 flue gas emissions would be the same as before construction and operation of the proposed CO_2 capture system (i.e., concentrations of pollutants would be as described in the flue gas feed column of Table 2-4.) During startup or shutdown of the CO_2 capture system, the captured CO_2 would be vented until systems stabilize. Before the CO_2 compressor is started, the captured CO_2 would be vented to the atmosphere through the CO_2 capture system emission point along with the normal CO_2 capture system vent gas. During this venting operation, there would be an increase in the CO_2 emission rate in the CO_2 capture system emission, but the other gas components in the vent gas from the CO_2 capture system would be largely unaffected. As the compressor is started, but before the product is permitted to enter the pipeline, the compressed CO_2 product would be vented through a silencer to the atmosphere. This vent would be nearly pure CO_2 (i.e., as described in the compressed CO_2 product column of Table 2-4). During shutdown, there could also be some short duration venting at this emission point.

The duration of the CO_2 capture system startup or shutdown process would be approximately four to six hours. The frequency of shutdowns would be dependent on the operation of the power plant and the test plan for the CO_2 capture system, which has yet to be developed. However, the CO_2 capture system should not require more than one scheduled shutdown per year.

2.3.2.4.3.3 Water Supply

The W.A. Parish Plant obtains its water supply from Smithers Lake and from six existing groundwater extraction wells (Figure 2-6). The W.A. Parish Plant requires approximately 1.6 to 2.3 million gallons per day (mgd) of groundwater and approximately 34 to 50 mgd of surface water (i.e., a total of 36 to 52 mgd), based on usage rates during 2010 and 2011 (NRG 2012a). The proposed CO_2 capture facility would increase the W.A. Parish Plant's rate of water use by approximately 4 to 5 mgd, which is approximately 10% over the existing demand for the plant. Approximately 95% of this additional water (i.e., approximately 3.5 to 4.9 mgd) would be supplied from Smithers Lake via a new surface water intake point, and the remaining approximately 5% (i.e., approximately 0.2 to 0.3 mgd) would be extracted from existing groundwater wells. The new surface water intake point would be developed by installing a new pump in an unused bay of the existing Smithers Lake Unit 7/8 intake structure to increase the capacity of the system. The cooling tower would use most of this additional water (i.e., approximately 3.6 to 4.9 mgd as make-up water, depending on the final project design). The CT/HRSG and the CO_2 capture system would each use approximately 0.1 mgd.

Additional details regarding groundwater and surface water resources that may be used or impacted by the proposed project are provided in Sections 3.6 and 3.7 of this EIS.

Figure 2-6. Existing W.A Parish Plant Water Supply Sources

2.3.2.4.3.4 Other Utilities

The existing electric generating units at the W.A. Parish Plant can generate approximately 3,865 MW (gross), including 650 MW from Unit 8. The current average full load auxiliary power demand at the W.A. Parish Plant is approximately 200 MW. The additional power demand for operation of the CO_2 capture facility would be approximately 50 MW, which would be accommodated by construction and operation of the proposed 80-MW natural gas-fired cogeneration power plant, as described in Section 2.3.3.2 of this EIS. Therefore, under normal operating conditions, approximately 50 MW would be used by the CO_2 capture system and nearly 30 MW would be placed into the electricity grid for sale.

The W.A. Parish Plant uses potable water from existing groundwater wells located on the plant property at an average rate of approximately 12,000 gallons per day (gpd). The potable water demand for the CO_2 capture facility would be limited to the needs of a daily workforce of 15 additional employees with seven employees on-site at any one time. Based on an estimated usage rate of 30 gpd per person of potable water for consumption and sanitary needs, the daily demand would increase by up to approximately 450 gpd, an increase of approximately 4%, as indicated in Table 2-5.

2.3.2.4.4 By-Products, Discharges, and Wastes (Process Outputs)

2.3.2.4.4.1 CO_2 Stream

Characteristics of the CO_2 product stream are presented in Table 2-5. A multi-stage compressor located downstream of the CO_2 capture system, as shown in Figure 2-5, would pressurize the CO_2 to approximately 2,115 psia as the CO_2 product stream leaves the CO_2 capture system to enter the pipeline.

2.3.2.4.4.2 Industrial Wastewater

The W.A. Parish Plant generates approximately 1,500 mgd of industrial wastewater (Table 2-5) for treatment at the plant's wastewater treatment plant (WWTP) prior to discharge in accordance with NRG's TPDES Permit No. 01038, USEPA ID No. TX0006394. Facilities installed at the W.A. Parish Plant as part of the proposed project would generate approximately 7,200 to 36,000 gpd of additional industrial wastewater, an increase of less than 1% (i.e., 0.0005% to 0.002%). NRG's existing WWTP has the capacity to treat the additional industrial wastewater that would be generated as a result the proposed project without modification.

2.3.2.4.4.3 Solid Waste

The operation of the CO_2 capture facility would produce a solid hazardous waste stream that would be identified as reclaimer effluent, which would be generated at the rate of approximately 2,712 pounds per day. Additional details are provided in Section 3.14 of this EIS (Materials and Waste Management).

2.3.2.4.4.4 Air Emissions

The proposed CO_2 capture system would be designed to achieve a 90% CO_2 capture efficiency during steady-state operations, which equates to approximately 1.6 million tons per year (tpy) of CO_2 emissions reduction. While the CO_2 capture system may offer the additional benefit of reducing some other residual emissions (e.g., SO_2 emissions), these other reductions would be ancillary benefits and not the focus of the CO_2 capture process.

With the exception of VOC emissions (i.e., amine solvent and acetaldehyde, as discussed below), the CO_2 capture system is not expected to increase the emission rates of any regulated emissions in the flue gas stream exiting the facility. However, associated equipment in the CO_2 capture facility (i.e., the CT/HRSG, cooling tower, and emergency generator, and fugitive emission components) would result in new emissions. As part of the Nonattainment New Source Review (NNSR) permitting process, NRG would be required to provide offsets (i.e., emission reduction credits [ERCs] or allowances) to reduce the total net project increases of ozone precursors (i.e., NO_x and VOC) within the Houston Galveston Brazoria Metropolitan Statistical Area (HGB MSA). As shown in Table 2-5, emissions of SO_2 from the flue gas slipstream would be effectively eliminated and emissions of HCl, HF, and NH_3 would be substantially reduced when the capture system is operational. Emissions of amine solvent and acetaldehyde, which may be formed by reaction of the amine-based solvent with oxygen present in the flue gas, would be increased. The treated flue gas exiting the CO_2 capture facility would be vented from a new stack (i.e., the CO_2 capture system vent). Table 2-5 summarizes the estimated concentrations of the treated flue gas exiting the CO_2 capture facility. Construction-related emissions would include emissions from operation of construction equipment (i.e., from fuel combustion) and particulate matter emissions from construction-related activities.

Table 2-5. Utility Requirements for the Existing W.A. Parish Plant and Proposed CO_2 Capture Facility

Utility	Existing Plant	Proposed CO_2 Capture Facility		Source
		Construction	Operation	
Auxiliary Power	Approximately 200 MW (full-load)	Negligible	Approximately 50 MW (full-load)	W.A. Parish Plant (proposed 80-MW cogeneration plant)
Potable Water	Approximately 12,000 gpd	Approximately 10,800 gpd	Approximately 450 gpd	Construction: W.A. Parish Plant and other local sources Operation: Existing W.A. Parish Plant groundwater wells
Plant Process Water	Approximately 36 to 52 mgd	Approximately 12,000 gpd over 24-month construction phase for dust control and general washdown Approximately 3.5 million gallons for hydrotesting and system startup	Approximately 4 to 5 mgd	Smithers Lake (new intake point) and existing W.A. Parish Plant groundwater wells
Sanitary Wastewater	Approximately 4,000 gpd (Permitted for 8,000 gpd)	Approximately 5,625 to 11,250 gpd	Approximately 225 to 450 gpd	Construction: portable restroom trailers and local WWTP(s) Operation: W.A. Parish Plant WWTP
Industrial Wastewater	1,500 mgd (Permitted for 2,121 mgd)	Approximately 3.5 million gallons (from hydrotesting and system startup)	Approximately 7,200 to 36,000 gpd	W.A. Parish Plant WWTP

CO_2 = carbon dioxide, gpd = gallons per day, mgd = million gallons per day, MW = megawatt; WWTP = wastewater treatment plant

Please refer to Section 3.2 of this EIS (Air Quality and Climate) for further discussion on potential emissions from the proposed project and associated mitigation measures (i.e., administrative and engineering controls, treatment, and offsets).

2.3.2.4.4.5 By-Products

NRG does not anticipate that the proposed CO_2 capture facility would generate any significant by-product streams other than the waste streams described above.

2.3.3 CO_2 Pipeline

The proposed project would construct and operate a 12-inch-diameter underground pipeline to convey CO_2 from the compressor station at the W.A. Parish Plant to the West Ranch oil field. The pipeline would be approximately **81** miles long.

2.3.3.1 Location and Background

The proposed pipeline would convey CO_2 from the W.A. Parish Plant in Fort Bend County, through Wharton County, to the West Ranch oil field in Jackson County near Vanderbilt, Texas (Figure 2-2). The pipeline would be constructed and operated by TCV. NRG considered several potential routes for the pipeline, as discussed in Section **2.3.8.4** of this EIS. The ideal route would follow a relatively straight path from the W.A Parish Plant to the West Ranch oil field, thereby reducing the pipeline length and associated construction costs. The pipeline would also be collocated along or within existing utility ROWs, avoiding construction in greenfield areas to reduce potential environmental and socioeconomic impacts that could result from establishing new ROWs; and would avoid population centers and sensitive environmental resources.

Land between the W.A. Parish Plant and the West Ranch oil field is not owned by NRG; therefore, NRG would establish a pipeline corridor and obtain legal ROWs, setbacks, and easements as needed for construction and maintenance of the pipeline. As proposed, NRG's pipeline would be collocated along or within existing mowed and maintained utility ROWs for approximately **75**% of the route. Although NRG's proposed pipeline would be located at least partially within existing ROWs for the majority of its length, NRG would need to re-visit existing landowner agreements along the ROW to negotiate for construction of the proposed pipeline. Since expansion of currently maintained ROW may be required in some areas to provide access for routine inspection and maintenance of the proposed pipeline, expansion of the maintained ROW would also need to be addressed with landowners.

Beginning at the W.A. Parish Plant, the proposed pipeline corridor extends generally southwest for **49** miles along the existing CenterPoint HVTL corridor to the CenterPoint Hilje substation, located on County Road (C.R.) 403 between State Highway 71 and C.R. 401. This route also parallels the proposed Energy Transfer Partners (ETP) 16-inch-diameter Spirit/Justice natural gas liquid (NGL) pipeline, which is scheduled for construction in the summer of 2012, for a distance of approximately 42 miles. **Two notable changes to the pipeline route were proposed by NRG since the Draft EIS was published. These changes were made to accommodate landowner concerns. At approximately milepost 33, the proposed route angles to the south for a distance of approximately 1.3 miles, then west for 1 mile, then northwest for approximately 2.2 miles until it rejoins the route defined in the Draft EIS. A second change begins at approximately mile post 47 and continues to the south, then west for a distance of approximately 2.2 miles. Appendix D-4 includes a set of maps showing the revised pipeline alignment in more detail, including the minor realignments made to the proposed route to accommodate landowner concerns or to allow for better access for directional drilling.** From the CenterPoint Hilje substation, the proposed pipeline corridor extends approximately 24 miles along the existing South Texas Electric Cooperative (STEC) HVTL corridor west to C.R. 401, then northwest to C.R. 307, then generally southwest toward the West Ranch oil field. Near MP 72, the proposed pipeline corridor leaves the STEC ROW and extends south through a greenfield area for approximately four miles until it reaches the Kinder Morgan Tejas Pipeline ROW. The proposed corridor parallels the Kinder Morgan Tejas Pipeline ROW for the remaining approximately four miles to the proposed CO_2 recycle facility within the West Ranch oil field.

The impact analysis has been updated to reflect the minor changes to the proposed pipeline route discussed above. As these proposed pipeline changes are minor, increasing the overall pipeline length by approximately 1 percent, and were implemented to address concerns of land owners located in the areas of these changes, the results and conclusions of the impact analysis presented in the Final EIS are consistent with those presented in the Draft EIS. In addition, the impact analysis presented in the Draft EIS was developed conservatively, providing adequate bounding to encompass these minor changes.

The approximately **21** miles of pipeline corridor that does not parallel existing utility ROW includes the following pipeline corridor segments, as can be seen in Appendix D-**4** to this EIS:

- **Approximately 4.5 miles between MP 33 and MP 37.5;**
- **Approximately 2.0 miles between MP 47.1 and MP 49.1;**
- Approximately 2.3 miles between MP **51.9** and MP **54.2**;
- Approximately 3.9 miles between MP **56.9** and MP **60.9**;
- Approximately 4.2 miles between MP **73** and MP **77.2**; and
- **Several** minor deviations from existing utility ROWs totaling approximately **4.1** miles, primarily to cross roads and waterbodies at a 90-degree angle.

2.3.3.2 System Component Overview

Captured CO_2 would be transported via a new nominal 12-inch-diameter underground pipeline to the proposed CO_2 recycle facility at the West Ranch oil field. The CO_2 pipeline would be designed, tested, and operated in accordance with applicable federal regulations. These include the U.S. Department of Transportation (DOT) regulations and the U.S. Department of Labor OSHA requirements, which were enacted to ensure adequate protection of the public and to help prevent pipeline accidents and failures. The proposed pipeline would be sited in accordance with applicable federal regulations, including 49 CFR 195, *Transportation of Hazardous Liquids by Pipeline*. Applicable pipeline siting requirements include Section 195.210, *Pipeline Location*:

- Pipeline ROWs must be selected to avoid, as far as practicable, areas containing private dwellings, industrial buildings, and places of public assembly.
- No pipeline may be located within 50 feet of any private dwelling, any industrial building, or place of public assembly in which persons work, congregate, or assemble, unless it is provided with at least 12 inches of soil cover in addition to that prescribed in 49 CFR 195.248 (Cover Over Buried Pipeline).

The main components of the proposed pipeline would include pipeline materials, controls, and monitoring systems. The pipeline would be constructed of carbon steel and would be approximately 12 inches in diameter[3]. The pipeline would operate at pressures up to 2,115 psia. NRG would prepare the final design of the pipeline during the design phase of the proposed project.

As currently designed, all segments of the pipeline would be installed below ground. The only pipeline features that would potentially be visible along the route would be: (1) pipeline location markers (primarily positioned at road and stream crossings, fence lines, or in areas where the pipeline would be above the ground surface); (2) cathodic protection test posts located on each side of all road crossings and

[3] 12-inch-diameter pipe has an outer diameter of 12.75 inches and inner diameter between approximately 11.9 and 12.1 inches, depending on the thickness of the pipe wall.

at waterbody crossings with main live valves (MLVs); and (3) aboveground facilities (i.e., valves, launchers/receivers, and meter stations). Location posts, cathodic protection, and facilities would be located within the maintained ROW. Location posts would be approximately 4.5-feet-tall and display the mileage as well as a cautionary statement such as, "In case of emergency or before digging, call (owner's name and telephone number)." NRG would follow common industry practice for pipelines of this length and install shut-off valves on either side of each major river crossing, plus block and check valves as required by DOT regulations.

NRG plans to install 12 MLVs along the proposed pipeline to stop the release of CO_2 should a puncture or rupture occur. These valves, along with pipeline pressure monitoring equipment, would be linked to the CO_2 capture system operations control room, which would be staffed at all times when the CO_2 capture system is in operation. In the event of a pressure drop significant enough to indicate a pipeline rupture, the control room operator would shut down the CO_2 capture system and remotely activate the main line valves to prevent further damage to the pipeline and minimize impacts to the surrounding environment. As currently designed, NRG plans to install 12 MLVs (approximately 100 square feet each) along the proposed pipeline, including MLVs on either side of the San Bernard River, Jones Creek, Colorado River, Blue Creek, and Lavaca River. In some areas where two waterbodies are located close together, a single pair of MLVs may be installed around more than one waterbody (e.g., around the Colorado River and Jones Creek). There would be two meter stations, one of which would be located within the CO_2 capture facility area at the W.A. Parish Plant. The other approximately 0.25-acre meter station would be located within a five-acre parcel of land along the pipeline ROW near the intersection of C.R. 432 and C.R. 433 (i.e., near MP **77**), approximately one mile east of the Lavaca River crossing, as shown in Appendix D-1. Launchers and receivers for in-line inspection tools (e.g., smart pigs) would be integrated into the meter station footprints.

Table 2-6 provides more specific characteristics of the proposed CO_2 pipeline route, including the number of waterbody crossings (i.e., streams, rivers, canals, ditches, and ponds), area of potential wetland impacts within the construction ROWs, and number of residences within 500 and 1,000 feet of the proposed route. No hospitals or schools are located within 1,000 feet of the proposed pipeline route.

Table 2-6. Summary of CO_2 Pipeline Route

Pipeline Segment Name	Route Length (miles)	Existing ROW (miles)	New ROW (miles)	Number of Waterbody Crossings	Acres of Construction ROW	Wetland Areas within Construction ROW (acres)	Residences near Pipeline, within[a]:	
							1000 feet	500 feet
Fort Bend County	20.2	20.2	0	**64**	**258**	28	**65**	**32**
Wharton County	**37.3**	**24.9**	**12.4**	103	**477**	**27**	**18**	**5**
Jackson County	**23.8**	**15.2**	8.6	**44**	**304**	26	**40**	**10**

[a] There are no hospitals or schools located within 1,000 feet of the pipeline corridor.

2.3.3.3 Construction Phase

A typical **pipeline construction spread** consists of the following operations:

- Site preparation (clearing and grading)
- Trenching
- Pipe stringing and bending
- Welding, coating, and inspection
- Lowering pipe and backfilling
- Testing
- Restoration (final grading and re-establishment of vegetation)

For the Parish PCCS Project, the proposed pipeline would be constructed by a single, approximately 20-mile-long construction spread.

The pipeline construction ROW would be approximately 100 feet wide in most areas, although the width of the construction ROW may be reduced to 75 feet in some areas to minimize impacts to wetlands. The permanent pipeline ROW would be approximately 30 feet wide. NRG would work with landowners to negotiate agreements for construction ROW, permanent ROW, construction access roads, and any other temporary or permanent land use for the proposed project. As NRG's proposed pipeline would not be considered a common carrier (i.e., a utility with more than one customer beside the utility owner) under current Texas law, NRG does not have the right of eminent domain and cannot acquire a landowner's property by condemnation. Figure 2-7 shows typical pipeline construction methods. Construction of the proposed pipeline would take place over approximately six months beginning in **July** 2014.

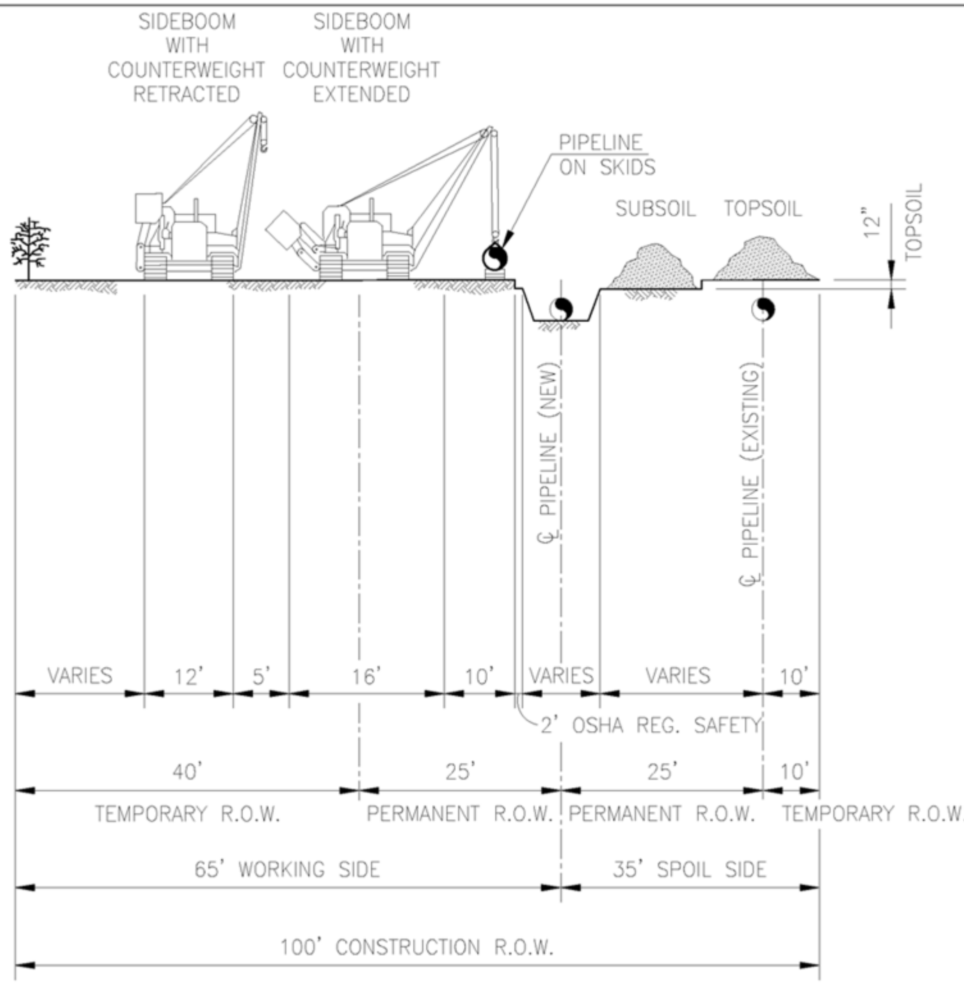
Construction techniques may include excavated trenching, boring, tunneling, and horizontal directional drilling (HDD). Typical pipeline construction equipment would include excavators, trenching machines, pipe layer, mobile cranes, bulldozers, motor graders, dump trucks, front-end loaders, portable welding rigs, radiographic inspection equipment, pipe bending machines, water pumps and filters, transport trucks, and crew trucks and buses. The size and quantity of equipment would vary based on the terrain characteristics and obstacles that would be traversed by the pipeline. During pipeline construction, materials would be staged adjacent to the pipeline ROW or trucked in as necessary.

Because near-surface soils along the proposed pipeline route are composed of unconsolidated sediments, NRG does not anticipate that blasting would be required for pipeline construction. If blasting becomes necessary, NRG would develop a blasting plan for safety purposes and would notify occupants of nearby buildings, residences, agricultural areas, and other areas of public gathering sufficiently in advance.

The pipeline construction process looks much like a moving assembly line, which is conducted by a series of operations that make up a construction spread (see box at right). For the Parish PCCS Project, the proposed pipeline would be constructed by a single, approximately 20-mile-long construction spread.

During site preparation, the full width of the ROW (i.e., including temporary construction ROW and permanent ROW) would be cleared of trees and brush. After clearing, the ROW would be graded so that equipment could operate safely. Next, the trench for the pipeline would be excavated. The soil removed during trenching would be placed on one side of the trench, while the opposite side would be used for pipeline assembly (i.e., stringing and bending), welding operations, and operation of other equipment. Welds would be radiographically inspected (i.e., x-rayed) before a protective coating is applied to welded areas, and the pipe lowered into the trench.

In agricultural areas and wetlands, topsoil would be temporarily stored separately from other excavated material and in a manner to minimize erosion. A majority of the excavated material would be returned to the trench and the site would be restored to its original grade. The topsoil would be replaced as the upper-most soil layer following pipeline construction.



LAND USE	SPOIL SIDE (FT.)	WORKING SIDE (FT.)	CONSTRUCTION R.O.W. (FT)
AGRICULTURAL, PASTURES, HAY- FIELDS AND RESIDENTIAL AREAS	35	65	100
WETLANDS	35	40	75

NOTES:

1. ALTHOUGH THE DIMENSIONS SHOWN ARE TYPICAL, SOME VARIATIONS MAY EXIST DUE TO SITE SPECIFIC CONDITIONS. UNLESS OTHERWISE INDICATED ON THE ALIGNMENT SHEETS, THE MAXIMUM WIDTH OF THE CONSTRUCTION RIGHT-OF-WAY SHALL BE AS SHOWN IN THE TABLE FOR THE APPROPRIATE PIPE DIAMETER.
2. TOPSOIL AND SUBSOIL SHALL BE SEGREGATED WITHIN WETLAND, RESIDENTIAL, AGRICULTURAL, PASTURES, HAYFIELDS AND OTHER AREAS AT LANDOWNER'S OR LAND MANAGING AGENCY'S REQUEST.

petra nova
an NRG company

TYPICAL CONSTRUCTION RIGHT-OF-WAY

DRAWN BY: PCS	CHK'D. BY: PCS
DATE: 11/28/2011	APPRV. BY: PCS
DWG. NO. PERMIT-001	REV A

Figure 2-7. Typical Pipeline Construction Methods

In general, NRG would attempt to reduce the width of the construction ROW in wetland areas from 100 feet to 75 feet. However, since NRG would be collocating the proposed pipeline with a number of other utilities and would be required to maintain an adequate distance from its construction activities to those existing utilities, NRG's options to minimize wetland impacts may be limited in some areas. If a reduction in ROW width to 75 feet achieves only minor reductions in wetlands impacts (e.g., less than 0.01 acre) or in areas where topsoil may be inundated, and therefore difficult to segregate effectively in a 75-foot-wide ROW, NRG would make a field determination during construction as to whether the ROW width can be reasonably reduced to 75 feet without increasing overall environmental impacts (e.g., increased number of access roads and longer construction schedule because reduced construction ROW width would eliminate the traffic lane from the construction ROW, requiring transport of construction equipment around wetland areas). If reduction of the ROW width would increase overall environmental impacts, then NRG may use a 100-foot-wide construction ROW along with topsoil segregation and/or matting or low ground pressure equipment to minimize wetland impacts.

Typically, the pipeline would be covered by a minimum of three feet of compacted soil. The pipeline would be buried deeper (e.g., minimum of four feet in cultivated areas) or would be encased in reinforced concrete when needed to accommodate planned surface activities or when crossing under roadways, wetlands, or water bodies. Techniques for crossing streams would depend on considerations of safety, environmental compliance, and constructability factors specific to the particular location. After lowering and backfilling the pipeline in the trench, the pipeline would be tested by filling the pipeline (or section of pipeline) with water and pressure-testing it using pressures higher than the normal operating pressures (i.e., hydrostatic testing, or hydrotesting).

After pipeline installation is complete, the ROW would be graded to restore the ground surface to pre-construction contours and allowed to revegetate. Wastes generated from the construction of the proposed CO_2 pipeline would primarily consist of land clearing waste, drilling mud from HDDs, and spent hydrotest water generated during the hydrostatic testing of the pipeline. NRG would ensure that the pipeline contractor provides an acceptable plan for off-site disposal (e.g., landfarming, landfills, other construction areas needing fill material) of any debris that is not suitable for placement on the ROWs.

NRG's current project design would use HDD construction techniques in **six** sections of the proposed pipeline corridor, including the section between the CO_2 capture facility and the CenterPoint ROW **and** five **sections where larger** water bod**ies are crossed** (i.e., Big Creek, San Bernard River, Colorado River **and** Jones Creek **[as one crossing]**, Lavaca River**, and Menefee Bayou**). An HDD is conducted using a surface-launched drilling rig to drill an underground pilot hole from an entry pit in a shallow (i.e., low-angle) arc using a steerable cutting head until it reaches the exit pit on the other side of the HDD. The pilot hole is then reamed until the final borehole diameter is achieved. During drilling and reaming, the borehole is filled with drilling mud to hold it open. After reaming, the drill string is connected to a pipe string that has been fabricated on the exit side and the pipe string is pulled through the borehole while drilling mud is collected into a mud pit adjacent to the entry pit. If the HDD is not parallel with the section of pipeline ROW on the exit side of the HDD, a length of "false ROW", so named because it is located off the ROW in which the pipeline would be installed, is generally cleared parallel with the HDD to assemble the pipe string that would be pulled back through the HDD borehole. Figure 2-8 illustrates a typical waterbody crossing plot plan using HDD construction techniques.

NRG's current design would use a 20-inch to 24-inch-diameter cutting head to ream HDDs to final diameter for the 12-inch-diamter pipeline. Entry and exit pits, each approximately 10 feet wide and 10 feet long, would be dug on either side of the HDD to the depth of the adjacent pipeline trench (i.e., three to four feet deep). The mud pit at the entry side of the HDD would be approximately 25 feet wide, 25 feet long, and five feet deep.

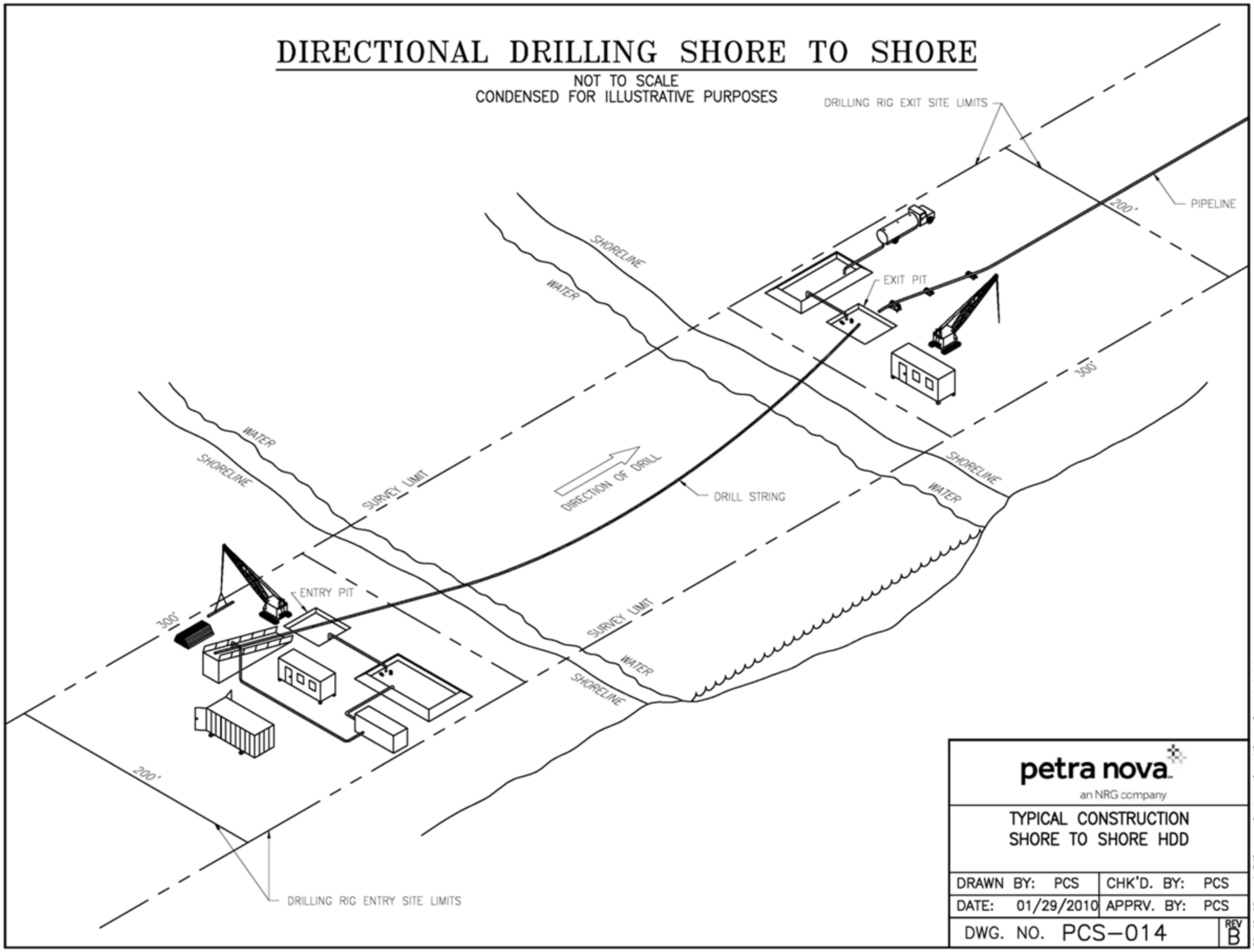


Figure 2-8. Typical HDD Waterbody Crossing Plot Plan

NRG's current design also includes conventional bores for most road crossings. As shown in Figure 2-9, these bored road crossings are similar to HDD borings except the borehole is advanced over a shorter distance in an approximately straight line from the entry pit to the exit pit.

Construction water use would be heaviest during the hydrostatic testing of the pipeline. As designed, two primary hydrotests would be conducted with each test evaluating the integrity of approximately 40 miles of the overall pipeline. Separate, smaller hydrotests may also be conducted for each HDD. Water required for hydrostatic testing may be trucked in or obtained from surface water bodies adjacent to the pipeline. NRG does not anticipate the need to use groundwater or drill groundwater wells to obtain hydrotest water or other water required for pipeline construction. If surface water is used for hydrotesting, TCEQ water appropriation permits would be obtained, as appropriate, prior to water uptake. Hydrotest water would be reused for subsequent pressure tests if practicable. Assuming that the majority of hydrotest water can be reused, approximately 1.25 million gallons of hydrotest water (i.e., 40 miles of 12-inch-diameter pipe) would be required for hydrostatic testing.

Spent hydrotest water would be tested to properly characterize the waste prior to discharge. To the extent practicable, NRG plans to discharge spent hydrotest water to upland areas. NRG would conduct hydrotest water discharges consistent with RRC guidelines, and RRC discharge permits if applicable, and TCEQ BMPs for water management and erosion control, including use of appropriately designed discharge structures (e.g., silt fencing and/or hay bales). NRG would obtain applicable permits from the RRC, as appropriate, and from the EPA (i.e., if water would be discharged to waters of the U.S.) for the discharge of hydrotest water prior to conducting hydrotests.

The pipeline construction workforce would average **250** workers and reach a peak of 500 workers over the six-month construction period. Construction activities would generally be conducted 10 hours per day and six days per week. NRG would provide the construction workers with potable water, portable toilets, and hand-wash stations.

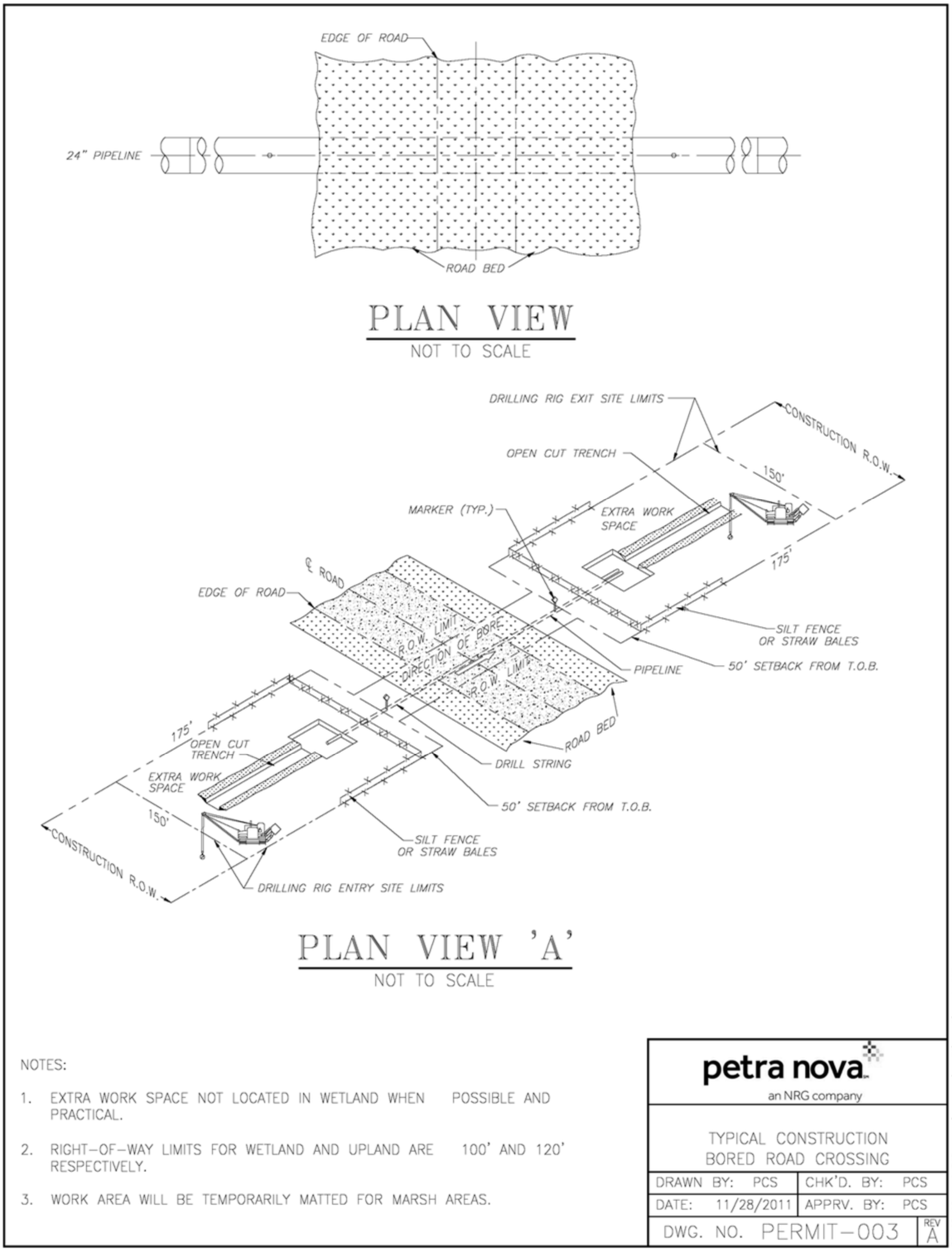


Figure 2-9. Typical Bored Road Crossing Plot Plan

2.3.3.4 Operation Phase

The DOT Pipeline and Hazardous Materials Safety Administration (PHMSA) and the RRC would have regulatory jurisdiction over the proposed CO_2 pipeline. The CO_2 pipeline would be designed, operated, and maintained in accordance with the federal DOT safety standards in 49 CFR 195 (Transportation of Hazardous Liquids by Pipeline), which require the pipeline operator (i.e., TCV) to:

- develop and implement an emergency plan (see below), working with local fire departments and other agencies, to identify personnel to be contacted, equipment to be mobilized, and procedures to be followed in responding to a hazardous condition caused by the pipeline or associated facilities;
- establish and maintain a liaison with the appropriate fire, police, and public officials to coordinate mutual assistance when responding to emergencies; and
- establish a continuing education program to enable customers, the public, government officials, and those engaged in excavation activities to recognize a CO_2 pipeline emergency and report it to appropriate public officials.

Key elements of any emergency plan would include procedures for:

- receiving notifications of, identifying, and classifying emergency events such as gas leakage, fires, explosions, and natural disasters;
- establishing and maintaining communications with local fire, police, and public officials and coordinating emergency responses;
- making personnel, equipment, tools, and materials available at the scene of an emergency,
- providing proactive protection for people and insuring human safety from actual or potential hazards; and
- ensuring emergency shutdown of the system and safely restoring service.

Before placing the pipeline in service, TCV would prepare a procedure manual for operation and maintenance of the pipeline. During operations, TCV would monitor and maintain the pipeline in compliance with all regulatory requirements. Typical monitoring and maintenance procedures could include:

- population density survey, once every two years;
- ROW inspection, 26 times each year (i.e., every two weeks);
- valve maintenance and inspection, twice each year;
- emergency systems check, once each year;
- rectifier maintenance, six times each year;
- cathodic-protection survey, once each year;
- internal inspection of the pipeline using an electronic tool, every seven years or more frequently if necessary;
- check of overpressure safety devices, once each year; and
- public awareness and damage prevention program.

> **Pigging** refers to the practice of using pipeline inspection devices or "pigs" to perform various operations on a pipeline without stopping the flow of the product in the pipeline. These operations include, but are not limited to, cleaning and inspection of the pipeline.

ROW inspections would be conducted to identify dry vegetation, soil erosion, unauthorized encroachment, or other conditions that could result in a safety hazard or require preventative repairs or maintenance. Inspections would also ensure that no third-party activity would be likely to jeopardize the pipeline (e.g., via excavation). Cathodic protection surveys would be conducted annually to verify that corrosion protection is adequate.

Inspection activities may require that pipeline "pigging" be performed occasionally to displace water during or after long periods of reduced flow rate or to displace contaminants after an upset condition.

2.3.4 EOR Operations

2.3.4.1 Location and Background

The proposed EOR activities would take place at the West Ranch oil field in Jackson County, located south of the town of Vanderbilt, as shown in Figure 2-10 and Figure 2-11. The West Ranch oil field has produced oil continuously since 1938, first by primary production (i.e., conventional pumping) and then by water flooding the reservoirs (i.e., secondary production) under a series of different owners. In recent years, production rates at the West Ranch oil field have declined as the easily produced oil has been depleted from several units in the Frio Formation. HEC has started implementing plans to upgrade piping and well head infrastructure and remove or demolish obsolete or unneeded equipment to prepare the site for future EOR operations.

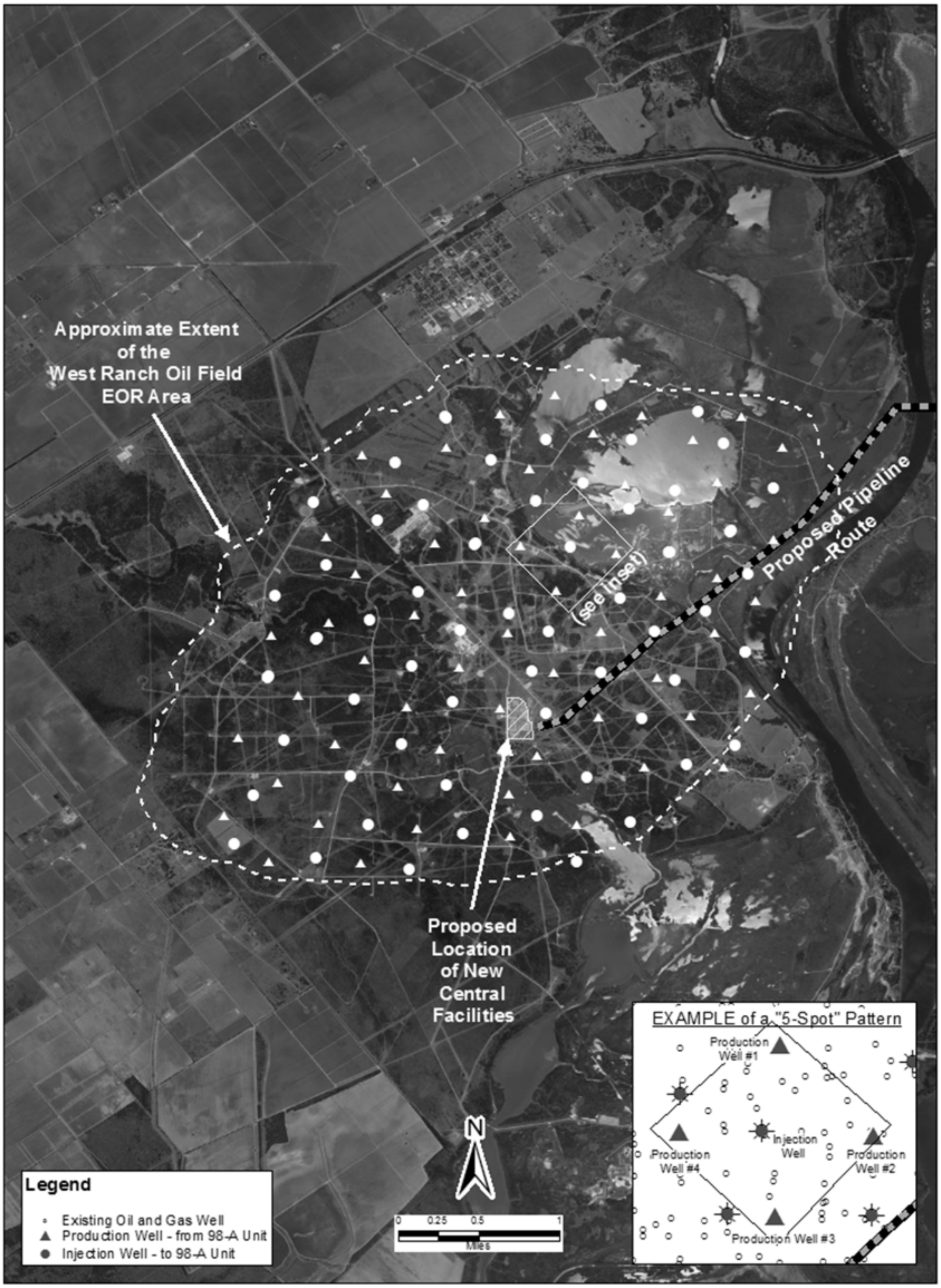


Figure 2-10. Map of West Ranch Oil Field Showing Conceptual Arrangement of Injection and Production Wells for Proposed CO_2 Flood

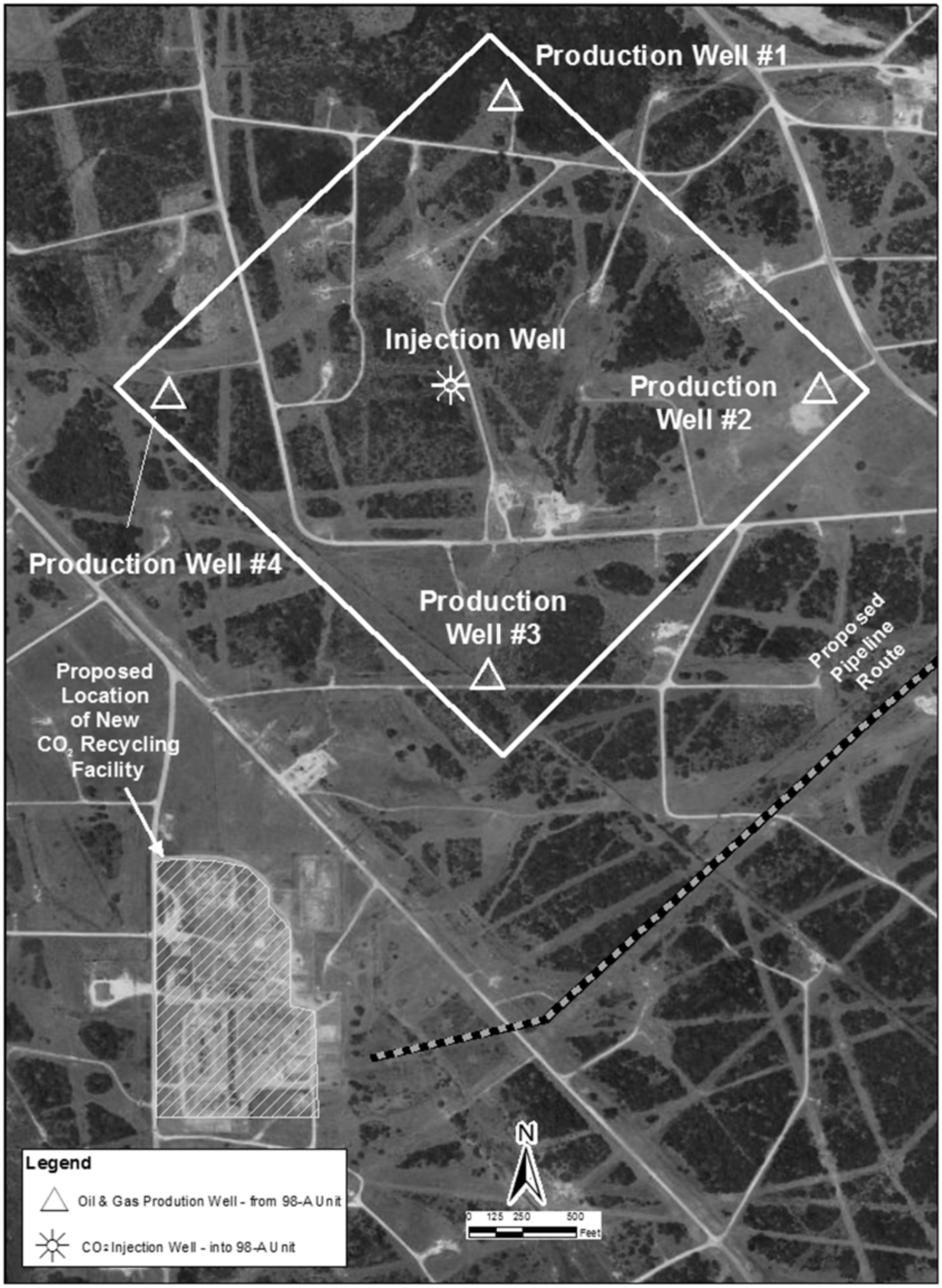


Figure 2-11. Example "5-Spot" Pattern for Enhanced Oil and Gas Recovery by CO_2 Injection

2.3.4.2 System Component Overview

2.3.4.2.1 Overview of Frio Formation

The Frio Formation of the Gulf coastal plain is a well-characterized oil-producing geological formation which is found between approximately 5,000 and 7,200 feet bgs in the area of the West Ranch oil field, as discussed in Section 3.4 of this EIS (Geology). NRG's proposed project would inject approximately 1.6 million tons of CO_2 per year into the 98-A, 41-A, Glasscock, and Greta sand units of the Frio Formation, which are oil-bearing geologic units that lie approximately 5,000 to 6,300 feet bgs. The CO_2 injection that would occur during the proposed EOR operations is also referred to as tertiary production or a "CO_2 flood". Successful recovery of oil at this stage in the field's history requires the injection of large volumes of CO_2, which in this case would be obtained from the W.A. Parish Plant CO_2 capture facility and delivered to the West Ranch oil field in the proposed pipeline described in Section 2.3.4 of this EIS. NRG and its partner HEC anticipate that through the use of a CO_2 flood, the tertiary production phase at the West Ranch oil field could yield significantly more oil than could be recovered by additional primary and secondary production. TCV's portion of the West Ranch oil field currently contains approximately 51 active, 415 inactive, and 244 plugged and abandoned wells and has approximately two million barrels of conventional proven oil reserves. However, TCV estimates that using CO_2 floods (i.e., EOR), the West Ranch oil field could produce an additional 55 and 75 million barrels of oil (HEC 2012b).

Sandstones of the Oligocene-age Frio Formation are ancient river delta and beach deposits that extend regionally around the Gulf Coast Basin from the Texas-Mexico border to just west of the Texas-Louisiana border. In general, the Frio sands are typical of reservoir sandstones along the Texas and Louisiana Gulf coasts, where porosity ranges between 28% and 32% and permeability is high (i.e., in the 200 to 2,000 millidarcy [mD] range). The Anahuac Formation, which is over 400 feet thick and overlies the Frio Formation at the West Ranch oil field, is expected to provide an effective caprock above the proposed Frio Formation injection reservoir for inhibiting CO_2 migration into overlying geologic formations. The high reservoir net thickness, porosity, and permeability of the target geologic units along with the integrity of the caprock gives the Frio Formation a high storativity and, presumably, low risk of leakage. High primary oil recoveries, which presumably were aided by a strong water drive, suggest that areal and vertical sweep efficiencies (i.e., ability to recover additional oil) using CO_2 floods should also be excellent (NRG/BEG 2010).

CO_2 injection and geologic storage within the Frio Formation have been demonstrated as part of the Frio Brine pilot study near Dayton, Texas (Hovorka, et al. 2005; NETL 2009). CO_2 injection and EOR within the Frio Formation have also recently been demonstrated at the Hastings field near Alvin, Texas, with the initiation of CO_2 injection in December 2010 and EOR operations beginning in January 2012 (Denbury 2012). Preliminary reservoir modeling conducted by the Texas Bureau of Economic Geology (BEG), which is presented in Appendix H of this EIS, indicates that injected CO_2 and the associated areas of elevated pressure within the target geologic units would remain within the TCV lease areas both during and after EOR activities. The effectiveness of the Anahuac Formation in confining buoyant fluids over geologic time has been demonstrated directly by hydrocarbon accumulation (e.g., oil and gas) beneath the West Ranch oil field. Additionally, data collected on pressure and fluid migration for over 70 years of production history at the West Ranch oil field provides a strong base of experience to support the findings of the preliminary reservoir modeling (i.e., Appendix H of this EIS) that CO_2 would be retained in the Frio Formation within the proposed West Ranch oil field EOR area.

Testing and monitoring would be conducted for an approximately 12-month period prior to the injection of CO_2 to characterize subsurface conditions in and around the West Ranch oil field. Monitoring would also be conducted during the test program to continue assessing the integrity of the field (i.e., in accordance with RRC requirements, as specified in 16 TAC 5.305). Details of the CO_2 monitoring program are provided in Section 2.3.5 of this EIS.

TCV **conducted** a CO_2 injection pilot test at the West Ranch oil field beginning in September 2012. Results of the pilot test would be used to develop the CO_2 injection strategy and monitoring plan, and provide input to the UIC permit application. The **duration of the** pilot test **was 17 days and required** up to 850 tons per day of commercially produced CO_2. Approximately 20 CO_2 tankers parked on an existing gravel pad at the West Ranch oil field to provide the CO_2 supply for the pilot test and approximately 40 tankers per day **delivered** additional CO_2 through the duration of the pilot test. The pilot test **included** one production well and four associated injection wells. Other equipment required for the pilot test **included** temporary pumps, CO_2 piping, and approximately 2,000 gallons of diesel fuel storage, which **were** located on-site at the West Ranch oil field. Natural gas and CO_2 **were** produced during the pilot test, with the natural gas flared and the CO_2 vented on-site.

2.3.4.2.2 Injection and Production Wells

Once operational, the injection well network at any point during operation would be capable of accommodating a total of approximately 1.6 million tons of CO_2 per year to be delivered to the West Ranch oil field via the proposed pipeline. Over the life of anticipated EOR operations, approximately 130 injection wells may be needed, each with an estimated CO_2 injection capacity of 500,000 tpy. The total number of injection and production wells operating at one time would depend on pilot test results. TCV estimates that approximately 9 injection wells and 16 production wells would be used initially. The number of injection and production wells would increase over the duration of the project to as many as 130 injection wells and 130 production wells.

A final plan for implementing CO_2 injection activities at the West Ranch oil field is currently being developed by TCV and the BEG. The preliminary plan proposes developing a series of “5-spot” patterns, with each pattern including one CO_2 injection well surrounded by four oil producing wells. Each 5-spot pattern would average approximately 40 acres in size. The precise locations of the proposed injection wells and precise configurations of the 5-spot patterns are not yet known. An example of the proposed 5-spot pattern is shown on Figure 2-10 and Figure 2-11. These maps display a potential CO_2 flood design using 5-spot patterns. The white triangles (production wells) and circles (CO_2 injection wells) depict the production/injection well locations in the target unit at depth. The current project design anticipates that existing wells at the West Ranch oil field would be used to the extent practicable for the proposed project. New injection wells would be drilled if the existing wells cannot be reworked for injection. All new injection wells would require UIC permits and TCV would install the new injection wells in accordance with the design standards specified by the RRC UIC Program. New wells would be installed on existing well pads to the extent practicable.

Preliminary plans call for the general order of CO_2 injection to include flooding the lowest sand unit (98-A) first. When enough recycle CO_2 is available, the CO_2 flood would then proceed upward toward the highest sand unit (Greta). The current plan would be to sequentially flood each sand one at a time. Two adjacent sand unit floods may be conducted simultaneously (e.g., 98-A and 41-A floods, followed by the Glasscock and Greta floods). TCV currently projects that the flood program may include the use of up to 130 CO_2 injection wells by the end of the EOR project. Each injection well would be installed to a sufficient depth that it could be completed to allow for injection into the 98-A, 41-A, Glasscock, and Greta sand units. Therefore, production from all four sand units could be accomplished using the same set of 130 injection wells.

The injected CO_2 plume would be expected to move laterally outward toward production wells, with limited vertical movement within each target injection formation. As the CO_2 is injected into the formation and in-situ formation water and trapped oil and gas are forced laterally away from each injection well, pressures would increase within the injection zone. However, because oil production would accompany CO_2 injection, the area of increased pressure and CO_2 and fluid migration would generally be maintained between the injection and production wells. In other words, development of injection and production wells in the proposed 5-spot patterns would be expected to limit the distribution of CO_2 so that it promotes migration of formation water and trapped oil and gas toward the production wells rather than flowing freely away from the area of each injection well.

Although current operations at the West Ranch oil field generate between 40,000 and 60,000 barrels per day (bpd) of produced water for reinjection or disposal, rates of produced water generation at the West Ranch oil field exceeded 100,000 bpd from 1978 to 2008 (HEC 2011b). TCV anticipates that the proposed EOR operations could generate up to 25% to 50% more produced water (i.e., an additional 10,000 to 30,000 bpd) than is currently generated at the West Ranch oil field. Consistent with current practices for ongoing oil production activities at the West Ranch oil field, residual produced water left after recovery of oil and gas from the EOR operations would be reinjected into the Catahoula Sandstone or, if necessary, other deeper-lying geologic formations. The reinjection zone(s) would be at a depth of approximately 4,000 feet bgs or greater. Each new injection well would have an approximately seven-inch-diameter casing that would extend to the full depth of the well (i.e., approximately 6,500 feet bgs). This casing would extend well below the bottom of the lowest underground source of drinking water (USDW) underlying the West Ranch oil field, which is at approximately 1,350 to 1,600 feet bgs. Some wells at the West Ranch oil field may also be constructed with an additional outer casing, (e.g., approximately 10 inches in diameter) to further isolate the overlying USDW during well construction (HEC 2011).

To the extent practicable, existing permitted produced water disposal wells at the West Ranch oil field would be used during EOR operations. TCV does not anticipate that new produced water disposal wells would be required; however, all CO_2 injection wells would also intermittently inject produced water into the formation to control sweep and improve recovery. The EOR-generated produced water would be reinjected under a typical pressure of approximately 900 psi. Each reinjection well/system would be rated to accommodate reinjection pressures up to approximately 2,000 psi.

2.3.4.3 Construction Phase

CO_2 injection activities at the West Ranch oil field would include construction of additional facilities at the field. New facilities and components required at the West Ranch oil field for separating CO_2 from produced oil and dehydrating the CO_2 recycle stream would primarily be constructed in a centrally-located CO_2 recycle facility. As shown in Figure 2-12 and described below, other new equipment required for EOR operations would be located at existing satellite areas and adjacent to injection wells.

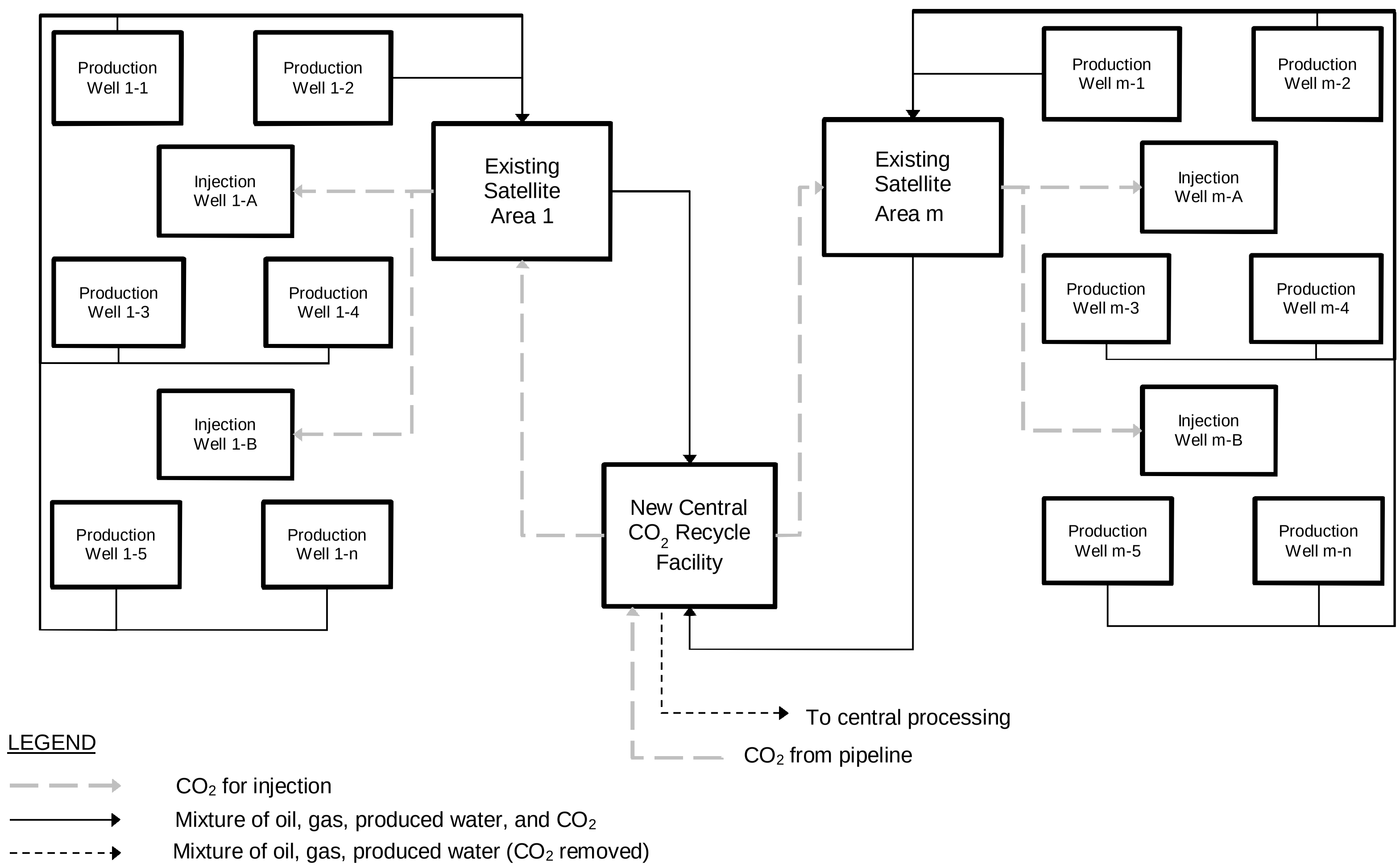


Figure 2-12. Conceptual Block Flow Diagram for EOR Facilities

TCV anticipates that injection of CO_2 into the target geologic units would require the installation of some new wells, designed for CO_2 injection in compliance with current UIC Program requirements, if the existing wells cannot be reworked for injection. Additionally, new underground piping for CO_2 distribution would be installed, to the extent practicable, along existing piping corridors. Approximately 6- to 8-inch-diameter piping would be used for trunk lines and 3- to 4-inch-diameter piping would be using to construct spurs. The trunk line would run the length of the EOR area from northeast to southwest, with the spurs running perpendicular (i.e., from the northwest to the southeast). New components that may be installed at each CO_2 injection well location would include the following:

- injection well;
- the injection wellhead;
- piping to bring the CO_2 to the well from the CO_2 distribution system manifold;
- high pressure CO_2 injection pump;
- a casing pressure transmitter;
- tubing temperature and pressure gauges and transmitters;
- an injection control building;
- an electrical panel for the injection well site;
- an injection manifold;
- an alternating water/gas injection manifold;
- a test separator; and
- CO_2 storage tanks.

Injection equipment would be stationed on the existing well pad. Equipment would be mobile and trailer-mounted, including pumping equipment and skid mounted CO_2 storage tanks, and would be mobilized off location once a CO_2 injection pilot test is finished. To provide short-term storage for the CO_2 flood operations, new injection batteries would be constructed at existing West Ranch oil field satellite facilities and would include the following equipment:

- a water tank,
- approximately two oil tanks,
- a spillover tank,
- a “gun barrel” settling tank to separate solids and water from the crude oil stream (1,000-barrel to 3,000-barrel capacity),
- an inlet separator (approximately 36-inch to 48-inch diameter),
- high pressure triplex pumps, and
- low pressure transfer pumps.

TCV would locate this equipment in existing satellite facilities consistent with the existing process flow at the oil field. There are currently 19 satellite production sites at the West Ranch oil field, each of which is approximately 0.5 to 1.0 acres in area and services several adjacent production wells. Oil from these satellite facilities is sent to one of two central tank batteries for additional processing before it is shipped offsite via pipeline. The sizing of equipment for each injection battery would depend on the expected production rates for the adjacent wells.

The new, centrally-located CO_2 recycle facility would likely include the following components:

- a single-stage separator to separate liquids out of the recycle gas stream,
- a membrane separation unit to remove CO_2 from the recycle gas stream (if required),
- a glycol contactor to dehydrate the CO_2 recycle stream,

- a compressor to increase the pressure in the CO_2 recycle stream to the level required for injection,
- flow meters and other instrumentation,
- supply and distribution headers to connect the central CO_2 recycle facility to satellite collection areas, and
- a flare to control emissions in the event of an upset condition.

HEC maintains glycol supplies in existing tanks to support existing operations at the West Ranch oil field. The additional amount of glycol required to support the CO_2 recycle facility (i.e., approximately 200-barrel storage capacity) would be negligible compared to the current glycol storage at the West Ranch oil field.

2.3.4.3.1 CO_2 Recycle Facility Construction

The CO_2 recycle facility would be constructed in a brownfield area of the West Ranch oil field, previously occupied by an oil field gas processing facility that was demolished by HEC in 2011. The exact location of the CO_2 recycle facility within this area has not yet been defined; however, the CO_2 recycle facility would have a construction footprint of approximately 1.5 acres.

The CO_2 recycle facility would likely be constructed using skid-mounted equipment on gravel pads and would require a work force of approximately 12 workers during the three-month construction period. Construction workers would likely be hired locally and contracted by TCV. Construction of the CO_2 recycle facility would likely require the following equipment: a bulldozer, a mobile crane, a support truck for moving equipment, and a small excavator.

2.3.4.3.2 Well Construction

TCV plans to use existing wells (i.e., re-refurbished or deepened, as needed) for the proposed project to the extent practicable so that few, if any, new production wells would be needed. New injection wells would be drilled if the existing wells cannot be reworked for injection. All new injection wells would require UIC permits and TCV would install the new injection wells in accordance with the design standards specified by the RRC UIC Program. Drilling of the new injection wells would take place primarily during the early part of the project, most likely during the first year of operation. New wells would be installed on existing well pads to the extent practicable. The following section describes how new wells would be constructed.

Each well would be constructed in four phases over a period of approximately one to four months, as follows:

- Phase 1: Site Preparation
- Phase 2: Drilling
- Phase 3: Evaluation and Permitting
- Phase 4: Completion and Production

The site preparation phase would take approximately one week to one month to complete, during which time the drill pad would be cleared and graded, if necessary, mud pits would be excavated and lined, and access roads would be regraded, as necessary. Trucks would be required to bring fill material for access roadways as necessary, remove unneeded equipment or debris from the construction sites, and stockpile fill material. Drilling the well would require approximately one month. Evaluation and permitting would take approximately three months (i.e., to obtain RRC approval). Completion of the well and tie in to the facility would take approximately one week. A typical drilling rig would require five workers per 12-hour shift, with one crew on shift and one crew off. These crews would reside at their own homes or other living quarters in nearby towns (e.g., Vanderbilt). A number of additional personnel may be required to be on location during various stages of the drilling operation, including a geologist, a mud logger, and other service personnel. In some cases, these individuals would be required to remain on location 24 hours per day during drilling operations.

TCV would improve existing access roads to each injection well, as needed, to support drilling activities. Gravel and road base would be used for the access roads, material storage areas, and parking areas. Access roads would be between 12 and 15 feet wide, with approximately five-foot drainage ditches on each side. Access roads would accommodate trucks up to 40 tons. Existing roads would be used to the extent practicable to access EOR and CO_2 monitoring areas within the West Ranch oil field. No new road construction is anticipated. New wells would be installed on existing well pads to the extent practicable. Well pad and access road construction, if required, would require a maximum of four workers for a period of approximately five days per location. These workers would include both heavy equipment operators engaged in road and well pad construction and truck drivers hauling heavy equipment and materials to and from locations. Construction workers would likely be hired locally and contracted by TCV.

During construction, each injection well site would require approximately 0.5 to 2.0 acres to support the construction process. Fencing around each well site would not be needed because the West Ranch oil field perimeter is fenced to control access. The equipment, materials, and temporary infrastructure required to support the drilling operations would be brought on site. Potable (drinking) water, portable toilets, and hand-wash stations would be provided for use by construction workers at each well site. Figure 2-13 shows a conceptual layout of the well construction area, including typical facilities and equipment that would be required to support drilling operations. This equipment would include the following:

- Drilling Rig – a mobile drilling rig with a portable tower derrick to be installed over the well bore (120 to 180 feet in height);
- Pipe Racks – temporary structures used to hold (1) drilling pipe before and after use and (2) well casing and tubing before it is installed into the well;
- Storage Sheds – for equipment and materials storage;
- Office Trailers – trailers or conex boxes for temporary office space, break areas, or equipment storage areas;
- Air Compressors – very large portable air compressors with self-contained diesel-powered generators to supply air to drilling rig;
- Generators – self-contained, portable diesel-powered generators to supply power to construction equipment and facilities as needed;
- Holding Tanks – large, tractor-trailer sized storage tanks for temporary storage of drilling fluids or other fluids (i.e., brine, formation fluids, and acid) that are pumped to or from the well (may also be used for storage of non-potable water or brine to support drilling operations);
- Water Tank –for the storage of non-potable water;
- Mud Tanks –for mixing drilling fluids (drilling mud);
- Mud Pits – pits excavated in the ground lined and used for the temporary storage of drilling fluids during drilling operations; and
- Mud Pumps – used to convey drilling fluids from mud tanks to the borehole.

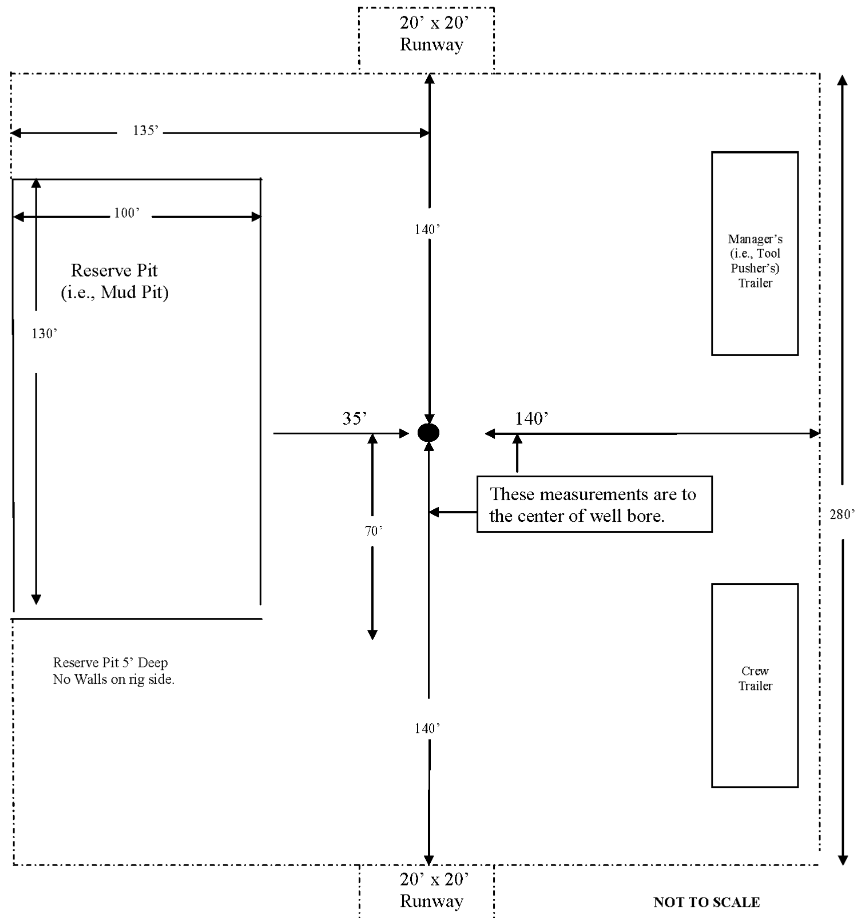


Figure 2-13. Conceptual Layout of Well Construction Area

Wells would be installed as described in Table 2-7. Fresh water aquifers would be protected by running steel casing into the open borehole and cementing the casing into place. Cementing would also isolate all other formations in the hole and minimize the potential for contamination between hydrocarbon zones and/or water aquifers and other mineral resources. The casing is installed into the well and cemented in place by pumping cement slurry between the casing and the sides of the borehole. The base of each injection well would use CO_2-resistant cement. No abnormal temperatures, high pressures, or hydrogen sulfide (H_2S) are anticipated to be encountered during drilling.

Table 2-7. Typical Injection/Production Well Construction

Casing String	Casing Diameter (inches)	Borehole Diameter (inches)	Cemented Interval (feet)	Approximate Set Depth (feet bgs)
Steel Casing (Prod. CSG 7" 23# L-80 BTC)*	7	9-5/8**	From total depth of borehole to the surface	6,500

*Prod. CSG 7" 23# L-80 BTC = specification for steel pipe with seven-inch nominal outside diameter (CSG 7"), weighing 23 pounds per foot tubing (23#), with buttress thread casing coupling (BTC). L-80 describes the joint strength. Wall thickness is 0.317 inches.
**Borehole would be drilled with a nominally 9.625- inch-diameter auger.

After the well casing has been installed and cemented in place, the well head would be set, gauges would be installed, and the distribution and collector piping would connected to the well. The final phase of the well construction process (i.e., stabilization and site restoration) would then be initiated. The drilling rig and derrick would be dismantled and taken offsite and the well site would be restored. All drilling equipment and infrastructure would be removed from the site, the mud pits would be filled in, and the site would be regraded as necessary. The disturbed soils would be reseeded and restored to pre-construction conditions. In the event that roads are damaged through site construction activities, TCV would perform repairs as necessary to return the roadway to its pre-construction condition.

Approximately 30,000 to 50,000 gallons of water would be required to drill each new well. Assuming no re-use, the total volume of water used for drilling 32 wells would range from 960,000 to 1,600,000 gallons. This water would be obtained from water supply wells in the field. Drilling new wells would take place primarily during the early part of the project, most likely during the first three years of operation.

Typical BMPs that would be implemented to avoid or minimize potential impacts to surface waters during construction activities are described in Section 3.7 of this EIS (Surface Water). If any spills of reportable quantities for oil, gas, or other fluids occur, TCV would immediately initiate response actions established in the West Ranch oil field’s SWPPP and SPCC plan, as applicable; provide notice to regulatory agencies; and initiate cleanup efforts.

Any new injection or disposal wells would require a Class II injection well permit to be issued as part of the RRC’s UIC Program prior to construction. This permitting process also requires an evaluation to determine if nearby abandoned wells have been plugged in a manner that would prevent movement of fluids into strata other than the authorized injection or disposal zone within a quarter-mile (0.25-mile) radius of the proposed well location.

2.3.4.4 Operation Phase

After completion of initial testing and monitoring, increased amounts of CO_2 would be injected into the Frio Formation and full-scale EOR operations would commence. TCV estimates that approximately 9 injection wells and 16 production wells would be used initially. The number of injection and production wells would increase over the duration of the project to as many as 130 injection wells and 130 production wells. Approximately 5,475 tons of CO_2 would be injected daily.

Injection of CO_2 helps lower the oil viscosity and reduce trapping forces in the reservoir, slightly swells the volume of the oil, and helps provide a driving force to sweep oil from the reservoir to the production wells. In this manner, EOR helps contact bypassed and occluded oil that could not be recovered during primary (i.e., conventional pumping) and secondary (i.e., water flood) phases of production. Water may also be injected as part of EOR to assist in pushing oil towards the production wells. These actions enable a portion of this “stranded oil” to become mobile, moving the oil to a wellbore where it can be recovered.

As shown in Figure 2-14, EOR is a multiple contact process involving interactions between the injected CO_2 and the reservoir’s oil. During this process, CO_2 vaporizes the lighter oil fractions into the injected CO_2 phase and CO_2 dissolves into the reservoir’s oil phase. This leads to two reservoir fluids that become miscible (i.e., mixing in all parts) with favorable properties of low viscosity, enhanced mobility, and low interfacial tension (NETL 2008). Figure 2-14 illustrates the manner in which CO_2 injection helps mobilize oil within the oil reservoir, allowing it to more freely flow to a production well.

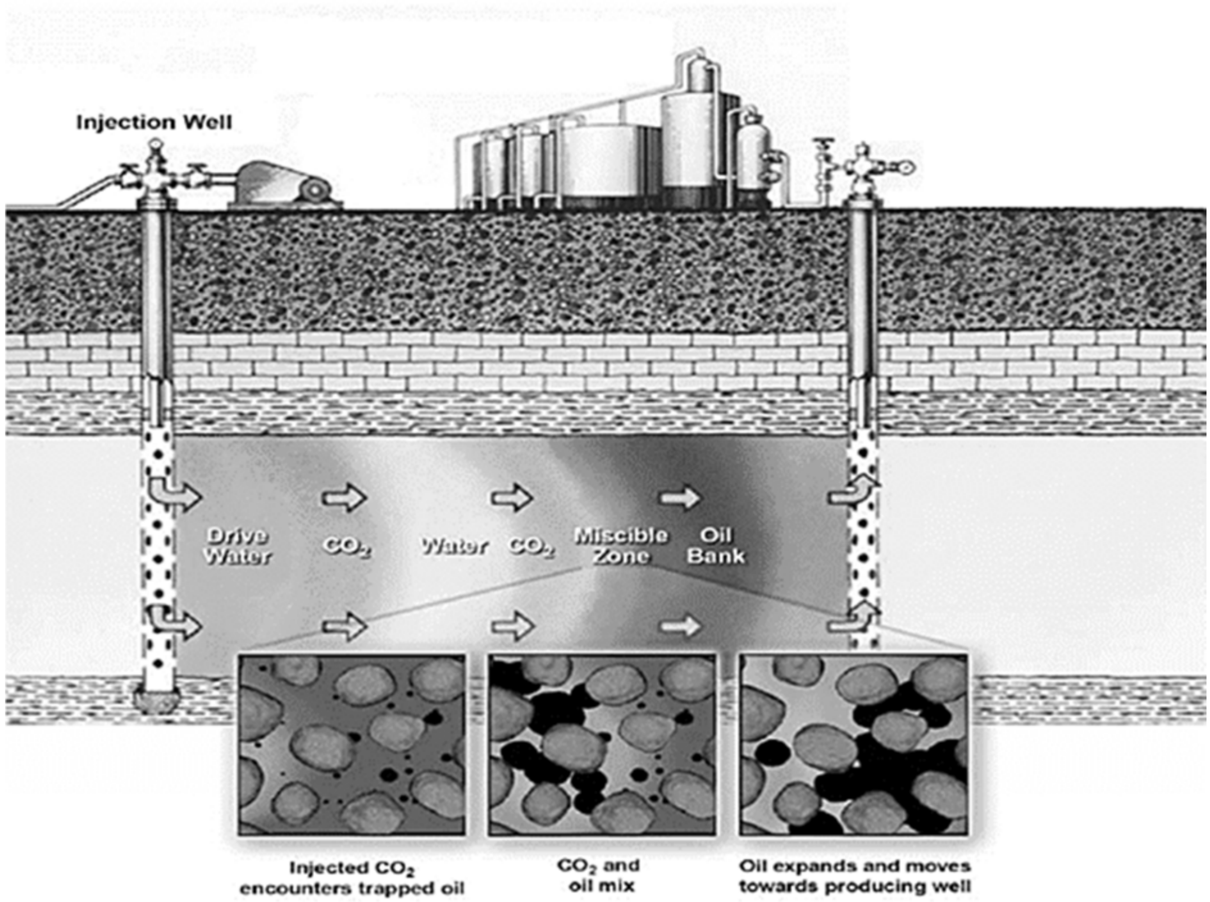


Figure 2-14. Enhanced Oil Recovery Schematic
Source: NETL 2010.

Crude oil pumped from the reservoir would be mixed with natural gas, CO_2, and water. As indicated in Figure 2-3, the CO_2 recycle facility would separate the CO_2, compress and dehydrate it, and combine it with CO_2 from the 12-inch-diameter CO_2 pipeline for reinjection into the formation. Excess produced water would be treated and reinjected as part of EOR operation of injected into the Catahoula Sandstone, at a depth of approximately 4,250 to 4,500 feet bgs, through a disposal well in the same manner that HEC manages produced water from current operations at the West Ranch oil field. Natural gas would be delivered to the existing Kinder Morgan pipeline that currently serves the West Ranch oil field. An additional approximately five million standard cubic feet of natural gas would be produced daily. The existing Kinder Morgan natural gas pipeline is a six-inch-diameter pipeline with the capacity to receive the maximum amount of natural gas that would be produced from the EOR operations.

Each injection well would require approximately 0.1 to 0.5 acres during operations. This area would be maintained and kept clear of new tree or shrub growth. The following maintenance activities may occur during operation of the proposed injection wells on an as-needed basis:

- Well Workover – pulling the tubing out of the well, inspecting the tubing, packer, and downhole assembly on the way out of the well, performing any necessary repairs or downhole modifications, and reassembling the well.

- Wellhead Maintenance – includes greasing wellhead valves, replacing seals, and replacing any defective parts.
- Acidizing – Certain geologic formations require acidizing (i.e., pumping acid down the well and into the target geologic unit) to enhance the efficiency of oil production. The Frio Formation does not normally require acidizing. In cases of formation damage due to drilling and well workovers, small acid jobs may be performed to return the permeability of the formation back to its original state.
- Swabbing – During swabbing operations, pipe, wireline tools, or rubber-cupped seals are moved within the well to reduce pressure and draw fluids into the well and towards the surface. Fluids pumped from the well (i.e., produced water, formation fluids, and potentially acid) are collected at the existing water separation facility, treated, and discharged.

Wastes generated during the maintenance of injection wells would consist of old parts or seals replaced on various well components. These would be properly disposed of as solid waste in the same manner that these wastes are currently managed at the West Ranch oil field. During swabbing operations, an acid/produced water mixture would be generated that would be hauled offsite by a service vendor in tanker trucks to an appropriate disposal facility.

HEC currently operates the West Ranch oil field with six-person crews working 24 hours per day (two shifts per day), seven days per week. Because EOR operations would be automated to the extent practicable, TCV anticipates that current operations personnel would also be responsible for the EOR operations. No additional operations personnel would be required.

2.3.5 CO_2 Monitoring Program

TCV intends to seek certain tax exemptions related to use of CO_2 for EOR and use of CO_2 from anthropogenic sources. To qualify, the RRC requires certification under the provisions of 16 TAC 5 that oil was produced using CO_2 and that the CO_2 was from an anthropogenic source. TCV intends to pursue both of these certifications in order to qualify for these tax exemptions. In addition to satisfying the CO_2 monitoring requirements of the CCPI Program, the CO_2 monitoring program that would be conducted at the West Ranch oil field would be designed to satisfy the monitoring, sampling, testing, and reporting requirements of the RRC certification program.

BEG is working as a consultant to TCV to support the CO_2 monitoring program. TCV and BEG are currently in the process of developing a CO_2 Monitoring Plan for the West Ranch oil field to define the particular activities that would be conducted as part of the Parish PCCS Project CO_2 monitoring program. In addition to developing the CO_2 Monitoring Plan, BEG would assist TCV in analyzing the data generated by the CO_2 monitoring program. Results of the CO_2 monitoring program would be reported to the RRC, which is the certifying agency for the CO_2 tax credits. The RRC is also the regulatory agency that implements the UIC Program for oil and gas facilities in Texas.

This section of the EIS describes the types of activities that may be conducted as part of the proposed CO_2 monitoring program, based on preliminary information regarding the CO_2 Monitoring Plan (BEG 2012a), to provide a context for the assessment of environmental impacts that may result from CO_2 monitoring activities. The number and locations of tests to be conducted and monitoring wells to be installed, as well as other details of the CO_2 monitoring program, would be developed in the CO_2 Monitoring Plan in early 2013.

The CO_2 monitoring program would be conducted in two primary phases, a preparation phase and an implementation phase. As discussed below, the preparation phase would include two primary activities:

subsurface characterization and modeling, and an inventory of existing wellbores. During the implementation phase, a variety of monitoring activities would be conducted (e.g., CO_2 accounting, geophysical monitoring, gas tracer testing, groundwater monitoring, and soil gas monitoring) to determine whether CO_2 or other fluids are migrating from the production formation in the planned EOR area. Additional details regarding the two phases of the CO_2 monitoring program are provided below.

2.3.5.1 Monitoring Preparation Phase

2.3.5.1.1 Subsurface Characterization and Modeling

A major component of monitoring preparation would include subsurface characterization and modeling. Geologic data from the vicinity of the West Ranch oil field would be analyzed for evidence of faulting. Also, predictive fluid flow and pressure modeling would be completed to estimate the extent of CO_2 migration within the reservoir zone. Subsurface characterization and modeling would include analysis of the reservoir, seal, and overburden zones, as described below.

- Reservoir: Work on the reservoir zone would focus on quantification of injectivity and storage capacity. TCV would provide data for input into static geologic and dynamic fluid-flow reservoir models, and possibly the models themselves. BEG would undertake reservoir modeling using initial available data to predict range of plume sizes and the magnitude and distribution of pressure elevation.
- Seal: Hydrocarbon entrapment at oil fields provides clear evidence of the presence of a barrier to vertical migration of buoyant fluids (e.g., oil). In addition, during site characterization of a reservoir seal, petrophysical properties can be estimated from existing wireline logs. Seals that trapped oil and gas can also be expected to trap CO_2 (Meckel 2010). However, capillary entry pressure of fine grained rocks is lower for CO_2 than for methane and much lower than oil. Despite differing capillary pressures, reservoirs that accumulated oil or gas should be retentive for CO_2 (Meckel 2010). If available, BEG would analyze cores from the Anahuac Formation that overlies the Frio Formation at West Ranch to characterize the properties of the caprock formation.
- Overburden: The overburden consists of all sediments above the seal. Existing wireline logs would be compiled to delineate the vertical and lateral distribution of sand bodies in the overburden. Sandy strata may have higher permeability than surrounding silt or clay layers and therefore would be attractive intervals in which to complete monitoring wells. BEG would conduct supplementary static and dynamic modeling for these zones.

As discussed in Section 2.3.4.2.1, preliminary reservoir modeling conducted by the BEG, which is presented in Appendix H of this EIS, indicates that injected CO_2 and the associated areas of elevated pressure within the target geologic units would remain within the TCV lease areas both during and after EOR activities. Also, as discussed in Section 3.4 (Geology) and Appendix I of this EIS, an evaluation of geologic data in the vicinity of the West Ranch oil field indicates that there are no large-scale subsurface faults located within the West Ranch oil field EOR area.

2.3.5.1.2 Well Inventory and Performance Testing

The presence of numerous wells within an oil field presents a leakage risk during CO_2 injection. For example, wells that perform adequately during hydrocarbon extraction under negative pressure can become upwardly transmissive during injection when pressure is increased in the production formation. An inventory of existing wells at the West Ranch oil field would include a review of active oil and gas production wells, inactive but accessible wells, idled wells, and plugged and abandoned wells. Some wells would be remediated to assure they are ready for the pressure increase associated with injection. In most wells requiring remediation, the placement of cement is not sufficient to provide certainty of zonal isolation. Hence, oil field operators often reenter and re-develop selected wells to be used in injection/production patterns. Planned methods for assessing well integrity include:

- Review of thermal anomalies through casing (hot fluids expelled from depth, or cold areas in shallow zones where CO_2 flashes to gas) and noise anomalies through casing;
- Review of pressure and geochemical anomalies that require perforations; and
- Fixed gas/augmented soil gas/aquifer surveillance methods (e.g., methane, CO_2, noble gases/isotopes, tracers).

Surveillance of inactive wells would be performed with less frequency than active wells, but weekly inspection of the wellhead and surface/casing pressures would be performed by oil field technicians. The wellhead and casing valves on inactive wells would be maintained (i.e., greased and pressure tested) like those of active wells, ensuring that the operator can open or close the valves when needed. Wells that are open can be inspected via a logging program, as discussed below in Section 2.3.5.2.2. However, wells that have been plugged and abandoned would be prohibitively expensive to reenter to inspect due to multiple cement plugs being set in the casing, with top plugs set inside and outside the production casing. Normal plugging includes cutting the casing off below ground level and welding on a steel plate. Oil field technicians would periodically conduct a visual inspection of plugged and abandoned wells. If a fluid or pressure release were noticed, appropriate remedial action would be taken.

2.3.5.2 Monitoring Implementation Phase

During EOR operations, it is generally assumed that pressure gradients from injection wells to production wells control most of the flow within the production formation. TCV's proposed CO_2 monitoring program would employ a suite of technologies to demonstrate the retention of CO_2 in the injection/hydrocarbon reservoir zone. For example, data recorded at injection and monitoring wells can be used for CO_2 accounting and plume tracking. Time-lapse seismic surveying can track CO_2 in a reservoir (e.g., early breakthrough at production well or out of zone migration) but cannot account for mass changes. Borehole seismic surveying (e.g., vertical seismic profiling [VSP]) can monitor CO_2 at higher resolution than surface seismic methods. Tracers (e.g., perfluorocarbon tracer [PFT]) can detect CO_2 front arrival and delineate preferential flow paths. Wireline logging (e.g., cement bond log) can assess the integrity of cement seals needed to keep the injected CO_2 from migrating into overlying strata. Groundwater monitoring for pressure and geochemistry, as well as soil gas monitoring, can be used to demonstrate that CO_2 has not migrated into the shallow subsurface. The sections below describe the various activities that would be conducted as part of the implementation phase of the CO_2 monitoring program.

2.3.5.2.1 CO_2 Accounting

A great deal of information about subsurface conditions can be inferred from injection and production data collected during EOR operations. As part of this accounting program, TCV would track injected CO_2; oil, produced water (i.e., brine), and gas production volumes related to its commercial operation; methane production; and CO_2 recycling on a monthly basis. These data would account for CO_2 purchase and recycle volumes, which can be used to calculate the mass of CO_2 within the reservoir. TCV would most likely calculate a material balance for each injection/production well pattern on a monthly basis to define changes in reservoir performance. Significant changes in injection/withdrawal ratios would identify potential problem wells within the pattern (e.g., mechanical problems with injection wells or inactive wells causing loss of CO_2 out of the pattern, or a mechanical problem with the production wells within that pattern). Problematic wells would be identified and repaired (i.e., re-plugged or remediated).

2.3.5.2.2 Geophysical Monitoring

Geophysical monitoring methods that may be employed as part of the CO_2 monitoring program include seismic surveys, gravity surveys, and borehole logging, as described below:

Seismic: Seismic surveys use the propagation of sound waves in the subsurface to track CO_2 in a reservoir and verify that CO_2 remains in the planned EOR area. Two seismic survey methods may be employed as part of the CO_2 monitoring program for the proposed project: time-lapse, surface seismic surveys and three-dimensional (3D) vertical seismic profiling (VSP). Time-lapse seismic surveying compares images of the subsurface collected at two or more time periods. For example, seismic surveys taken pre- flood and post-flood can be used to track CO_2 in a reservoir (e.g., early breakthrough and out of zone migration). Seismic surveys, however, cannot account for mass changes caused by CO_2 injection or production, a question that can be addressed by gravity survey, as discussed below.

Borehole seismic methods, such as VSP, allow monitoring of CO_2 at higher resolution than surface seismic. With high resolution 3D-VSP seismic data, sand units as thin as 10 feet can be studied. When 3D-VSP surveys are repeated, velocity differences caused by changes in density and pressure allow mapping of reservoir fluid properties. VSP data would be used to show that the flood is conforming to the expected patterns and would provide data about out-of zone migration if it occurs.

Gravity: TCV may conduct gravity surveys to augment seismic surveys and to estimate changes in CO_2 mass stored. Because the density variance between CO_2 and reservoir fluids in the field should be more significant than the density variance of the injected water and oil in the reservoir during a water flood, gravity monitoring of the CO_2 flood could be used to define the location and extent of the CO_2 plume. During a gravity survey, BEG would monitor above, below, and in the reservoir zones at the West Ranch oil field.

Borehole Logging: Potential pathways for CO_2 or produced water migration out of the target zones may result from unexpected defects in well seals resulting from undetected construction flaws or seal damage in either new, existing, or abandoned wells. Unintended upward leakage of CO_2 or produced water along cementation defects in the annulus around a well casing could act as a potential pathway for leakage of CO_2 intended for EOR and/or possible displacement from deeper to shallower formations. Ensuring proper abandonment of existing unused wells in the area of the proposed injection wells may become a part of the pre-construction design to mitigate the potential for upward leakage. Many borehole geophysical logs already exist for the West Ranch oil field, which could provide the basis for most of the current knowledge of the subsurface properties of the field. The mechanical integrity of each well within the project area can also be evaluated by running cased hole cement bond logs and/or mechanical pressure tests, using a packer as needed, to assure USDWs are protected. If cement damage were found, holes would be squeezed with cement and retested to verify that the mechanical integrity of the well has been restored. Issues with damaged well bores, for example equipment stuck at depth limiting access for standard plugging, would be dealt with on a case-by-case-basis.

2.3.5.2.3 Gas Tracer Testing

During a gas tracer test, a chemical tracer, such as perfluorocarbon tracer (PFT), is injected into the target EOR formation with the injected CO_2. PFT can be detected at much lower concentrations than CO_2; therefore, changes in PFT concentrations can be detected in advance of a detectable change in the CO_2. Since the tracer chemical would move through the formation with the injected CO_2, monitoring of adjacent wells for the presence of the tracer chemical can help determine where the injected CO_2 is moving, track CO_2 front arrival, and delineate preferential flow paths with much higher resolution than can be obtained from other CO_2 monitoring techniques. For example, PFTs can be used to detect possible leakage along idled or plugged and abandoned wells. Recent experience with a PFT added to CO_2 injected into a coal seam in Virginia indicated that they can be conservative even in presence of organic compounds (BEG 2012a). The high resolution that tracers offer could allow time for a mitigation plan to be implemented if small amounts of CO_2 were to migrate out of the target injection zone. If a tracer program were implemented, fluids may be sampled at production wells and in the above zone monitoring intervals. Once PFTs are produced, they would be distributed throughout the field as a result of CO_2 recycling, which would reduce the future value of gas tracer tests. Therefore, use of PFTs would be reserved for specific, significant uncertainties.

2.3.5.2.4 Groundwater Monitoring

Groundwater monitoring in the vicinity of the West Ranch oil field would be conducted to determine whether EOR activities affect overlying USDWs. The monitoring would most likely take place at multiple depth intervals (i.e., zones with varying concentrations of dissolved solids) above the injection/production zone(s). Specifics of the above zone monitoring would be determined after TCV defines the CO_2 injection methodology. However, the general groundwater monitoring plan would be conducted in three stages, as follows:

<u>Site reconnaissance</u>: Assuming a favorable DOE ROD for the Parish PCCS Project, site reconnaissance would be initiated shortly after DOE issuance of the ROD for the Parish PCCS Project. BEG has already begun compiling existing data from historical records for fresh water wells in the area to define regional drinking water resource characteristics, including flow patterns and water quality. Other types of work that have begun and would continue to be conducted to demonstrate protection of USDWs include:

- identification of depths to groundwater with TDS concentrations of 1,000; 3,000; and 10,000 milligrams per liter (mg/L);
- determining the relationship of TDS zones to surface casing depths in existing injection and production wells;
- assessment of heterogeneity in the geologic systems that would affect permeability and fluid migration pathways; and
- analysis of current and historical oil field operations to identify existing perturbations in unsaturated and saturated groundwater zones.

Analysis of current and historical oil field operations would include review of:

- historical air photographs for evidence of past oil spills, or surface impacts from produced water evaporation pits or leaking pipelines;
- historical water quality data for evidence of historical leakage from produced water injection wells; and
- mechanical integrity tests, fluid-level monitoring results, and plugging records for existing wells to look for evidence of compromised well completions.

All of these sources of surface and subsurface data would be used to determine how to best test for interaction between CO_2, water, and formation matrix materials (e.g., sand, silt, clay, or rock) should unintended CO_2 migration occur. The BEG team would also conduct an on-the-ground survey, search records at the RRC, and communicate with TCV for information on existing wells during site reconnaissance to determine if a sufficient number and quality of wells exist or if additional wells would need to be constructed to define an effective monitoring network.

Baseline: BEG would establish a baseline by sampling available monitoring points (i.e., wells or piezometers) to confirm groundwater flow and quality data collected during site reconnaissance. Additional groundwater monitoring points would be installed, as necessary, to define pressure gradients within the shallow subsurface and between the shallow and deep subsurface. Shallow subsurface monitoring would most likely take place in multiple depth intervals, including the deepest USDW, which may **be** as deep as approximately 1,500 feet bgs in the vicinity of the West Ranch oil field. Subsurface modeling would be initiated to allow prediction of reservoir performance and refinement of monitoring network.

Operations: During operations, previously existing wells and those installed during the baseline stage would be monitored to assess whether EOR activities may be affecting overlying USDWs. Predictive models would be updated with field measurements to evaluate their accuracy. If necessary, the approach to oilfield operations and associated monitoring would change if questionable monitoring results are obtained.

A combination of existing wells, where practicable, and new wells, if required, would be used as groundwater monitoring wells for the CO_2 monitoring program. New wells would be installed on existing well pads to the extent practicable. For the purposes of this EIS, TCV estimates approximately 10 to 13 monitoring wells (i.e., one monitoring well for each 10 to 15 injection wells) would be used in the CO_2 monitoring program.

2.3.5.2.5 Soil Gas Monitoring

Because CO_2 may leak from the production formation through historical (i.e., plugged and abandoned or idled) production wells (e.g., due to casing corrosion or an inappropriate plug), BEG would undertake an initial assessment of soil gas conditions near representative plugged and abandoned oil wells to reduce uncertainties about well integrity. The soil gas survey would be conducted near a number of historical production wells using a surface-mounted CO_2 isotope analyzer and gas chromatograph to measure soil gas composition and concentration. Based on the initial survey, one or two historical production wells would be selected for detailed gas monitoring. Four soil gas wells would be drilled at different distances to the historic production well at depths between 30 and 60 feet bgs, depending on the local sediment stratigraphy. Soil gas from these wells would be periodically sampled for analysis of gas composition. Measurements from these gas wells would be analyzed to detect whether there are potential leakage signals from the historic production well.

2.3.5.3 Implementation Schedule

Tasks conducted as part of the CO_2 monitoring program would proceed sequentially in roughly the following order, although some tasks may be conducted concurrently:

- Site characterization data collection and static geologic modeling coupled with predictive fluid flow and pressure modeling for estimating reservoir/injection zone capacity and injectivity and identifying best possible monitoring intervals;
- Well inventory and performance testing;
- Baseline data collection (e.g., geophysical surveys, soil gas and groundwater analyses, pressure);
- Cross-well hydraulic/pressure testing;
- Measurement of injected and produced CO_2 volumes in support of CO_2 accounting;
- Indirect surveillance of production/injection wells by monitoring for changes in pressure and/or chemistry in the above zone monitoring intervals;

- In-zone (reservoir/injection zone) monitoring (pressure and chemistry);
- Adjustment of static geologic and dynamic fluid-flow models with data obtained to date;
- Monitoring for changes in USDWs; and
- Monitoring for changes in soil gas near plugged and abandoned (P&A) wells.

2.3.6 Decommissioning

The project would be designed for 20 years of operation. NRG and TCV would develop a closure plan prior to decommissioning. Decommissioning, which is the removal of project facilities from service, may range from "mothballing" (i.e., temporarily storing the equipment in place) to the permanent removal of all equipment and facilities. NRG and TCV would provide the closure plan to the RRC for review and approval prior to decommissioning. The process would involve decommissioning of surface facilities, including the CO_2 pipeline between the W.A. Parish Plant and the West Ranch oil field. Pipeline decommissioning may involve filling the pipe with nitrogen and sealing it in place, filling the pipe with grout to seal it in place, removing the pipe, or a combination of these closure methods in different sections of the pipeline, depending on adjacent land use at the time and the conditions of land agreements. TCV would plug and abandon wells drilled for EOR or CO_2 monitoring operations in accordance with RRC UIC program regulations.

2.3.7 Measures to Reduce Potential Impacts

For all environmental resources, the mitigation of potential adverse impacts from project activities would be achieved through the implementation of controls generally required by permitting processes and other federal, state, or municipal regulations and ordinances. Chapter 4 of this EIS (Mitigation Measures) outlines specific mitigation measures, including those required under federal, state, or local regulations, and permitting requirements that NRG and/or TCV would implement to reduce adverse environmental impacts in specific resource areas.

2.3.8 Alternatives Considered by NRG

While preparing its response to the DOE FOA and during the preliminary design phase that followed selection by the DOE, NRG considered a number of design alternatives for the various components of the Parish PCCS Project. As discussed below, these alternatives included locations for the CO_2 capture facility, methods of CO_2 capture, locations for the EOR field, and pipeline routes to the selected EOR site.

2.3.8.1 CO_2 Capture Facility Location Alternatives

Because of the high cost of developing and operating a CO_2 capture project, NRG determined that an EOR component to its project was necessary to make it economically viable. EOR is a proven technology, used for 40 years in the Permian Basin, and is particularly appropriate for development of mature oil fields in which production rates from primary and/or secondary recovery are diminishing (NETL 2010). When first contemplating the DOE FOA, NRG reviewed the many power plants that it owns or operates as candidates for a large, integrated PCCS project. The primary criteria for selection were for a plant to have a sufficiently large coal-fired unit and for the plant to be located in proximity to oil fields suitable for tertiary recovery. NRG's W.A. Parish, Big Cajun II, and Limestone Plants met these criteria. All three of these plant sites offer sufficient acreage for a CO_2 capture facility and supporting infrastructure. In the end, NRG selected the W.A. Parish Plant as the location for the proposed project because there are more oil fields in the area that are suitable for tertiary recovery than either the Big Cajun II or Limestone Plants. NRG determined that the location of the W.A. Parish Plant, which is near many oil fields that are suitable candidates for EOR, would improve the chances of identifying a suitable oil field partner for the EOR component of the project.

2.3.8.2 CO_2 Capture Alternatives

NRG owns and operates a large fleet of traditional generating sources, using diverse fuels including natural gas, fuel oil, and coal and continually explores ways to improve the operations of these assets. To meet the challenge of environmental sustainability, NRG is exploring ways to reduce its GHG emissions. One way to accomplish this on existing facilities is through retrofitting these facilities with post-combustion CO_2 capture system. GHG emissions also can be reduced through switching to lower carbon fossil fuels or biofuels. However, the backend control approach offers the benefits of continued use of existing power generation facilities (and the investment represented by these facilities); use of equipment similar to other emissions control processes already commonly employed in the power industry; capture system deployment without requiring a substantial change in basic existing combustion technology; and operational flexibility to safely shut the capture system down during an upset condition without disrupting power generation. Accordingly, NRG's project and technology selection process focused on the set of commercially available post-combustion CO_2 capture technologies.

Most post-combustion CO_2 capture technologies capture CO_2 from exhaust gas through the use of distillation, membranes, or absorption (i.e., physical or chemical). Many of these technologies, however, are in various experimental, laboratory, bench, or pilot stages of development and were ultimately determined to be too experimental to meet the requirements of the DOE program, which aims for industrial-scale deployment. CCPI Round 3 solicitation requires that the demonstration system operate at a capture efficiency of at least 90% and that the system should be sufficiently sized to capture at least 300,000 tons of CO_2 per year for beneficial reuse and sequestration. As a result, NRG's project and technology selection process was a careful and deliberate balance between meeting the demonstration requirements of the DOE's CCPI solicitation and finding a suitably developed technology under a feasible commercial arrangement, all of which had to align with NRG's capital allocation and risk management approach. Among the technologies currently available, only a few chemical absorption processes using ammonia or aqueous amines were determined to be sufficiently proven for a commercial-scale application.[4] For this reason, and because an ammonia absorption project had already been selected as a demonstration project by the DOE CCPI program, NRG elected to scale up a comparatively proven amine-based capture technology.

2.3.8.3 EOR Location Alternatives

The Texas Gulf Coast contains many mature oil fields suitable for tertiary recovery. EOR production along the Texas Gulf Coast has only recently begun with the completion of Denbury Resources' Green Pipeline in 2010. Denbury's EOR operations at the Oyster Bayou field, located east of Houston, began tertiary oil production in December 2011 and EOR operations at the Hastings Field near Alvin, Texas, in which EOR was initiated in Frio Formation sands beginning in December 2010, began tertiary oil production in January 2012 (Denbury 2012).

Prior to selection of HEC's West Ranch oil field for the EOR site for this project, NRG approached the owners of several other oil fields located closer to the W.A. Parish Plant that NRG believed would be suitable for tertiary recovery using EOR. However, NRG was not able to reach an agreement with any of

[4]The Rectisol® process was not considered because of the additional power required to maintain the subzero process temperatures (-60 °C to -30 °C) and because the Rectisol® process is typically designed for processing syngas rather than oxygen-containing flue gas. (Lurgi 2012)

these other oil fields due to various commercial, technical, timing (i.e., time required for field development plans and general production maturity), or other reasons. During this selection process, NRG determined that, of the prospective teaming partners who own or operate fields suitable for EOR along the Texas Gulf Coast, HEC was the candidate most aligned with the proposed project vision. Therefore, NRG and HEC entered into a joint venture (i.e., TCV). Based on previous work conducted in the Frio Formation in Texas, such as the Hastings field development and the Frio Brine Pilot Study near Dayton, Texas (Hovorka, et al. 2005; NETL 2009) as well as HEC's experience, NRG determined that the West Ranch oil field would be a suitable candidate for EOR and that the Frio Formation sand units had favorable characteristics for the ultimate sequestration of CO_2. As a result, affiliates of NRG and HEC entered into a joint venture (i.e. TCV) and collectively determined that the West Ranch oil field was the most suitable candidate for the CO_2 injection and EOR component of this project.

2.3.8.4 CO_2 Pipeline Alternatives

During project development NRG considered several potential pipeline routes from the W.A. Parish Plant to the West Ranch oil field. The seven primary alternatives considered by NRG are described below.

2.3.8.4.1 Route Alternatives Considered within the W.A. Parish Plant

Four options were developed for the initial portion of the route, which extends from the compressor station at the CO_2 capture facility to the CenterPoint ROW, as shown in Figure 2-15. The proposed route, Option A, was selected since it is the most direct route and would avoid impacts to plant facilities and utilities using HDD drilling techniques to install pipe beneath existing structures. The route for the selected option (Option A) has been adjusted since selection. See Figure 2-4 for an updated route and locations of other project components, which are outdated in Figure 2-15.

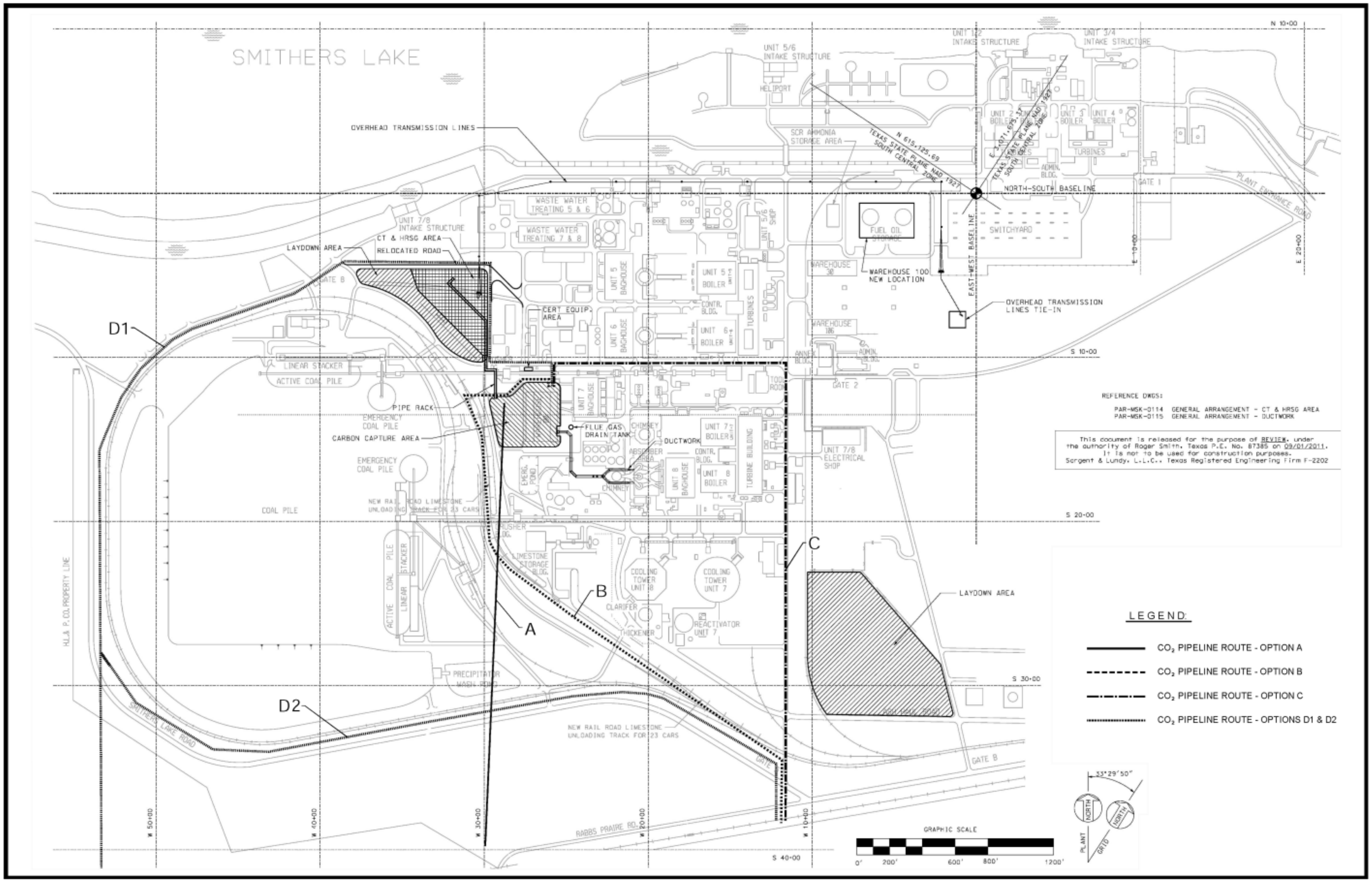


Figure 2-15. Pipeline Route Options within the W.A. Parish Plant

(Note: Option A has been adjusted since selection. See Figure 2-4 for locations of other project components, which are outdated in Figure 2-15.)

2.3.8.4.2 Union Pacific Pipeline Route Alternative

This route alternative, shown in Figure 2-16, parallels CenterPoint transmission lines for the first approximately 40 miles (i.e., northeast segment) before turning south through 16 miles of greenfield (and/or paralleling existing roadways). It then parallels 32 miles of Union Pacific railroad ROW before turning south for 2.5 miles into the West Ranch oil field. As compared to NRG's proposed route, this alternative would have resulted in approximately 10 additional miles of pipeline (i.e., approximately 90 miles total) and increased project costs. Furthermore, this route alternative is further south (i.e., closer to the coast) than NRG's proposed route and goes through three riparian corridors (i.e., adjacent to West Carancahua Creek, East Carancahua Creek, and the Tres Palacios River) that are avoided by NRG's proposed route, increasing the potential for wetland and other environmental impacts. Additionally, the Union Pacific route would have taken the project through several population centers (e.g., Lolita, La Ward, Francitas, and Blessing) that are avoided by NRG's proposed route. Finally, NRG had some safety concerns about constructing and maintaining a pipeline in close proximity to a railroad corridor.

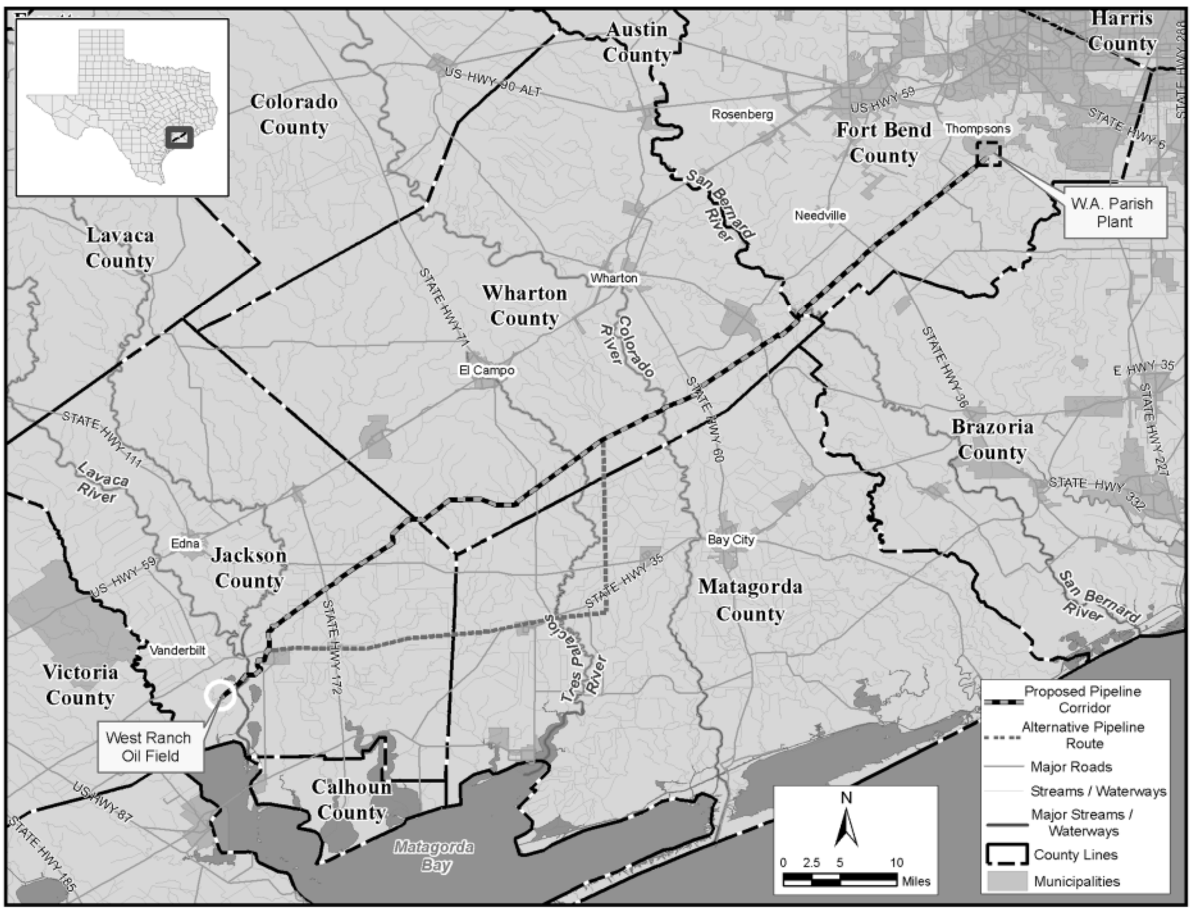


Figure 2-16. Union Pacific Pipeline Route Alternative

2.3.8.4.3 Pipeline Route Alternative 1

This route alternative, shown in Figure 2-17, parallels CenterPoint transmission lines for the first approximately 19 miles, then turns south through eight miles of greenfield, and collocates with multiple pipelines for 56 miles before turning south for 2.5 miles into the West Ranch oil field. The primary advantage of this route is that it would avoid some population centers in Wharton County. The primary difficulty with this route is that NRG could not reach an arrangement with the pipeline owners in the southwestern segment for collocation because of other planned projects between the Eagle Ford shale play and Houston. At a length of approximately 85 miles, this route is approximately five miles longer than NRG's proposed route, which would increase project costs, and includes eight miles of greenfield route, which would have an increased potential for environmental impacts and for difficulties with land acquisition.

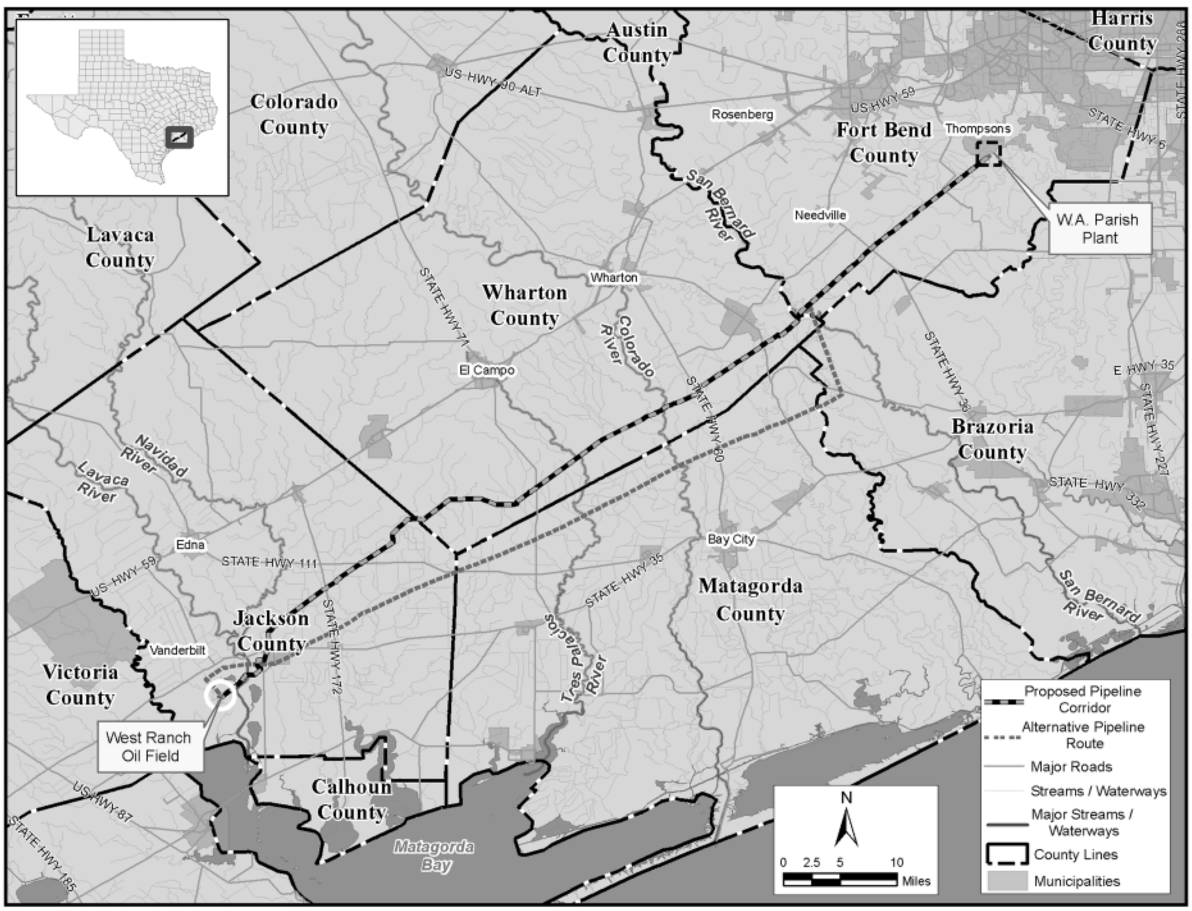


Figure 2-17. Pipeline Route Alternative 1

2.3.8.4.4 Pipeline Route Alternative 2

This route alternative, shown in Figure 2-18, was found to have essentially the same issues as Pipeline Route Alternative 1, described above, because it parallels the same pipelines. However, this route alternative was 90 miles long, which would increase project costs and increase the potential for environmental impacts and potential difficulties with land acquisition.

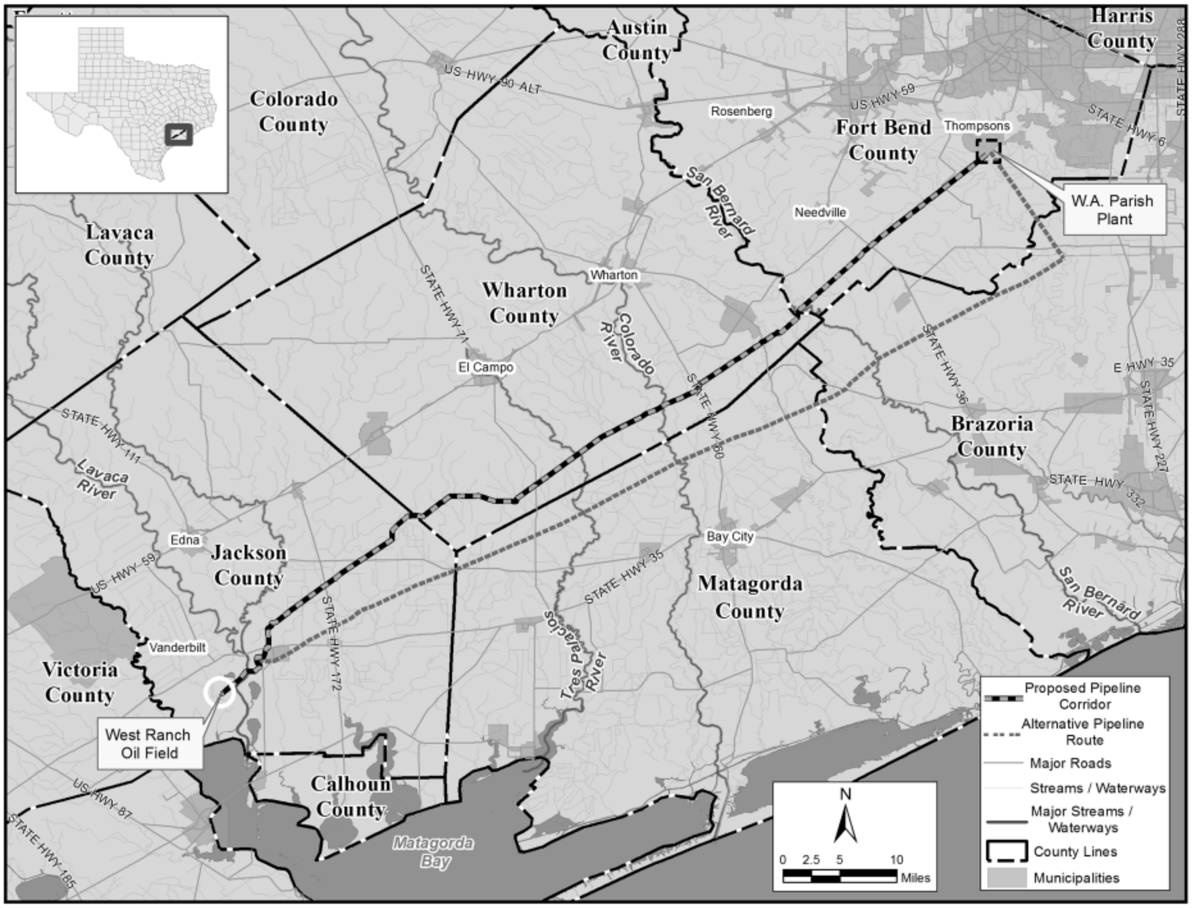


Figure 2-18. Pipeline Route Alternative 2

2.3.8.4.5 AEP Route Alternative

This route alternative, shown in Figure 2-19, would parallel CenterPoint transmission lines for the northeast segment (i.e., approximately 50 miles) and AEP transmission lines for the southwest segment (i.e., approximately 30 miles). This route would have been a preferred route, since it is approximately the same length as NRG's proposed route and includes no construction through greenfield areas. However, NRG could not reach an arrangement with AEP for ROW acquisition, so NRG would have had to acquire land outside of AEP's maintained ROW, which would have increased the potential for environmental impacts and for difficulties with land acquisition.

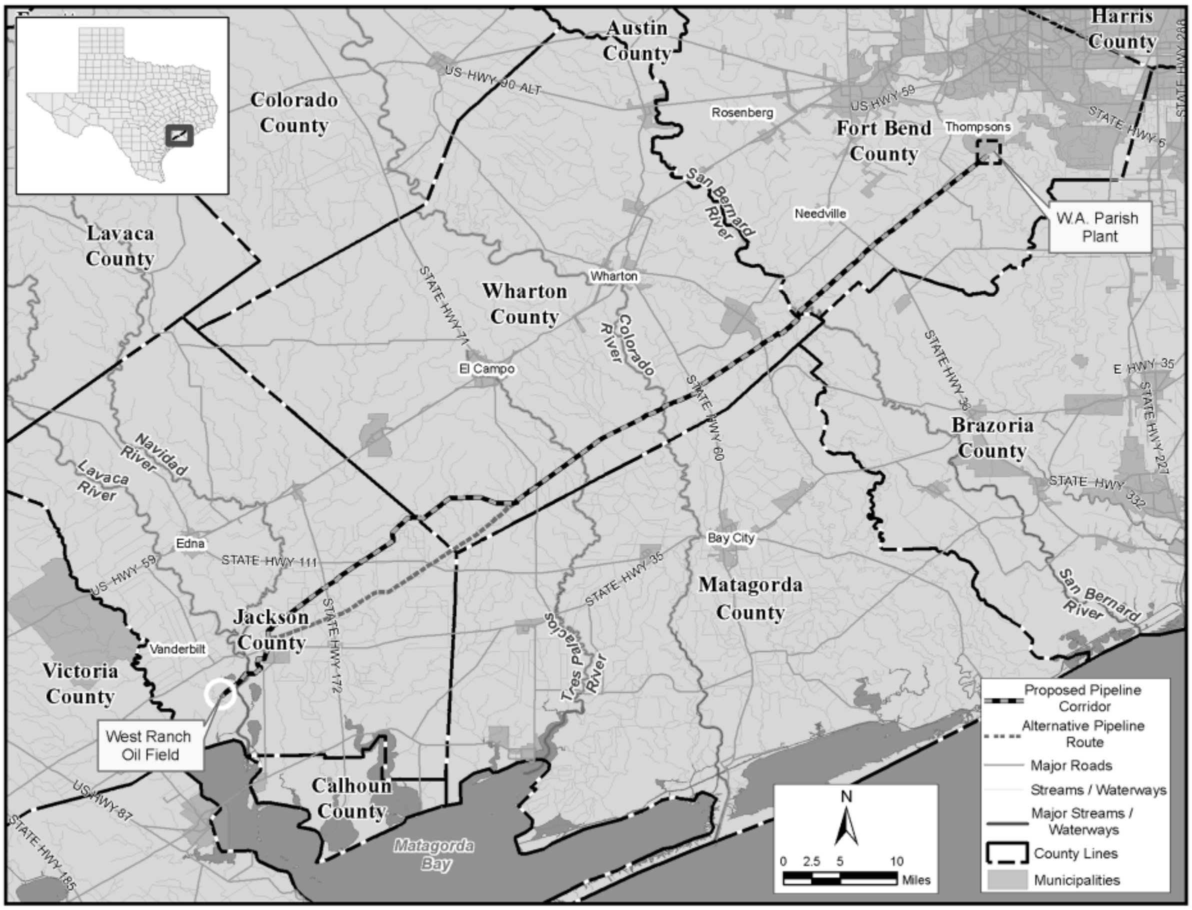


Figure 2-19. AEP Route Alternative

2.3.8.4.6 Central Segment Route Alternative

During project scoping, NRG included two options in the central segment of the pipeline route (i.e., between the northeast and southwest segments), as shown in Figure 2-20. Alternative 1 (i.e., the northern route) followed a county road through a two-mile-long greenfield area to the STEC Danevang substation to bypass the CenterPoint Hilje substation and then paralleled the STEC ROW. Alternative 2 (i.e., the southern route) paralleled the CenterPoint ROW to the Hilje substation and then paralleled the STEC ROW. NRG selected Alternative 2 (i.e., the southern route) for the proposed route because without a greenfield area, NRG believed ROW acquisition along Alternative 2 would be more easily negotiated than Alternative 1. Also, because Alternative 2 does not include the two-mile-long greenfield area, the potential for environmental impacts along Alternative 2 would likely be less than along Alternative 1. Therefore, NRG selected Alternative 2 (i.e., the southern route) for the central portion of the proposed pipeline route.

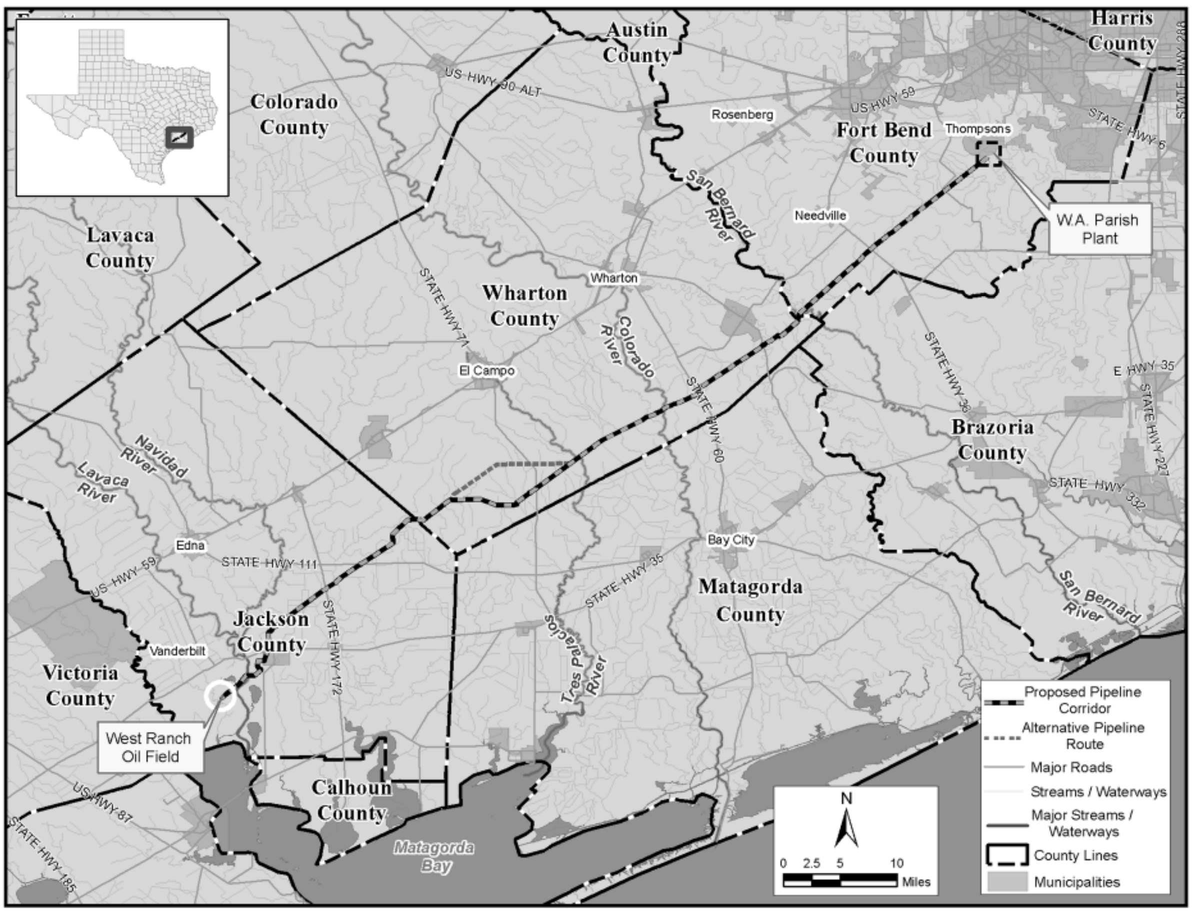


Figure 2-20. Central Segment Route Alternative

2.3.8.4.7 West Ranch Approach

Two options were considered for the approach to the West Ranch oil field. As shown in Figure 2-21, Option 1 follows the STEC corridor past Vanderbilt and then turns south and enters the field from the north along Old Mobile Road. Option 2 turns south before Vanderbilt and enters the field from the east. Option 2 goes through approximately four miles of greenfield area and then parallels an existing pipeline corridor for approximately four miles to the West Ranch oil field. NRG selected Option 2 for the proposed route because it would avoid construction through Vanderbilt and would also cross the Lavaca River at a point downstream from its confluence with the Navidad River, thereby eliminating the cost and potential for environmental impacts of a Navidad River crossing.

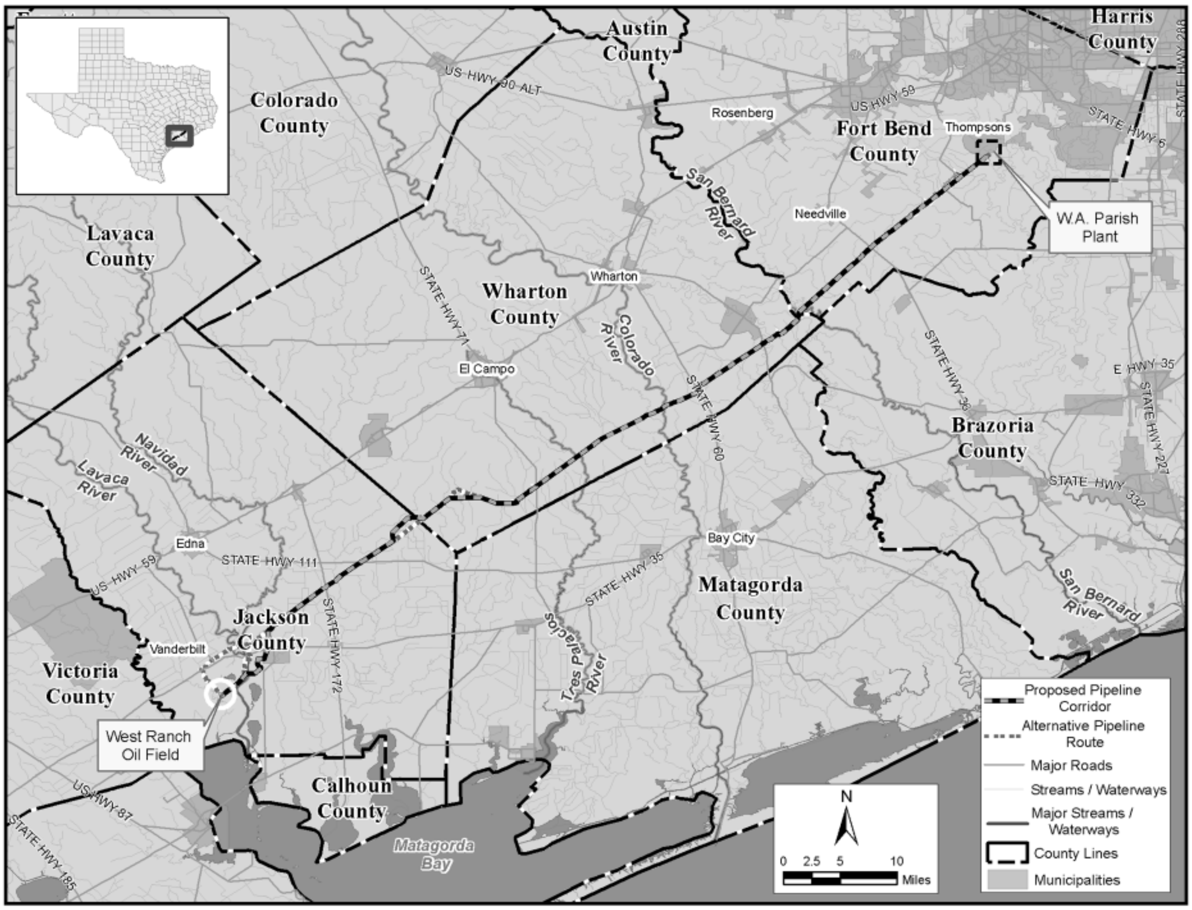


Figure 2-21. West Ranch Approach

Based on the analysis above, NRG selected the pipeline route described in Section 2.3.3 of this EIS because it would minimize the length of the pipeline to approximately 81 miles and would be collocated along or within existing mowed and maintained utility ROWs for approximately 75% of its length, which would help to minimize potential environmental impacts by allowing NRG to use existing maintained ROW during construction. Additionally, as noted above, this route avoids several riparian corridors and population centers that would have been crossed by more southerly routes, but it is not so far north as to impact development around the U.S. Highway 59 corridor.

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3 AFFECTED ENVIRONMENT AND IMPACTS

3.1 CHAPTER INTRODUCTION

3.1.1 Chapter Organization

This chapter describes the existing physical, biological, cultural, social, and economic conditions within the region of influence (ROI) for the Parish PCCS Project, as well as the potential impacts of the proposed project and the No-Action Alternative in relation to these baseline conditions. The ROI defines the geographic extent of potential impacts on the important elements of a respective resource. The ROI includes, at a minimum, the proposed CO_2 capture facility at the W.A. Parish Plant, the proposed CO_2 pipeline construction ROW, and the proposed EOR area at the West Ranch oil field. However, the size of the ROI varies by resource depending on the extent of potential impacts on respective resources. The ROI for each resource area is defined in the following subsections.

This chapter is organized into sections for 18 resource areas, as listed below:

- Air Quality and Climate (Section 3.2)
- Greenhouse Gases (Section 3.3)
- Geology (Section 3.4)
- Physiography and Soils (Section 3.5)
- Groundwater (Section 3.6)
- Surface Water (Section 3.7)
- Wetlands and Floodplains (Section 3.8)
- Biological Resources (Section 3.9)
- Cultural Resources (Section 3.10)
- Land Use and Aesthetics (Section 3.11)
- Traffic and Transportation (Section 3.12)
- Noise (Section 3.13)
- Materials and Waste Management (Section 3.14)
- Human Health and Safety (Section 3.15)
- Utilities (Section 3.16)
- Community Services (Section 3.17)
- Socioeconomics (Section 3.18)
- Environmental Justice (Section 3.19)

Each section begins with an introduction to the resource, including a description of the applicable ROI, the methods used to analyze potential impacts, and important factors considered in the analysis. Each introduction is followed by a description of the affected environment (baseline conditions) for the resource, a description of the direct and indirect impacts of the proposed project, and a description of the direct and indirect impacts of the No-Action Alternative.

3.1.2 Characterization of Potential Impacts

Where possible, potential impacts associated with the proposed project and the No-Action Alternative are quantified. Often, it is not possible to quantify impacts; therefore, a qualitative assessment of potential impacts is presented. The following descriptors are used qualitatively to characterize impacts on respective resources:

- ***Beneficial*** – Impacts would improve or enhance the resource.
- ***Negligible*** – No apparent or measurable impacts would be expected; may also be described as "no impact" if appropriate.
- ***Minor*** – Barely noticeable but measurable adverse impacts on the resource. Mitigation measures may be considered for these impacts.
- ***Moderate*** – Noticeable and measurable adverse impacts on the resource. Mitigation measures would usually be considered for these impacts.
- ***Substantial*** – Obvious and extensive adverse effects, and potentially significant impacts on a resource. Mitigation measures would be sought to reduce these impacts.

Additionally, impacts may consist of direct or indirect effects:

- ***Direct impacts*** are defined as those caused by the action and occurring at the same time and place. Examples include habitat destruction, soil disturbance, increased air emissions, and reduction in available water supplies.
- ***Indirect impacts*** are defined as those caused by the action, but occurring later in time or farther removed in distance from the action. Examples include changes in surface water quality resulting from soil erosion, and alteration of wetlands resulting from changes in surface water quantity.

Context and intensity are taken into consideration in determining a potential impact's significance as defined in 40 CFR 1508.27. The context of an impact takes into account the ROI, the affected interests, and the locality. For example, a site-specific action is more likely to have a significant effect on the immediate environment or population within the ROI, than on a wider geographic region. However, some aspects, such as GHG emissions, may have implications for a broader geographic area (e.g., global). The intensity of a potential impact refers to the severity of the impact and should consider the following aspects: beneficial and adverse impacts; the degree of effects on public health and safety; the proximity of, and degree to which actions may adversely impact, protected features or unique characteristics of the geographic area (e.g., protected species and their habitats, cultural resources, wetlands, prime farmland, park lands, wild and scenic rivers); the levels of public and scientific controversy associated with a project's impacts; the degree of uncertainty about project impacts or risks; whether the action establishes a precedent for future actions with significant effects; whether related or connected actions have been appropriately considered in the analysis of impacts; or whether the action threatens to violate federal, state, or local law, or requirements imposed for protection of the environment.

3.2 AIR QUALITY AND CLIMATE

3.2.1 Introduction

This section describes existing air quality in the region potentially affected by the proposed construction and operation of the Parish PCCS Project and analyzes the potential effects from this project on air quality. The topics discussed include applicable air quality regulations, regional ambient air monitoring, and emissions to the atmosphere.

3.2.1.1 Region of Influence

The ROI used for this air quality analysis includes the counties in which the proposed project components would be constructed, as follows: Fort Bend County (CO_2 capture facility and northern portion of pipeline corridor), Wharton County (central portion of pipeline corridor), and Jackson County (southern portion of pipeline corridor and the West Ranch oil field). Fort Bend County is part of the eight-county Houston Galveston Brazoria (HGB) Metropolitan Statistical Area (MSA), which includes Chambers, Galveston, Brazoria, Liberty, Harris, Fort Bend, Montgomery and Wharton Counties.

3.2.1.2 Method of Analysis

The air quality analysis includes review of emissions to the atmosphere of six criteria pollutants (i.e., carbon monoxide [CO], lead, nitrogen dioxide [NO_2], respirable particulate matter [particulate matter with a diameter of 10 microns or less (PM_{10}) and particulate matter with a diameter of 2.5 microns or less ($PM_{2.5}$)], ozone [O_3], and sulfur dioxide [SO_2]), as well as emissions of sulfuric acid (H_2SO_4), ammonia (NH_3), and CO_2 from equipment used during the construction and operational phases of the proposed project. Emissions of these pollutants from the construction phase would be generated mainly by equipment used during construction (e.g., trucks, dozers). Emissions of these pollutants during the operational phase would result from the CO_2 capture facility and the CO_2 recycle facility. As noted in Chapter 2, the term "CO_2 capture facility" refers to all of the equipment at the W.A. Parish Plant that relates to the Parish PCCS Project including the CO_2 capture system, the CT/HRSG, the cooling tower, the emergency generator, and associated equipment. This section of the EIS (i.e., Section 3.2) quantifies operational emissions of CO_2, since the same project details are used to calculate emissions of criteria pollutants and greenhouse gas (GHG) pollutants. Construction emissions of CO_2 and the potential impacts associated with all CO_2 emissions are discussed in Section 3.3 of this EIS (Greenhouse Gases).

In Texas, the only applicable air standards are the National Ambient Air Quality Standards (NAAQS) promulgated by the EPA. In areas where the NAAQS are being attained, an evaluation should be conducted to determine whether the proposed emission increases would result in degradation of the existing air quality. This approach has been used in this EIS for CO, lead, NO_2, PM_{10}, $PM_{2.5}$, and SO_2, since the ROI is in attainment for these pollutants. However, Fort Bend County, which is included in the ROI, is not attaining the NAAQS for ozone and has been classified as a severe nonattainment area for ozone (EPA 2012g). Since the Fort Bend County is in an ozone nonattainment area, the EPA requires an analysis to determine conformity with the Texas state implementation plan (SIP) according to the provisions of 40 CFR 93.153, to assess air quality impacts from federal actions, such as the Parish PCCS Project, that are proposed within the HGB.

Because volatile organic compounds (VOC) and nitrogen oxides (NO_x) are the compounds most responsible for ozone generation (i.e., ozone precursors), this conformity determination must evaluate whether VOC and NO_x emissions related to the construction portion of the Parish PCCS Project would conform to the Texas SIP. The method used to determine ozone impacts is based on EPA rules for General Conformity (40 CFR 94.153). For the construction phase of the project, if VOC and NO_x emissions are lower than thresholds documented in the Conformity Rules, then it is concluded that the impact of these emissions are negligible or minor. If the proposed project were to cause emission increases that were larger than these thresholds, a more detailed analysis would be needed to quantify the impact. For the operational phase of the project, the potential impact of the proposed project would be based on whether the project, including any associated mitigation, increases emissions of ozone precursors.

The method used to determine CO, NO_2, PM_{10}/$PM_{2.5}$ and SO_2 impacts from construction emissions is based on a review of the existing air quality in the ROI and a comparison of emissions resulting from the proposed project to the total emissions in the ROI. This comparison is based on the premise that since the ROI is attaining the NAAQS for these pollutants, a small increase in emissions of these pollutants would have a negligible or minor impact on air quality within the ROI. For the operational phase, results of an air dispersion modeling study that NRG submitted to TCEQ on August 1, 2012 are used to demonstrate compliance with the NAAQS (ERM 2012). The modeling study, which was performed based on TCEQ modeling protocols, is currently under review by the TCEQ.

3.2.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to air quality based on whether the Parish PCCS Project would directly or indirectly:

- result in emissions of criteria pollutants;
- cause an adverse change in air quality as compared to the NAAQS; or
- conflict with the Texas SIP requirements for attaining or maintaining compliance with the NAAQS.

3.2.2 Affected Environment

3.2.2.1 Federal and State Air Quality Regulations

EPA regulations specify maximum acceptable levels of air pollutants in the NAAQS. The Clean Air Act (CAA) established two types of NAAQS. Primary standards set limits to protect public health and secondary standards set limits to protect public welfare, which includes environmental and property damage. The EPA Office of Air Quality and Planning Standard (OAQPS) set NAAQS for the following six criteria pollutants: CO, lead, NO_2, PM_{10} and $PM_{2.5}$, O_3, and SO_2 (EPA 2012e). These primary and secondary standards are shown in Table 3.2-1.

The CAA requires states to develop federally approved regulatory programs, called State Implementation Plans (SIPs), for meeting the NAAQS throughout the state. The TCEQ is responsible for improving and monitoring air quality in Texas for each of the criteria pollutants and assessing compliance. Areas that meet the NAAQS for a criteria pollutant are designated as being in “attainment” for that pollutant. Areas where a criteria pollutant concentration exceeds the NAAQS are designated as “nonattainment” areas.

Table 3.2-1. NAAQS for Criteria Pollutants

Pollutant (and final rule citation)		Type of Standard	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		Primary	8-hour	9 ppm (10,000 μg/m^3)	Not to be exceeded more than once per year
			1-hour	35 ppm (40,000 μg/m^3)	
Lead [73 FR 66964, Nov 12, 2008]		Primary and Secondary	Rolling 3-month average	0.15 μg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		Primary	1-hour	100 ppb (188 μg/m^3)	98th percentile, averaged over 3 years
		Primary and Secondary	Annual	53 ppb (2) (100 μg/m^3)	Annual mean
Ozone [73 FR 16436, Mar 27, 2008]		Primary and Secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution [71 FR 61144, Oct 17, 2006]	**$PM_{2.5}$**	Primary and Secondary	Annual	15 μg/m^3	Annual mean, averaged over 3 years
			24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		Primary	1-hour	75 ppb (4) (196 μg/m^3)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm (1300 μg/m^3)	Not to be exceeded more than once per year

Source EPA 2012e

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
(2) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; ppb = parts per billion; ppm = parts per million; µg/m^3 = micrograms per cubic meter

One of the programs in the SIP is the NSR permitting program. Before construction can be started on a new stationary source, an NSR permit must be obtained from the TCEQ. In areas where the NAAQs are being attained, the new source owner or operator must prepare a permit application that documents how the new source would meet all applicable regulations and would not cause or contribute to an exceedance of the NAAQS. In areas where the NAAQS have been exceeded (i.e., nonattainment areas), the owner or operator must submit a permit application that documents how the new source would meet all applicable regulations and commits to offsetting the new emissions so that the air quality is not further degraded.

In addition to the NEPA review conducted by DOE (i.e., as documented in this EIS), NRG must obtain two major NSR air permits from the TCEQ for the operational facilities at the W.A. Parish Plant prior to initiating facility construction. The first major NSR permit is a Prevention of Significant Deterioration (PSD) permit, which is applicable in NAAQS attainment areas. The second major NSR permit is a Nonattainment NSR (NNSR) permit, which must be obtained because the project would be in a nonattainment area. Based on these requirements, NRG must obtain a PSD permit for emissions of CO, NO_2, $PM_{10}/PM_{2.5}$, and SO_2 and an NNSR permit for emissions of VOC and NO_x. The application for these air permits, which was submitted to the TCEQ on September 16, 2011, is currently being reviewed by the TCEQ.

3.2.2.2 Existing Air Quality

Throughout the HGB MSA, air pollutants are measured by numerous air monitoring stations operated by the TCEQ, Harris County, and the City of Houston. Most of the stations in the region measure the concentrations of criteria pollutants, as well as outdoor temperature, wind velocity, wind direction, and other meteorological parameters. A map of the stations that monitor criteria pollutants in the ROI is provided as Figure 3.2-1.

Air quality monitoring results are typically presented as summary data that is in the form of the specific standard being reviewed. Table 3.2-1 identifies the standards and the method in which compliance with each standard must be demonstrated (i.e., the form of the standard, such as “not to be exceeded more than once per year”, “annual mean, averaged over 3 years”, “98th percentile, averaged over 3 years”, etc.). Monitored criteria air pollutant concentrations, in the form of the ambient air standards, for the ROI are shown in Table 3.2-2.

Not all of the criteria pollutants are monitored in the counties included in the ROI. Therefore, as a surrogate for air quality data in the ROI, the monitoring results presented in Table 3.2-2 show the results from the HGB MSA, which includes one of the counties in the ROI (i.e., Fort Bend County). As shown in Table 3.2-2, the monitoring data shows that the ROI is in attainment of all of the NAAQS except for ozone in Fort Bend County. It should be noted that there are no locations in Wharton or Jackson counties where ambient air quality is routinely measured. However, these counties have fewer emissions of all criteria pollutants than the counties in the HGB MSA. Table 3.2-3 shows the total criteria pollutant emissions within the three-county ROI. Table 3.2-4 shows the percentage of the overall ROI emissions that originate from each county. Based on this general observation, it can be concluded that the air quality in Jackson and Wharton Counties would be no worse than the air quality in the HGB MSA. Therefore the monitoring data presented in this EIS, which is only available for counties in the HGB MSA, is generally representative of the air quality in the ROI.

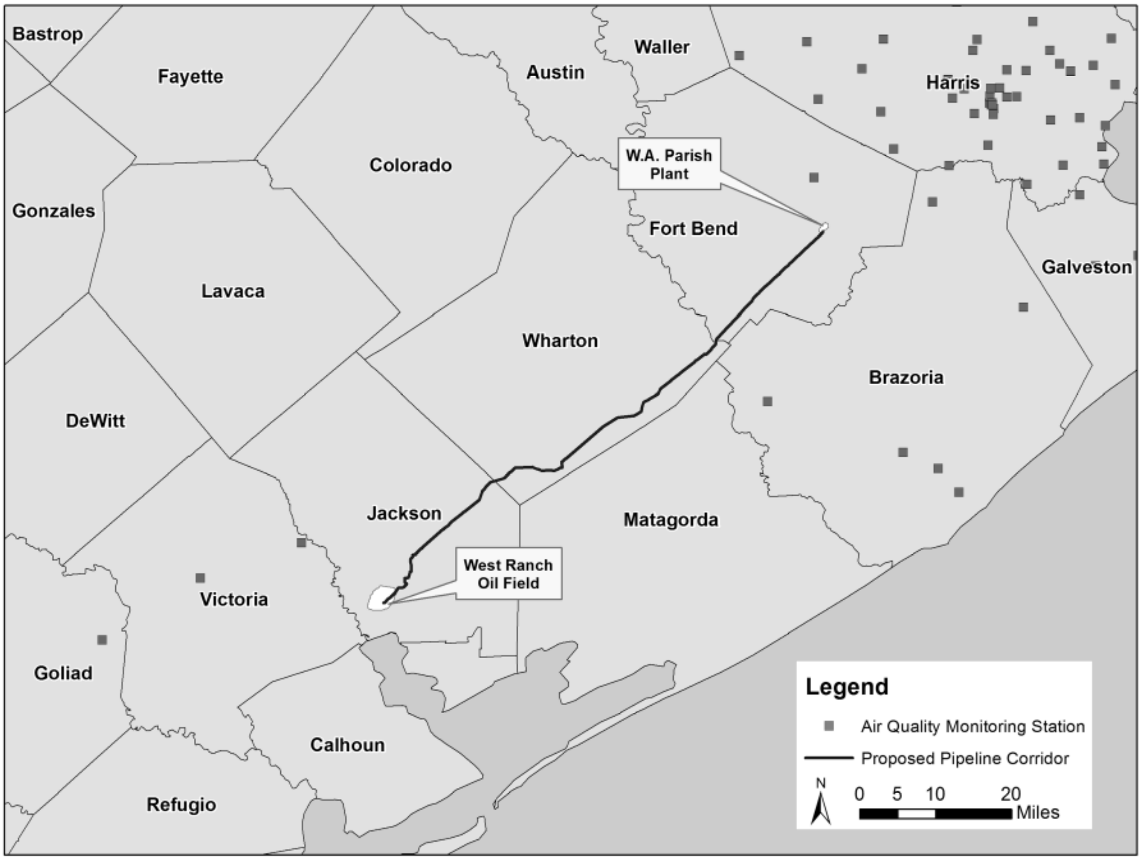

Figure 3.2-1. Map of Stations that Monitor Criteria Pollutants in the ROI
Source: TCEQ 2012a

Table 3.2-2. Monitored Concentrations for the ROI

Pollutant	2008	2009	2010	2011	NAAQS	% of NAAQS[1]
CO: 2nd Maximum 1-hr (ppm)	8	3	3	2	35	23%
CO: 2nd Maximum 8-hr (ppm)	6	2	2	2	9	67%
Lead: Mean 24-hr ($\mu g/m^3$)	0.01	0	0.01	0.01	0.15	7%
NO_2: 98th Percentile 1-hr (ppm)	0.066	0.059	0.068	0.059	0.100	68%
NO_2: Annual Mean (ppm)	0.01600	0.014	0.014941	ND	0.053	30%
Ozone: 2nd Maximum 1-hr (ppm)	0.13	0.14	0.13	0.13	0.12	117%
Ozone: 4th Maximum 8-hr (ppm)	0.083	0.091	0.087	0.09	0.075	121%
$PM_{2.5}$: 98th Percentile 24-hr ($\mu g/m^3$)	31	24	23	24	35	89%
$PM_{2.5}$: Weighted Mean 24-hr ($\mu g/m^3$)	13.4	12.6	12.2	13.8	15	92%
PM_{10}: 2nd Maximum 24-hr ($\mu g/m^3$)	127	102	82	92	150	85%
SO_2: 99th Percentile 1-hr (ppm)	0.062	0.059	0.046	0.04	0.075	83%
SO_2: 2nd Maximum 24-hr (ppm)	0.015	0.03	0.014	0.012	0.14	21%
SO_2: Annual Mean (ppm)	0.002	0.004	0.002336	ND	0.03	13%

Source: EPA 2012e, f
[1] **Percentage is calculated using the maximum monitored concentration observed during the 2008 – 2011 observation period**
CO = carbon monoxide; $\mu g/m^3$ = micrograms per cubic meter; NO_2 = nitrogen dioxide; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; ppb = parts per billion; ppm = parts per million

Table 3.2-3. Criteria Pollutant Emissions in ROI

County	Emissions (tpy)					
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Fort Bend	50,307	15,282	28,496	4,684	54,946	31,165
Jackson	10,984	4,028	7,451	1,389	58	23,709
Wharton	18,209	6,820	16,089	2,786	103	30,511
Total	**79,501**	**26,130**	**52,036**	**8,859**	**55,108**	**85,386**

Source: EPA 2012h
CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds
Due to rounding, total may be slightly more or less than the sum of individual emissions.

Table 3.2-4. Percentage of Emissions by County

County	Percentage of ROI Emissions					
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Fort Bend	63.3%	58.5%	54.8%	52.9%	99.7%	36.5%
Jackson	13.8%	15.4%	14.3%	15.7%	0.1%	27.8%
Wharton	22.9%	26.1%	30.9%	31.4%	0.2%	35.7%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; VOC = volatile organic compounds

3.2.2.3 Climate and Meteorology

The winds in the ROI are predominately from the direction of the Gulf of Mexico (i.e., from the south and southeast). Wind roses from Houston's George Bush International Airport (IAH) and the Victoria/WSO Airport are shown in Figure 3.2-2 and Figure 3.2-3, respectively. Winds from the Gulf of Mexico create the humid subtropical climate that is typical of the area. Fort Bend's warmest month, on average, is August at 94.4 °F, and the coldest month being January at 43.0 °F. The average yearly precipitation level is 49.5 inches (NOAA 2012b). The ROI occasionally experiences severe weather, mostly in the form of strong thunderstorms which often result in flooding. Spring supercell thunderstorms sometimes bring tornadoes to the area. The ROI sometimes experiences tropical cyclones during hurricane season (i.e., June 1st through November 30th), which can cause significant damage due to high winds, storm surge, and flooding from heavy rains. The last hurricane to hit the area was Hurricane Ike in 2008. Additional details regarding monthly average temperatures and rainfall are provided in Table 3.2-5.

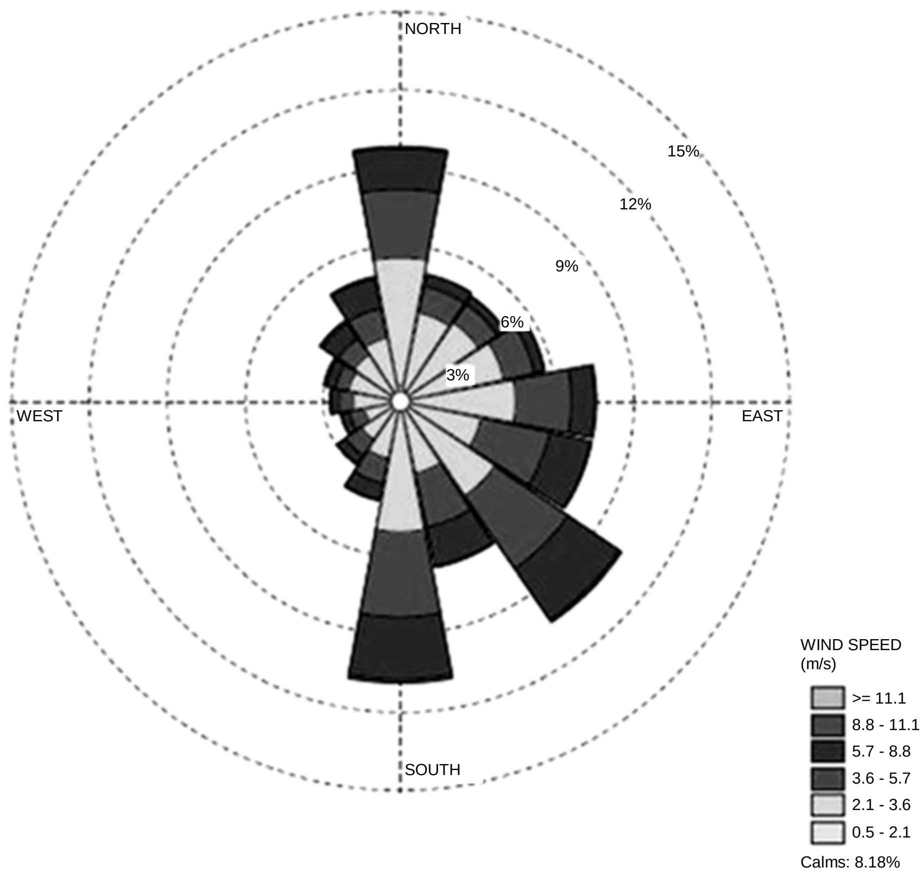

Figure 3.2-2. Wind Rose from Houston's Intercontinental Airport (IAH)
Source: LES 2012

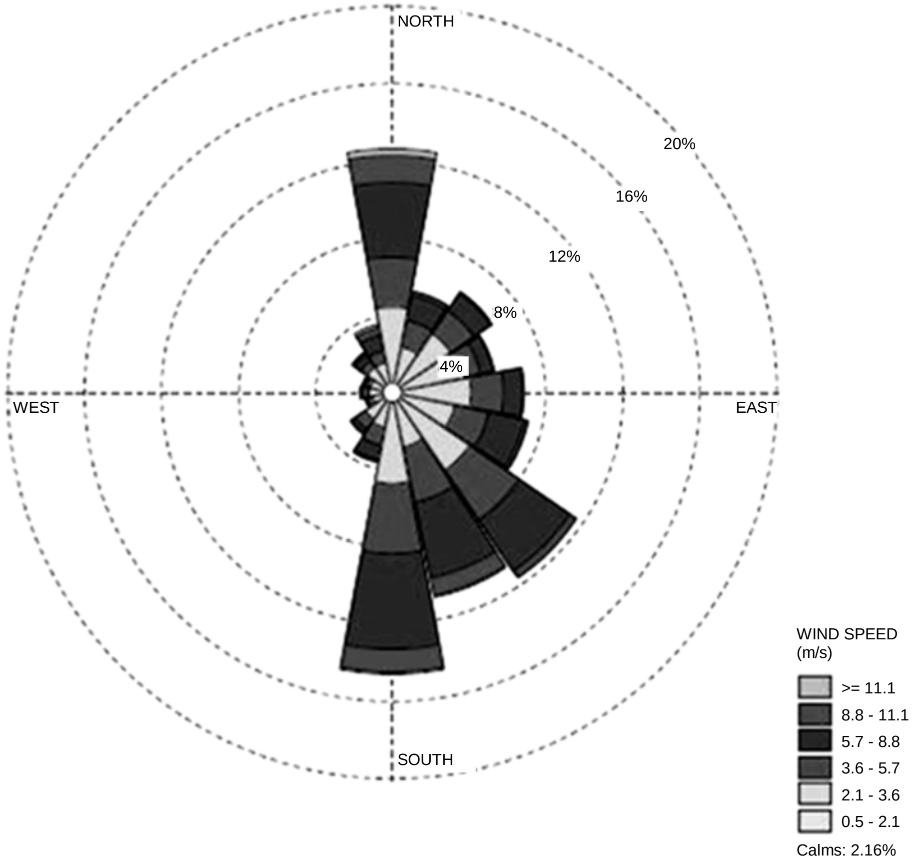

Figure 3.2-3. Wind Rose from Victoria/WSO Airport
Source: LES 2012

Table 3.2-5. Average Annual Climate in the ROI (years 1981-2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)	63.3	66.5	72.9	79.9	86.2	91.4	93.6	94.4	90.0	82.7	73.7	65.0	80.0
Average Minimum Temperature (°F)	43.0	46.2	52.4	59.3	67.5	73.3	75.1	74.9	70.1	61.1	52.1	43.8	59.9
Average Monthly Temperature (°F)	53.2	56.4	62.6	69.6	76.8	82.3	84.4	84.6	80.0	71.9	62.9	54.4	69.9
Average Precipitation (inches)	3.66	2.97	3.54	3.39	4.60	5.73	4.15	4.34	4.60	4.96	4.32	3.22	49.48

Source: NOAA 2012b
°F = degrees Fahrenheit

3.2.2.4 Emissions from Existing Facilities

Emissions of CO, NO_X, particulate matter (i.e., PM, PM_{10}, and $PM_{2.5}$), SO_2, and VOC that originate in the Unit 8 boiler would be delivered to the proposed CO_2 capture facility as part of the Unit 8 flue gas slipstream. This slipstream would be routed to the CO_2 capture facility after is has been passed through a high efficiency baghouse to remove particulate matter and a wet flue gas desulfurization (WFGD) system to remove SO_2. Existing emissions associated with the slipstream are currently authorized under the Texas state permit for the Unit 8 boiler (TCEQ NSR Permit No. 7704) and are not considered project emission increases. In August 2012, NRG applied for an alteration to TCEQ Permit No. 7704, which currently authorizes the Unit 8 boiler, to indicate that the Unit 8 boiler and the new CO_2 capture system would operate in a dual stack configuration (i.e., some current emissions from Unit 8 would be emitted through the CO_2 capture system vent instead of the existing Unit 8 emission point). Permit alterations are used to update a permit in cases where there is no increase in emission limits. The duration of the TCEQ review and approval process for a permit alteration is approximately 45 days and no public notice is required. In cases where emission limits are increasing, the TCEQ requires a permit amendment, which is a lengthier process (i.e., approximately 9 to 12 months for review and approval) that generally requires public notice.

3.2.3 Direct and Indirect Impacts of the Proposed Project

3.2.3.1 Construction Impacts

The emissions associated with the construction of the project would be from two general types of sources: emission from material handling (e.g. dirt moving) and emissions from combustion of fuel (i.e., gasoline and diesel) in mobile sources, which are mainly non-road construction equipment. Each of these source types is discussed below.

3.2.3.1.1 Material Handling

Material handling activities would result in emissions of particulate matter (PM). Construction of each project component would include several different activities, such as site clearing, demolition, excavation, and hauling of material. These types of emissions are difficult to quantify, as they depend considerably on types and number of equipment used (e.g., bulldozers, dump trucks, excavators, graders, and compactors), equipment operational hours, soil type, soil moisture, wind speed, and ambient temperature. However, taking all these considerations into account, the EPA estimates a conservatively high emission factor of 1.2 tons of PM emissions per acre of construction per month in AP-42 Chapter 13.2.3.1 (EPA 1995). This estimate of 1.2 tpy PM is an overestimation of the PM_{10} or $PM_{2.5}$ emissions, since these latter two compounds are a subset of PM.

The total maximum acreage disturbed at any one time by the proposed project is approximately 273 acres (i.e., approximately 29 acres at the W.A. Parish Plant, approximately 1.5 acres at the West Ranch oil field, and approximately 242 acres for the single pipeline construction spread). This acreage assumes a single pipeline construction spread[1] of approximately 20 miles in length using the entire 100-foot-wide construction corridor. Based on an estimated 12 months per year of construction at the W.A. Parish Plant,

[1] As discussed in Chapter 2, the pipeline construction process looks much like a moving assembly line, which is conducted by a series of operations that make up a construction spread. For the Parish PCCS Project, the proposed pipeline would be constructed by a single, approximately 20-mile-long construction spread.

four months of active pipeline construction (i.e., of the total six-month-long pipeline construction schedule with work in isolated areas only during two months), and three months of construction at the West Ranch oil field, material handling emissions would be 1,585 tons of PM during 2013 (i.e., [1.2 tons PM/acre/month][29 acres x 12 months + 242 acres x 4 months + 1.5 acres x 3 months]) and 418 tons of PM during 2014 (i.e., [1.2 tons PM/acre/month][29 acres x 12 months] for emissions from ongoing CO_2 capture facility construction).

3.2.3.1.2 Mobile Source Emissions

The main source of mobile source emissions from Parish PCCS Project construction activities would be from the combustion of fuel in non-road construction equipment, resulting in emissions of NO_x, VOC, CO, SO_2, and $PM_{2.5}$. Non-road construction equipment includes a diverse collection of vehicles and equipment, including:

- all-terrain vehicles;
- construction equipment, such as graders and backhoes; and
- other industrial equipment, such as fork lifts.

Table 3.2-6 through Table 3.2-8 summarize estimated emissions from non-road construction equipment during the Parish PCCS Project construction timeframe (i.e., 2013 and 2014). These emissions were calculated by using emission factors developed for EPA's NONROAD 2005 model (EPA 2005), which documented emission factors for CO, NO_x, PM, SO_2, and VOC for each type of equipment that may be used on the proposed project. Estimated emissions were calculated using the following equation:

$$Q = EF_{eq} \text{ x } Hr_{eq} \text{ x } hp_{eq} \text{ x } load_{eq} \text{ x } C_{g\text{-}lb} \text{ x } C_{lb\text{-}ton}$$

Where:

Q = emissions in tons per year (tpy)
EF_{eq} = NONROAD emission factor for each equipment type (grams per horsepower-hour [g/hp-hr])
Hr_{eq} = total hours in a year this equipment type is operated (hrs)
Hp_{eq} = horsepower of the equipment type (hp)
$Load_{eg}$ = load factor (%)
$C_{g\text{-}lb}$ = Conversion from grams to pounds (453.59 g/lb)
$C_{lb\text{-}ton}$ = Conversion from pounds to ton (2000 lb/ton)

As an example:

$EF_{excavators}$ = 5.36 g/hp-hr
$Hr_{excavators\ pipeline\ construction}$ = 8,640 hrs (6 excavators for 6 months at 6 days/week for 10 hours/day)
$Hp_{excavators}$ = 165hp
Load $factor_{excavator}$ = 50%

Therefore,

$$Q = (5.36) \text{ x } (8,640) \text{ x } (165) \text{ x } (.5) \text{ x } (1/453.59) \text{ x } (1/2000) = 4.21 \text{ tpy}$$

Table 3.2-9 compares the total estimated construction emissions for the Parish PCCS Project during 2013 and 2014 to the total emissions in the ROI from stationary sources. As can be seen in Table 3.2-9, emissions of all pollutants are less than 1% of the total emission in the ROI, except the conservatively high estimate of PM10 emissions during 2013, which accounts for 3.1% of total ROI emissions.

Table 3.2-6. 2013 Pipeline Corridor Construction Emissions

Description[a]	Total Use (hp-hrs)[b]	CO (tpy)	NO_x (tpy)	PM_{10} (tpy)[c]	SO_2 (tpy)	VOC (tpy)
Bore/Drill Rigs Diesel	36,000	0.03	0.24	0.01	1.06	0.01
Excavators Diesel	712,800	1.05	4.21	0.27	21.16	0.28
Cranes Diesel	996,480	1.46	6.61	0.24	29.26	0.22
Non-Road Trucks Diesel	936,000	1.18	2.27	0.32	27.78	0.33
Crawler Tractor/Dozers Diesel	950,400	2.13	5.97	0.32	28.21	0.22
Commercial Welders	432,000	2.90	2.94	0.44	16.62	0.57
Total[d]	**4,063,680**	**8.73**	**22.24**	**1.60**	**124.08**	**1.62**

[a] All pipeline construction would occur in 2013.
[b] NONROAD 2005 emission factors are based on the power of the equipment and the number of hours the equipment is used. Emissions in tons per year (tpy) are the product of the emission factor and the total equipment use, which is measured in horsepower hours (hp-hrs).
[c] Emission factors for construction equipment do not differentiate between PM_{10} and $PM_{2.5}$.
[d] Due to rounding, total may be slightly more or less than the sum of individual emissions.
CO = carbon monoxide; hp-hrs = horsepower hours; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

Table 3.2-7. 2013 CO_2 Capture Facility Construction Emissions

Description	Total Use (hp-hrs)[a]	CO (tpy)	NO_x (tpy)	PM_{10} (tpy)[b]	SO_2 (tpy)	VOC (tpy)
Plate Compactors Diesel	81,712.5	0.08	0.51	0.03	2.40	0.03
Bore/Drill Rigs Diesel	162,000.0	0.13	1.08	0.04	4.76	0.04
Excavators Diesel	217,593.8	0.32	1.29	0.08	6.46	0.08
Cranes Diesel (600 hp)	249,750.0	0.37	1.66	0.06	7.33	0.06
Graders Diesel	197,100.0	0.25	1.15	0.07	5.85	0.07
Non-Road Trucks Diesel	640,312.5	0.80	1.55	0.22	19.00	0.23
Rubber Tire Loaders Diesel	131,625.0	0.17	0.78	0.04	3.91	0.05
Tractors/Loaders/Backhoes Diesel	244,525.0	0.60	1.68	0.15	8.47	0.21
Crawler Tractor/Dozers Diesel	176,400.0	0.39	1.11	0.06	5.24	0.04
Non-Road Tractors Diesel	9,625.0	0.01	0.06	0.00	0.29	0.00
Generators	1,500.0	0.00	0.01	0.00	0.04	0.00
Pumps	90,000.0	0.20	0.53	0.03	2.67	0.03
Cranes Diesel (< 300 hp)	177,300.0	0.26	1.18	0.04	5.21	0.04
Mixer/Vibrator	40,950.0	0.03	0.25	0.01	1.20	0.01
Pump Trucks	235,625.0	0.30	1.37	0.08	6.99	0.08
Haul Trucks	1,333,575.0	1.68	3.23	0.46	39.58	0.47
Total[c]	**3,989,593.8**	**5.59**	**17.44**	**1.37**	**119.4**	**1.44**

[a] NONROAD 2005 emission factors are based on the power of the equipment and the number of hours the equipment is used. Emissions in tons per year (tpy) are the product of the emission factor and the total equipment use, which is measured in horsepower hours (hp-hrs).
[b] Emission factors for construction equipment do not differentiate between PM_{10} and $PM_{2.5}$.
[c] Due to rounding, total may be slightly more or less than the sum of individual emissions.
CO = carbon monoxide; hp-hrs = horsepower hours; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

Table 3.2-8. 2014 CO_2 Capture Facility Construction Emissions

Description	Total Use (hp-hrs)[a]	CO (tpy)	NO_x (tpy)	PM_{10} (tpy)[b]	SO_2 (tpy)	VOC (tpy)
Plate Compactors Diesel	44,550	0.04	0.28	0.01	1.31	0.02
Trenchers Diesel	72,516	0.09	0.42	0.02	2.15	0.03
Excavators Diesel	97,200	0.14	0.57	0.04	2.88	0.04
Cranes Diesel (600 hp)	298,500	0.44	1.98	0.07	8.76	0.07
Non-Road Trucks Diesel	399,000	0.50	0.97	0.14	11.84	0.14
Rubber Tire Loaders Diesel	115,500	0.15	0.68	0.04	3.43	0.04
Tractors/Loaders/Backhoes Diesel	115,500	0.28	0.79	0.07	4.00	0.10
Commercial Welders	187,500	1.26	1.28	0.19	7.21	0.25
Generators	39,900	0.10	0.25	0.02	1.18	0.02
Air Compressors	73,500	0.11	0.43	0.03	2.18	0.03
Cranes Diesel (< 300 hp)	360,000	0.53	2.39	0.09	10.57	0.08
Mixer/Vibrator	48,600	0.04	0.30	0.01	1.43	0.02
Pump Trucks	406,250	0.51	0.99	0.14	12.06	0.14
Scissor Lift	14,742	0.09	0.08	0.01	0.57	0.02
Asphalt Paver	4,000	0.01	0.03	0.00	0.14	0.00
Haul Trucks	778,950	0.98	1.89	0.27	23.12	0.27
Total[c]	**3,056,208**	**5.27**	**13.33**	**1.15**	**92.83**	**1.27**

[a] NONROAD 2005 emission factors are based on the power of the equipment and the number of hours the equipment is used. Emissions in tons per year (tpy) are the product of the emission factor and the total equipment use, which is measured in horsepower hours (hp-hrs).
[b] Emission factors for construction equipment do not differentiate between PM_{10} and $PM_{2.5}$.
[c] Due to rounding, total may be slightly more or less than the sum of individual emissions.
CO = carbon monoxide; hp-hrs = horsepower hours; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

Table 3.2-9. Comparison of Construction Emissions with Total Emissions in the ROI

Pollutant	Total Emissions in ROI [a] (tpy)	2013 Construction Emissions (tpy)	2013 Construction Emissions as a percent of Total ROI Emissions	2014 Construction Emissions (tpy)	2014 Construction Emissions as a percent of Total ROI Emissions
CO	79,501	14.3	0.02%	5.3	0.007%
NO_x	26,130	39.7	0.15%	13.3	0.05%
PM_{10}	52,036	1,588[b]	3.1%	419[b]	0.80%
$PM_{2.5}$	8,859	3.0[c]	0.03%	1.2[c]	0.01%
SO_2	55,108	243.5	0.44%	92.8	0.17%
VOC	85,386	3.1	0.004%	1.3	0.001%

[a] Source: EPA 2012h
[b] PM_{10} emissions includes material handling emissions, which are based on a conservatively high estimate of PM emissions. Material handling emissions are included as PM_{10} because the AP-42 emission equations are not designed for the estimation of $PM_{2.5}$ emissions. 2013 construction emissions, including PM_{10} emissions from material handling, are compared to emissions from stationary sources in the ROI, which do not include PM emissions from other construction projects or land cultivation in the area. For example, Jackson County had an estimated 250,000 acres of cropland in cultivation in 2008 (NRCS 2012), approximately 1,000 times the construction acreage for the proposed project. Therefore, construction-related PM_{10} emissions from the proposed project actually account for a much smaller percentage of PM emissions in the ROI than is reflected in this comparison.
[c] $PM_{2.5}$ emissions do not include material handling because the AP-42 emission factor is for total PM and does not differentiate for PM2.5 emissions.
CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; ROI = region of influence; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

3.2.3.1.3 Summary of Construction Impacts

As discussed above, because the HGB MSA is currently designated as a “severe non-attainment” area for ozone, the EPA requires a conformity determination to assess air quality impacts from federal actions, such as the Parish PCCS Project, that are proposed within the HGB MSA. Per the provisions of 40 CFR 93.153, a conformity determination is required when the annual direct and indirect emissions from a federal action in a non-attainment area equal or exceed a threshold rate. For the HGB MSA, the applicable thresholds are 25 tons per calendar year of NO_x and 25 tons per calendar year of VOC. Since Fort Bend County is located in the HGB MSA and Wharton County and Jackson County are not, only emissions from the portions of the proposed project that are located in Fort Bend County must be compared to the 25 tpy threshold rates for NO_x and VOC.

The indirect emissions from the Parish PCCS project would be the emissions resulting from construction of the CO_2 capture facility and the approximately 20.5 miles of pipeline corridor in Fort Bend County (i.e., approximately 25.5% of total pipeline construction emissions). As can be seen in Table 3.2-10, the construction-related NO_x emissions in Fort Bend County would be approximately 23.1 tpy in 2013 and 13.3 tpy in 2014. The construction-related VOC emissions in Fort Bend County would be approximately 1.9 tpy in 2013 and 1.3 tpy in 2014. Since these NO_x and VOC emissions are less than the 25 tpy threshold, a conformity determination is not required for indirect emissions related to the Parish PCCS Project.

Based on this general conformity analysis and the emissions related to materials handling and mobile sources discussed above, construction emissions from the proposed project would not be expected to directly or indirectly cause an adverse change in ROI air quality as compared to ambient air quality standards. Therefore, impacts to air quality in the ROI due to construction emissions can be considered to be minor.

Table 3.2-10. Comparison of Construction Emissions in Fort Bend County with General Conformity Thresholds

Pollutant	2013 Construction Emissions in ROI (tpy)	2013 Construction Emissions in Fort Bend County (tpy)	2014 Construction Emissions in ROI (tpy)	2014 Construction Emissions in Fort Bend County (tpy)	General Conformity Thresholds (tpy)[a]
NO_x	39.7	23.1	13.3	13.3	25
VOC	3.1	1.9	1.3	1.3	25

[a] 40 CFR 93.153

NO_x = nitrogen oxides; ROI = region of influence; tpy = tons per year; VOC = volatile organic compounds

3.2.3.2 Operational Impacts

3.2.3.2.1 CO_2 Capture Facility

As described in Chapter 2 of this EIS, the CO_2 capture facility at the W.A. Parish Plant would consist of an amine-based CO_2 capture system, a natural gas-fired CT/HRSG, a cooling tower, an emergency generator, and associated support equipment. This CO_2 capture facility would be designed to treat a slipstream that accounts for approximately 250 MWe of flue gas extracted from the existing Unit 8 boiler flue gas. The extracted flue gas would be routed to the CO_2 capture system after it is filtered and scrubbed to remove PM and SO_2 in the existing fabric filter baghouse and WFGD systems that are currently part of the Unit 8 system.

In this section, DOE is only addressing new emissions and impacts associated with the following new equipment:

- CO_2 capture system – CO_2, NH_3, and VOC;
- Natural gas-fired CT/HRSG – CO, CO_2, H_2SO_4, NH_3, NO_X, PM, SO_2, and VOC;
- Cooling tower – PM; and
- Emergency generator –CO, NO_X, PM, SO_2, and VOC.

The criteria pollutant and other emission increases associated with this equipment, as well as fugitive emissions (i.e., emissions due to leaks and various other unintended or irregular releases of gases) from associated equipment, are shown in Table 3.2-11 and Table 3.2-12, respectively. The details of each of the emission points were documented in the permit application for the CO_2 capture facility submitted to TCEQ on September 16, 2011 (ERM 2011). The impacts of NRG's proposed W.A. Parish PCCS Project are discussed by pollutant in the section below.

Table 3.2-11. New Emissions Associated with the CO_2 Capture Facility: Criteria Pollutants and Ozone Precursors

Compound Emitted		New Equipment					
		CO_2 Capture System	CT/HRSG	Cooling Tower	Emergency Generator	Fugitives	Total
CO	lb/hr	N/A	450	N/A	1.25	N/A	**451.25**
	tpy	N/A	102.06	N/A	0.01	N/A	**102.07**
NO_x	lb/hr	N/A	170	N/A	1.42	N/A	**171.42**
	tpy	N/A	37.63	N/A	0.01	N/A	**37.64**
PM	lb/hr	N/A	16.58	2.2	0.07	N/A	**18.85**
	tpy	N/A	71.7	9.65	Negligible	N/A	**81.35**
PM_{10}	lb/hr	N/A	16.58	0.77	0.07	N/A	**17.42**
	tpy	N/A	71.7	3.38	Negligible	N/A	**75.08**
$PM_{2.5}$	lb/hr	N/A	16.58	Negligible	0.07	N/A	**16.65**
	tpy	N/A	71.7	0.02	Negligible	N/A	**71.72**
SO_2	lb/hr	N/A	1.75	N/A	0.44	N/A	**2.195**
	tpy	N/A	6.92	N/A	0.003	N/A	**6.923**
VOC	lb/hr	29.36	15.5	N/A	1.42	0.08	**46.363**
	tpy	51.9	12.88	N/A	0.01	0.34	**65.13**

Source: ERM 2011
CO = carbon monoxide; CO_2 = carbon dioxide; CT/HRSG = combustion turbine/heat recovery steam generator; lb/hr = pounds per hour; N/A = not applicable; NO_x = nitrogen oxides; PM = particulate matter; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

Table 3.2-12. Other New Emissions Associated with the CO_2 Capture Facility

Compound Emitted		New Equipment					
		CO_2 Capture System	CT/HRSG	Cooling Tower	Emergency Generator	Fugitives	Total
CO_2	lb/hr	50,668	147,483	N/A	40.75	N/A	**198,191**
	tpy	192,051	582,238	N/A	0.24	N/A	**774,289**
H_2SO_4	lb/hr	N/A	0.62	N/A	N/A	N/A	**0.62**
	tpy	N/A	2.44	N/A	N/A	N/A	**2.44**
NH_3	lb/hr	1.35	8.67	N/A	N/A	0.02	**10.04**
	tpy	5.7	34.2	N/A	N/A	0.08	**39.98**

Source: ERM 2011
CO_2 = carbon dioxide; CT/HRSG = combustion turbine/heat recovery steam generator; H_2SO_4 = sulfuric acid; lb/hr = pounds per hour; N/A = not applicable; NH_3 = ammonia; tpy = tons per year

3.2.3.2.2 Pipeline Corridor

No pump stations would be installed along the pipeline corridor and the planned meter stations would be powered using electricity provided from the local grid. Therefore, there would be no stationary combustion equipment installed along the pipeline corridor. Mobile source emissions may result from vehicles used to periodically inspect and maintain pipeline components; however, these emissions would be much smaller than the construction emissions discussed above, which were found to be minor. Therefore, impacts to air quality in the ROI due to operational emissions from the pipeline corridor would be considered negligible.

3.2.3.2.3 West Ranch Oil Field

As described in Chapter 2 of this EIS, new equipment that would be installed in the EOR area of the West Ranch oil field (i.e., at the injection well locations, in existing satellite facilities, and in the proposed CO_2 recycle facility) as part of the Parish PCCS Project would include tanks, separators, pumps, an amine unit to remove CO_2 from the recycle gas stream, a glycol contactor to dehydrate the CO_2 recycle stream, a compressor to increase the pressure in the CO_2 recycle stream to the level required for injection, and a flare to control emissions in the event of an upset condition. Table 3.2-13 presents criteria pollutant emissions from a larger (i.e., higher throughput) CO_2 recycle facility located at the West Hastings oil field in Alvin, Texas. These West Hastings oil field emissions provide an order of magnitude estimate of the emissions that would result from EOR equipment at the West Ranch oil field, but are likely higher than actual emissions would be at the West Ranch oil field. Some additional emissions may result from vehicles used to periodically inspect and maintain EOR and CO_2 monitoring equipment at the West Ranch oil field; however, these emissions would be expected to be similar to current operations. Total operations emissions related to the Parish PCCS Project CO_2 recycle facility are summarized in Table 3.2-13and discussed below.

Table 3.2-13. Representative CO_2 Recycle Facility Emissions

Compound Emitted	Representative Emissions (tpy)
CO	9.6
CO_2	11,052[a]
NO_x	10.3
PM_{10}	0.7
$PM_{2.5}$	0.7
SO_2	0.1
VOC	14.6

Source: TCEQ 2012b

[a] CO_2 emissions are based on ratios of CO emissions to estimated CO_2 emissions derived from EPA guidance (EPA 1995) (i.e., approximately 1,429 tons of CO_2 per ton of CO) and 7.74 tpy of permitted CO emissions from combustion-related sources at the Hastings Field (TCEQ 2012b).

CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

3.2.3.2.4 Summary of Operational Impacts

As discussed above in Section 3.2.3.1.1, because Fort Bend County is within a “severe non-attainment” area for ozone (i.e., within the HGB MSA), the EPA requires a conformity determination to assess air quality impacts from federal actions proposed in Fort Bend County. The direct emissions from the Parish PCCS project would be the operational emissions for the CO_2 capture facility, which are 37.64 tpy of NO_x and 65.13 tpy of VOC, as shown in Table 3.2-11. Although these operational emissions would exceed the 25 tpy threshold rates for NO_x and VOC, they would be exempted from EPA requirements for a conformity determination by 40 CFR 93.153(d)(1) because NRG would be required to obtain an NNSR permit for the emissions source prior to construction. As part of the NNSR permitting process, NRG would be required to provide offsets (i.e., emission reduction credits or allowances) to reduce the total net project increases of ozone precursors (i.e., NO_x and VOC) within the HGB MSA.

Emission reduction credits (ERCs) and discrete emission reduction credits (DERCs) are generated when the holder of an existing air permit shuts down a source of emissions or reduces existing emissions and registers the emissions reduction with the TCEQ. The Mass Emissions Cap & Trade (MECT) allowances were granted by the TCEQ to cap and regulate the emissions of NO_x in the HGB MSA (Texas Administrative Code 2007). Emission credits and allowances can either be obtained from a broker maintaining a "bank" of emissions credits and allowances generated by previously completed emissions reduction projects, or can be obtained directly from another company. In either case, the credits and allowances must be registered with the TCEQ in order to qualify as offsets for a new project, such as the proposed Parish PCCS Project.

NRG would be required to obtain and retire 1.3 tons of credits or allowances, as applicable, for each ton of NO_x and VOC emissions increase related to the proposed project. NRG owns and has assigned the appropriate amount of NO_x emission credits approved for use in the HGB MSA to the PCCS project.

In order to offset the VOC emission increases, NRG has petitioned TCEQ and EPA to use NO_x DERCs to satisfy the VOC emission reduction requirements. TCEQ rule 30 TAC 101.372(a) (Emission Banking And Trading, Discreet Emission Credit Banking And Trading General Provisions) provides for interprecursor trading, whereby one pollutant reduction is used to satisfy the reduction requirements of another pollutant. In a September 27, 2012 request, NRG petitioned EPA and TCEQ to invoke this interprecursor trading and allow NO_x DERCs to be used to satisfy the VOC emission reduction requirements at a 1 to 1 (1:1) ratio of NO_x emission reductions to VOC emission reductions. The ratio of emission reductions to emission increases would remain 1.3:1. In an October 12, 2012 letter to NRG, EPA stated "we find the use of NO_x DERCs for VOC emission increases is supported through the EPA-approved SIP." In an October 26, 2012 letter, TCEQ approved the interprecursor trading stating "we approve the use of NO_x DERCs to offset VOC emission increases for this project at a ratio of 1:1…" Based on these approvals, NRG would obtain 1.3 tons of NO_x emission reductions for every 1 ton of VOC emission increases that result from this proposed project.

Due to the 1.3 to 1 retirement ratio of emission credits and allowances, the proposed project would result in no net adverse impact on air quality in the HGB MSA with regard to ozone. Additionally, NRG would be required to identify and assign emission credits for use before the permit is issued; therefore, the current project demonstrates conformity with the Texas SIP for the HGB MSA (TCEQ 2007). NRG submitted a permit application to the TCEQ on September 16, 2011. Public notice of TCEQ's preliminary determination occurred on November 4, 2012. TCEQ issued the permit on December 21, 2012.

The EPA has defined Significant Impact Levels (SILs) for criteria pollutants that serve as threshold concentrations to determine whether a source may cause or contribute to a violation of the NAAQS (i.e., a significant deterioration of air quality). If an applicant for an air permit projects, based on an air dispersion modeling study, that an increase in emissions would result in ambient air concentrations of a criteria pollutant that are greater than the established SIL, the permit applicant would be required to perform additional analyses to determine if those impacts would cause or contribute to a violation of the NAAQS. If the applicant's predicted concentrations are lower than the applicable SILs, then the TCEQ would conclude that the source would not cause or contribute to a violation of the NAAQS and that additional analysis is not required.

NRG has completed an air dispersion modeling study to determine the predicted impact of emissions from the proposed project, which was submitted to the TCEQ on August 1, 2012. **The TCEQ has a rigorous process for evaluation of dispersion modeling studies submitted as part of permit applications. The applicant also must meet with TCEQ dispersion modelers to discuss the project. After the "modeling meeting", the applicant must submit a detailed modeling protocol for TCEQ approval. NRG has completed this detailed process and the August 2012 modeling study met all of the criteria and has been approved by TCEQ.** The results of this study, as summarized in Table 3.2-14, show that the operational emissions from the proposed project would not result in concentrations exceeding applicable SILs for criteria pollutants. Therefore, adverse impacts to air quality in the ROI due to operational emissions from the proposed project would be considered minor. The modeling study is currently under review by the TCEQ.

Additionally, as shown in Table 3.2-15, a comparison of total operational emissions from the proposed project to the total of all other permitted emissions in the ROI shows that emissions of all pollutants would be less than 1% of the total emissions in the ROI. Based on this comparison, operational emissions from the proposed project would not be expected to directly or indirectly cause an adverse change in ROI air quality as compared to ambient air quality standards.

In addition to CO_2 removal, as discussed in Section 3.3 of this EIS (Greenhouse Gases), the CO_2 capture system would also remove virtually all of the remaining SO_2 from the flue gas slipstream that is currently emitted through the flue gas vent. The removal of this SO_2 from the Unit 8 flue gas would be an additional beneficial impact of the proposed project.

Table 3.2-14. Comparison of Maximum Predicted Concentrations with Significant Impact Levels

Compound Emitted	Averaging Period	SIL ($\mu g/m^3$)	Maximum Predicted Concentration ($\mu g/m^3$)	Are Predicted Concentrations Significant?[a]
CO	24 Hour	2000	102.9	No
	8 Hour	500	46.6	No
NO_2	1 Hour	7.5	6.5	No
	Annual	1	0.01	No
PM_{10}	24 Hour	5	0.42	No
	Annual	1	0.03	No
$PM_{2.5}$	24 Hour	1.2	0.32	No
	Annual	0.3	0.02	No
SO_2	1 Hour	7.8	0.16	No
	3 Hour	25	1.87	No
	24 Hour	5	0.06	No
	Annual	1	0.002	No

Source: ERM 2012

[a] Predicted concentrations are significant if they exceed applicable SILs. Predicted concentrations that are less than SILs are not significant.

$\mu g/m^3$ = micrograms per cubic meter; CO = carbon monoxide; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SIL = Significant Impact Level; SO_2 = sulfur dioxide

Table 3.2-15. Comparison of Operational Emissions Associated with the CO_2 Capture Facility with Total Emissions in ROI

Compound Emitted	Total Emissions in ROI[a] (tpy)	CO_2 Capture Facility Operational Emissions (tpy)	Representative CO_2 Recycle Facility Emissions (tpy)	Total Estimated Operational Emissions (tpy)	Total Estimated Operational Emissions as a percent of Total ROI Emissions
CO	79,501	102.1	9.6	111.7	0.1%
NO_x	26,130	37.6	10.3	47.9	0.2%
PM_{10}	52,036	75.1	0.7	75.8	0.1%
$PM_{2.5}$	8,859	71.7	0.7	72.4	0.8%
SO_2	55,108	6.9	0.1	7.0	0.01%
VOC	85,386	65.1	14.6	79.7	0.1%

[a]Source: EPA 2012h
CO = carbon monoxide; CO_2 = carbon dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter with a diameter of 10 microns or less; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compounds

3.2.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to air quality **due to the project. However, under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013, and would be a new source with emissions of criteria pollutants. The criteria pollutant emissions associated with the cogeneration plant are: 102.1 tpy of CO, 37.6 tpy of NO_x, 75.1 tpy of PM_{10} , 71.7 tpy of $PM_{2.5}$, 6.9 tpy of SO_2, and 12.88 tpy of VOC (Table 3.2-15). These potential emission increases were evaluated by TCEQ and included in this EIS, and are authorized in the TCEQ permit that was issued on December 21, 2012.**

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3.3 GREENHOUSE GASES

3.3.1 Introduction

CO_2 is one of a number of compounds collectively referred to as greenhouse gases (GHGs). This section identifies and describes emissions of GHGs that could potentially occur as a result of the construction and operation of NRG's proposed Parish PCCS Project. This section also estimates the contribution of these GHG emissions on a regional, national, and global scale. Potential benefits of the project resulting from reductions in GHG emissions are also addressed, particularly the capture of up to 1.6 million tons per year of CO_2 from the W.A. Parish Plant and delivery to the West Ranch oil field for use in EOR and ultimate sequestration.

3.3.1.1 Region of Influence

The ROI for GHG emissions is broadly discussed in regional (the State of Texas), national (the U.S.), and global terms. Potential impacts of GHGs on climate change are generally viewed from a global cumulative perspective.

3.3.1.2 Method of Analysis

In general, GHG emissions to the atmosphere, and CO_2 emissions specifically, are not considered to have acute or chronic impacts on health or welfare. Increases (or decreases) of project-specific GHG emissions are only relevant as they relate to climate change potential. The potential for climate change is related to the GHG concentrations in the atmosphere on a global scale. However, there are no well-defined methods that are used to predict GHG atmospheric concentrations from mass emission rates of GHGs. Therefore, the method used for this analysis is an evaluation of the change in GHG emissions resulting from the Parish PCCS Project. If the proposed project were to result in an overall increase in GHG emissions, there would be some adverse impact on GHG concentrations. If the project were to result in a net decrease in GHG emissions, there would be a beneficial impact on GHG concentrations. GHG data for this evaluation were obtained from the U.S. Energy Information Agency (EIA).

3.3.1.3 Factors Considered for Assessing GHG Emissions

DOE assessed the potential for changes in emissions of GHGs based on whether the project would directly or indirectly

- cause significant increases in emissions of GHGs to the atmosphere; or
- threaten to violate federal, state, or local laws or requirements regarding GHG emissions.

There are no generally accepted methods that allow for a direct evaluation of the impact on climate from a specific change in GHG emissions. Therefore, potential changes in climate are discussed as a cumulative impact in Section 4.2 of this EIS (Cumulative Impacts).

3.3.2 Affected Environment

GHGs trap incoming radiation (heat) from the sun, causing a warming of the planet's surface. The EIA estimates that 87% of U.S. GHG emissions are related to energy consumption (EIA 2012a). From 1990 to 2009, GHG emissions in the U.S. increased by about 0.04% per year. Figure 3.3-1 shows the historical trend for CO_2 emissions for selected sectors (EIA 2012a). The U.S. accounts for about 20% of the world's total energy-related CO_2 emissions (EIA 2012a). Because GHGs trap radiation (heat) from the sun and warm the planet's surface, a certain amount of these gases is beneficial. But as concentrations of these gases increase due to human activity (i.e., anthropogenic activity), more warming may occur than would happen naturally. This section documents the magnitude of the anthropogenic GHG emissions so that the impacts from the Parish PCCS Project can be assessed.

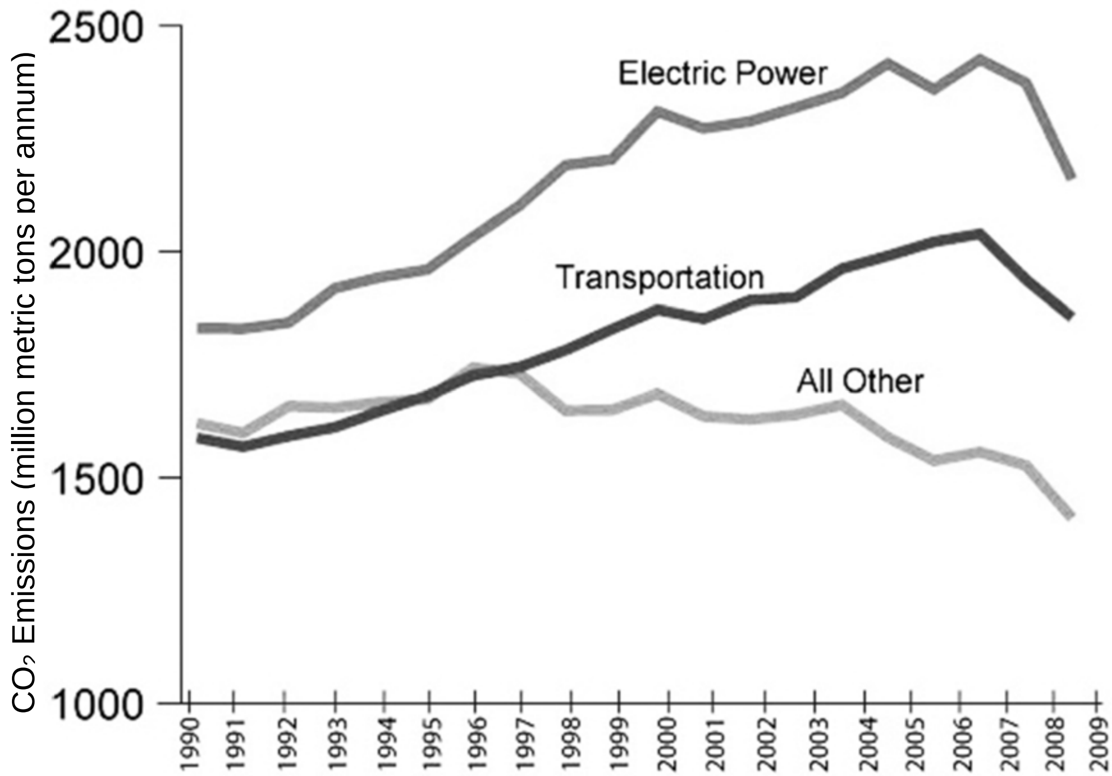

Figure 3.3-1. U.S. Energy-Related CO_2 Emissions for Selected Sectors, 1990-2009
Source: EIA 2012a

3.3.2.1 Emissions of GHGs

The EIA estimated that global CO_2 emissions from anthropogenic sources totaled 30,190 million metric tons in 2008. In this analysis, China was the largest contributor to this global loading followed by the United States, Europe, and Russia. Details of the distribution of the estimated global emissions in 2009 are shown in Table 3.3-1 in million metric tons per annum (MMTA). Table 3.2-2 shows the distribution of 2009 U.S. GHG emissions by end user, with electricity generation accounting for about 40% of U.S. CO_2 emissions. Figure 3.3-2 shows the U.S. energy-related CO_2 emissions by fuel type. Table 3.3-3 shows the distribution of CO_2 emissions across the ten states that are the top U.S. emitters. Texas had the most CO_2 emissions in 2009, accounting for approximately 11% of the total U.S. emissions.

Table 3.3-1. Global Emissions of CO_2 in 2009

Region	2009 CO_2 Emissions (MMTA)	Percent of Total Emissions
China	7,797	26%
United States	5,426	18%
Europe	4,111	14%
Russia	1,605	5%
India	1,549	5%
Japan	1,087	4%
Others	8,705	28%
Total	**30,280**	**100%**

Source: EIA 2012a
CO_2 = carbon dioxide; MMTA = million metric tons per annum

Table 3.3-2. U.S. CO_2 Emissions By End User in 2009

End-User	2009 CO_2 Emissions (MMTA)	Percent of Total Emissions
Residential	1,162.2	21%
Commercial	1,003.6	18%
Industrial	1,405.4	26%
Transportation	1,854.5	34%
Total[a]	**5,425.7**	**100%**
Electricity Generation	*2,160.3*	*40%*

[a] Electric power sector emissions are distributed across all end user sectors
Source: EIA 2012a
CO_2 = carbon dioxide; MMTA = million metric tons per annum

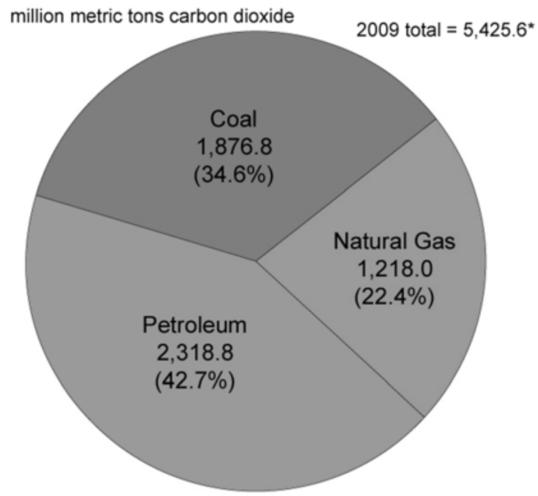

Figure 3.3-2. U.S. Energy-Related CO_2 Emissions by Major Fuel, 2009

Source: EIA 2012a

Table 3.3-3. U.S. CO_2 Emissions By State (Top 10)

State	2009 CO_2 Emissions (MMTA)	Percent of Total Emissions
Texas	605.5	11%
California	375.8	7%
Pennsylvania	246.4	5%
Ohio	238.2	4%
Illinois	226.5	4%
Florida	227.0	4%
Indiana	209.4	4%
New York	175.6	3%
Michigan	164.8	3%
Georgia	164.2	3%
Total U.S.	**5,404.2**	**100%**

Source: EIA 2011

CO_2 = carbon dioxide; MMTA = million metric tons per annum

3.3.2.1.1 Greenhouse Gas Initiatives and Programs

Concerns regarding the relationship between GHG emissions from anthropogenic sources and changes to climate have led to a variety of federal, regional, and state initiatives and programs aimed at reducing or controlling GHG emissions from human activities. Table 3.3-4 summarizes important federal legislation, policy, and legal decisions regarding GHGs. In addition to federal actions, numerous states and regional organizations, including the State of Texas, have also taken action to address GHG concerns. However, there are currently no Texas regulations pertaining to limits in emissions of GHGs.

Table 3.3-4. Federal Legislation, Policy, and Legal Decisions Regarding GHGs

Federal Actions	Description
DOE Clean Coal Demonstration Programs	Three DOE funding assistance programs to demonstrate Clean Coal projects including: 1. Clean Coal Technology Demonstration Program, established in 1986. 2. Power Plant Improvement Initiative, established in 2000. Completed its fourth and final project. 3. Clean Coal Power Initiative, established in 2001. Invests in projects that demonstrate advanced coal-based technologies that capture and sequester, or put to beneficial use, CO_2 emissions from commercial scale coal-fired power plants. (NETL 2012a).
DOE Carbon Sequestration Grants	In October 2006, DOE announced $24 million in grants for carbon sequestration research aimed at developing novel and cost-effective technologies to capture CO_2 so it can be safely and permanently sequestered. Grant recipients would contribute nearly $8 million in cost-sharing for the program (NETL 2006).
U.S. Supreme Court Decision	U.S. Supreme Court decision (Massachusetts v. EPA, April 2007) that six key GHGs meet the CAA definition of air pollutants. The decision concluded that EPA has authority to regulate GHGs if it is determined they pose an endangerment to public health and welfare.
Consolidated Appropriations Act of 2008/ Public Law 110-161 / Mandatory GHG Reporting Program. 40 CFR 98	Consolidated Appropriations Act of 2008 directed the EPA to develop a mandatory reporting rule for GHGs. EPA issued 40 CFR 98 requiring annual reporting of GHGs from large sources and suppliers in the U.S. that emit 25,000 metric tons or more of GHG emissions. Part 98 became effective December 2009. Final Rule signed September 2009. Requires emitters of GHGs to report emissions to EPA, with first annual emissions reports due in 2011 (74 FR 56260).
American Recovery and Reinvestment Act of 2009 ("The Stimulus Bill")	Under the Act, DOE received $36.7 billion to fund renewable energy, carbon capture and storage, energy efficiency, and smart grid projects, among others (February 2009). The projects are expected to provide reductions in both energy use and GHG emissions.

Table 3.3-4. Federal Legislation, Policy, and Legal Decisions Regarding GHGs

Federal Actions	Description
EPA and DOT Proposed GHG Emissions and Corporate Average Fuel Economy (CAFE) Standards	EPA and DOT National Highway Traffic and Safety Administration promulgated new standards for model year 2012 to 2016 light- to medium-duty vehicles to reduce GHG emissions under the CAA, and new CAFÉ standards to improve fuel economy under the Energy Policy and Conservation Act (September 2009) (EPA 2010b).
Executive Order (EO) 13514, Federal Leadership in Environmental, Energy and Economic Performance	EO (issued October 2009) to make reduction of GHG emissions a priority for federal agencies.
EPA GHG Endangerment Finding	A determination issued by EPA in December 2009. EPA found that six key GHGs pose threat to public health and welfare for current and future generations, and emission of these GHGs from new motor vehicle emissions contribute to GHG pollution (EPA 2009a).
Prevention of Significant Deterioration (PSD)/Title V GHG Tailoring Rule	EPA rule (May 2010) limits applicability of GHG emissions standards under the CAA to new and modified stationary sources that emit more than 75,000 tons of CO_2 equivalent (CO_2-eq) annually and that are subject to PSD and Title V for another regulated pollutant (beginning January 2, 2011). If GHGs exceed the threshold, the GHG emissions would be subject to Best Available Control Technology (BACT) and other relevant requirements that apply to PSD permits (40 CFR 52.21).

In addition to the federal items addressed above, potential policies to limit or reduce GHG emissions are in various stages of development at the state and regional federal levels. Some of the initiatives include:

- In September 2006, California passed Assembly Bill (A.B.) 32, the Global Warming Solutions Act of 2006. A.B. 32 aims to reduce the state's GHG emissions to 1990 levels by 2020. In December 2011, California established a final regulation identifying market-based compliance measures for a cap on GHG emissions. The purpose of this regulation is to reduce GHG emissions through the establishment, administration, and enforcement of the California Greenhouse Gas Cap-and-Trade Program to apply an aggregate GHG allowance budget on covered entities and providing a trading mechanism for compliance instruments.
- In November 2007, the governors of nine Midwestern states signed the Midwestern Greenhouse Gas Reduction Accord. The preliminary design recommendations (issued Dec 2008) include 15% to 25% reductions by 2020 and 60% to 80% reductions by 2050 (FERC 2010).
- California and four Canadian provinces have established the Western Climate Initiative (WCI). In June 2008 they developed a draft rule that aims at an economy-wide cap on six GHGs, including CO_2 (WCI 2012). The WCI continues to develop recommendations for establishing a rigorous offset system to support a cap-and-trade program. On February 11, 2012, the WCI released its final recommendations for the offset and credit creation programs that will be needed for GHG trading programs.
- Ten states in the northeast are moving forward with mandatory emissions reduction programs. For the 10 northeastern states, 2009 is the inaugural year of the Regional Greenhouse Gas

Initiative (RGGI), a cap-and-trade program for power plant emissions of CO_2 (RGGI 2012). As of June 2012 RGGI has had 16 CO2 allowance auctions.

- The Washington Department of Ecology adopted Chapter 173-441 WAC – Reporting of Emissions of Greenhouse Gases on December 1, 2010. The rule becomes effective on January 1, 2011. This rule establishes mandatory GHG reporting requirements for owners and operators of certain facilities that directly emit GHGs as well as for certain suppliers of liquid motor vehicle fuel, special fuel, or aircraft fuel.
- At the national level, numerous bills to reduce GHGs have been introduced in the U.S. Congress in recent years. Several have proposed a cap-and-trade system for CO_2 and other GHGs, but to date no new federal legislation has been enacted in the U.S. that limits GHG emissions. However, on March 27, 2012 the EPA issued a proposed rule under the existing authority of the CAA that would limit CO_2 emissions from certain new fossil fuel-fired electric utility generating units. (Note: The regulation does not address emissions from existing facilities.) This proposed rule, which the EPA refers to as the “Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units” (EPA 2012i and 77 FR 22392), is the first proposed federal regulation in the U.S. that specifies defined limits for GHG emissions from stationary sources.

3.3.3 Direct and Indirect Impacts from the Proposed Project

3.3.3.1 Construction Emissions

GHG emissions into the atmosphere from the construction activities would result from combustion of fuel (e.g., gasoline and diesel) in vehicles and construction equipment. Emissions from these mobile sources (i.e., non-road construction equipment and on-road vehicles) are discussed below.

Mobile Source Emissions

Mobile source emissions are typically categorized as either on-road (e.g., cars, trucks, and motorcycles) or non-road emissions. This analysis focuses on on-road and non-road emissions directly related to construction activities. The non-road emissions result from the use of fuel in a diverse collection of vehicles and equipment, including vehicles and equipment in the following categories:

- all-terrain vehicles;
- construction equipment, such as graders and back hoes; and
- other industrial equipment, such as fork lifts.

All of the activities and equipment identified above would result in some emissions. However, emissions from each of these activities occur for a limited time period. DOE used the NONROAD 2005 (EPA 2005) model to document the emissions from the non-road construction equipment. This model calculates a fuel usage (in pounds of fuel per horsepower-hour) for each of the types of equipment identified above. Using the assumption that the average carbon content of the fuel is 87%, the CO_2 emissions can be calculated if the horsepower of the equipment is known and if the total hours of usage are known. Based on this process, the CO_2 emissions from non-road construction equipment (in metric tons per annum, or MTA) have been calculated and detailed in Table 3.3-5 for the proposed CO_2 capture facility construction and Table 3.3-6 for the CO_2 emissions from proposed construction on the pipeline corridor. CO_2 emissions from construction at the West Ranch oil field have been estimated based on a comparison with a similar facility in Texas. Table 3.3-7 shows the total construction CO_2 emissions in MMTA.

Table 3.3-5. CO_2 Emissions from CO_2 Capture Facility Construction

Description	Total Use (hp-hrs)	CO_2 Emissions (MTA)[a,b]
Plate Compactors Diesel	81,713	43.4
Bore/Drill Rigs Diesel	162,000	86.0
Excavators Diesel	217,594	116.8
Cranes Diesel (600 hp)	249,750	132.6
Graders Diesel	197,100	105.8
Non-Road Trucks Diesel	640,313	343.7
Rubber Tire Loaders Diesel	131,625	70.7
Tractors/Loaders/Backhoes Diesel	244,525	153.2
Crawler Tractor/Dozers Diesel	176,400	94.7
Non-Road Tractors Diesel	9,625	5.2
Generators	1,500	0.8
Pumps	90,000	48.3
Cranes Diesel (< 300 hp)	177,300	94.2
Mixer/vibrator	40,950	21.7
Pump trucks	235,625	126.5
Haul Trucks	1,333,575	715.9
Total	**3,989,595**	**2159.5**

[a]The emissions presented in this table are exclusively CO_2 emissions. For these source types, there may be emissions from other GHG pollutants, but the magnitude of the other pollutant emissions would be small compared to CO_2 emissions.
[b]The plant construction spans the years 2013 and 2014. This table presents the maximum annual emissions, which would occur in 2013.
CO_2 = carbon dioxide; hp = horsepower; hp-hrs = horsepower hours; MTA = metric tons per annum

Table 3.3-6. CO_2 Emissions from Pipeline Corridor Construction

Description	Total Use (hp-hrs)	CO_2 Emissions (MTA)[a]
Bore/Drill Rigs Diesel	36,000	19.1
Excavators Diesel	712,800	382.6
Cranes Diesel	996,480	529.2
Non-Road Trucks Diesel	936,000	502.5
Crawler Tractor/Dozers Diesel	950,400	510.2
Commercial Welders	432,000	300.7
Total	**4,063,680**	**2,244.3**

[a]The emissions presented in this table are exclusively CO_2 emissions, For these source types, there may be emissions from other GHG pollutants, but the magnitude of the other pollutant emissions is small compared to the CO_2 emissions.
CO_2 = carbon dioxide; hp-hrs = horsepower hours; MTA = metric tons per annum

Table 3.3-7. Total Construction CO_2 Emissions

Construction Phase	CO_2 Emissions (MTA)[a]
CO_2 Capture Facility	2159.5
Pipeline Corridor	2,244.3
Total	**4,403.8**

CO_2 = carbon dioxide; MTA = metric tons per annum
Due to rounding, total may be slightly more or less than the sum of individual emissions.
[a]The emissions presented in this table are exclusively CO_2 emissions, For these source types, there may be emissions from other GHG pollutants, but the magnitude of the other pollutant emissions is small compared to the CO_2 emissions.

As can be seen in the information above, the total GHG emissions from construction activities would be approximately 4,854 tpy (4,404 MTA) (i.e., all from CO_2, since other GHG emissions related to the proposed project would be negligible in comparison to CO_2 emissions). Since these GHG emissions are currently not regulated, they would not threaten to violate any federal, state, or local laws or requirements.

The cumulative impacts of GHG emissions are discussed in Section 4.2 of this EIS (Cumulative Impacts). Construction activity impacts from GHG tailpipe emissions could be reduced through the use of BMPs, such as reducing or eliminating equipment idling time and using properly maintained equipment.

3.3.3.2 Operational Emissions

Estimated new CO_2 emissions from the proposed CO_2 capture facility and from EOR operations at the West Ranch oil field would be 774,289 tpy (0.70 MMTA) and 11,052 tpy (0.01 MMTA), respectively, as shown in Table 3.2-12 and Table 3.2-13. Therefore, total new operational CO_2 emissions from the Parish PCCS Project would be approximately 785,000 tpy (0.71 MMTA). Other potential sources of operational CO_2 emissions related to the proposed project (e.g., additional vehicular traffic for operational personnel or deliveries and waste management related to the CO_2 capture facility) would be negligible in comparison. As discussed in Section 2.3 of this EIS, the Parish PCCS Project would remove approximately 1.6 million tons of CO_2 annually (1.5 MMTA) from the W.A. Parish Plant Unit 8 flue gas for use in EOR and ultimate sequestration at the West Ranch oil field. Therefore, the Parish PCCS Project would result in a net reduction of approximately 815,000 tpy (0.74 MMTA) of CO_2 emissions, which corresponds to a total reduction of approximately 16.3 million tons (14.8 million metric tons) of CO_2 emissions over the 20-year span of the proposed project. Therefore, this project would have a beneficial impact as it relates to GHG emissions.

Because the Parish PCCS Project would result in a net decrease in GHG emissions (i.e., based on analysis of CO_2 emissions, since other GHG emissions related to the proposed project would be negligible in comparison), the operational emissions related to the proposed project would not threaten to violate federal laws or requirements regarding GHG emissions. At this time, there are no applicable state or local laws or other requirements that limit GHG emissions.

3.3.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to GHG emissions **due to the project**. **However, under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without**

DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013, and would be a new source with emissions of GHG. The GHG emissions associated with the cogeneration plant are: 582,328 tpy of CO_2, 2.44 tpy of H_2SO_4, and 34.2 tpy of NH_3. Since, in the No-Action Alternative, there will be no emission reductions to offset the emission increases from the cogeneration plant; there would be an increase in GHG emissions. Therefore, the No-action Alternative would result in additional GHG loading in the atmosphere. These GHG emission increases would have to be authorized under a PSD permit from the EPA.

3.4 GEOLOGY

3.4.1 Introduction

This section identifies and describes geologic resources that could potentially be affected by the construction and/or operation of Parish PCCS Project facilities. This section also analyzes the potential impacts of the proposed project on these resources, including migration of CO_2 from deep geologic formations and the potential consequences should this occur.

3.4.1.1 Region of Influence

The ROI for potential impacts to geologic resources includes areas containing alluvial deposits and economic minerals or petroleum resources, if any, underlying or in the vicinity of the proposed project facilities. The ROI varies for each of the three components of the project. For the CO_2 capture facility, the 29-acre ROI for geologic resources includes the geologic strata below the construction footprints of the CO_2 capture facility and associated infrastructure within the W.A. Parish Plant, as shown in Figures 2-4 and 2-5. For the pipeline corridor, the ROI for geologic resources is approximately **1,197** acres in size, including the construction ROW, additional temporary workspace (ATWS) areas, and access roads. At the West Ranch oil field, the ROI for assessing impacts on near-surface geologic resources includes subsurface soils and geologic units directly disturbed by construction and/or operation of CO_2 injection wells, production wells, produced water injection and disposal wells, and monitoring wells or other monitoring devices. Existing wells would be used (i.e., re-refurbished or deepened, as needed) to the extent practicable. New injection wells would be drilled if the existing wells cannot be reworked for injection. New wells would be installed on existing well pads to the extent practicable.

At the West Ranch oil field, CO_2 injection into the target geologic units (i.e., within the Frio Formation) and reinjection or disposal of produced water from EOR operations at injection and disposal well sites would involve subsurface geologic units at deeper depths and to a greater lateral extent than is the case along the pipeline and beneath the CO_2 capture facility. The lateral extent of CO_2 dispersion from injection wells located at the West Ranch oil field would be dependent on the rate and volumes of CO_2 injected and the properties of the reservoir and overlying geologic units at and surrounding the well locations. Recent preliminary reservoir modeling conducted by the BEG, as discussed in Appendix H of this EIS, indicates that injected CO_2 and associated zones of increased pressure would not be expected to migrate laterally outside the area at the West Ranch oil field that is leased and operated by TCV. Therefore, the ROI for EOR and CO_2 monitoring activities at the West Ranch oil field is defined as the area within the proposed 5,500-acre EOR area, as described in Section 2.3.4 of this EIS, plus the area surrounding the proposed EOR area but within the current TCV lease area in the West Ranch oil field. As a simplifying assumption for the purposes of this EIS, this ROI is expressed as a two-mile radius surrounding the boundary of the proposed EOR area, which includes the area modeled in Appendix H.

The RRC regulates the injection of water, steam, gas, oil and gas wastes, or other fluids into porous formations producing oil, gas, or geothermal resources in the State of Texas under 16 TAC 3.46 using Class II injection well permits. The Class II injection permits that would be required for the proposed CO_2 injection or produced water disposal wells also require an evaluation to determine if all abandoned wells have been plugged in a manner that would prevent movement of fluids into strata other than the authorized injection or disposal zone within a quarter-mile (0.25-mile) radius of each proposed well location (RRC 2012b). Since these wells are located within the proposed EOR area, the West Ranch oil field ROI described above (i.e., within two miles or less of the approximately 5,500-acre EOR area) encompasses the area to be evaluated for Class II injection well permits.

For evaluating potential impacts from seismic (i.e., earthquake) effects, an area of potential interest located within approximately 30 miles of the proposed CO_2 capture facility, pipeline corridor, and West Ranch oil field EOR area was identified for evaluation purposes. This search distance is consistent with evaluations performed for other projects in the U.S. regarding potential seismic events that could reasonably result in effects to the project. The 30-mile area of potential interest used for evaluating potential seismic effects allows for an analysis of earthquakes and potential faults located outside the injection plume ROI. As described elsewhere in this section, the risk of seismic events occurring within the proposed project area is very low based on data from United States Geological Survey (USGS) seismic hazard maps. In this context, use of this 30-mile area of interest in this EIS is considered extremely conservative.

3.4.1.2 Method of Analysis

The impacts to geologic resources resulting from construction and operation of the proposed project facilities were evaluated based on review of data derived from published USGS topographic and geologic maps, USGS seismic hazard maps and fault map database information, and information derived from oil and gas well location and production field data. The assessment also considered the potential maximum extent of pressure fronts that would be induced by CO_2 injection in the West Ranch oil field based on the results of preliminary reservoir modeling conducted by the BEG, as discussed in Appendix H of this EIS. Section 3.5 of this EIS (Physiography and Soils) provides additional details of the near-surface geology and potential impacts from proposed project facilities. Section 3.6 of this EIS discusses groundwater resources and potential groundwater impacts associated with the proposed project activities.

3.4.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to geology based on whether the proposed project activities would directly or indirectly:

- result in a locally-induced seismic activity (earthquakes), ground heave/settlement, or (soil) mass wasting (e.g., landslides) and damage to structures;
- change the value of mineral or petroleum resources;
- result in patterns or trends in surface operations or land development and use that would hinder or preclude access to such mineral or petroleum resources;
- alter unique geologic features or landforms;
- result in migration of injected and displaced fluids significantly outside of the target injection/EOR production units (i.e., within the Frio Formation) and intended containment strata; and/or
- affect the mineralogical properties of other geologic formations (e.g., mineral dissolution and reduction in buffering capacity for any acidic fluids present).

3.4.2 Affected Environment

3.4.2.1 Regional Geologic Setting

The proposed project facilities would be located within the Texas Gulf Coastal Plain (Figure 3.4-1). Sediments of the Texas Gulf Coastal Plain were deposited in fluvial-deltaic and shallow-marine environments during the Miocene to the Pleistocene periods. Repeated sea-level changes and basin subsidence caused the development of cyclic sedimentary deposits composed of discontinuous sand, silt, clay, and gravel layers extending around the coastal plains of the Gulf of Mexico Basin (Figure 3.4-2). (Baker 1979; Mace, et al. 2006) In the Texas Gulf Coastal Plain, the resulting sedimentary sequences exhibit considerable heterogeneity (Kasmarek and Robinson 2004; Mace, et. al 2006).

> Processes related to streams and rivers are called **fluvial** processes. During fluvial erosion, weathered sediment is moved to new locations and then deposited (i.e., settled in layers). **Deltaic** deposition at the mouth of a river forms a delta. **Fluvial-deltaic** environments are formed by a combination of fluvial and deltaic processes (i.e., formed by the accumulation of fluvial sediment at the mouth of a river). (**AGI 1957**)

The Texas Gulf Coastal Plain is subdivided into three geographically-based areas: the East Coastal Plain, the Central Coastal Plain, and the South Coastal Plain (Figure 3.4-1). The proposed project facilities would be located within the Central Coastal Plain area. Stratigraphic units underlying the proposed project areas, as depicted in Figure 3.4-3, include Quaternary-age and late Cenozoic-age sediments down to and including the Jackson Group sediments (not shown), which underlie, in ascending order, the Vicksburg Formation and the Frio Formation. The Frio Formation is the geologic interval proposed for EOR activities. Deeper-lying units, including early Cenozoic, Mesozoic, and underlying deformed Paleozoic rocks of Ouachita facies, are not shown in Figure 3.4-3 as they are unlikely to be impacted and considered outside the ROI of the proposed EOR activities.

The regional stratigraphy is shown on the cross section provided on Figure 3.4-4, which is adapted from the regional cross sections presented in publications by Baker (1979; 1995). This cross section traverses the Gulf Coastal Plain from the northwest towards the southeast. The middle of the cross section at well locations 6 through 9 lies along the boundary between Jackson and Wharton Counties and is offset about 22 miles from the West Ranch oil field in Jackson County. Production in this oil field is primarily from the Frio formation shown on this stratigraphic cross section. This cross section also displays the hydrologic units that make up the primary groundwater aquifers in this area of the Gulf Coastal Plain. The groundwater units and the relationship between the deeper producing units are further discussed in Section 3.6 of this EIS (Groundwater).

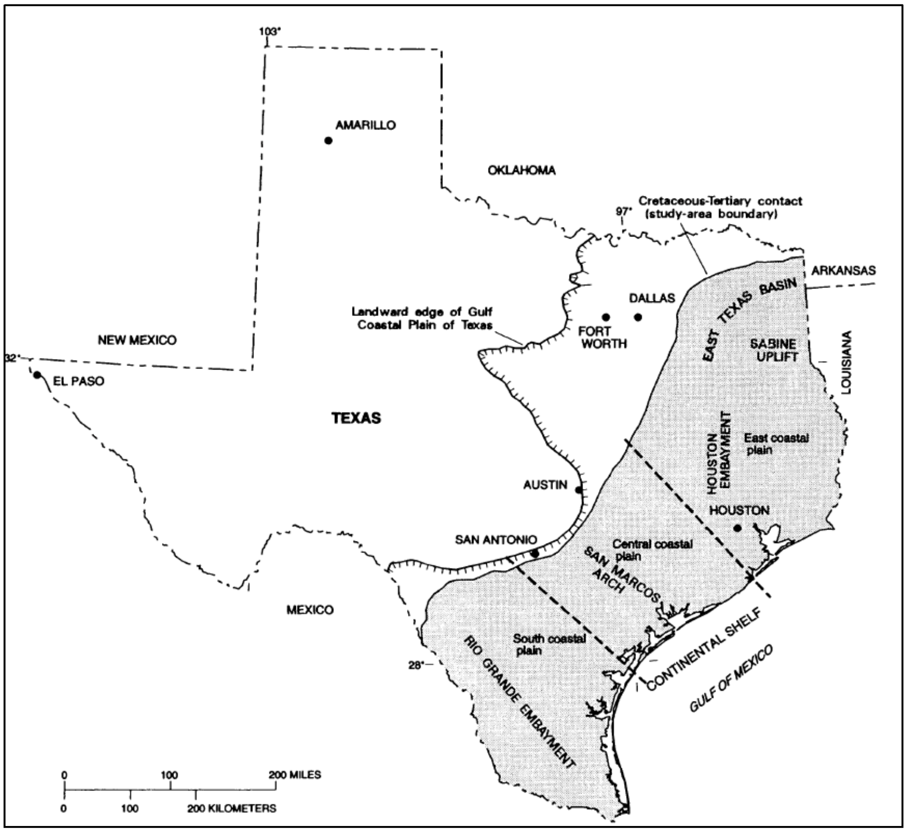

Figure 3.4-1. Location of the Texas Gulf Coastal Plan
Source: Baker 1995

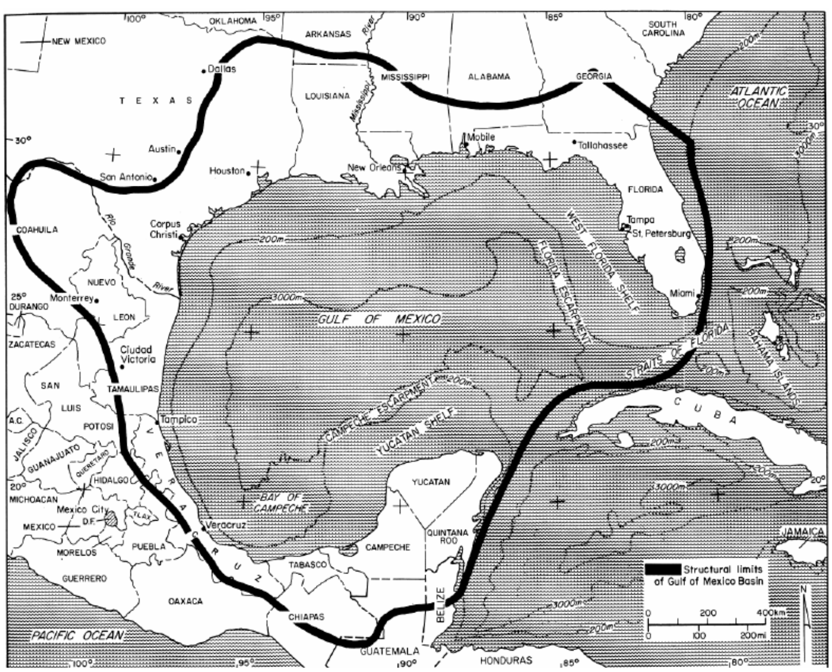

Figure 3.4-2. Geographic Extent of the Gulf of Mexico Basin
Source: Mace, et al. 2006

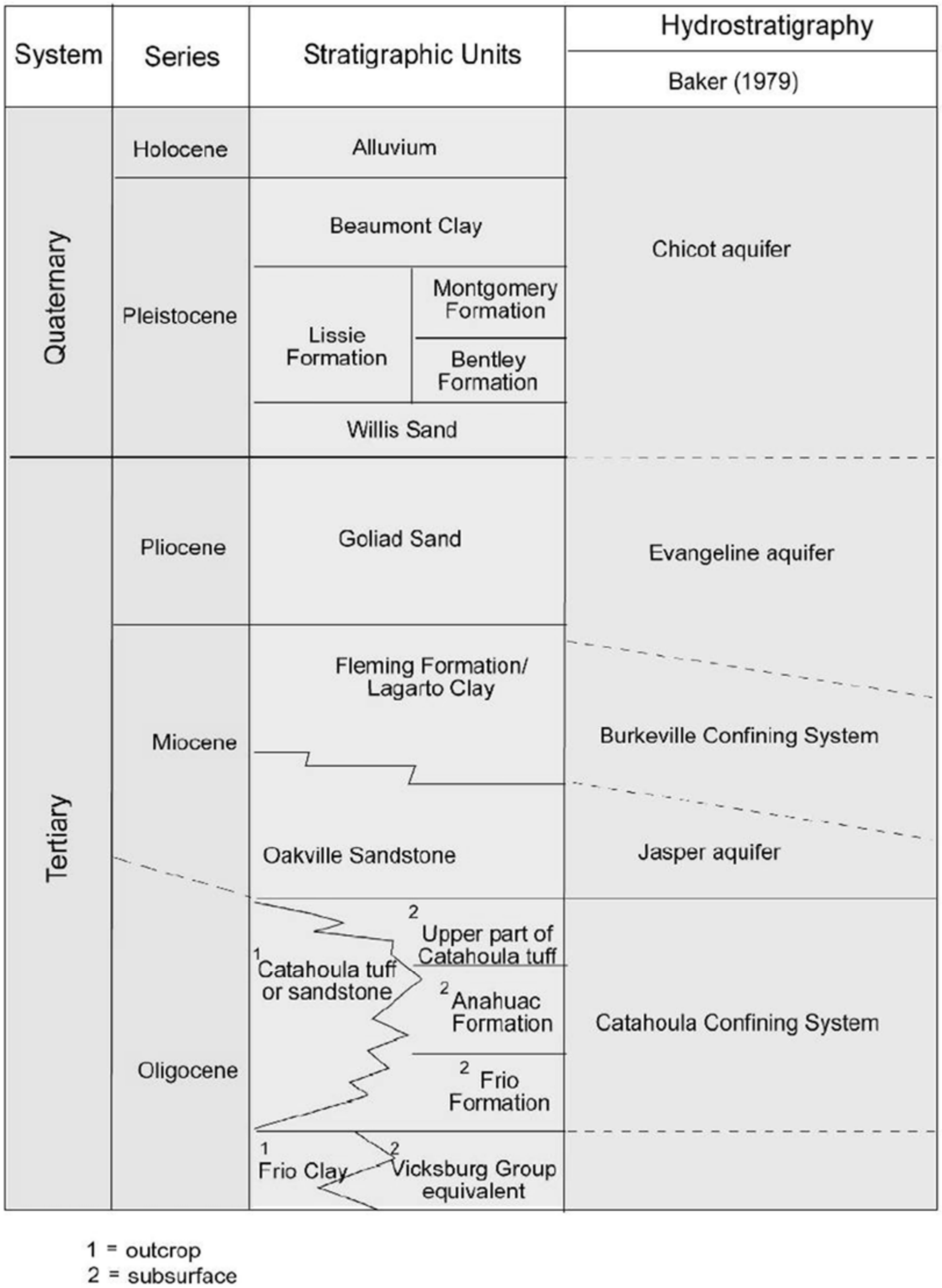

Figure 3.4-3. Stratigraphy of the Gulf Coastal Plain Showing Sediment Successions Formed During the Oligocene to the Pleistocene Periods and Hydrostratigraphic Divisions for Corresponding Stratigraphic Units

Source: Mace, et al. 2006

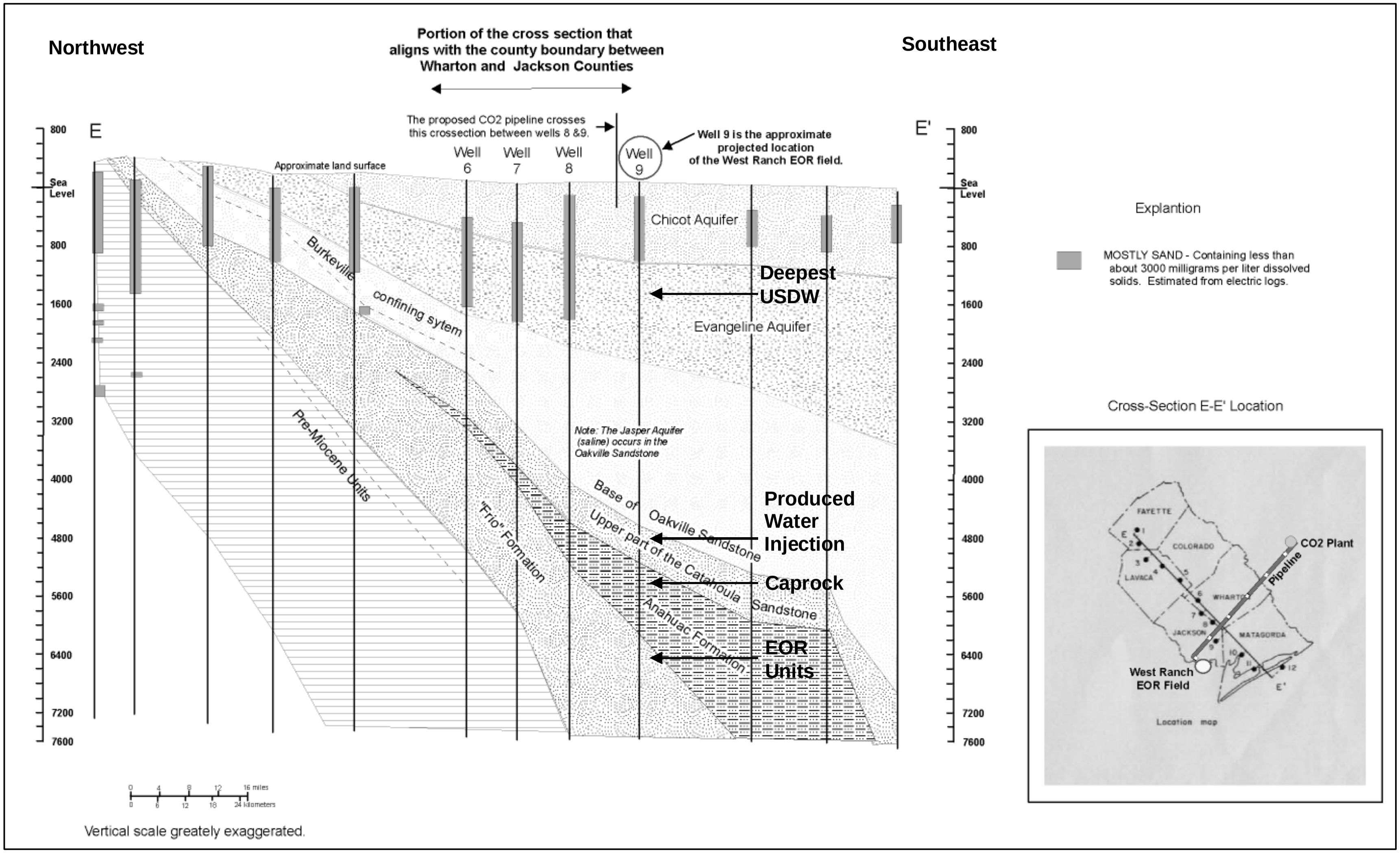

Figure 3.4-4. Generalized Stratigraphic and Hydrologic Cross Section

Note: Depths of structural features are approximate due to projection across approximately 22 miles from Cross-Section E-E' to the location of West Ranch Oil Field
Source: Adapted from Baker 1979, 1995

A **fault** is a subsurface fracture or discontinuity in geologic strata, across which there is observable displacement as a result of earth movement.

Growth faults are common along the Gulf of Mexico in areas where sediment layers move or subside at different rates. (USGS 2012c, Schlumberger 2012)

The presence or absence of faults or seismic activity is particularly relevant to EOR and sequestration projects because faults, if present, could provide preferential pathways for injected and/or displaced fluids to migrate from the target geologic units. Although the Gulf Coast Basin has a large number of subsurface salt domes, many of which may be associated with faults, the proposed project area (i.e., the W.A. Parish Plant, pipeline corridor, and West Ranch oil field) is located in a relatively low risk zone/region for earthquakes and there are no major mapped faults within or near the proposed project areas. A seismic hazard map (USGS 2008; USGS 2009), which is produced by the USGS based on historical earthquake locations and recurrence rates of ground ruptures, shows estimated ground-shaking hazards. Seismic hazard data indicate a probable peak ground acceleration, expressed as percent gravity (% g), within the proposed project area and surrounding region of between 2% g to 4% g with regard to horizontal motion with a 2% probability of exceedance within a 50-year period (USGS 2009). For context, buildings that are not earthquake-resistant undergo structural damage when the peak ground acceleration exceeds 10% g. The risk of seismic events occurring within the proposed project area is therefore very low. The largest earthquake known to have occurred in Texas was a magnitude 5.8 earthquake, which occurred in 1931 near Valentine, Texas, approximately 600 miles west-northwest of the West Ranch oil field (USGS 2011b).

Despite the generally low seismicity in the state of Texas, a number of growth faults (i.e., gravity-driven faults) occur in the vicinity of Houston, Texas northeast of the W.A. Parish Plant and in the vicinity of the West Ranch oil field, as discussed in Appendix I. Though growth faults are not the kinds of faults that cause significant earthquakes, slow, gradual slippage along these types of faults can affect building foundations, pipelines, production and injection wells, and road integrity. Most of these faults result from crustal extension and differential subsidence associated with deposition along the coastline (Englekemeir and Khan 2007).

Three faults have been identified in the Fort Bend Subsidence District: the Addicks, Clodine, and Renn faults. However, these faults are located approximately ten miles northeast of the W.A. Parish Plant (Fort Bend Subsidence District 1998). Also, as discussed in Appendix I, the BEG conducted a geophysical-log-based evaluation of regional structural features in the vicinity of the West Ranch oil field and found two growth faults in the deep subsurface to the northwest and southeast of the West Ranch oil field. The shallowest expression of the two faults is approximately 2,500 feet below mean sea level (msl) and both faults extend through the Greta, Glasscock, 41-A, and 98-A units of the Frio Formation. An approximately 200-foot offset of geologic strata on either side of the fault to the northwest of the oil field reveals the simple domal structure that is responsible for hydrocarbon trapping in the West Ranch oil field. Neither of these faults extends upward to land surface nor do they lie within the boundaries of the oil field (Appendix I, Figures 4 through 8). No obvious or large-scale faults occur within the West Ranch oil field itself. Beneath the pipeline corridor, some subsurface faulting may exist; however, there are no known surface expressions of faulting and there is no evidence of current reactivations or expected activity based on the low seismicity of the region.

3.4.2.2 Geology of CO_2 Capture Facility, Pipeline Corridor, and West Ranch Oil Field

3.4.2.2.1 Surficial Geology

CO_2 Capture Facility

The existing W.A. Parish Plant is located on an approximately 4,880-acre parcel in Fort Bend County, approximately 40 miles north of the Gulf of Mexico. This region's relatively flat terrain exhibits ground surface elevations ranging from about 65 to 70 feet above msl (USGS 2010). Holocene-age alluvium immediately underlies the W.A. Parish Plant and the proposed capture facility area. Near-surface geologic materials mapped in the area include alluvial gravelly sand, delta sand, silt, and gravel (distributary channel facies of the Beaumont Formation in Texas), or delta silt and clay (interdistributary mud facies of Beaumont Formation in Texas) (Pope, et al. 1990).

Pipeline Corridor

The proposed CO_2 pipeline would cross approximately **81** miles of the Texas Gulf Coastal Plain southwest of Houston from the W.A. Parish Plant in Fort Bend County, across Wharton County, to the West Ranch oil field in Jackson County. The relatively flat ground surface terrain along the pipeline corridor exhibits elevations ranging from approximately 25 to 70 feet above msl (ESRI ArcGIS Online 2011). Near-surface geologic conditions traversed by the pipeline include alluvial sands, silt, clay, and gravel deposits, delta sand and silt (distributary channel facies) deposits, and delta silt and clay (interdistributary facies) deposits (Moore and Wermund 1993; Moore, et al. 1993); or alluvial gravelly sand, delta sand, silt, and gravel (distributary channel facies of the Beaumont Formation in Texas) or delta silt and clay (interdistributary mud facies of Beaumont Formation in Texas) (Pope, et al. 1990). No caves, sinkholes, or other karst features are known to exist in Fort Bend, Wharton, or Jackson County (Elliot 2010).

West Ranch Oil Field

Near-surface geologic conditions in the vicinity of the West Ranch oil field in Jackson County include alluvial sands, silt, clay, and gravel deposits, delta sand and silt (distributary channel facies) deposits, and delta silt and clay (interdistributary facies) deposits (Moore, et al. 1993). The topography of the West Ranch oil field consists of a low, nearly flat coastal plain that dips to the south. The surface formations overlying the West Ranch oil field consist of the interbedded clays, silts, and sands of the Beaumont Formation, as described below, throughout most of the West Ranch oil field and geologically recent flood-water deposits (i.e., Quaternary alluvium, composed of sand, silt, clay, and gravel) in the vicinity of the Lavaca River and Garcitas Creek (USGS 2011a).

3.4.2.2.2 Subsurface Geology

Beaumont, Montgomery, Bentley, and Lissie Formations and Willis Sand

The Beaumont Formation (aka, Beaumont Clay), as shown in Figure 3.4-3, outcrops across the majority of the West Ranch oil field and is the first geologic (stratigraphic) unit encountered beneath the recent alluvium in the vicinity of the Lavaca River and Garcitas Creek (Baker 1995, USGS 2011a). This formation extends along the Texas Gulf Coast from the Holocene floodplain of the Mississippi River in Louisiana to northeastern Kleberg County near the southern extent of Texas. The majority of the Beaumont Formation was deposited as alluvial and deltaic sediments from ancestral versions of the modern rivers that drain into the Gulf of Mexico along the Texas coast. The Beaumont Formation formed primarily during the late Pleistocene between roughly 125,000 and 70,000 years ago, with younger parts of the formation possibly being as young as 43,000 to 23,000 years old. No caves, sinkholes, or other karst features are known to exist in Fort Bend County (Elliot 2010).

The Beaumont Formation is predominantly composed of interbedded layers of low permeability clay and silt with lenses of fine sand. In some areas, intermixed and interbedded very fine to fine quartz sand and silt predominate with clay deposits. (USGS 2011a, Moore and Wermund 1993; Moore, et al. 1993) Additional near-surface Quaternary-age deposits in the area are the clay-rich zones of the Beaumont Formation and the underlying Montgomery, Bentley, and Willis Sand and/or Lissie Formations (Baker 1979; 1995). The Montgomery and Bentley formations are lithologically similar to the Willis Sand and the Beaumont Clay (Baker 1979). The Willis Formation consists of valley fill and braided stream deposits of the oldest delta plain that parallels the Gulf Coast (Moore and Wermund 1993). The Lissie Formation Consists of distributary sand and interdistributary mud facies which together form deposits of the oldest fluvial-deltaic plain that parallels the Gulf Coast and underlies the deltaic Beaumont Formation (Moore, et al. 1993). The undifferentiated Lissie Formation has also been considered equivalent in age to the Montgomery and the Bentley formations with the bottom of the latter being considered the base of the Pleistocene, and the Montgomery Formation is also occasionally included within the Beaumont Clay (Mace, et al. 2006). These units collectively make up the sediments of the Chicot aquifer (Figure 3.4-3), which is discussed in Section 3.6 of this EIS (Groundwater).

Goliad, Fleming, and Oakville Formations

The Pliocene-age Goliad sand and Miocene-age Fleming Formation and Oakville sandstone (undifferentiated) underlie the Pleistocene units described above (Figure 3.4-3). The Evangeline Aquifer flows through the Goliad Sand and the Jasper Aquifer flows through the Oakville Sandstone. These two sandy units are separated by the relatively lower permeability Fleming Formation, which is identified as the Burkeville confining system in Figure 3.4-3 and Figure 3.4-4. The Burkeville confining system consists primarily of low permeability silt and clay with typical thicknesses ranging from approximately 300 to 500 feet, with a maximum thickness of approximately 2,000 feet in Jackson County. The Burkeville confining system historically has been defined as a confining unit (i.e., a unit that impedes groundwater flow) by its lithology, which is characterized as the interval having the lowest sand content (i.e., the most widespread distribution of clayey material) between the Evangeline and Jasper Aquifers. The cross section presented in Figure 3.4-4 is oriented perpendicular to the proposed pipeline route. Well location “9” on this cross section is the closest location to the pipeline and indicates the approximate depths and thicknesses of the units in the project area. The Oakville Sandstone contains laterally discontinuous sand and gravel lenses inter-bedded with shale and clay. Massive sandstone beds at the base of the formation thin upward with greater amounts of shale and clay (Loskot, et al. 1982; Baker 1995).

Catahoula Sandstone

As shown in Figure 3.4-3, the Catahoula Confining System (aka, the Catahoula Restricted Aquifer) is composed of three primary formations, including (in descending order) the Catahoula Sandstone (aka, the Catahoula Tuff or the upper part of the Catahoula sandstone), the Anahuac Formation, and the Frio Formation. The Catahoula Sandstone is a very coarse-grained, homogenous sandstone unit of 300 to 400 feet uniform thickness that extends across the coastal area, as shown in Figure 3.4-4. The amount of clay and other fine-grained clastic material in the Catahoula generally increases downdip, as it changes laterally into the Anahuac Formation (Bauernschmidt 1962). The Anahuac and Frio Formations are described below.

Anahuac Formation

The Oligocene-age Anahuac Formation extends across the coastal area of Texas from the Sabine River to the Rio Grande River. This unit is a regionally extensive, dark mudstone and is generally greater than 500 feet thick (Mace, et al. 2006) near the present day coastline. At the West Ranch oil field, the Anahuac Formation averages approximately 450 feet in thickness (see Figure 3.4-5; Bauernschmidt 1944; 1962). The Anahuac Formation consists of a slightly micaceous, calcareous shale with very fine layers of sand (Ellisor 1944). Locally, the Anahuac Formation contains the Discorbis, Heterostegina, and Marginulina sandy zones. Beneath the West Ranch oil field, the Anahuac Formation contains a thin Discorbis sand unit and a basal Marginulina sand unit, but primarily consists of shale, as shown by the electric logs on the West Ranch oil field cross section (Figure 3.4-5).

The Anahuac Formation provides the confining layer, or seal, at the top of the West Ranch oil field reservoir. The confining properties of the Anahuac Formation were studied as part of the Frio Brine pilot study near Dayton, Texas (Hovorka, et al. 2005; NETL 2009), and results of that study demonstrate that this formation serves as an excellent seal for the study field. Based on core test data from a study near Beaumont, Texas, Tsang and Apps (2005) report the average permeability (to liquid) of the Anahuac Formation is 5.2×10^{-6} millidarcies (mD). For the West Ranch oil field, the Frio Formation has held large quantities of buoyant fluids (i.e., oil and gas) over geologic time, indicating that very little migration occurs, if any, through the overlying Anahuac Formation. The Anahuac Formation is, therefore, expected to serve as an effective confining layer for inhibiting migration of injected or displaced fluids from the oil and gas producing units into overlying geologic formations.

Frio Formation

The unit underlying the Anahuac Formation is the Frio Formation. The Frio Formation was formed by a barrier island/lagoon depositional system and includes several massive sand units. Together with ideal source rock material and structural traps, these units have created a number of highly prolific oil and gas reservoirs, including the West Ranch oil field. The major oil-producing zones of the Frio Formation are the Greta, Glasscock, Menefee, Ward, 41-A, Venado, 98-A (aka, the 4-Way), Vanderbilt, and Lavaca units, as shown in Figure 3.4-5.

The proposed project would incorporate EOR activities in four sandstone units at the West Ranch oil field: the Greta, Glasscock, 41-A, and 98-A units. As noted in Section 2.3.4 of this EIS (EOR Operations), preliminary plans call for the general order of CO_2 injection to include flooding the lowest sand unit (98-A) first. When enough recycled CO_2 becomes available, the CO_2 flood would then proceed upward toward the highest sand unit (Greta). EOR activities may or may not be conducted in the Greta unit. The thicker and more homogeneous Greta unit may require more CO_2 for efficient EOR than would be available from NRG's proposed project. In contrast, the Glasscock, 41-A, and 98-A units are thinner, less continuous units composed of interlayered sand and shale. TCV anticipates that oil recovery would be more efficient in the 41-A and 98-A units using the volumes of CO_2 available from NRG's proposed project than in the Greta unit or other oil-producing units at the West Ranch oil field. Based on work conducted by previous West Ranch oil field operators, TCV has determined that CO_2 would be miscible with the oil present in the reservoir sands at the field. Additionally, pressures in oil-producing units at the West Ranch oil field have been adequately maintained during primary production using a strong water drive. Therefore, the miscibility of oil and CO_2 and current oil-producing unit pressures were not factors in selection of the target geologic units for EOR operations at the West Ranch oil field.

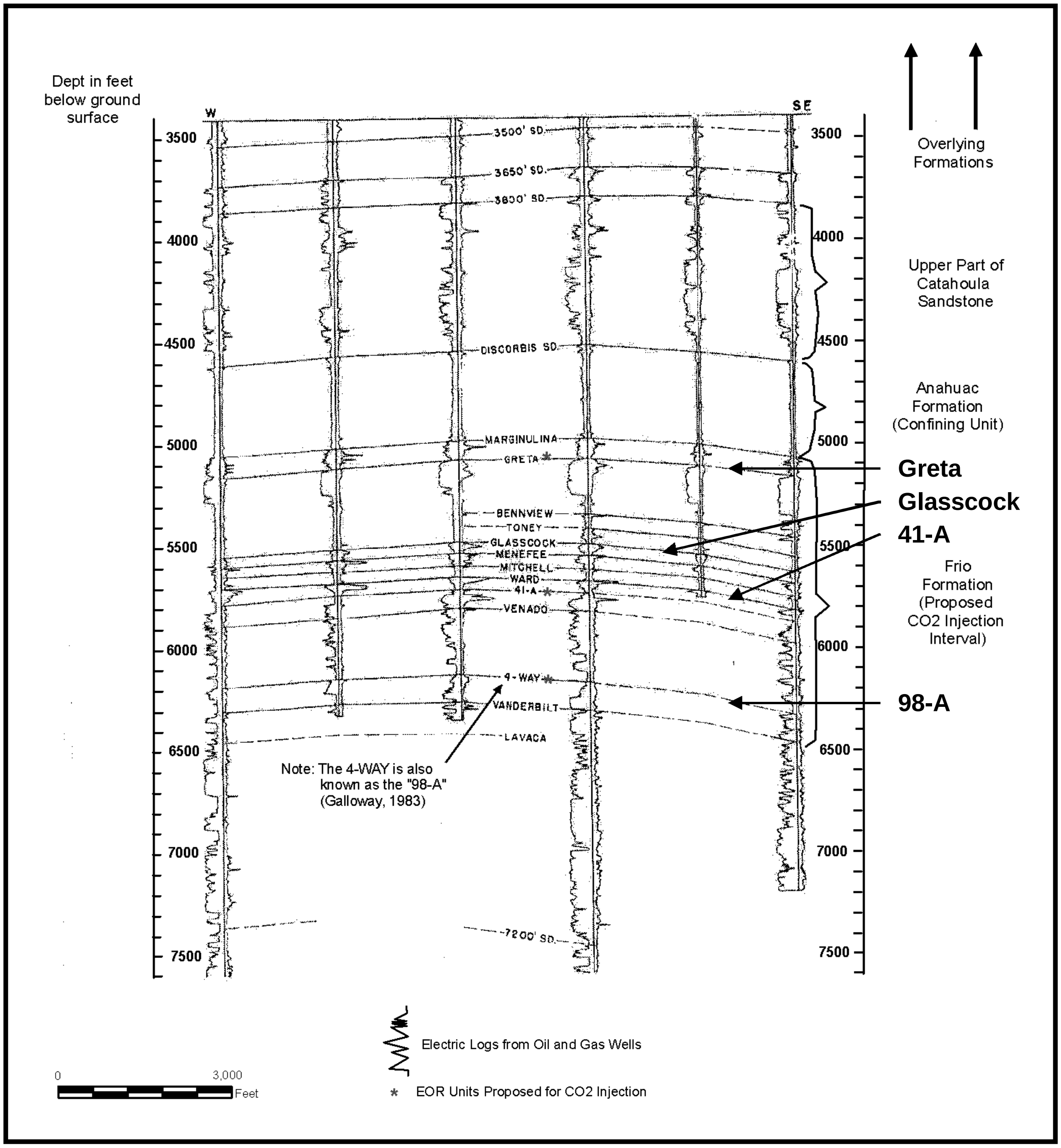

Figure 3.4-5. Geologic Cross Section showing the Proposed CO_2 Injection Units in the West Ranch Oil Field
Sources: Adapted from Bauernschmidt 1944, 1962

TCV **conducted** a CO_2 injection pilot test at the West Ranch oil field beginning in September 2012. The **duration of the** pilot test **was 17 days and required** up to 850 tons per day of commercially produced CO_2. Approximately 20 CO_2 tankers parked on an existing gravel pad at the West Ranch oil field to provide the CO_2 supply for the pilot test and approximately 40 tankers per day **delivered** additional CO_2 through the duration of the pilot test. The pilot test **included** one production well and four associated injection wells. Other equipment required for the pilot test **included** temporary pumps, CO_2 piping, and approximately 2,000 gallons of diesel fuel storage, which **were** located on-site at the West Ranch oil field. CO_2 and the natural gas produced during the pilot **was** flared on-site.

CO_2 injection and geologic storage within the Frio Formation have been demonstrated as part of the Frio Brine pilot study near Dayton, Texas (Hovorka, et al. 2005; NETL 2009). CO_2 injection and EOR within the Frio Formation have also recently been demonstrated at the Hastings field near Alvin, Texas, with the initiation of CO_2 injection in December 2010 and EOR operations beginning in January 2012 (Denbury 2012). Preliminary reservoir modeling conducted by the BEG, which is presented in Appendix H of this EIS, indicates that injected CO_2 and the associated areas of elevated pressure within the target geologic units would remain within the TCV lease areas both during and after EOR activities. The effectiveness of the Anahuac Formation in confining buoyant fluids over geologic time has been demonstrated directly by hydrocarbon accumulation (e.g., oil and gas) beneath the West Ranch oil field. Additionally, data collected on pressure and fluid migration for over 70 years of production history at the West Ranch oil field provides a strong base of experience to support the findings of the preliminary reservoir modeling (i.e., Appendix H of this EIS) that CO_2 would be retained in the Frio Formation within the proposed West Ranch oil field EOR area.

In the area of the proposed EOR activities, the top of the Frio Formation is approximately 5,000 feet deep and extends to about 7,200 feet below ground surface (bgs), as shown on Figure 3.4-5. As discussed above and in Appendix I of this EIS, an evaluation of geologic data in the vicinity of the West Ranch oil field indicates that there are no large-scale subsurface faults located within the West Ranch oil field EOR area.

3.4.2.2.3 Oil/Mineral Deposits

Southeast Texas is particularly rich in oil and gas resources. The State of Texas is the leading producer of crude oil and natural gas in the U.S., contributing nearly 30% of the nation’s total supply (EIA 2009). Additional details regarding oil and gas production in the ROI are discussed below.

CO_2 Capture Facility

There are seven oil producing fields within a ten-mile radius of the W.A. Parish Plant: Thompson Field, Thompson North, Thompson South, Thompson Southeast, Blue Ridge, Sugarland and Big Creek. Thompson Field is the closest, located approximately four miles southeast of the W.A. Parish Plant. Proposed project activities at the W.A. Parish Plant would not affect surface features and wells associated with any oil and gas fields. The rationale for selection of the West Ranch oil Field in Jackson County, Texas as the proposed location for Parish PCCS Project EOR activities is provided in Section 2.3.8.3 of this EIS (EOR Location Alternatives).

Pipeline Corridor

There are many oil-producing fields along the proposed approximately **81**-mile-long pipeline corridor. The subsurface geology of these fields would not be affected by the pipeline because the pipeline is buried only a few feet below the surface whereas the oil and gas reservoirs are several thousand feet deep. The pipeline would be collocated along or within existing mowed and maintained utility corridors for approximately **75**% of its length. Consequently, it is unlikely that the surface features and wells associated with any oil and gas fields along the proposed pipeline route would be affected by the pipeline. Therefore these oil/mineral deposits are not described here.

West Ranch Oil Field

The primary mineral and oil deposits in the area of the West Ranch oil field are the residual oil and gas deposits targeted for EOR as part of this proposed project. The reservoir unit, the Frio Formation, is the most important oil-producing Tertiary formation in the Gulf Coast. Oil activity in the Frio Formation dates from the foundations of the present oil industry with the discovery of oil at Spindletop, Texas and Jennings, Louisiana in 1901 (Burke 1958). The producing belt for the Anahuac and Frio Formations ranges from 40 to 60 miles wide and extends for a length of approximately 675 miles from Mexico to the State of Mississippi (Burke 1958). The four primary oil-producing zones at the West Ranch Oil Field (i.e., the Greta, Glasscock, 41-A, and 98-A units) have produced more than 322 million barrels of oil at the West Ranch oil field since 1938 and over 388 million barrels has been produced from all production zones (HEC 2012b). The West Ranch oil field currently produces oil and gas at the rates of approximately 600 barrels of oil per day (BOPD) and 530 thousand cubic feet of gas per day (530 mcfd), respectively (HEC 2012a,b). None of this production currently results from CO_2-based EOR.

One reason that the Frio Formation is a prolific oil and gas producer is its favorable position between two marine shales. These shales may have provided additional source material for oil and gas, and an adequate caprock (i.e., the Anahuac Formation) for the overall formation (Burke 1958).

The Greta (sandstone) unit is the single most productive litho-stratigraphic unit of the Frio oil play because of the thickness of the sand body, which is approximately 50 feet thick at the West Ranch oil field (Galloway 1986). The Glasscock (sandstone) unit, found at depths of approximately 5,500 feet at the West Ranch oil field (Figure 3.4-5), is thinner than the Greta but is more widespread such that it is the most extensive oil-producing horizon in the West Ranch oil field. The Glasscock unit is a relatively low permeability unit compared to the other West Ranch reservoirs (Galloway 1986). In the units with the highest production rates, such as the Greta and 41-A units, recovery efficiency has been high, commonly approaching 50% of the oil in place, due to high permeability in these units. The thicknesses of the sandstone bodies of the 41-A unit range from 10 to 20 feet along the updip (landward) margin of the West Ranch oil field to more than 100 feet downdip (Galloway 1986). The oil-producing portions of the 41-A unit vary laterally in thickness, with some oil wells showing 60 feet of sand thickness, but other wells showing sand divided by shale lenses into two, three, or four separated sand bodies. The sand zone covers approximately 3,000 acres in the main part of the West Ranch field (Bauernschmidt 1944). The sand zone in the 98-A unit covers approximately 2,500 acres in the field. The historical oil-producing interval in this unit is approximately 75 feet in thickness, but the sands show much lateral variation (Bauernschmidt 1944).

3.4.2.2.4 Oil and Gas Wells and History of the West Ranch Oil Field

The West Ranch oil field was initially discovered by Magnolia Petroleum Company (Mobil Oil Company). Three early wells drilled north of the main field produced limited oil from 1934 to 1937. In

1938, the West Ranch No. 3-A well was drilled, which resulted in the discovery of the West Ranch oil field. West Ranch No. 3-A was completed in the West sand from 5,080 to 5,086 feet bgs, with an initial production rate of 133 BOPD (Bauernschmidt 1944). Table 3.4-1 and Figure 3.4-6 below show the oil production history at the West Ranch oil field from 1934 to 2010. The combined production from all the reservoirs in the West Ranch oil field peaked at a rate of approximately 50,000 BOPD (oil) and 100,000 mcfd (gas) in the late 1960s and early 1970s. Current West Ranch oil field production rates are much lower (i.e. oil is currently produced at a rate of approximately 600 BOPD and gas at approximately 530 mcfd). With the exception of a temporary rise in gas production rates between 2000 and 2008, oil and gas production rates at the West Ranch oil field have, in general, steadily declined since the 1970s.

The West Ranch oil field has been extensively developed for over 70 years. Figure 3.4-7 shows the numerous active oil and gas wells in the vicinity of the West Ranch oil field, and Figure 3.4-8 and Figure 3.4-9 show the additional plugged and abandoned oil and gas wells and the produced water injection wells in this area. Currently, HEC is the primary operator of the West Ranch oil field. Figure 3.4-10 shows the produced water injection and disposal wells currently being used by HEC for oil and gas production at the West Ranch oil field.

HEC uses produced water injection wells as part of the oil and gas production process. Additionally, HEC uses separate underground injection wells to dispose of excess produced water produced during oil and gas production. This excess produced water at the West Ranch oil field is reinjected into the Catahoula Sandstone at a depth of approximately 4,250 to 4,500 feet bgs. Injection well casings extend to approximately 1,350 to 1,600 feet bgs, which is below the bottom of the fresh water zone underlying the West Ranch oil field (HEC 2011a).

In Texas, the RRC regulates injection wells related to oil and gas production, such as the injection wells at the West Ranch oil field, by issuing Class II injection well permits as part of the Underground Injection Control (UIC) Program. Under this program, Class II permits required for injection or disposal wells also require evaluations to determine if nearby abandoned wells (i.e., within a quarter-mile [0.25-mile] radius of each proposed well location) have been plugged in a manner that would prevent movement of fluids into strata other than the authorized injection or disposal zone (RRC 2012b).

Existing wells at the West Ranch oil field would be used to the extent practicable for the proposed project. New injection wells would be drilled if the existing wells cannot be reworked for injection. All new injection wells would require UIC permits and TCV would install the new injection wells in accordance with the design standards specified by the RRC UIC Program. New wells would be installed on existing well pads to the extent practicable.

Table 3.4-1. West Ranch Oil Field Historic Oil Production

Year	Approximate Average Annual Oil Production for Previous Five Years (barrels/year)	Approximate Cumulative Oil Production (barrels)
1940	450,000	2,300,000
1945	6,200,000	33,000,000
1950	6,300,000	65,000,000
1955	6,400,000	97,000,000
1960	5,400,000	123,000,000
1965	4,700,000	147,000,000
1970	11,000,000	202,000,000
1975	16,000,000	284,000,000
1980	11,000,000	339,000,000
1985	4,200,000	360,000,000
1990	2,800,000	374,000,000
1995	1,400,000	381,000,000
2000	740,000	385,000,000
2005	500,000	387,000,000
2010	280,000	388,000,000

Source: Bauernschmidt 1962, HEC 2011b

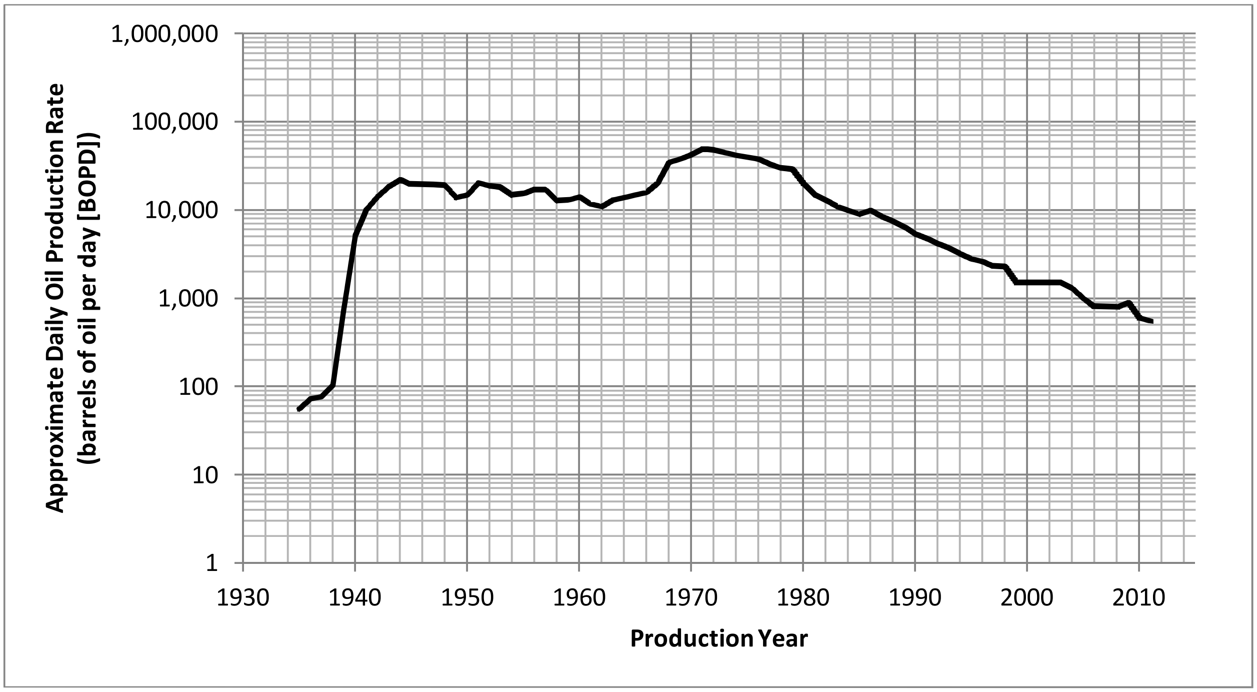

Figure 3.4-6. Oil Production History, West Ranch Oil Field, 1935 to 2010
Source: Bauernschmidt 1962, HEC 2011b

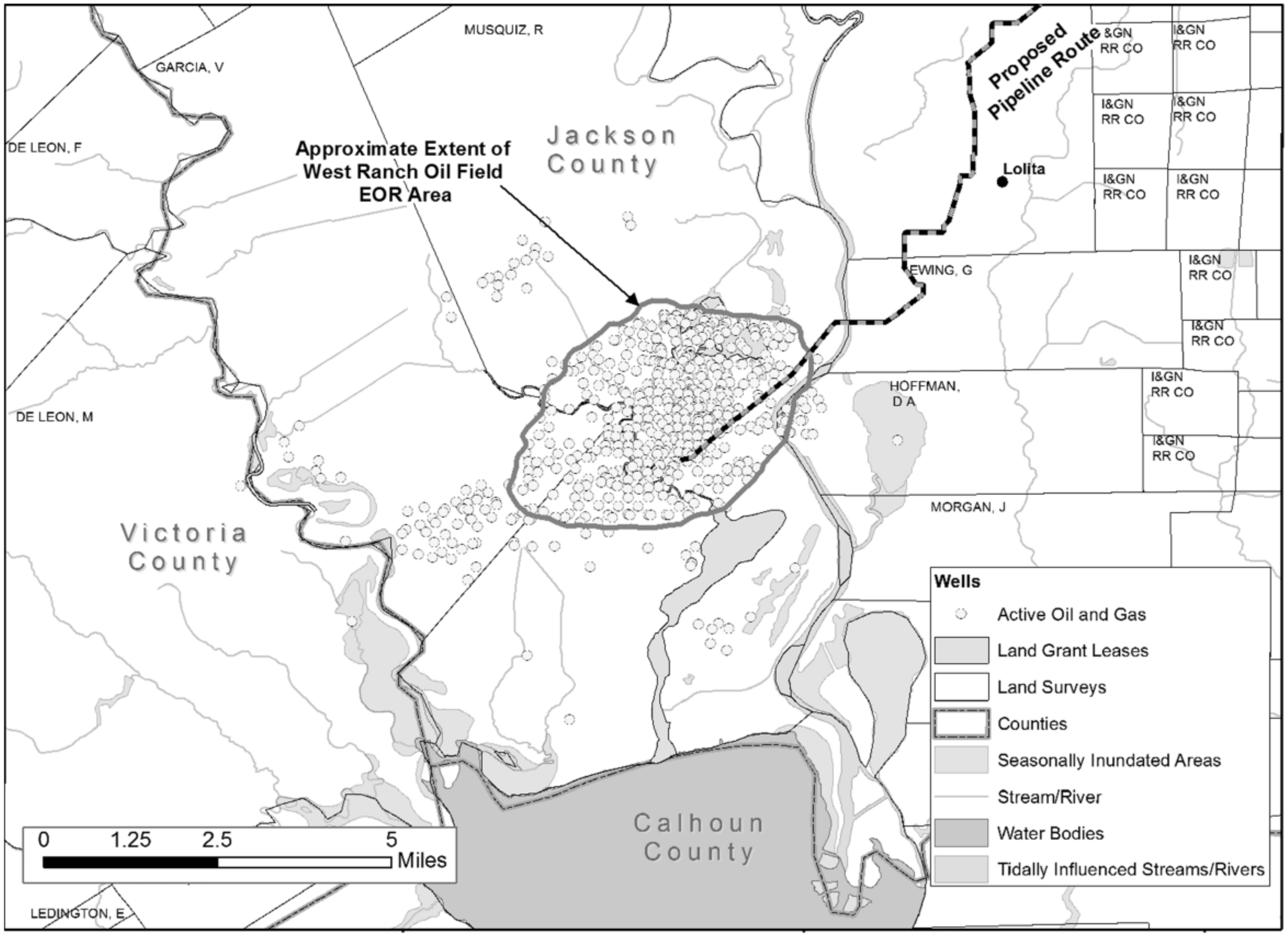

Figure 3.4-7. Active Oil and Gas Wells in the Vicinity of the West Ranch Oil Field
Source: RRC 2010, GLO 2011

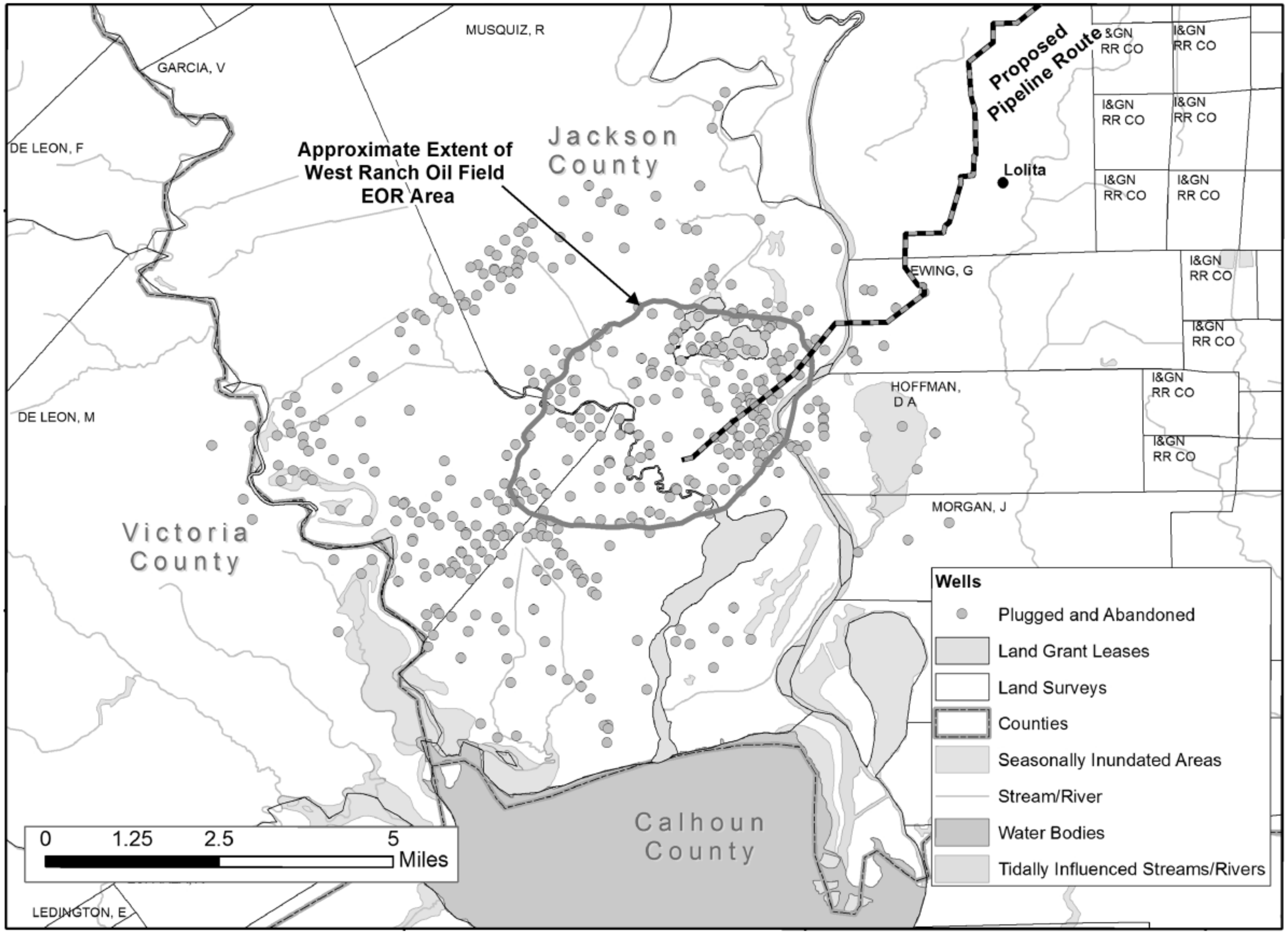

Figure 3.4-8. Plugged and Abandoned Oil and Gas Wells in the Vicinity of the West Ranch Oil Field
Source: RRC 2010, GLO 2011

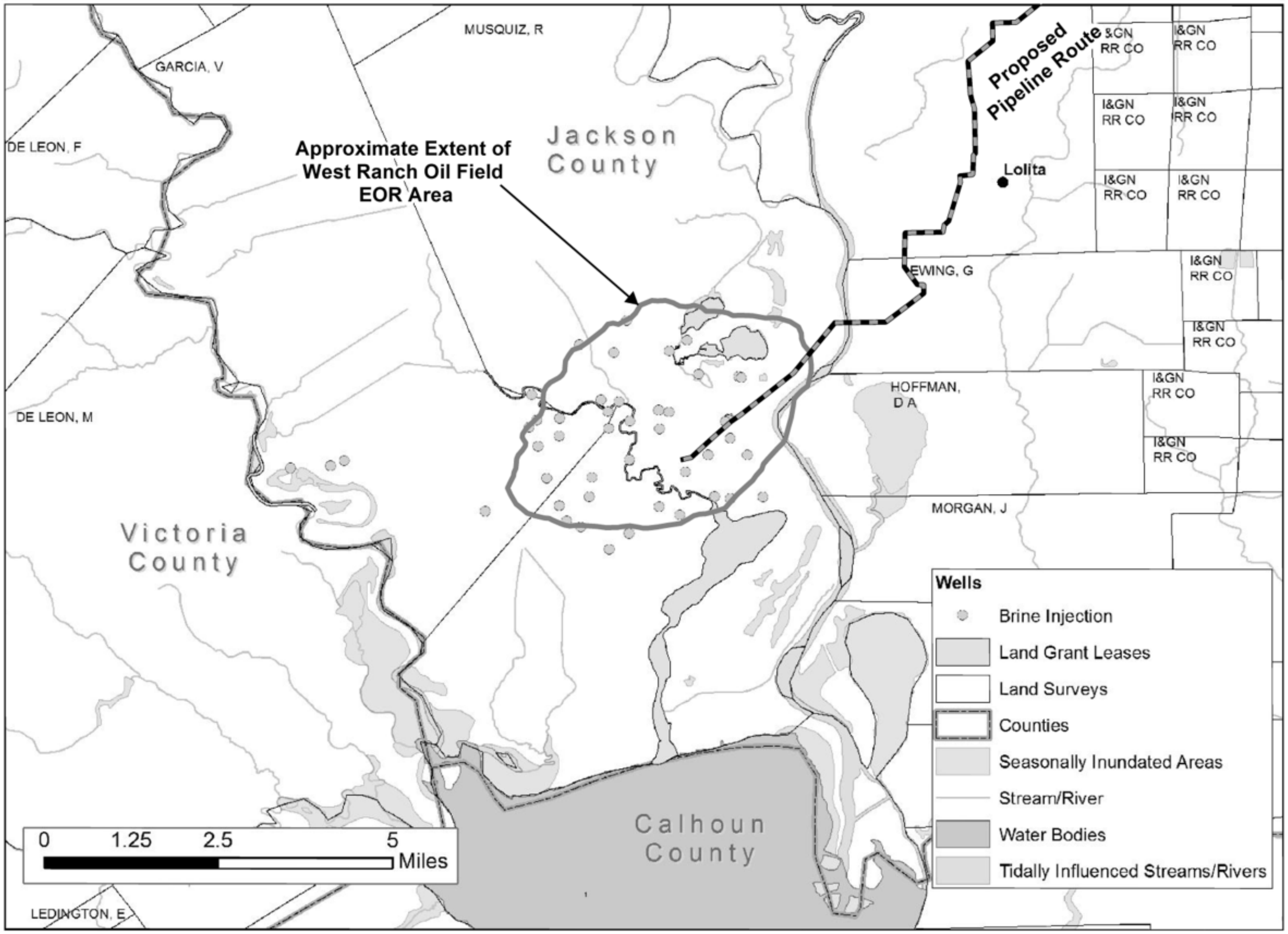

Figure 3.4-9. Produced Water Injection Wells in the Vicinity of the West Ranch Oil Field
Source: RRC 2010, GLO 2011

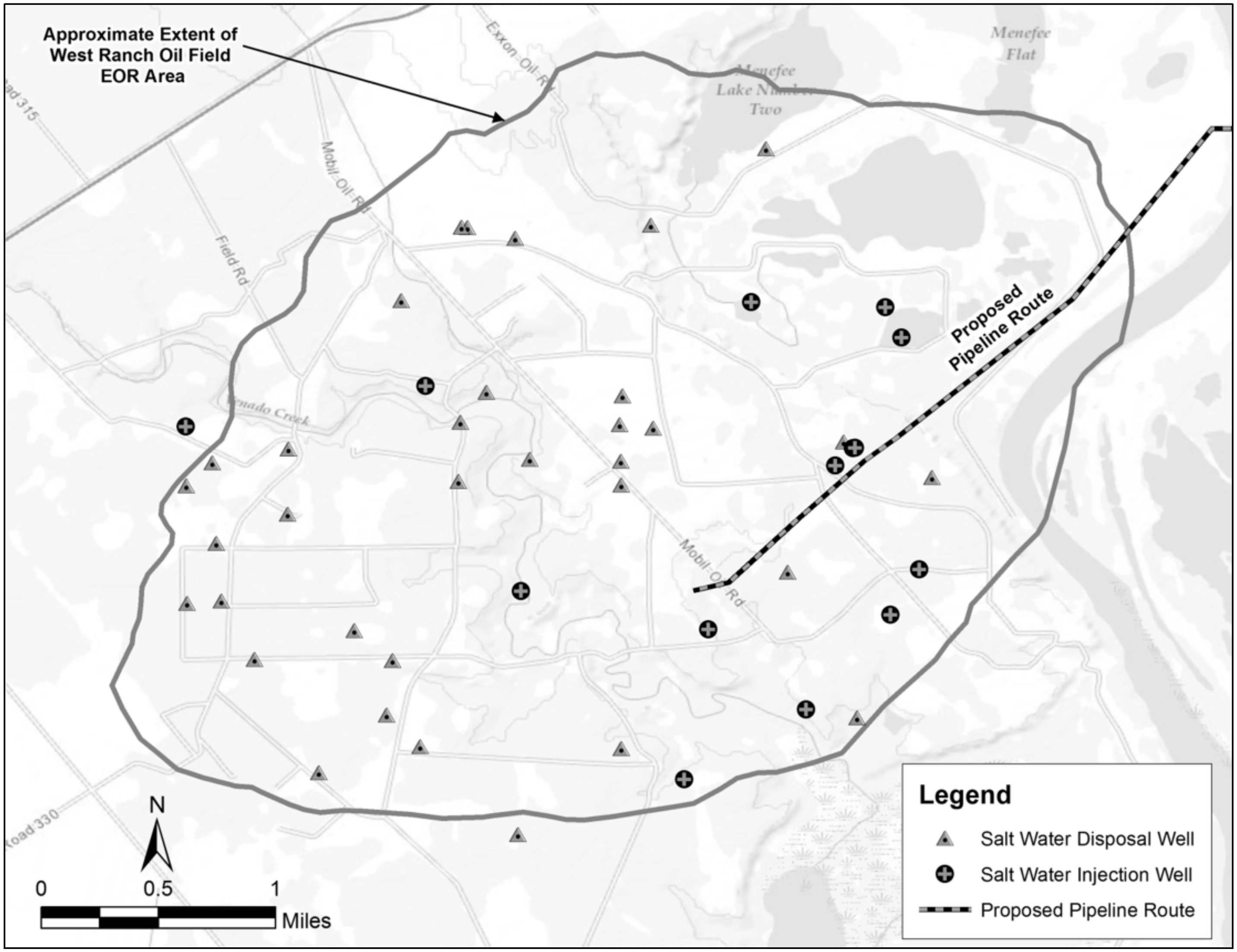

Figure 3.4-10. Produced Water Injection and Disposal Wells at the West Ranch Oil Field
Source: RRC 2010, GLO 2011

3.4.3 Direct and Indirect Impacts of the Proposed Project

DOE assessed the potential for impacts to geologic resources based on whether the Parish PCCS Project would result in any of the effects identified in Section 3.4.1.3.

3.4.3.1 Construction Impacts

CO_2 Capture Facility

Impacts to geologic resources from construction of the CO_2 capture facility would be negligible to very minor and limited to near-surface geology in areas of soil-related impacts, as discussed in Section 3.5 of this EIS (Physiography and Soils). The CO_2 capture facility would be built on the existing W.A. Parish Plant property in an area previously disturbed from construction activities. As described above, no on-site or nearby geologic resources (e.g., valuable gravel or clay or other deposits) are known to exist in the plant area that could be impacted by construction of the CO_2 capture facility. Construction of the CO_2 capture facility would not result in any seismic events that could lead to damage of structures or facilities on the property.

Pipeline Corridor

There would be negligible impacts to geological resources from construction of the proposed CO_2 pipeline. The pipeline would be collocated along or within existing mowed and maintained utility ROWs for approximately **75%** of its length. With the exception of aboveground facilities (e.g., meter stations and valves), all portions of the pipeline would be located underground, but none of the pipeline corridor crosses mapped valuable geologic resources. Southeastern Texas exhibits low seismicity and there are no mapped fault traces on the ground surface near the proposed pipeline corridor. Based on these conditions, there is minimal potential for geologically-related impacts to occur either to the proposed pipeline facilities or to geologic resources as a result of pipeline construction.

NRG does not anticipate that any blasting would be required for the pipeline installation. In the unlikely event that shallow bedrock or other subsurface materials are encountered that cannot be readily excavated, tractor ripping equipment would be used, if necessary. Due to the overall low topographic relief of the terrain that would be crossed by the pipeline corridor, construction of the pipeline is not expected to require any stabilization efforts to ensure that landslides or ground instability would not be induced as a result of construction. As needed, standard construction practices and BMPs used in the pipeline construction industry, as described in Section 3.5 of this EIS (Physiography and Soils), would be implemented to minimize the potential for construction to result in locally-induced ground instability. Oil or gas exploration, production, processing, or treatment operation, or transmission facilities are not required to submit National Pollutant Discharge Elimination System (NPDES) (or Texas Pollutant Discharge Elimination System [TPDES]) permit applications to the EPA or the TCEQ in accordance with 40 CFR 122.26(c)(1)(iii). Although NPDES/TPDES construction stormwater permitting would not be required for the proposed project and NRG would not be required to develop a permit condition-based Stormwater Pollution Prevention Plan (SWPPP), NRG would, however, prepare a project-specific SWPPP to conform to EPA guidance for exempt construction activities. This project-specific SWPPP would describe BMPs to be implemented during the construction phase of the project, which are described in further detail in Section 3.5 of this EIS (Physiography and Soils).

West Ranch Oil Field

NRG proposes to use existing wells to the extent practicable for the EOR process and CO_2 monitoring. New injection wells would be drilled if the existing wells cannot be reworked for injection. All new injection wells would require UIC permits and TCV would install the new injection wells in accordance with the design standards specified by the RRC UIC Program. New wells would be installed on existing well pads to the extent practicable. Well construction would be performed in accordance with RRC permitting requirements. CO_2-resistant cement would be used from the depth of the well bore to the next shallowest casing depth. The use of CO_2-resistant cement in the bottom casing would minimize the potential for CO_2 to degrade the cement and migrate vertically upwards along the well bore. Existing wells used by the project would be reworked to bring them up to current construction standards, resulting in a beneficial impact to geologic resources by reducing the risk of leakage due to improperly sealed wells. Well construction would not be expected to induce seismic activity that could damage structures or impact high-value or unique geologic resources so that they would become inaccessible. Furthermore, well construction would not cause measurable displacement of the ground surface. Drilling for this project would result in negligible impacts above levels already observed as a result of ongoing oil and gas production activities at the West Ranch oil field.

The drilling of small-diameter, shallow boreholes (i.e., generally less than approximately 100 feet in depth) for use in the CO_2 monitoring program would likely be conducted using small truck-mounted equipment and would cause negligible impacts to the shallow geology. Although the boreholes could act as preferential pathways for vertical migration, the potential for vertical migration would be mitigated by properly constructing the wells and sealing the borehole annulus to isolate the interval that is being monitored. In most cases, CO_2 monitoring program-related construction activities would be conducted in or around existing wells in the EOR area. The final quantity and location of monitoring wells would be based on the CO_2 monitoring plan. The plan would be developed in consultation with BEG during the preparation phase of the CO_2 monitoring program to meet the requirements of the CCPI Program and RRC regulations for certification of CO_2 storage related to EOR operations. Activities undertaken as part of the CO_2 monitoring program associated with this project would not involve the removal or injection of any materials that would result in geologic subsidence or heave.

EOR implementation at the West Ranch oil field would also include construction of an aboveground CO_2 recycle facility, as discussed in Chapter 2 of this EIS, in a previously developed approximately 1.5-acre area. As the CO_2 recycle facility would be aboveground, no impacts to geologic resources would be expected due to the construction of the CO_2 recycle facility.

Given the low topographic relief at the West Ranch oil field, there would be a very low potential for landslides to occur as a result of construction activities associated the proposed EOR and CO_2 monitoring activities.

3.4.3.2 Operational Impacts

CO_2 Capture Facility

Impacts to geologic resources from operation of the CO_2 capture facility would be negligible and limited to areas of soil-related impacts, as discussed in Section 3.5 of this EIS (Physiography and Soils). No on-site or nearby geologic resources (e.g., valuable gravel or clay or other deposits) are known to exist that could be impacted by operation of the facility. Operation of the CO_2 capture facility would not be expected to result in seismic effects that could lead to damage of structures or facilities; result in impacts to, or render inaccessible, any unique geologic resources; or result in displacement of the ground surface.

Pipeline Corridor

There would be negligible impacts to geologic resources from the operation of the proposed CO_2 pipeline. Pipeline repairs or maintenance may be required during operation; however, these activities would only disturb surficial and near-surface soils that were previously disturbed during construction of the pipeline. Operation of this project component would not be likely to result in any seismic effects that could damage structures; result in destruction of high-value or unique geologic resources; render any such resources inaccessible; or cause displacement of the ground surface. There are no known karst features underlying or within the proximity of the proposed pipeline. Differential settlement of the land surface as a result of compaction of underlying sediments, fluid withdrawal, or fault-related movements is not expected in magnitudes that would affect the pipeline. Therefore, there is little potential for either short-term or long-term geologic impacts during operation of the pipeline as a result of vertical ground surface movements.

West Ranch Oil Field

Potential impacts to geologic resources related to EOR operations and CO_2 monitoring activities at the West Ranch oil field could result from one of the following conditions:

- CO_2 migration through a permeable zone in the caprock;
- CO_2 migration through improperly plugged and abandoned wells or unknown wells; or
- CO_2 migration through an existing injection, production, or monitoring well.

However, DOE expects adverse impacts to geologic resources at the West Ranch oil field to be unlikely and negligible to minor for a variety of reasons, as discussed below.

As discussed in Appendix I of this EIS, no known major faults occur within the West Ranch oil field. At other locations, such as the Denver Basin near Denver, Colorado, injection of fluids into deep geologic formations has caused fluid pressure buildup within fault zones, leading to an increase in seismic activity (i.e., earthquakes) (Hsieh and Bredehoeft 1981). However, because there are no known major faults within the West Ranch oil field or within the area of maximum predicted EOR-induced impacts to geologic formations, as discussed in Appendix H, the potential is low for the proposed project activities to increase seismic activity or for seismic activity to impact proposed project activities or facilities. Therefore, potential impacts related to seismic events or induced seismicity are expected to be negligible.

Additionally, the West Ranch oil field has held large quantities of oil and gas over geologic time, indicating that if smaller faults exist in the EOR area that have not yet been detected, leakage along such faults (if any) must be small and the potential for CO_2 to migrate from the injection interval to other geologic formations through such a fault or fracture pathway would be low. Based on this observation, DOE expects the Anahuac Formation, which has an average thickness of about 450 feet in the West Ranch field area, to be sufficiently impermeable to confine and prevent the vertical migration of injected fluids (i.e., CO_2 and/or produced water) and displaced fluids. The Burkeville confining system, which lies above the Anahuac Formation and below the Evangeline Aquifer, would also reduce the potential for any migrating injected or displaced fluids to reach overlying geologic units during or following EOR and/or produced water disposal operations.

Leakage from one or more previously plugged and abandoned wells, oil-producing wells, injection wells, or observation wells might occur if any casing and/or cement placed in or around a well were to leak. To mitigate the potential for impacts related to casing or annular seal issues associated with wells in the proposed injection area, TCV and BEG would conduct a well integrity testing program prior to EOR operations and TCV would correct deficiencies prior to the use of such wells. These improvements to existing wells would result in a beneficial impact to geological resources by reducing the chance of leakage due to improperly sealed wells.

Although it is considered unlikely that CO_2 would leak from the injection zone, as discussed in Appendix F to this EIS (Health Risk Assessment), the possibility exists, in theory, for impacts to occur to shallower geologic units if leakage of CO_2 from the injection reservoir units were to occur. Increased groundwater acidity could result from elevated CO_2 concentrations in shallower geologic units under such a hypothetical leakage scenario. If severe enough, the increased acidity could cause damage to nearby oil and gas production resources (e.g., well components) and/or result in increased costs for oil and gas development by requiring more corrosion-resistant well materials, pumps and/or other equipment (e.g., in the Frio Formation or the two deeper oil and gas-producing units underlying the West Ranch oil field, the Vanderbilt and Lavaca). Mineral dissolution within shallower geologic units could also result from increase groundwater acidity. If severe enough, mineral dissolution could lead, in theory, to establishment of preferential flow pathways for migration of injected or displaced fluids through well construction materials (e.g., cement backfill) or into a portion of the caprock formation (Kharaka, et al. 2006). Therefore, the proposed project may result in minor impacts to geologic resources. However, because CO_2 leakage from the target geologic units (i.e., within the Frio Formation) is unlikely, the potential for these types of impacts to occur due to the proposed EOR activities is expected to be very low.

Ongoing monitoring and modeling would serve as the primary means of reducing the potential for impacts to geological resources from the proposed project. Recent preliminary reservoir modeling conducted by the BEG, as discussed in Appendix H of this EIS, indicates that injected CO_2 and areas of elevated pressure would remain within the TCV lease areas. As part of the proposed CO_2 monitoring program, TCV and BEG would conduct studies to detect migration of injected or displaced fluids, should migration occur, so that potential long term impacts to geologic resources may be minimized or avoided (e.g., by correcting deficiencies in well construction, adjusting injection and production rates or locations, or other appropriate mitigation strategies). This CO_2 monitoring program is described briefly in Section 2.3.5 of this EIS and will be described further in the monitoring plan scheduled to be developed in early 2013. Considering the proposed mitigation measures (i.e., the well integrity testing program and the CO_2 monitoring program) and the low probability of CO_2 leakage from the target geologic units, potential impacts related to migration of injected and displaced fluids through improperly sealed wells or unknown faults or fracture pathways are expected to be negligible to minor.

TCV would use monitoring results from pre-EOR injection testing (e.g., testing **conducted during** September 2012) and data from the EOR activities, once initiated, to guide the operation and monitoring procedures for future injection and oil production wells. During the subsurface characterization and modeling phase of the CO_2 monitoring program, as discussed in Section 2.3.5 of this EIS, TCV and the BEG would conduct modeling to predict the movement of CO_2 and zones of increased pressure during EOR operations. As planned, the volume of fluid injected (i.e., at reservoir pressures and temperatures) during EOR operations would approximately equal the volume of fluid recovered from the target geologic unit, such that the unit as a whole would not experience increasing fluid pressures or an expanding CO_2 plume during the course of EOR operations. Over time, pressures would equalize within the target geologic units (e.g., between injection and production wells), further reducing the potential for CO_2 migration.

While operation of the proposed injection wells would necessarily alter conditions within the target geologic units, DOE expects overall impacts to geologic resources related to the proposed project activities at the West Ranch oil field to be negligible to minor, when mitigated as discussed above. In addition, DOE expects the injection of CO_2 to beneficially impact production of oil and gas from the Frio Formation sand units within the West Ranch oil field. More specifically, use of CO_2 for EOR activities would be expected to induce the migration of additional hydrocarbon fluids present within the target geologic units (i.e., oil and gas which would otherwise be trapped in the formation, as shown in Figure 2-15) toward the oil production wells within the West Ranch oil field, boosting oil production rates over those currently achieved. As discussed in Section 2.3.4.2 of this EIS, TCV estimates that using CO_2 floods (i.e., EOR), the West Ranch oil field could produce an additional 55 and 75 million barrels of oil (HEC 2012b). As compared to the production history of the field (i.e., over 388 million barrels of oil produced in over 70 years), the beneficial impact to oil production at the field is expected to be substantial. Furthermore, the presence of infrastructure for CO_2 floods may also make oil production from other geologic units at the field more feasible, resulting in an indirect beneficial impact to the value of these geologic resources.

3.4.4 Direct and Indirect Impacts of the No Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to geologic resources.

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3.5 PHYSIOGRAPHY AND SOILS

3.5.1 Introduction

This section describes the physiography (i.e., the earth's surface and exterior physical features) and soils that could potentially be affected by the construction and/or operation of the proposed Parish PCCS Project. This section also analyses the potential effects the project may have on these resources.

3.5.1.1 Region of Influence

The ROI for physiography and soils includes the areas that may be disturbed, directly or indirectly, by the proposed project. These include direct impacts to soils and land forms located within proposed construction areas. The land in the vicinity of the Parish PCCS Project is generally flat, so indirect (downslope) impacts would be negligible compared to direct impacts. Proposed construction areas include the CO_2 capture facility, the pipeline corridor, and the approximately 5,500-acre EOR area at the West Ranch oil field. At the West Ranch oil field, direct impacts would occur at the area of the CO_2 recycle facility and direct impacts could also occur during well installation and development, access road construction, or piping installation; however, existing piping corridors, access roads, and well pads would be used for construction activities to the extent practicable. Specifically, this ROI includes:

- **CO_2 Capture Facility**: Soils within construction footprints of the CO_2 capture facility and other proposed and associated facilities within the W.A. Parish Plant. The construction areas within the W.A. Parish Plant total approximately 29 acres.
- **Pipeline Corridor**: Soils within the approximately **81**-mile pipeline ROW. This includes a nominally 100-foot-wide construction ROW (i.e., generally 35 feet from the pipeline centerline on the spoil placement side of the ROW and 65 feet from the pipeline centerline on the traffic side of the pipe) in most areas, although the construction ROW would be reduced to 75 feet in width (i.e., generally 35 feet on the spoil side of the pipe and 40 feet on the traffic side) in certain wetland areas, as is discussed in Section 3.8 of this EIS (Wetlands and Floodplains). **Construction of the pipeline would require use of approximately 43 miles of access roads.** Additional temporary workspace (ATWS) areas (i.e., as needed at road crossings, HDD entry and exit locations, and locations required for construction activities that are outside the 100-foot-wide construction ROW) **and access roads** are included in this ROW. These areas include approximately **1,197** acres.
- **West Ranch Oil Field**: Soils within the approximately 1.5-acre CO_2 recycle facility at the West Ranch Oil Field. Soils are also evaluated for the approximately 5,500-acre EOR area. Existing wells would be used (i.e., re-refurbished or deepened, as needed) for CO_2 injection wells. Produced water injection wells, EOR oil production wells and associated monitoring wells, and new wells (if needed) would be installed on existing well pads to the extent practicable. Existing access roads would be used to the extent practicable to access construction areas within the West Ranch oil field; and existing piping corridors would be used for any required new CO_2 piping.

3.5.1.2 Method of Analysis

DOE reviewed information and data on the physiography and soils that may be affected by the project from the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) soil surveys for Fort Bend, Wharton, and Jackson Counties, Texas (NRCS 2011). In addition, DOE delineated wetlands in the study area during the period from January to **November** 2012, as discussed in Section 3.8 of this EIS (Wetlands and Floodplains). Maps and a table summarizing delineated wetlands are provided in Appendices D-1 and D-2 to this EIS. Both wetland (hydric) and upland soils were examined, recorded, and compared to the soils mapped by the NRCS. DOE also conducted a Phase I archeological and architectural survey in the study area (see Appendix G). Soils were examined in shovel test pits along the pipeline corridor and soil color and texture of each cultural or diagnostic horizon were recorded according to U.S. Department of Agriculture (USDA) methodology.

Quantitative estimates of the potential for loss of soil resources were calculated using geographic information systems (GIS) and existing NRCS soil data. Qualitative assessments were made on the potential effects on physiography and soils based on individual soil properties and the expected attributes of the proposed project. The following questions were considered during the analysis of the affected environment within the study area:

- What is the distribution of soil units within the ROI?
- Are the soils characterized by high potential for surface runoff and erosion? Which soils have very steep slopes?
- What is the distribution of Prime Farmland[1] located within the ROI?
- Are there any urban soils or other soils already impacted by development within the ROI?

3.5.1.3 Factors Considered for Assessing Impacts

The potential impacts to physiography and soils are assessed based on whether the project would directly or indirectly:

- Disturb soils during the construction and/or operations phase of the project, whether temporarily or permanently;
- Disturb soils classified as Prime Farmland;
- Disturb soils on land surfaces with slopes in excess of 8%; and/or
- Disturb soils with moderate to severe potential for surface erosion.

3.5.2 Affected Environment

3.5.2.1 Physiography

The proposed project would be located in the Texas Gulf Coastal plain, which is a low-lying area with a gradual rise from sea level (at the Gulf of Mexico) in the south and east up to an elevation of about 900 feet above msl to the north and the west. The physiography originated from the deposition of sediments around the margins of the Gulf of Mexico in fluvial-deltaic to shallow-marine environments. The sediments near the land surface in the vicinity of the project were deposited during the Miocene, Pliocene, and Pleistocene epochs (i.e., from approximately 23 million to 11,700 years ago) (Mace, et al. 2006). In the vicinity of the project, most of the land is nearly flat (< 1 percent slope) with very small areas of slightly sloping land (< 8 percent, mostly < 3 percent).

[1] Prime farmland soils are protected under the Farmland Protection Policy Act (FPPA) of 1981 (7 USC 4201 et seq.). The intent of the FPPA is to minimize the extent to which federal programs contribute to the unnecessary or irreversible conversion of farmland soils to nonagricultural uses. The FPPA also ensures that federal programs are administered in a manner that, to the extent practicable, would be compatible with private, state, and local government programs and policies to protect farmland. The NRCS is responsible for overseeing compliance with the FPPA and has developed rules and regulations for implementing the Act (see 7 CFR 658, revised January 1, 1998).

3.5.2.2 Soils

The evaluation of soils potentially impacted by the proposed project is based on the mapped USDA soil units. A mapped soil unit is a collection of areas defined and named the same in terms of their soil components. Each map unit differs in some respect from all others in a survey area and is uniquely identified on a soil map. Soil units of the Gulf Coastal plain range from discrete, individually definable soil types to soil complexes. Soil units made up of two or more major soil types in a complex pattern or in a very small area (where each soil type cannot be identified separately) are considered soil complexes.

Potential impacts to Prime Farmland are evaluated below. The NRCS defines Prime Farmland as follows:

> Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the combination of soil properties, growing season, and moisture supply needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. (USDA 2012)

In addition, Prime Farmland is designated independently of current land use, but it cannot be areas of water or urban or built-up land.

CO_2 Capture Facility

Soils in and surrounding the W.A. Parish Plant are classified by the NRCS as Edna fine sandy loam, the Bernard-Edna complex, and Bernard clay loam. The soil types underlying the CO_2 capture facility ROI (i.e., approximately 29 acres) are classified by the NRCS as Prime Farmland (NRCS 2011), including both the Bernard clay loam and soils in the Bernard-Edna complex. However, the W.A. Parish Plant site has been extensively developed and the underlying soils disturbed during construction of the power plant complex. Therefore, the area would likely not be considered Prime Farmland today, as defined above. Soils underlying the W.A. Parish Plant, which are shown on Figure 3.5-1 and described in Table 3.5-1, are generally flat (i.e., zero to 1% slope) and have slight erosion potential.

Table 3.5-1. Soil Types and Characteristics within the Proposed CO_2 Capture Facility Areas

Soil Unit Symbol	Soil Unit Description	Hazard of Erosion	Drainage Class	Prime Farmland	Slope (%)
Ea	Edna fine sandy loam	Slight	Somewhat poorly drained	No	0-1
Bb	Bernard clay loam	Slight	Somewhat poorly drained	Yes[a]	0-1
Be	Bernard-Edna complex	Slight	Somewhat poorly drained	Yes[a]	0-1

[a] The W.A. Parish Plant site has been extensively developed and the underlying soils disturbed. Therefore, although soils in the area are categorized as Prime Farmland by the NRCS, the area would does not meet the definition of Prime Farmland.

Figure 3.5-1. Soil Types in the Vicinity of the Proposed CO_2 Capture Facility

Pipeline Corridor

Thirty-six (36) soil types occur within the ROI of the proposed **81**-mile pipeline corridor **and access roads**. The ROI would cross **20** NRCS-classified soil types that are identified as Prime Farmland soils (NRCS 2011). Within the proposed pipeline **corridor ROI** and based on NRCS geospatial data, these soil types comprise approximately **68**% of ROI, or approximately **819** acres (see Figure 3.5-2 through Figure 3.5-5). Three additional soil types, TxA, Ka, and Ba, are classified as "Prime Farmland, if drained" and comprise approximately **9**% of the soil area. The remaining **13** soil types that would be crossed by the pipeline are not considered Prime Farmland. Mapped soil types located within the ROI of the proposed pipeline are grouped into categories according to erodibility and to whether they are classified as Prime Farmland. Soils in the pipeline ROI are generally flat (i.e., zero to 8% slope) and, with the exception of areas of Oil-Waste land soils (soil type Wc) and Marcado sandy clay loam, 3 to 8 percent slopes (MaC), have slight to moderate erosion potential. Oil-Waste land soils have very severe erosion potential, and Marcado sandy clay loam, 3 to 8 percent slopes soils have severe erosion potential; these soil types make up **less than** 1% of the pipeline ROI. Figure 3.5-2 through Figure 3.5-5 show the distribution of the soils along the pipeline corridor. Relevant characteristics of the soil types along the pipeline corridor are summarized in Table 3.5-2. River crossings and soils affiliated with wetlands are discussed in Sections 3.7 and 3.8 of this EIS, respectively.

Table 3.5-2. Soil Types and Characteristics Within Pipeline ROI

Soil Unit Symbol	Soil Unit Name	Hazard of Erosion	Drainage Class	Prime Farmland	Slope (%)
Ar	Aransas clay	Slight	Poorly drained	No	0-1
As	Asa fine sandy loam	Slight	Well drained	Yes	0-1
Ba	Bacliff clay	NA	Poorly drained	Yes, if drained	0-1
Bb	Bernard clay loam	Slight	Somewhat poorly drained	Yes	0-2
Bc	Bernard Edna clay loam	Moderate	Somewhat poorly drained	Yes	0-1
BcA	Bernard clay loam	Slight	Somewhat poorly drained	Yes	0-1
Be	Bernard-Edna complex	Slight	Somewhat poorly drained	Yes	0-1
BeA	Bernard-Edna complex	Slight	Somewhat poorly drained	Yes	3-8
Ch	Chicolete clay	Slight	Moderately well drained	No	0-1
Cn	Clemville-Norwood complex	Slight	Well drained	Yes	0-1
DaA	Dacosta sandy clay loam	Slight	Moderately well drained	Yes	0-1
Ea	Edna fine sandy loam	Slight	Somewhat poorly drained	No	0-1
Eb	Edna fine sandy loam	Moderate	Somewhat poorly drained	No	0-1
Ec	Edna-Waller complex	Slight	Somewhat poorly	No	0-1

Table 3.5-2. Soil Types and Characteristics Within Pipeline ROI

Soil Unit Symbol	Soil Unit Name	Hazard of Erosion	Drainage Class	Prime Farmland	Slope (%)
			drained		
EdA	Edna fine sandy loam	Slight	Somewhat poorly drained	Yes	0-1
EtA	Edna-Cieno complex	Slight	Somewhat poorly drained	No	0-1
InB	**Inez fine sandy loam**	**Slight**	**Moderately well drained**	**Yes**	**0-2**
Ka	Kaman clay	Slight	Poorly drained	Yes, if drained	0-0
Kd	Kaman clay	Slight	Poorly drained	No	0-1
La	Lake Charles clay	Slight	Moderately well drained	Yes	1-4
LaA	Laewest clay	Slight	Moderately well drained	Yes	1-4
LaB	Laewest clay	Moderate	Moderately well drained	Yes	1-3
LaD3	Laewest clay	Moderate	Moderately well drained	No	3-8
Lb	Lake Charles Clay	Moderate	Moderately well drained	Yes	1-3
LcA	Lake Charles clay	Slight	Moderately well drained	Yes	0-1
MaC	Marcado sandy clay loam	Severe	Moderately well drained	No	3-8
Md	Clemville silty clay loam	Slight	Well drained	Yes	0-1
Me	Brazoria-Sumpf clay	Slight	Moderately well drained	Yes	0-1
NoB	Norwood silt loam	Moderate	Well drained	No	3-8
Pa	Pledger clay	Slight	Moderately well drained	Yes	0-1
Pc	Pledger clay	Slight	Moderately well drained	Yes	1-4
TfA	Telferner fine sandy loam	Slight	Moderately well drained	Yes	0-1
Tp	Cieno soils	Slight	Poorly drained	No	0-1
TxA	Texana-Cieno complex	Slight	Moderately well drained	Yes, if drained	0-1
Wa	Waller soils	Slight	Poorly drained	No	0-1
Wc	Oil-Waste land	Very Severe	NA	No	NA

Source: NRCS 2011

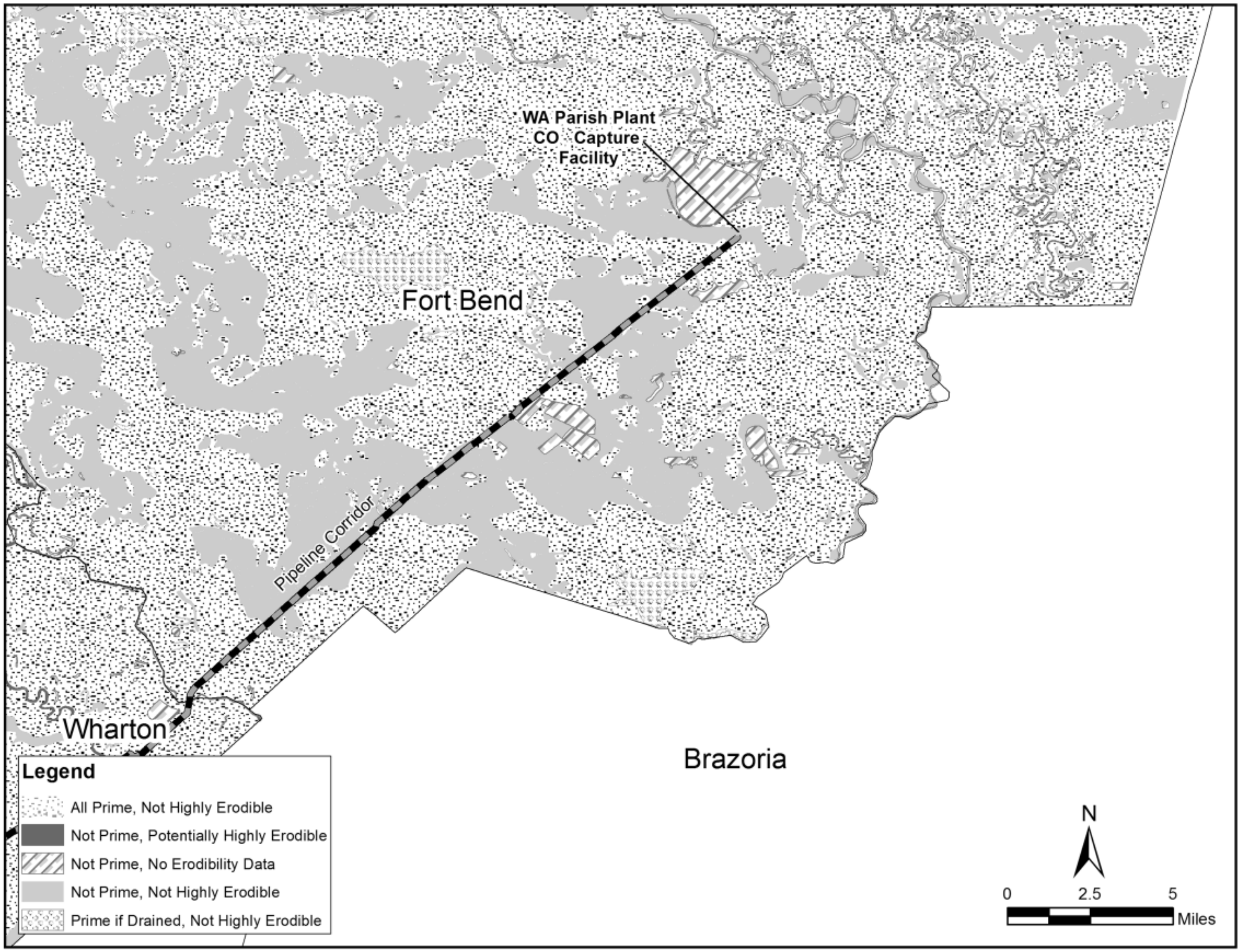

Figure 3.5-2. Soil Classification for Proposed Pipeline Corridor in Fort Bend County

Source: NRCS 2011

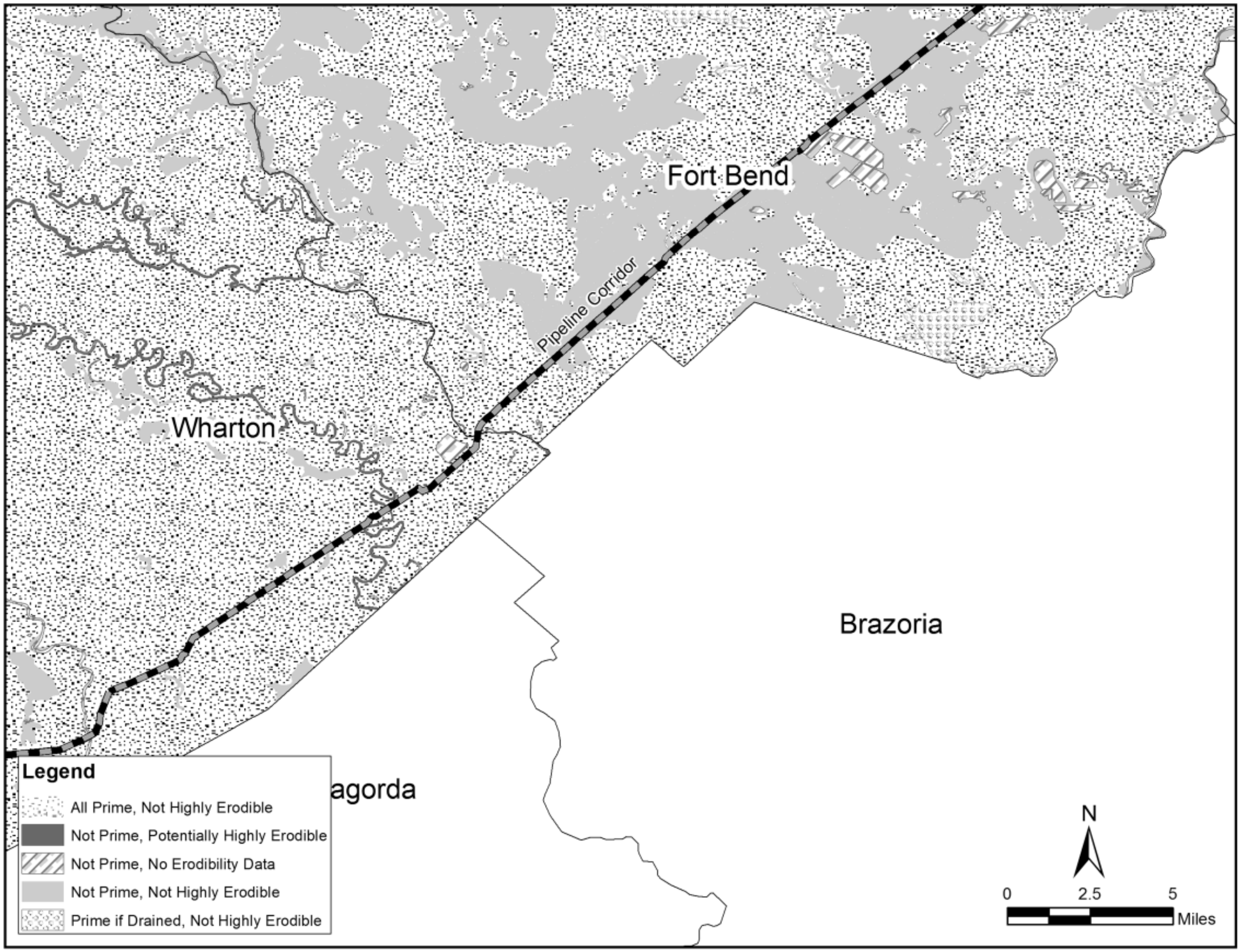

Figure 3.5-3. Soil Classification for Proposed Pipeline Corridor in Northern Wharton County
Source: NRCS 2011

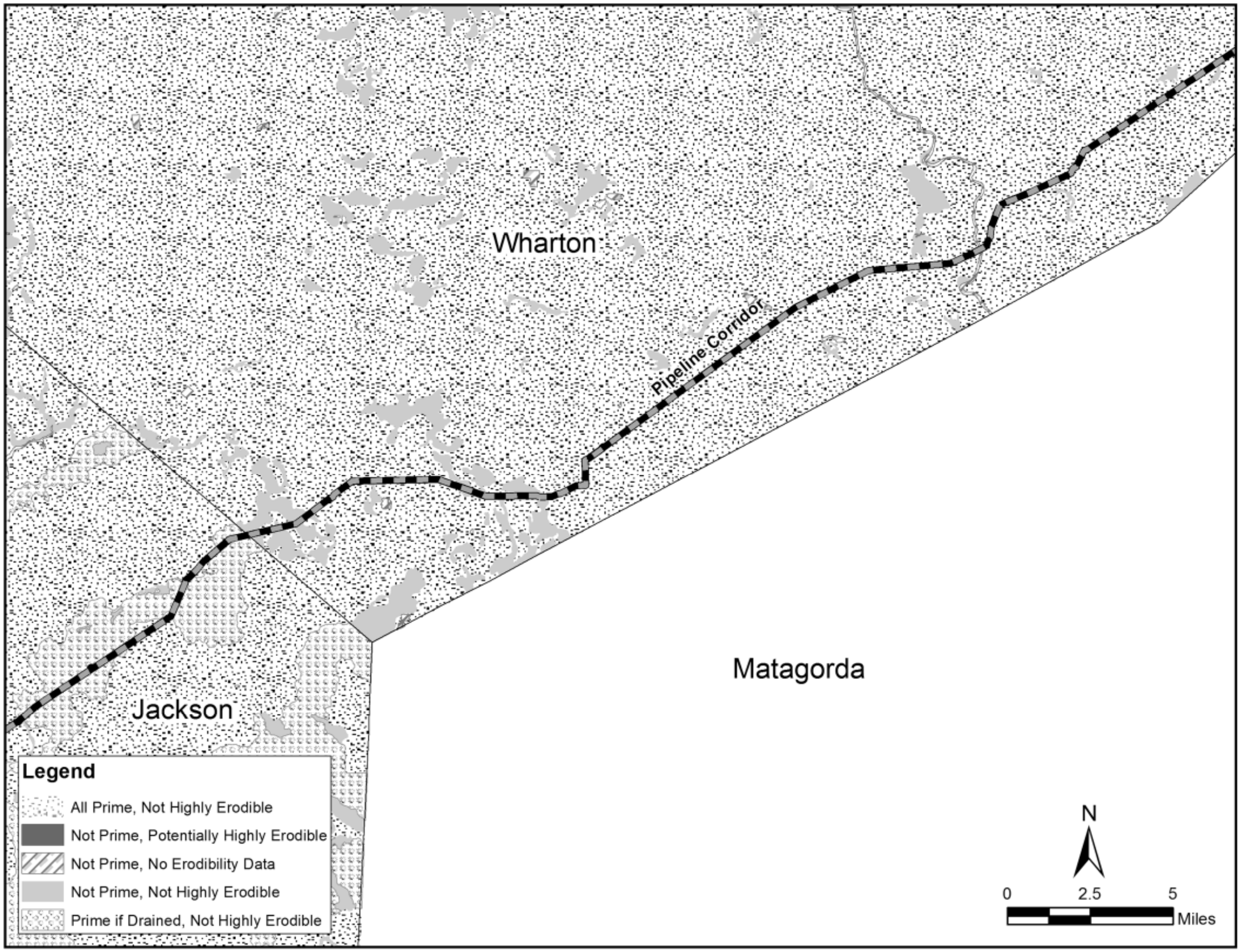

Figure 3.5-4. Soil Classification for Proposed Pipeline Corridor in Southern Wharton County
Source: NRCS 2011

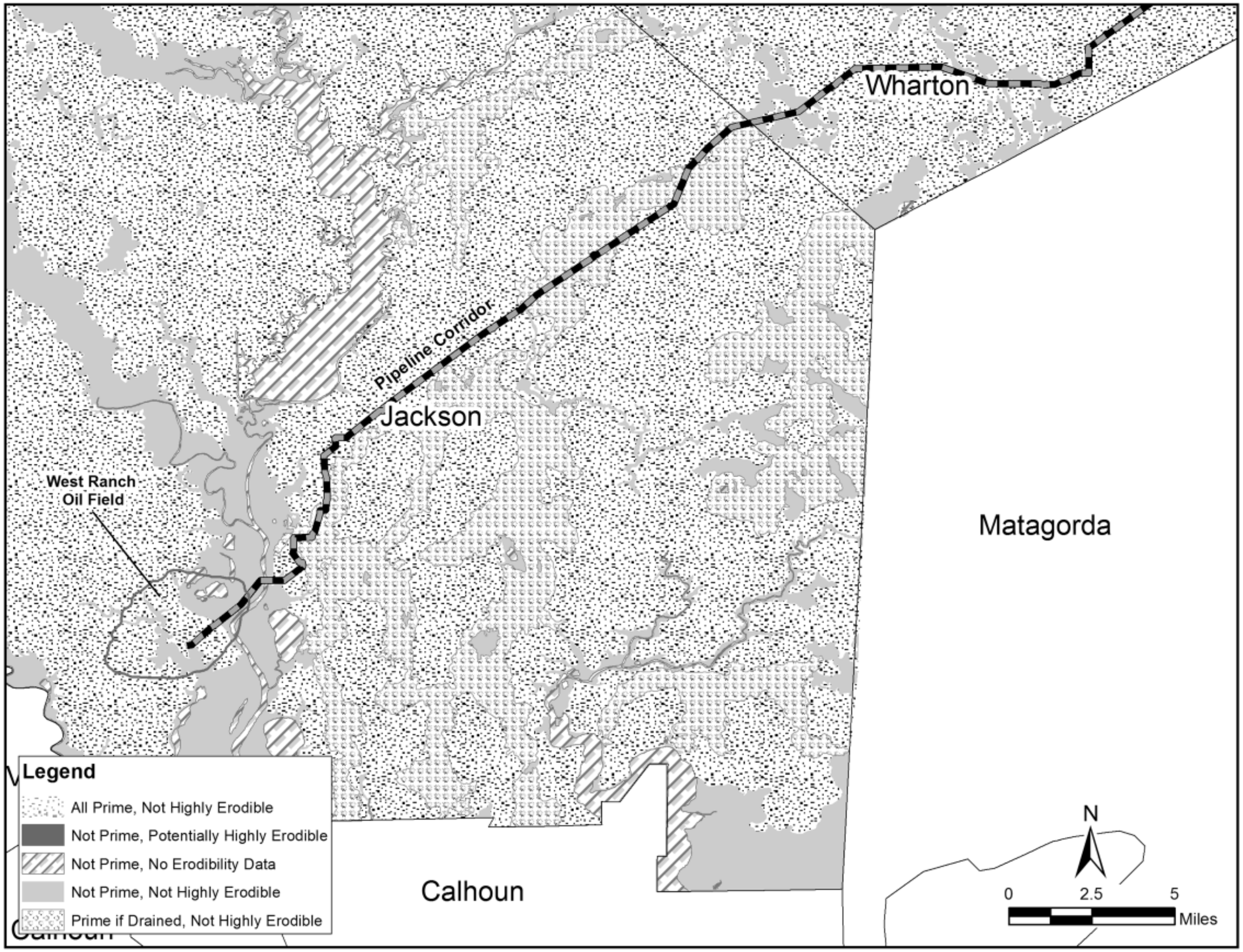

Figure 3.5-5. Soil Classification for Proposed Pipeline Corridor in Jackson County
Source: NRCS 2011

West Ranch Oil Field

Ten (10) soil types occur within the EOR area at the West Ranch oil field ROI. The soils are generally flat (i.e., zero to 8% slope) and, with the exception of areas of Oil-Waste land soils (soil type Wc), have slight to moderate erosion potential. Oil-Waste land soils have severe erosion potential. Selected characteristics of these soil types are summarized in Table 3.5-3. Four of these soil types, covering 61% (3,264 acres) of the ROI, are classified as Prime Farmland soils (Figure 3.5-6). These areas are currently used for cattle grazing within the areas of oil and gas development. The proposed CO_2 recycle facility would be constructed on an existing disturbed area near the terminus of the proposed pipeline (as shown on Figure 3.4-8 and Figure 3.4-9). This area was formerly used for a natural gas processing facility and has been heavily disturbed. The majority of the buildings and structures for the previous facility have been demolished and removed, leaving an approximately 22-acre area available for construction of the approximately 1.5-acre CO_2 recycle facility.

Table 3.5-3. Soil Properties and Characteristics within the EOR area at the West Ranch oil field

Soil Unit Symbol	Soil Unit Name	Hazard of Erosion	Drainage Class	Prime Farmland	Slope (%)
Ar	Aransas clay	Slight	Poorly drained	No	0-1
DaA	Dacosta sandy clay loam	Slight	Moderately well drained	Yes	0-1
InB	Inez fine sandy loam	Slight	Moderately well drained	No	0-2
LaA	Laewest clay	Slight	Moderately well drained	Yes	1-4
LaB	Laewest clay	Moderate	Moderately well drained	Yes	1-3
LaD3	Laewest clay	Moderate	Moderately well drained	No	3-8
MaC	Marcado sandy clay loam	Severe	Moderately well drained	No	3-8
Pd	Placedo clay	Slight	Very Poorly Drained	No	0-1
Sw	Swan Clay	Slight	Very Poorly Drained	No	0-1
TfA	Telferner fine sandy loam	Slight	Moderately well drained	Yes	0-1
Ar	Aransas clay	Slight	Poorly drained	No	0-1
DaA	Dacosta sandy clay loam	Slight	Moderately well drained	Yes	0-1
InB	Inez fine sandy loam	Slight	Moderately well drained	No	0-2

Source: NRCS 2011

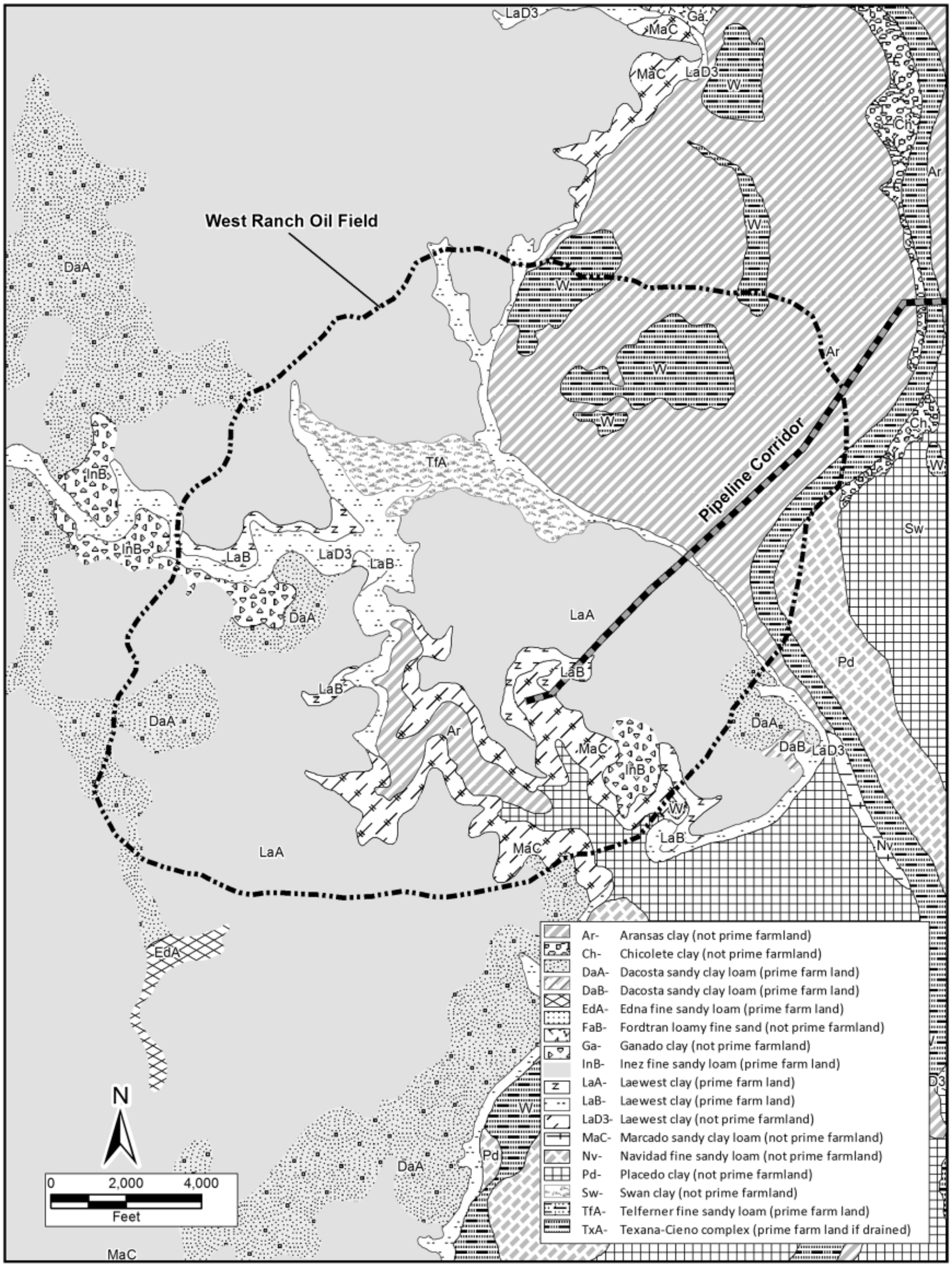

Figure 3.5-6. Soil Types in the Vicinity of West Ranch Oil Field
Source: NRCS 2011

3.5.3 Direct and Indirect Impacts of the Proposed Project

3.5.3.1 Construction Impacts

In general, potential impacts to physiography and soils include disturbance of soils (e.g., from grading, soil excavation activities, soil compaction), installation of impermeable surfaces over soils at some locations, and increased soil erosion. A project-specific SWPPP would be prepared for these construction activities to describe BMPs to be implemented during the construction phase of the project. This SWPPP would incorporate SPCC Plan elements, as applicable, to provide guidance to construction personnel regarding potential spills. The following BMPs would be employed to avoid and/or minimize impacts from construction activities to soils, groundwater, surface water, and wetlands:

- Grading, berming, or terracing would be used, as applicable, to reduce runoff of sediment and to divert storm water run-off to drainage ditches or vegetated areas off-ROW. Materials, equipment, and activities would be located in such a way that leaks are contained in existing containment and diversion systems or would have portable spill kits to contain leaks and spills.
- Secondary containment (i.e., sufficiently impervious dikes, berms, or retaining walls) with sufficient capacity to retain spilled materials (i.e., 110% of the volume of the largest tank or larger) should be provided for tanks and chemical storage containers greater than 55 gallons. Drainage from within dikes in permanent storage areas would be restrained by valves to prevent unintended discharge. Drainage from within dikes in temporary storage areas would use portable pumps once the water collected within the dike has been determined to meet discharge requirements. Inspections should be conducted to verify adequacy of secondary containment and prompt removal of any accumulated fluids (e.g., stormwater or spilled materials).
- There should be adequate security measures in place in bulk storage areas. Sites where storage tanks and/or hazardous chemicals are located should be accessible by authorized personnel only. After regular working hours, valves should be locked closed where possible.
- Personnel should be trained in spill prevention and spill control procedures, as well as hazard recognition.
- Spill/overflow protection equipment should be used where applicable. Pumps used for loading/unloading or refueling should have automatic shutoff switches and/or high level alarms to prevent overfilling of tanks.
- An operator or driver should be present and observant of any loading/unloading or refueling operations so they can manually stop fluid transfer (e.g., stop pump and/or close valves) in case of overfilling. Loading/unloading operations should be conducted in well-lit areas so as to easily identify spills.
- Drip pans and absorbents should be used under or around leaky vehicles and equipment or store indoors where feasible.
- Dust generation and off-site tracking of waste or potentially hazardous materials should be minimized by washing vehicles and equipment, as applicable, before they leave the work site and by employing dust suppression measures (e.g., covering loads, watering dusty areas during dry weather).
- Cleaning operations should be performed indoors, within storm resistant shelters, or within bermed areas that prevent runoff and run-on and that also that capture overspray.
- Wastes, garbage, and/or floatable debris should be prevented from entering surface waters by keeping exposed areas free of such materials or by intercepting them before they are discharged.
- Trench dewatering and storm water runoff should be diverted, contained, reused, or otherwise reduced to minimize the potential for pollutant discharges.

- Discharge structures and erosion control devices (e.g., silt fencing and/or hay bales) should be used to minimize erosion and sediment discharge to downgradient surface water or wetland areas.
- Construction areas should be revegetated as soon as practicable following construction. Areas with high erosion potential (e.g., steep slopes, particularly adjacent to surface water bodies) may require additional erosion control (e.g., mulch, erosion control blankets, turf reinforcement mats).
- Sorbent booms or diversion devices should be placed around any sumps or drains that may act as preferential pathways for groundwater or surface water contamination.
- Emergency contacts for large spills (e.g., company, local, state, federal) should be readily available in areas with higher probability for spills (e.g., oil or chemical storage areas, loading and unloading areas).
- Spills and leaks should be cleaned up promptly using dry methods (e.g., absorbents) to prevent the discharge of pollutants. Spill control kits (e.g., sorbent pads, socks, and/or booms) should be staged in areas with higher probability for spills (e.g., oil or chemical storage areas, loading and unloading areas).
- Installation of permanent trench plugs at stream crossings and in areas where subsurface flow of water may occur along the pipeline.

In accordance with 40 CFR 122.26(c)(1)(iii), and as noted in Section 3.4 of this EIS (Geology), construction activities related to oil or gas exploration, production, processing, treatment operations, or transmission facilities are considered to be exempt from NPDES permitting for related stormwater discharges. Due to EOR component of the proposed project (i.e., oil and gas production), this project would be considered to be exempt from NPDES (and TPDES) stormwater permitting. As a result, a TPDES Construction General Permit and related Notice of Intent, which are normally required by the TCEQ for construction stormwater discharges from non-oil and gas related projects, would not be required for the proposed project, since it would be exempted from NPDES/TPDES permitting. However, BMPs implemented for erosion control would be consistent with the BMPs published by the TCEQ for use on projects authorized under nationwide permits issued by the USACE (TCEQ 2012f).

CO_2 Capture Facility

Up to 29 acres of soil would be temporarily disturbed by construction activities within the CO_2 capture facility ROI, including 22 acres of laydown areas, 3.3 acres for the CO_2 capture system area, 0.44 acres for the CT/HRSG, and 3.2 acres for other project areas. Potential construction-related soil impacts, such soil compaction, soil erosion, and loss of soils, would be caused by activities such as surface grading and excavation of soils, and installing structures having impermeable surfaces within the capture facility footprint area.

Project construction at the W.A. Parish Plant would temporarily and/or permanently disturb soils during the construction phase of the project. However, DOE expects these impacts to be localized and negligible to minor. Because most of the plant property is in industrial use and has been previously disturbed, activities within these areas are not expected to result in impacts that would be significantly different than those that would occur as a result of normal, plant-related construction and/or operations activities. Therefore, although the primary mapped soil type underlying the W. A. Parish Plant has been classified by the NRCS as Prime Farmland, the proposed project would not impact Prime Farmland soils which have not already been converted into industrial use. Additionally, there would be no impacts to soils with slopes in excess of 8% or with moderate to severe potential for surface erosion since these types of soils are not found in the CO_2 capture facility ROI.

Due to the extent of previously disturbed soils within the CO_2 capture facility ROI, the potential overall for new long-term adverse impacts are considered negligible to minor. Construction activities could result in minor short-term indirect impacts, such as increased erosion during site preparation work as a result of clearing/grubbing of the ground surface to make it ready for construction use or as a laydown area. NRG would avoid or minimize adverse soil impacts to the extent practicable by implementing the BMPs described above during construction.

Pipeline Corridor

Construction of the proposed CO_2 pipeline would temporarily and/or permanently disturb existing soils along the proposed pipeline construction ROW. Table 3.5-4 summarizes the approximate areas of, and characteristics of, soils that could potentially be disturbed by construction of the proposed CO_2 pipeline. **NRG has made minor realignments to its proposed route to accommodate landowner concerns or to allow for better access for directional drilling to place the proposed pipeline under a paved road. These minor realignments account for the changes to the acreage of potentially disturbed soils in the pipeline ROI in** Table 3.5-4 **compared to the values presented in the Draft EIS.** Impacts to the affected land areas from pipeline construction are expected to be temporary in duration and localized to the pipeline construction ROW. Areas of pipeline installed using HDD construction techniques would not disturb surface soils except for temporary soil disturbances resulting from digging the approximately 10-foot-wide, 10-foot-long, and 5-foot-deep HDD entry and exit pits at either end of the HDD and the approximately 25-foot-wide, 25-foot-long, and 5-foot-deep drilling mud pit that would be located adjacent to the HDD entry pit. For the portions of the approximately **81**-mile pipeline corridor where the pipeline would be constructed using open cut trenching methods, construction personnel would remove soil to create a trench, stockpile the soil along the trench, and place the soil back into the trench once the pipe is laid.

The pipeline construction ROW **and access roads** includes a total of approximately **1,197** acres of land surface, approximately **819** acres of which would be classified as Prime Farmland soils. The actual area of new disturbance to Prime Farmland soils would likely be less than **819** acres since more than **75**% of the pipeline corridor is collocated along or within existing mowed and maintained utility ROWs **and most of the areas defined as access roads are existing roads**. In wetlands and agricultural areas, impacts to soil would be minimized by segregating the topsoil from the underlying soil and placing the topsoil back as the top layer when the trench is filled. In non-agricultural areas, soil segregation would not occur. There would be no impacts to soils with slopes in excess of 8% since these types of slopes are not found in the pipeline corridor ROI. However, as noted in Table 3.5-4, approximately **43** acres of land with moderate to very severe potential for surface erosion may be disturbed during pipeline construction. These potential impacts would be minimized through the implementation of BMPs, as described above.

Minor to negligible long-term impacts to the surface soils would include the conversion of land use for the installation and use of an approximately 0.25-acre meter station near the West Ranch oil field (i.e., near MP **77**) and 12 aboveground main line valves (MLVs) at various locations along the length of the pipeline. With the exception of these aboveground facilities, no long-term conversions are anticipated following completion of the pipeline construction. Implementation of BMPs would likely reduce soil impacts resulting from construction within the pipeline construction ROW to between negligible and minor levels. It is not known at this time if any of the approximately **43** miles of access roads that would be used during pipeline construction would require widening, which would be a permanent impact to soils in the areas that would be filled.

Table 3.5-4. Potentially Disturbed Soils Within Pipeline Construction ROW

Water Erosion Potential	Acres	Percent of Total Acres
Prime Farmland	**819**	**68**
Slightly erodible	***802***	*98*
Moderately erodible	***17***	*2*
Not Prime Farmland	**271**	23
Slightly erodible	***245***	***90***
Moderately erodible	***8***	*3*
Severely erodible	***15***	***6***
Very severely erodible	***3***	***1***
Prime Farmland if Drained	**105**	**9**
Slightly erodible	***104***	*99*
Erodibility not rated	*1*	*1*

Source: NRCS 2011

West Ranch Oil Field

Impacts to soils from well installation and development around CO_2 injection wells, produced water injection wells, EOR oil production wells, and associated monitoring wells and monitoring devices would be considered negligible because existing wells would be used (i.e., re-refurbished or deepened, as needed) to the extent practicable and new wells, if needed, would be installed on existing well pads to the extent practicable. Therefore, soil disturbance from well construction would generally be limited to previously disturbed soils within existing well pads. Existing access roads would be used to the extent practicable to access construction areas with the West Ranch oil field; therefore, soil impacts related to access roads are expected to be negligible. Any new piping required within the West Ranch oil field would be within existing piping corridors to the extent practicable. Therefore, soil impacts related to installation of piping within the West Ranch oil field are expected to be negligible.

Additionally, impacts to soils from construction of the new, approximately 1.5-acre CO_2 recycle facility would be considered negligible because this facility would be located in an area that was previously occupied by a gas processing facility and has been heavily disturbed. The proposed CO_2 recycle facility location is in an area of surface soil type LaA, which is identified in the NRCS database as Prime Farmland; however, since this area still contains concrete pads and foundations from the former gas recycling facility, this area would likely not be used for crops in the near future. TCV selected this site for the CO_2 recycle facility due to its previous disturbance, as well as other factors.

3.5.3.2 Operational Impacts

CO_2 Capture Facility

Overall, negligible impacts to physiography and soils would be expected from the operation of the CO_2 capture facility. Impacts to soils would not be significantly greater in magnitude or frequency than impacts to soils from existing operations at the W.A. Parish Plant. Areas not covered by impermeable surfaces (e.g., areas outside of the capture facility footprint and associated aboveground facilities) would be used and maintained in the same manner as for existing facility operations. No increase in soil erosion potential is anticipated to occur as a result of operation of the capture facility.

Pipeline Corridor

Overall, only minor short-term impacts would be expected from operations since the pipeline corridors would be reestablished with vegetative cover and returned to prior use. Soils in the ROW may have been previously disturbed during construction and therefore may be slightly more likely to erode than undisturbed soils. Operations and maintenance activities may potentially result in soil impacts due to erosion. TCV would implement BMPs, as discussed above, to minimize these potential impacts. The permanent ROW would be routinely inspected, and areas showing potential erosion would be stabilized. Negligible to minor short-term impacts could occur (e.g., dust generation) from occasional truck traffic on access roads performing inspections or maintenance of meters installed at various points along the pipeline.

West Ranch Oil Field

Impacts to soils around CO_2 injection wells, water injection wells, oil production wells, and associated monitoring wells and monitoring devices would be considered negligible during operations as they would be similar to current operations at the West Ranch oil field. Soil impacts related to reworking of wells would be similar to the construction impacts described above for well installation and development. During EOR field operations, the primary impacts to soils would be caused by light vehicles accessing well locations to maintain equipment and record observations. The potential for soil contamination from surface spills of hazardous materials during operations is generally considered be the same as for existing operations.

3.5.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and the EOR field operator might still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to physiography and soils.

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3.6 GROUNDWATER

3.6.1 Introduction

This section identifies and describes the groundwater resources potentially affected by the construction and operation of the proposed Parish PCCS Project. In addition, this section analyzes the potential effects of this project to these resources.

3.6.1.1 Region of Influence

The groundwater ROI for the proposed project includes shallow groundwater (i.e., from the Chicot and Evangeline Aquifers) underlying or within two miles of any ground surface areas expected to be disturbed during construction of the CO_2 capture facility and associated infrastructure at the W.A. Parish Plant, the CO_2 pipeline, and the EOR and CO_2 monitoring facilities at the West Ranch oil field (i.e., the proposed approximately 5,500-acre EOR area).

As discussed in Section 3.4 of this EIS (Geology), the RRC regulates the injection of water, steam, gas, oil and gas wastes, or other fluids into porous formations producing oil, gas, or geothermal resources in the State of Texas under 16 TAC 3.46 using Class II injection well permits. The Class II injection permits that would be required for the proposed CO_2 injection or produced water disposal wells also require an evaluation to determine if all abandoned wells have been plugged in a manner that would prevent movement of fluids into strata other than the authorized injection or disposal zone within a quarter-mile (0.25-mile) radius of each proposed well location (RRC 2012a). Since the produced water injection and disposal wells for the proposed project are located within the proposed EOR area, the ROI described above for the West Ranch oil field (i.e., within two miles or less of the EOR area) encompasses the area to be evaluated for Class II injection well permits.

Aquifer - an underground geologic formation composed of permeable layers of rock or sediment that holds and/or transmits water.

Groundwater - water obtained from an underground source (i.e., from an aquifer). In this EIS, **shallow groundwater** refers to groundwater from the Chicot and Evangeline Aquifers, which are discussed below.

Fresh water - water with bacteriological, physical, and chemical properties that make it suitable for beneficial use. (e.g., with TDS concentrations less than 1,000 mg/L).

Underground Source of Drinking Water (USDW) - an aquifer with less than 10,000 mg/L TDS, is currently being used as a drinking water source, or is of sufficient volume and adequate quality to be a future source for a public water system.

Brine - highly salty and heavily mineralized groundwater that may contain heavy metal and organic contaminants.

Produced water - brine separated from produced oil or gas at an oil field. Produced water may also be called brine, salt water, or process water.

(TWDB 2011b, EPA 2012a, EAW 2012)

3.6.1.2 Method of Analysis

DOE evaluated the potential impacts to groundwater resources resulting from construction and operation of the proposed project facilities based on review of published Texas Water Development Board (TWDB) mapping and GIS data, TWDB groundwater reports and regional groundwater plans, and construction information for existing wells in the ROI. DOE determined potential impacts to groundwater resources based on anticipated project water requirements and water supply plans, spill prevention and mitigation BMPs, and the results of preliminary reservoir modeling conducted by the BEG.

3.6.1.3 Factors Considered for Assessing Impacts

The potential for impacts to groundwater was assessed based on whether the Parish PCCS Project would directly or indirectly:

- Deplete groundwater supplies on a scale that would affect available capacity or quality of a groundwater source for use by existing water rights holders, interfere with groundwater recharge, or reduce the discharge rate to existing springs or seeps;
- Conflict with established water rights, allocations, or regulations protecting groundwater for future beneficial uses;
- Potentially contaminate USDWs through acidification of the aquifer due to migration of CO_2 or toxic metal dissolution and mobilization, displacement of naturally occurring brine due to CO_2 injection, or chemical spills, well drilling, well development, or well failures; or
- Conflict with regional or local aquifer management plans or the goals of governmental water authorities.

3.6.2 Affected Environment

3.6.2.1 Regional Groundwater Availability

3.6.2.1.1 Major and Minor Aquifers

As defined by the TWDB, major aquifers in Texas are aquifers that produce large amounts of water over large areas. The major aquifer beneath the proposed project area is the Gulf Coast Aquifer (Figure 3.6-1). This aquifer supplies 54 counties in Texas and the majority of the water withdrawn is used for municipal and irrigation purposes. Groundwater use is regulated in Fort Bend County and other counties due to the potential for over-drafting of the Gulf Coast Aquifer and resulting subsidence issues. Groundwater management plans have been published for Fort Bend, Wharton, and Jackson Counties as well as other counties in Texas that obtain groundwater from the Gulf Coast Aquifer. Groundwater in Fort Bend County is also managed by the Fort Bend Subsidence District, which regulates groundwater withdrawal to prevent subsidence that contributes to flooding, inundation, or overflow of areas within the District. Groundwater in Wharton and Jackson Counties is managed by the Coastal Bend Groundwater Conservation District and the Texana Groundwater Conservation District, respectively.

> **Major aquifers** produce large amounts of water over large areas. The TWDB recognizes nine major aquifers in the state of Texas, including the Gulf Coast Aquifer.
>
> **Minor aquifers** produce minor amounts of water over large areas or large amounts of water over small areas. The TWDB recognizes 21 minor aquifers in the state of Texas.
>
> (TWDB 2011b)

As defined by the TWDB, minor aquifers produce minor amounts of water over large areas or large amounts of water over small areas. The only minor aquifer in the proposed project area is the Brazos River Alluvium Aquifer, which extends from the southern end of Bosque County and Hill County to the eastern end of Fort Bend County approximately 15 miles north of the W.A. Parish Plant (Figure 3.6-1).

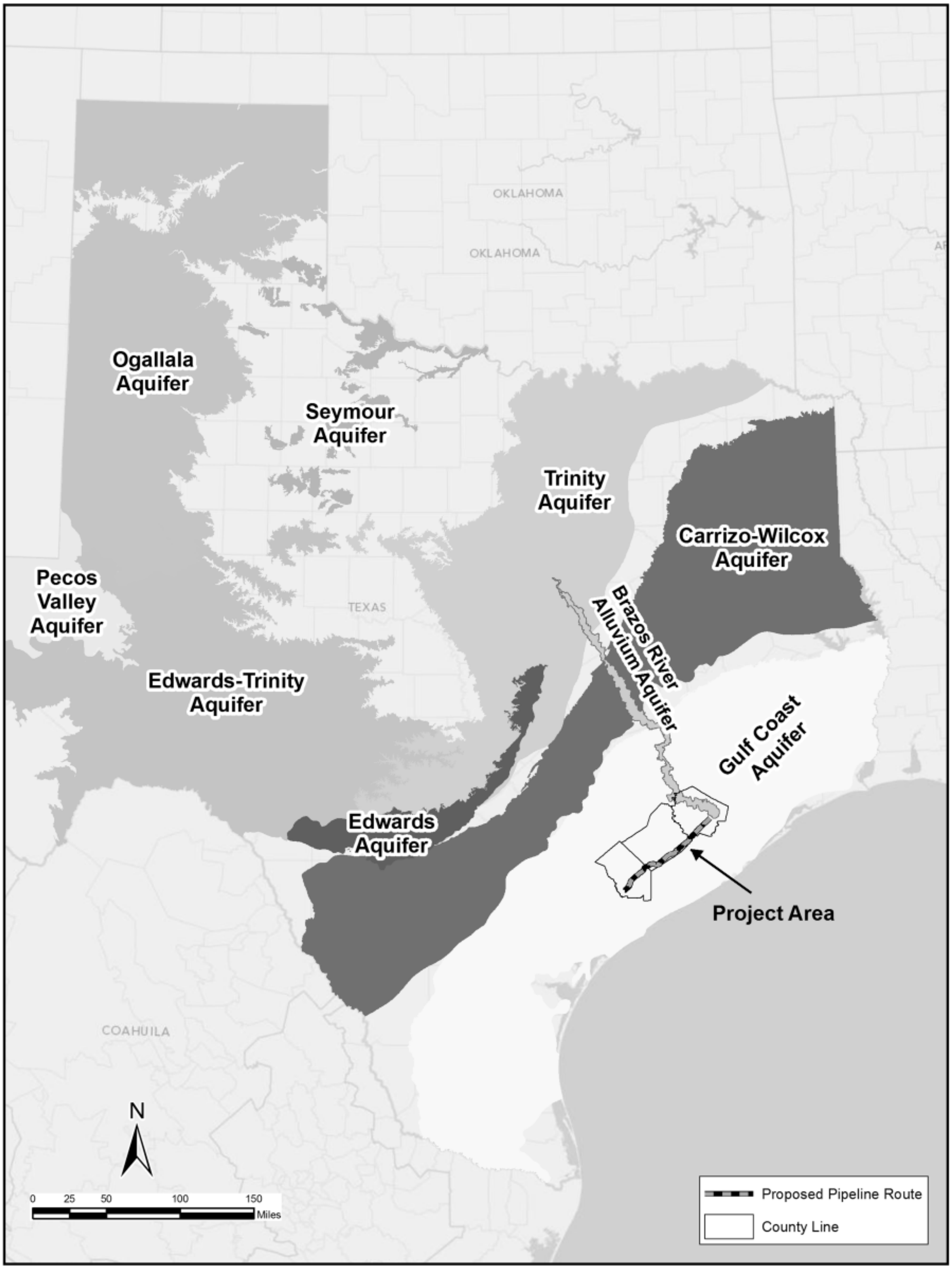

Figure 3.6-1. Selected Major and Minor Aquifers of Texas
Source: TWDB 2011b

The Brazos River Alluvium Aquifer occurs along the main stem of the Brazos River as it passes through the region. It is contained within Quaternary alluvial sediments consisting of clay, silt, sand, and gravel. The lower part of the Brazos River Alluvium Aquifer consists of more permeable sands and gravel (TWDB 1995). The alluvium width varies from under a mile to seven miles. The saturated sediment thickness ranges up to 85 feet. Water pumped from this aquifer is mainly used for irrigation. The Brazos River Alluvium Aquifer terminates north of the project area (Figure 3.6-1), but is hydraulically connected to the Brazos River, which supplies water to Smithers Lake for use by the W.A. Parish Plant. Therefore, water quality in the Brazos River Alluvium Aquifer and groundwater use from this aquifer are discussed in this EIS. However, the potential for direct impacts to the Brazos River Alluvium Aquifer is not discussed in this EIS.

The major Gulf Coast Aquifer and minor Brazos River Alluvium Aquifer provide approximately 30% of the water needs for the Gulf Coast Region (Texas Comptroller 2010).

3.6.2.1.2 Description of the Gulf Coast Aquifer

As shown in Figures 3.4-3 and 3.4-4 in Section 3.4 of this EIS (Geology), the Gulf Coast Aquifer is divided into four hydrostratigraphic units: the Chicot Aquifer, Evangeline Aquifer, Jasper Aquifer, and the Catahoula Confining System (aka, the Catahoula Restricted Aquifer). The Catahoula Confining System is composed of (in descending order) the Catahoula Sandstone, the Anahuac Formation, and the Frio Formation (Mace et al. 2006). Shale units at greater depths separate the Chicot and Evangeline Aquifers, which are the primary USDWs in the vicinity of the proposed project area, from the deeper oil and gas producing Frio Formation. These shale units include the Burkeville confining system, which separates the Evangeline and Jasper Aquifers, and the Anahuac shale. Recharge to the Gulf Coast Aquifer depends primarily on rainfall infiltration, which averages 56 inches in the northeast to 18 inches in the southwest annually (Mace et al. 2006). The Chicot and Evangeline aquifers are the more prolific water-producing units in the Gulf Coast aquifer (Region H Water Planning Group 2010).

> The **Gulf Coast Aquifer** is a regional aquifer that is composed of four hydrostratigraphic units: the Chicot Aquifer, Evangeline Aquifer, Jasper Aquifer, and the Catahoula Confining System (aka, the Catahoula Restricted Aquifer).
>
> A **confining unit** is a body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers.
>
> (TWDB 2011b, EAW 2012)

The four hydrostratigraphic units of the Gulf Coast Aquifer, comprised of interbedded layers of sand, silt and clay, are discussed in further detail below.

<u>Chicot Aquifer</u>

The Chicot Aquifer is the shallowest aquifer in the Gulf Coast Aquifer and is comprised of the following water-bearing units (in descending order): the Quaternary alluvium, Beaumont Clay, Lissie Formation, and Willis Sand, as shown in Figures 3.4-3 and 3.4-4 in Section 3.4 of this EIS (Geology). The Chicot is delineated from the Evangeline in the subsurface mainly on higher sand to clay ratios that give the Chicot higher hydraulic conductivity (Mace et al. 2006, Loskot, et al. 1982). However, it is similar to the Evangeline and difficult to distinguish. The base of the Chicot Aquifer lies at an elevation of approximately 800 to 1,000 feet bgs near in the ROI (Baker 1979, TWDB 2011a).

Evangeline Aquifer

The maximum depth of occurrence of fresh water in the Evangeline Aquifer is approximately 2,600 feet bgs (Mace et al. 2006, Baker 1979). The fresh water interval in the Evangeline ranges between 50 and 1,900 feet in thickness. The depth of existing groundwater wells drawing from the Evangeline Aquifer range from 170 to 1,715 feet deep. The Evangeline Aquifer is contained within the Goliad sands. (Mace et al. 2006, Baker 1979)

Jasper Aquifer

The Jasper Aquifer lies above the Catahoula and is mainly contained within the Oakville Sandstone. The interval of fresh to slightly saline water in the Jasper Aquifer ranges between approximately 200 and 800 feet in thickness. It reaches 2,500 feet of thickness down dip in Wharton County with a maximum thickness of approximately 3,200 feet (Loskot, et al. 1982; Baker 1995). Sediment thickness increases from the west to the east towards the Gulf of Mexico. Fresh water may be encountered in Jackson County as deep as 1,400 to 1,700 feet bgs (Loskot, et al. 1982; Baker 1995). The Burkeville confining system separates the Jasper from the overlying Evangeline aquifer and impedes water interchange between the two aquifers. The Burkeville confining system consists primarily of silt and clay, with a typical thickness ranging from approximately 300 to 500 feet and a maximum thickness of approximately 2,000 feet in Jackson County (Texana GCD 2011; Baker 1979, 1995).

Catahoula Confining System

The Catahoula Confining System, also sometimes referred to as the Catahoula Restricted Aquifer, underlies the Jasper Aquifer, and includes the Frio Formation, the Anahuac Formation, and the Catahoula Tuff or Sandstone, as shown in Figure 3.4-3 in Section 3.4 of this EIS (Geology). This assemblage comprises the lowest hydrostratigraphic unit of the Gulf Coast Aquifer as classified by Baker (1979). The unit contains some groundwater near locations where it outcrops in relatively restricted sand layers (Ashworth and Hopkins 1995). The Catahoula Sandstone is composed of non-marine sands and clays and volcano-clastic deposits interbedded with fluvial sediments (Mace et al. 2006). Beneath the West Ranch oil field, the Catahoula Sandstone occurs between approximately 4,250 to 4,500 feet bgs.

3.6.2.2 Groundwater Use

In 1997, the TWDB divided the state into 16 regional water planning areas and appointed representational Regional Water Planning Groups (RWPG) to guide the development of each region's groundwater management plan. Fort Bend County is one of the 15 counties that comprise the Region H Planning Group (Region H Water Planning Group 2010). The eastern part of Wharton County is represented by the Region K Planning Group (aka, the Lower Colorado Regional Water Planning Group) and the western part of Wharton County, along with Jackson County, is represented by the Region P Planning Group (Kasmarek and Robinson 2014). In Harris, Galveston, Fort Bend, Jasper, and Wharton Counties, water level declines of as much as 350 feet have led to land subsidence. As can be seen in Figure 3.6-2, the level of groundwater drawdown in the area is centered on Harris County.

As discussed above, the proposed CO_2 capture facility would be located at NRG's W.A. Parish Plant in Fort Bend County; the proposed CO_2 pipeline would be located in Fort Bend, Wharton, and Jackson Counties; and the proposed EOR and CO_2 monitoring facilities would be located at the West Ranch oil field in Jackson County. Groundwater use for each of these counties is discussed below.

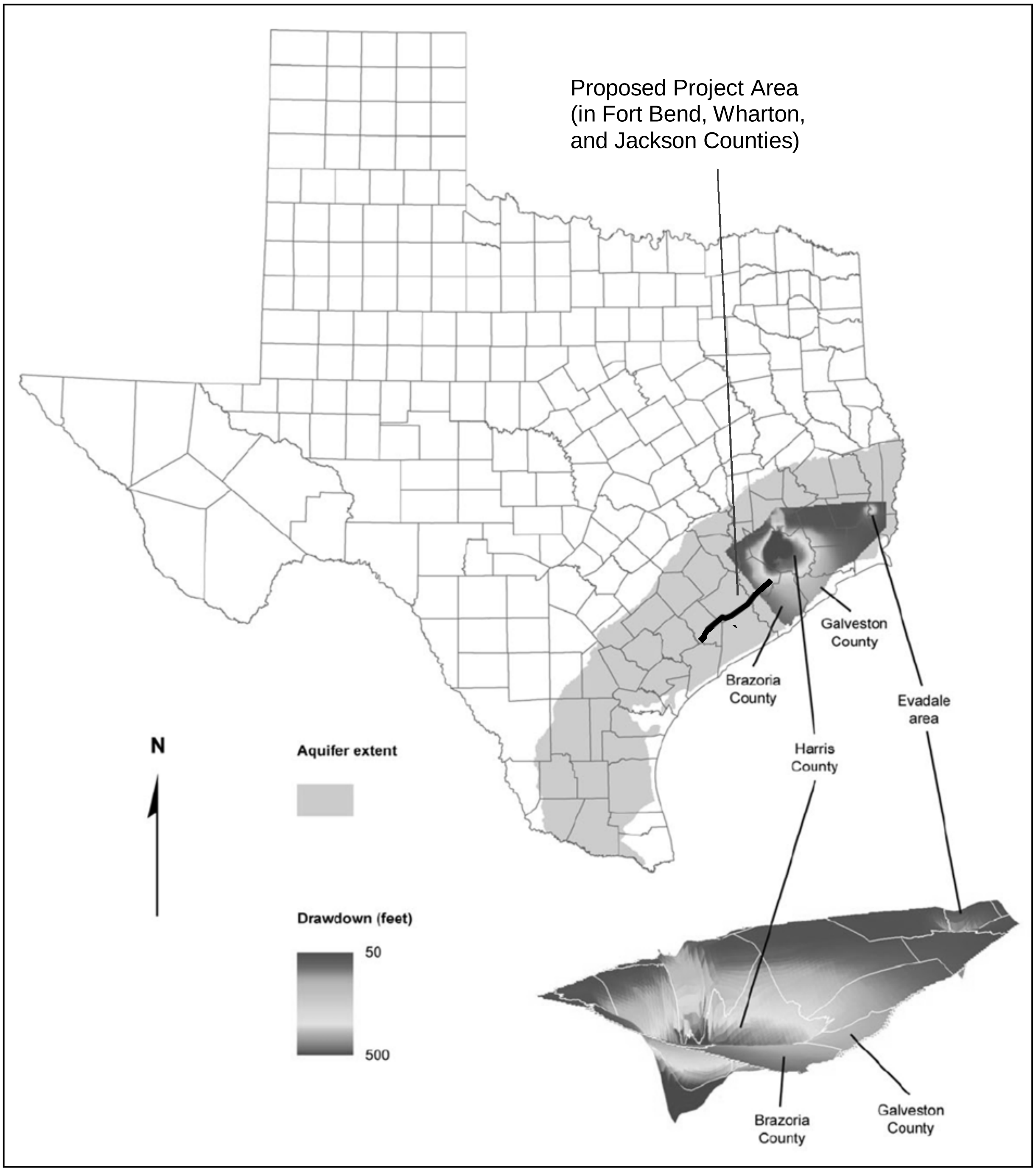

Figure 3.6-2. Gulf Coast Aquifer Drawdown in Harris, Galveston, and Brazoria Counties
Source: TWDB 2011b

3.6.2.2.1 Fort Bend County

The Brazos River Alluvium Aquifer provides Fort Bend County with groundwater for domestic and agricultural purposes (Region H Water Planning Group 2010). Groundwater supply from the Brazos River Alluvium Aquifer is supplemented by the Chicot Aquifer, which supplies the majority of southeastern Fort Bend County. Extensive use of groundwater in Fort Bend County has resulted in a decline in water levels in groundwater wells across the county and resulted in a small amount of surface subsidence since the 1980s. Subsidence problems resulted in the formation of the Fort Bend Subsidence District in 1989 by the Texas Legislature to control land subsidence and manage groundwater resources. The Fort Bend Subsidence District reports that, on average, 60% of the water supply for Fort Bend comes from groundwater and 40% from surface water. Groundwater supplied 69% of the overall water used in Fort Bend during 2010. The Fort Bend Subsidence District indicates there has been an overall water level decline from 1977 to 2011 in the Chicot Aquifer in southeastern Fort Bend County as well as in the northern and eastern parts of the county. (Fort Bend Subsidence District 2011)

According to its 2011 Water Plan, the Region H Planning Group projects that water demands for Region H will increase from approximately 2.38 million acre-feet per year (AF/yr) in 2010 to over 3.52 million AF/yr by 2060. Municipal water demands are projected to account for over half of the total regional water demands by 2060. (Region H Water Planning Group 2010)

3.6.2.2.2 Wharton and Jackson Counties

The Chicot and Evangeline Aquifers, subunits of the Gulf Coast Aquifer, are the predominant water supply sources for Wharton and Jackson Counties, supplying large amounts of groundwater to both counties, which is used primarily for irrigation and agriculture. Within the Lavaca Regional Water Planning Area in Wharton County, the aquifers contain fresh water to depths that range from about 1,400 to 1,700 feet bgs (Region P Water Planning Group 2010). In the 2006 regional water plan, groundwater availability was estimated for Wharton County as 89,941 AF/yr and was estimated as 87,876 AF/yr for Jackson County (Region P Water Planning Group 2010). Average groundwater withdrawal for Jackson County from 1984 to 2003 was 15,369 AF/yr. The groundwater withdrawals over these years has not caused significant static water level decline.

3.6.2.2.3 Existing Wells near the CO_2 Capture Facility

The TWDB groundwater well database was searched to locate public and private groundwater supply wells within the ROI for the CO_2 capture facility. There are nine wells located within the CO_2 capture facility ROI, as shown on Figure 3.6-3 and summarized in Table 3.6-1, which range in depth from approximately 200 to 900 feet bgs (TWDB 2011a). All of the groundwater wells within the CO_2 capture facility ROI are screened in the Chicot and Evangeline Aquifers. Six of these wells are industrial water supply wells owned by NRG (i.e., under the names Houston Lighting and Power and A.P. George). NRG's groundwater supply wells are capable of producing a total of approximately 6.7 mgd of groundwater, which is pumped into a settling basin and used as needed (NRG 2012f). Pumping rates for NRG's groundwater supply wells are summarized in Table 3.6-1.

3.6.2.2.4 Existing Wells near the Pipeline Corridor

Information obtained from the TWDB shows there are approximately **284** existing groundwater wells located in the ROI for the proposed pipeline corridor, as listed below in Table 3.6-2 and shown on Figure 3.6-4 through Figure 3.6-7, all of which are screened in the Chicot and Evangeline Aquifers (TWDB 2011a). **As shown in** Table 3.6-3**, many of these wells (i.e., 99 of 284) are used for irrigation. One** of these existing wells **is** located within the pipeline construction ROW**, an irrigation well near milepost**

59.7. All active water supply wells in the ROI for the proposed pipeline corridor are greater than **28** feet deep (TWDB 2011a).

Table 3.6-1. Water Supply Wells within ROI for the Proposed CO_2 Capture Facility

State Well ID	Water Use	Well Owner[1]	Target Aquifer	Well Depth (feet bgs)	Year Drilled	Pumping Rate (mgd)
6535302 (Well 1)	Industrial	NRG	Lower Chicot	702	1956	0.86
6535303 (Well 4)	Industrial	NRG	Chicot and Evangeline	803	1956	0.94
6535304 (Well 3)	Industrial	NRG	Chicot and Evangeline	853	1967	1.2
6535306 (Well 7)	Industrial	NRG	Chicot and Evangeline	851	1975	1.2
6535307 (Well 6)	Industrial	NRG	Chicot	850	1979	1.2
6535308 (Well 2)	Industrial	NRG	Evangeline	859	1981	1.3
6535319	Public Supply	Ash Management	Chicot	210	NA	NA
6536103	Unused	Y.U. Jones	Upper Chicot	209	Unknown	NA
6536104	Unused	Rudolph Gubbles	Gulf Coast (undifferentiated)	185	1919	NA

Source: TWDB 2011a, NRG 2012
[1] Wells listed as owned by NRG may be registered with the TWDB under the name of Houston Lighting and Power (Wells 1, 2 ,4, 6, and 7) or A.P. George (Well 3).
bgs = below ground surface; mgd = millin gallons per day; N/A = data not available

Table 3.6-2. Water Supply Wells within the ROI for the Proposed Pipeline

Water Use	Number of Wells	Well Depth Range (feet bgs)
Commercial	2	62-200
Plugged or Destroyed	31	65-1,022
Domestic	36	44-302
Irrigation	99	104-1195
Industrial	20	250-1,237
Public Water Supply	6	123-1,258
Recreational	2	180-250
Stock	14	31-1,250
Institutional	1	140
Unused	64	29-1,234
No Primary Use Identified	9	61-706

Source: TWDB 2011a

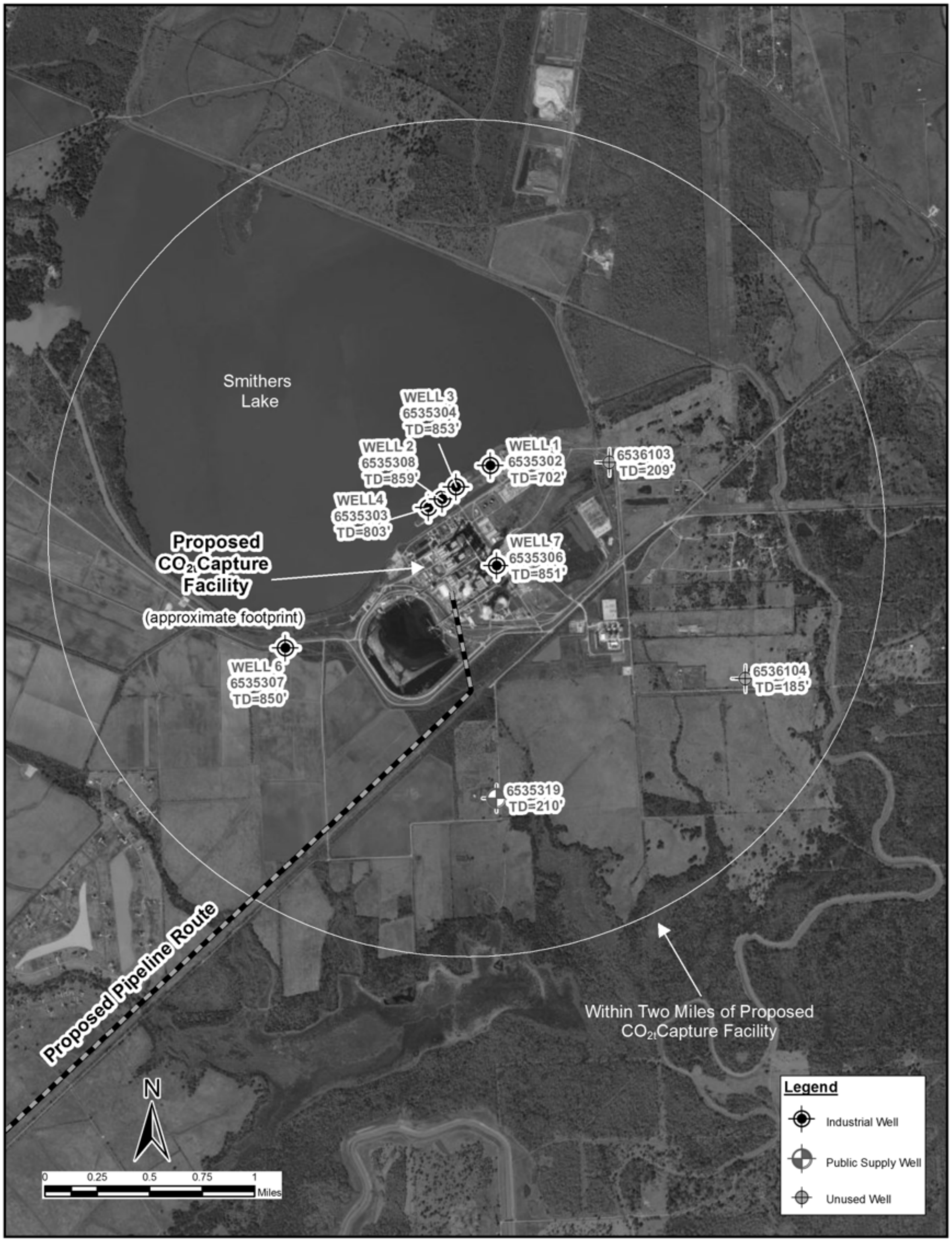

Figure 3.6-3. Groundwater Wells within the ROI for the Proposed CO_2 Capture Facility
Source: TWDB 2011b

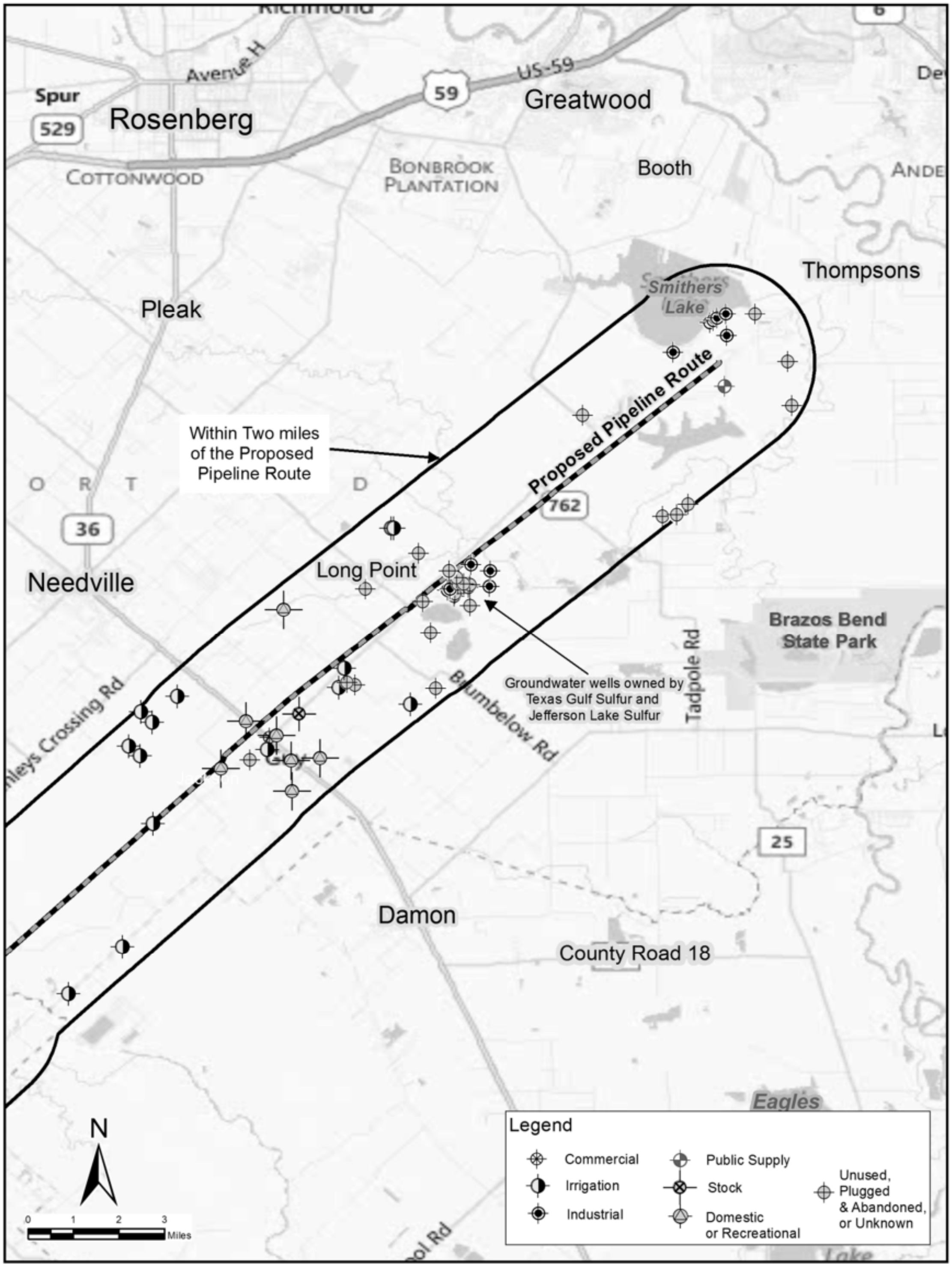

Figure 3.6-4. Groundwater Wells within ROI for the Northeast Segment of Proposed Pipeline Route

Source: TWDB 2011a

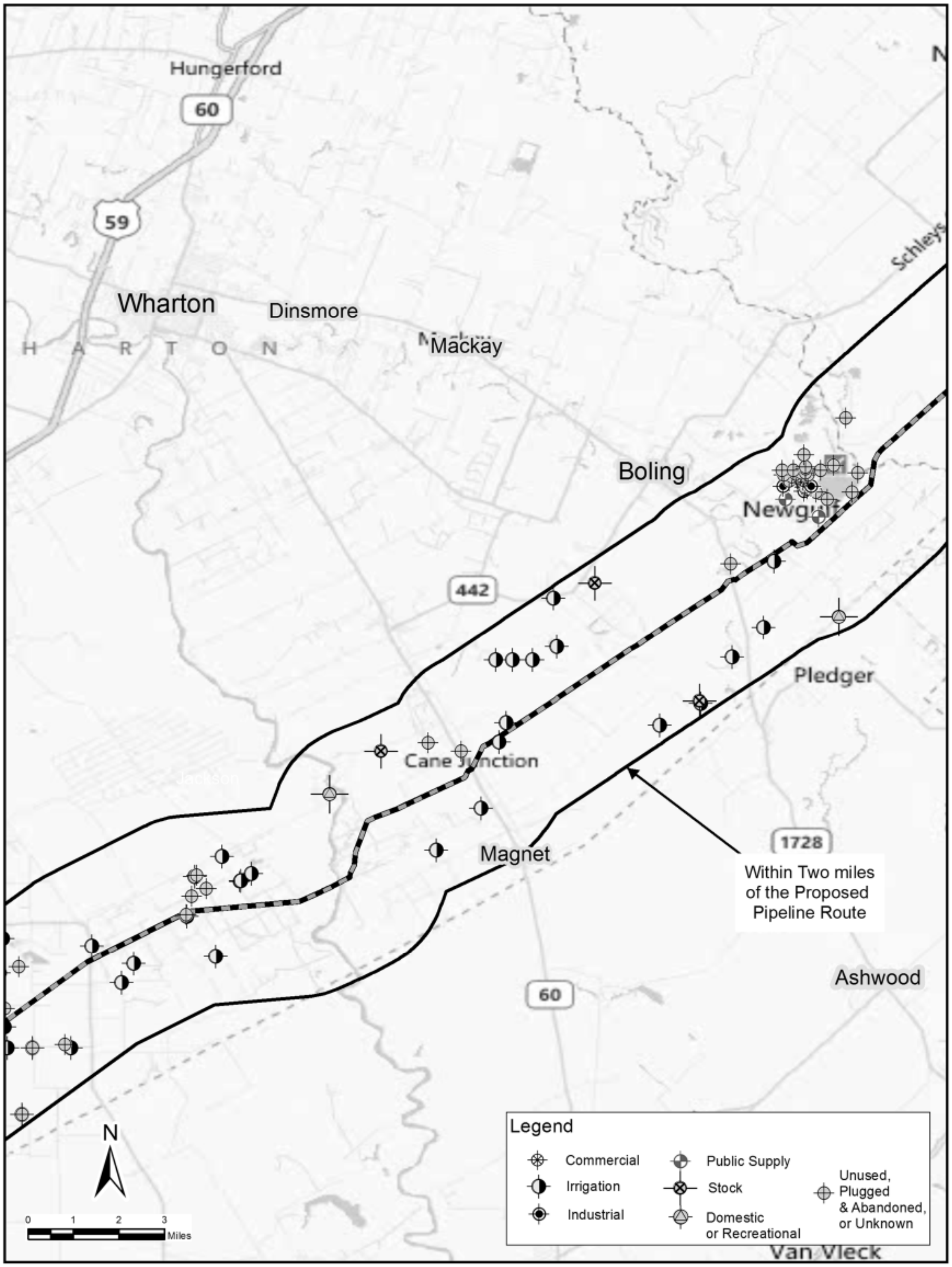

Figure 3.6-5. Groundwater Wells within ROI for the North Central Segment of Proposed Pipeline Route

Source: TWDB 2011a

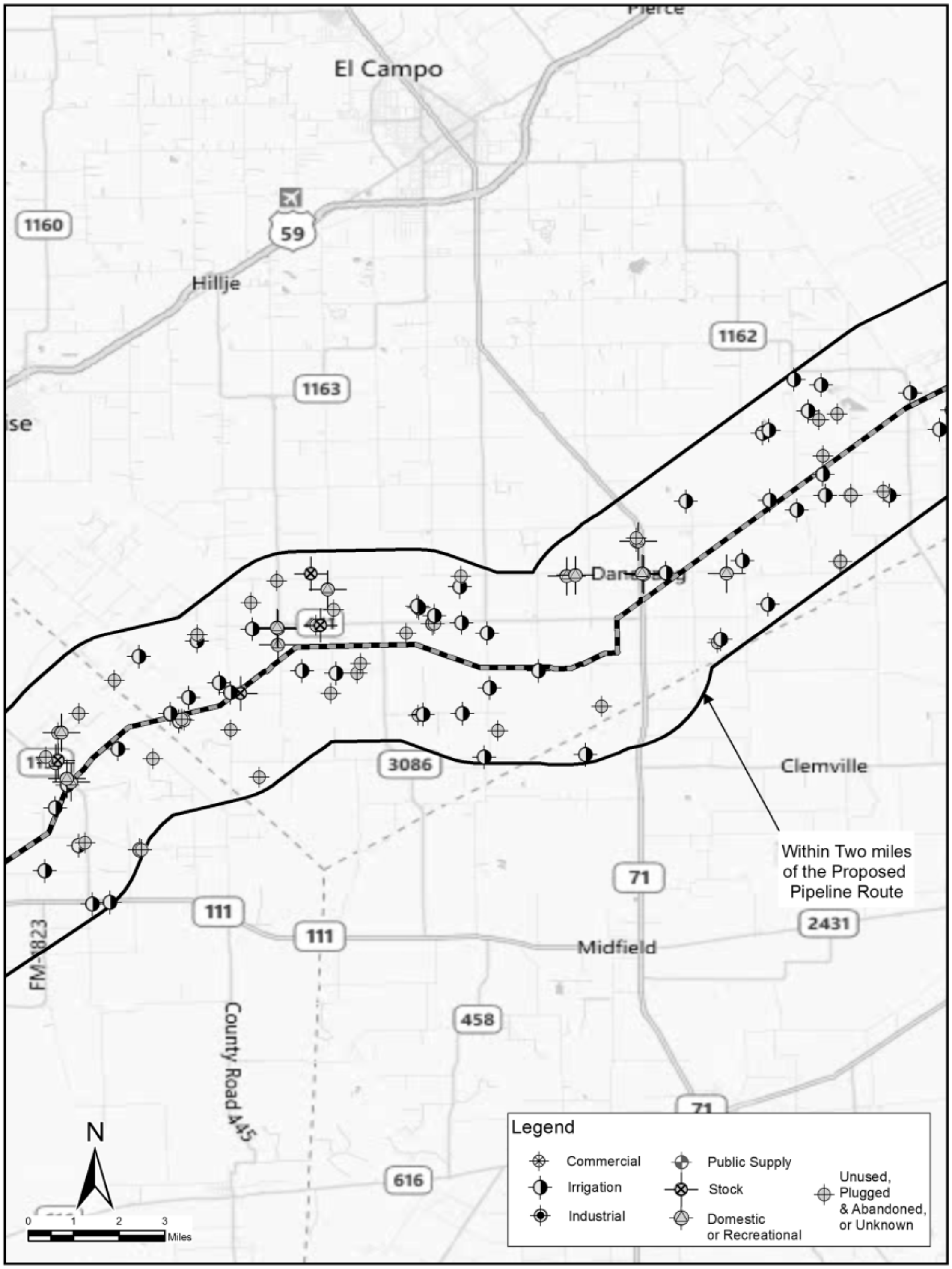

Figure 3.6-6. Groundwater Wells within ROI for the South Central Segment of Proposed Pipeline Route

Source: TWDB 2011a

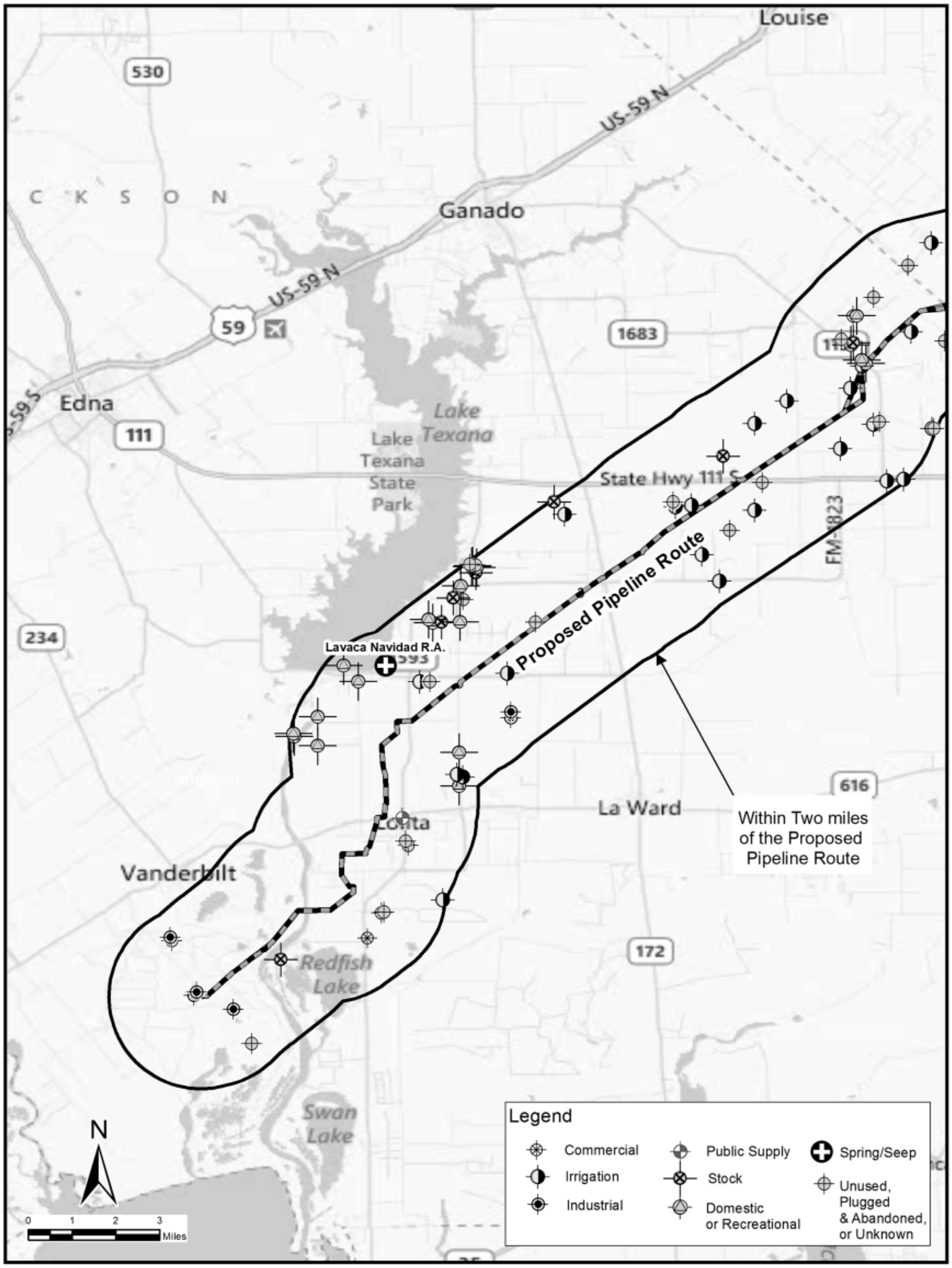

Figure 3.6-7. Groundwater Wells within ROI for the Southwest Segment of Proposed Pipeline Route

Source: TWDB 2011a, USGS 2012, LNRA 2012

Data from the USGS National Water Information System (NWIS) (USGS 2012) suggest the presence of a single spring in the ROI, located near the southeastern edge of Lake Texana in Jackson County, as shown in Figure 3.6-7. The Lavaca-Navidad River Authority (LNRA) categorizes this feature as a seep, rather than a spring, and reported that the USGS performed a study approximately four years ago looking at oxygen isotope levels in the seep discharge to try to determine the origin of this seep, but the results of the study were inconclusive. No other information on this feature was available from the LNRA or the USGS (LNRA 2012, USGS 2012).

3.6.2.2.5 Existing Wells in the Vicinity of the West Ranch Oil Field

According to the TWDB, there are a total of 13 existing groundwater wells located within the West Ranch oil field ROI. As shown in Table 3.6-3, these include one commercial well, two irrigation wells, five industrial wells, one public supply well, one stock well, and three wells listed as unused. Five of these water wells are located within the boundaries of the proposed West Ranch oil field EOR area, as shown on Figure 3.6-8.

Table 3.6-3. Water Supply Wells within ROI for the Proposed West Ranch Oil Field EOR Area

State Well ID	Water Use	Well Owner[1]	Target Aquifer	Well Depth (feet bgs)	Year Drilled
8011304	Unused	C.W. Martin	Gulf Coast	356	1958
8011602	Irrigation	Jerry Rozeypal	Gulf Coast	905	1944
8011603	Industrial	West Ranch	Gulf Coast	1256	1955
8011901	Irrigation	Rozeypal Bros.	Gulf Coast	1500	1951
8011902	Unused	George Schattel	Gulf Coast	400	1957
8012401	Unused	West Ranch	Gulf Coast	1232	1939
8012402	Public	Vanderbilt Water District (aka, Jackson County WCID #2)	Gulf Coast	1235	1953
8012403	Industrial[2]	West Ranch	Gulf Coast	1258	1953
8012503	Stock	L Ranch	Gulf Coast	1250	1942
8012504	Commercial	Columbus High Mart	Gulf Coast	200	1994
8012701	Industrial	West Ranch	Gulf Coast	1235	1941
8012702	Industrial	West Ranch	Gulf Coast	1237	1946
8012704	Industrial	West Ranch	Gulf Coast	1233	1938

Source: TWDB 2011a
[1] Wells listed as owned by West Ranch may be registered with the TWDB under the name of their former owner, Mobil Oil Co.
[2] Well 8012403, which is an industrial well, was erroneously identified as public water supply in an old TWDB report.

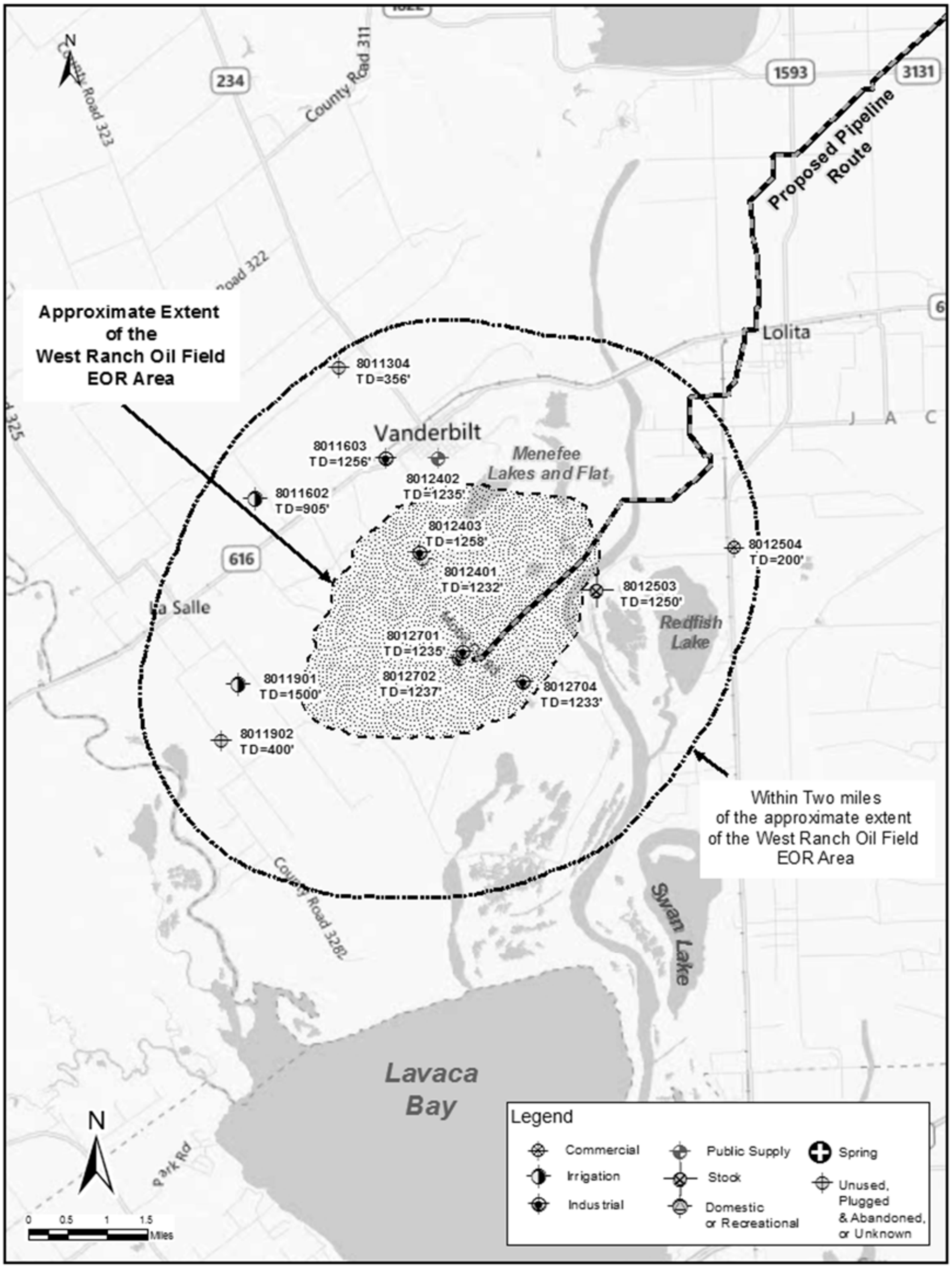

Figure 3.6-8. Groundwater Wells within ROI for the Proposed West Ranch Oil Field EOR Area
Source: TWDB 2011a

3.6.2.3 Groundwater Quality

In general, the quality of groundwater in the northern shallow portions of the Gulf Coast Aquifer (i.e., the Chicot and Evangeline Aquifers) makes it suitable for many purposes. In the project area, groundwater to a depth of approximately 3,200 feet bgs generally contains less than 500 mg/L of total dissolved solids (TDS) from the San Antonio River Basin, which is west of the West Ranch oil field, to the Louisiana border. Fresh water is defined as having bacteriological, physical, and chemical properties which make it suitable for beneficial use.

3.6.2.3.1 CO_2 Capture Facility

The groundwater quality in the Gulf Coast Aquifer within the CO_2 capture facility groundwater ROI (i.e., Fort Bend County) makes it suitable for many purposes. Groundwater from the Gulf Coast Aquifer within Region H generally has TDS concentrations below 1,000 mg/L and is free of contaminants. Groundwater in some areas of Region H (i.e., limited areas in northwest and west Harris County) contains arsenic and/or radon. However, no arsenic, radon, or other constituents exceeding maximum contaminant levels (MCLs) or other water quality criteria are reported for groundwater from the Gulf Coast Aquifer in Fort Bend County. (Region H Water Planning Group 2010)

Although the Brazos River Alluvium Aquifer terminates north of the project area (Figure 3.6-1), it is important to the CO_2 capture facility ROI because it is hydraulically connected to the Brazos River, which supplies water to Smithers Lake for use by the W.A. Parish Plant. Water quality in the Brazos River Alluvium Aquifer is typically hard, and TDS concentrations in the water can reach more than 1,500 mg/L. The primary use of water pumped from the aquifer is for irrigation. (Mace et al. 2006) Calcium, magnesium and sulfate cause high total hardness in portions of the Brazos River Alluvium Aquifer (Region H Water Planning Group 2010).

3.6.2.3.2 Pipeline Corridor

As described above, groundwater quality in the Gulf Coast Aquifer in Fort Bend County is good, with TDS concentrations below 1,000 mg/L (Region H Water Planning Group 2010). In Jackson County, the Chicot Aquifer is categorized as containing all fresh water and the Evangeline Aquifer contains fresh to slightly saline water with fresh water occurring as deep as 1,400 to 1,700 feet bgs (Texana GCD 2011). Similarly, in Wharton County, the Chicot Aquifer contains all fresh water and in the Evangeline Aquifer fresh water may occur as deep as 2,000 feet bgs (Coastal Bend Groundwater Conservation District 2009).

3.6.2.3.3 West Ranch Oil Field

Site-specific information provided by HEC indicates the base of the fresh water zone in the area of the West Ranch oil field occurs at approximately 1,350 to 1,600 feet bgs (HEC 2011a). Based on a review of regional hydrogeologic data, including electric log data, as interpreted by Baker (1979), the base of the Chicot Aquifer in the West Ranch oil field area is approximately 800 to 900 feet bgs, as shown in Figure 3.4-2 in Section 3.4 of this EIS. The base of the Evangeline Aquifer in the EOR area ranges from approximately 1,600 to 2,200 feet bgs. Table 3.6-4 summarizes recent groundwater data obtained from the TWDB (2011a) for wells located within approximately two miles of the West Ranch oil field EOR area.

Table 3.6-4. Groundwater Quality Data Near West Ranch Oil Field

Number of Samples	Year(s) Sampled	Analyte	Minimum Concentration	Maximum Concentration
Chicot Aquifer				
TDS and Major Cations and Anions (mg/L)				
2	1964-2009	Total Dissolved Solids	957	1416
2	1964-2001	Calcium	13	33
2	1964-2002	Magnesium	6	12
2	1964-2003	Sodium	337	510
1	1964-2004	Potassium	N/A	2
0	1964-2005	Carbonate	N/A	N/A
2	1964-2006	Bicarbonate	354	381
2	1964-2007	Sulfate	1	3
2	1964-2008	Chloride	395	670
Trace Metals (µg/L)				
1	2001	Aluminum	N/A	16.6
0	---	Silver	N/A	N/A
1	2001	Arsenic	N/A	4.2
1	2001	Barium	N/A	499.0
1	2001	Beryllium	N/A	<1.00
1	2001	Boron	N/A	1030.0
1	2001	Cadmium	N/A	<1.00
1	2001	Chromium	N/A	1.1
1	2001	Copper	N/A	6.1
1	2001	Iron	N/A	140.0
1	2001	Lead	N/A	<1.00
1	2001	Manganese	N/A	20.0
1	2001	Nickel	N/A	<1.00
1	2001	Selenium	N/A	4.0
1	2001	Vanadium	N/A	<1.00
1	2001	Zinc	N/A	18.1
Evangeline Aquifer				
TDS and Major Cations and Anions (mg/L)				
15	1942-2009	Total Dissolved Solids	776	1085
15	1942-2009	Calcium	7	12
15	1942-2009	Magnesium	2	5
15	1942-2009	Sodium	295	416
8	1953-2009	Potassium	2	3
2	1942-1982	Carbonate	4	16
16	1942-2009	Bicarbonate	384	512
15	1942-2009	Sulfate	<1	10

Table 3.6-4. Groundwater Quality Data Near West Ranch Oil Field

Number of Samples	Year(s) Sampled	Analyte	Minimum Concentration	Maximum Concentration
16	1942-2009	Chloride	248	408
Trace Metals (µg/L)				
4	1997-2009	Aluminum	<1.00	2.4
2	1992-2009	Silver	<1.02	<10.00
5	1992-2009	Arsenic	<10.00	5.7
5	1992-2009	Barium	250.0	343.0
4	1992-2009	Beryllium	---	<1.00
4	1997-2009	Boron	1090.0	1190.0
4	1992-2009	Cadmium	<1.00	<10.00
4	1992-2009	Chromium	<20.00	2.6
5	1992-2009	Copper	<20.00	4.9
6	1964-2009	Iron	20.0	107.0
5	1992-2009	Lead	<1.00	<50.00
5	1992-2009	Manganese	<20.00	4.3
2	1997-2001	Nickel	---	<1.00
5	1992-2009	Selenium	<2.00	2.0
4	1997-2009	Vanadium	<1.00	2.5
5	1992-2009	Zinc	<4.08	4.0

Source: TWDB 2012a

3.6.3 Direct and Indirect Impacts of the Proposed Project

Overall impacts to groundwater resources resulting from construction and operation of the proposed project facilities are anticipated to range from relatively minor in magnitude and extent to negligible. At the proposed CO_2 capture facility and along the proposed pipeline corridor, the proposed project is anticipated to have a negligible impact on existing groundwater quality and is not expected to impact existing groundwater withdrawals or conflict with existing regional groundwater use plans. A minor potential for impacts to groundwater would be expected in the groundwater zone at the West Ranch oil field immediately surrounding each proposed CO_2 injection well and each produced water injection well used for reinjection of EOR-generated produced water. The subsections below describe the details upon which these conclusions are based.

3.6.3.1 Construction Impacts

3.6.3.1.1 CO_2 Capture Facility

Existing on-site groundwater wells would be used for construction water needs and no new wells are anticipated to be needed during construction of project facilities. One public supply well is located in the vicinity of the proposed construction. This well (Well 6535319), as shown on Figure 3.6-3, is located over a mile from the construction area.

During construction of the CO_2 capture facility, accidental spills of fuel, fuel constituents, and other materials onto the ground surface may occur and could potentially impact shallow groundwater resources.

The potential for spills to impact groundwater is considered low as the BMPs described in Section 3.5 of this EIS (Physiography and Soils) would be applied to prevent spills and unintentional releases to groundwater from wastes or petroleum-based materials generated during construction. If spills were to occur, response actions and control measures specified in the W.A. Parish Plant's existing SPCC Plan would be employed to address the spill and to minimize the possibility of further impacts to groundwater resources. NRG would follow the requirements and procedures outlined in the W.A. Parish Plant's existing SPCC Plan for all proposed construction activities.

DOE expects that construction activities associated with the proposed CO_2 capture facilities would not conflict with established water rights or local aquifer management plans or affect the available capacity or quality of groundwater resources. Taking into account the BMPs that would be employed to minimize the risk of spills affecting groundwater resources, DOE anticipates that impacts to groundwater resources from the construction of the CO_2 capture facility within the W.A. Parish Plant would be negligible to minor.

3.6.3.1.2 Pipeline Corridor

One existing well is located within the pipeline construction ROW, an irrigation well near milepost 59.7. This well would be avoided during pipeline construction and maintenance, and NRG would test flow rates in the well before and after construction to ensure no impacts have occurred. Therefore, DOE does not expect construction activities **to** directly impact groundwater supplies. Based on the proposed depth of pipeline burial, shallow groundwater is unlikely to be encountered during excavation of the pipeline trench. The reported groundwater supply wells along the pipeline route are screened significantly deeper than the pipeline trench, and the aquifers used would not be directly impacted by trenching, drilling, or drilling muds because of their depth below the pipeline and the distance from the pipeline to the wells. Therefore, based on the current proposed pipeline plans, it is not anticipated that any existing water supply wells would be directly disturbed as a result of construction of the CO_2 pipeline. In the unlikely event that an existing supply well were to be directly impacted by the construction activities, resulting in the temporary impairment of the quantity or quality of water available in that well, alternative sources of water would be identified and provided (e.g., a new well would be drilled to replace the damaged well or other water service would be provided until such time as the issue was resolved).

NRG has no current plans to withdraw groundwater or to discharge directly to groundwater during construction of the proposed pipeline. Water required for construction purposes (e.g., hydrostatic testing, preparation of drilling muds, dust suppression) may be trucked in or obtained from surface water bodies adjacent to the pipeline. If hydrostatic test water is discharged to the ground after testing, a RRC permit would be obtained for each discharge, as appropriate, and applicable RRC procedures, including water quality testing, would be followed, as specified in 16 TAC 3.8(d)(6)(G) and associated RRC guidance.

During pipeline construction, accidental spills of fuel, fuel constituents, and other materials onto the ground surface may occur and could potentially impact shallow groundwater resources. As discussed in Section 3.5 of this EIS (Physiography and Soils), NRG would prepare a project-specific SWPPP to describe BMPs to be implemented during the construction phase of the project. This SWPPP would incorporate SPCC Plan elements, as applicable, to provide guidance to construction personnel regarding potential spills. BMPs related to spill avoidance and response, in particular, would help to avoid or minimize potential impacts to groundwater resources from accidental spills of fuel, fuel constituents, and other materials during pipeline construction.

DOE expects that construction activities associated with the proposed CO_2 pipeline would not conflict with established water rights or local aquifer management plans or affect the available capacity or quality of groundwater resources. Taking into account the BMPs that would be employed to minimize the risk of spills affecting groundwater resources, DOE anticipates that impacts to groundwater resources from the construction of the proposed pipeline would be minor.

3.6.3.1.3 West Ranch Oil Field

TCV plans to use existing wells (i.e., refurbished or deepened as needed) to the extent practicable to minimize the number of new production wells, produced water disposal wells, and monitoring wells that would be needed for EOR and CO_2 monitoring activities. New injection wells would be drilled if the existing wells cannot be reworked for injection. All new injection wells would require UIC permits and TCV would install the new injection wells in accordance with the design standards specified by the RRC UIC Program. Each new injection well would have a casing installed to the full depth of the well (i.e., approximately 6,500 feet bgs). This casing would extend well below the bottom of the deepest USDW underlying the West Ranch oil field, which is at approximately 1,350 to 1,600 feet bgs. The annular space between the well casing and the formation would be cemented from the total depth of borehole to the surface. This continuous casing and cement would minimize the potential for fluids from the production units to migrate vertically upwards along the well bore. Drilling may result in negligible impacts above levels already observed as a result of ongoing oil and gas production activities at the West Ranch oil field. Existing wells used by the project would be reworked to bring them up to current construction standards, resulting in a beneficial impact to groundwater resources by reducing the risk of leakage due to improperly sealed wells. As discussed in Section 3.4 of this EIS (Geology), well construction activities, if required, would not induce seismic activity that could cause potential for CO_2 leaks from the injection zone into the overlying aquifers.

During construction activities within the EOR area, accidental spills of fuel, fuel constituents, and other materials onto the ground surface may occur and could potentially impact shallow groundwater resources. Potential impacts to groundwater through infiltration of fluids accidentally spilled or discharged to the ground surface would be avoided or minimized by using BMPs described in the project-specific SWPPP, as described in Section 3.5 of this EIS (Physiography and Soils). As shown on Figure 3.6-8, there is one public supply well (i.e., well 8012402, operated by the Vanderbilt Water District) located in or within a quarter mile of the oil field (TWDB 2011a). The well has a total depth of 1,235 feet bgs and is identified by the TWDB as producing water from the Gulf Coast Aquifer. As indicated in Figure 3.4-4, the bottom of this well is located in the Evangeline Aquifer, which is the deepest USDW in the area. Due to its depth and the fact that the Chicot and Evangeline Aquifers are composed of interbedded layers of sand, silt and clay, it is unlikely that the Evangeline Aquifer would be impacted by surface spills.

In most cases, CO_2 monitoring program-related construction activities would be conducted in or around existing wells in the oil field area. The quantity and location of CO_2 monitoring wells would be based on the requirements of the CCPI Program, the RRC UIC Program, RRC regulations for certification of CO_2 storage related to EOR operations, and the results of geological characterization work to be conducted by TCV and the BEG. Both shallow and deep wells may be components of the monitoring program. The drilling of small-diameter, shallow boreholes, and their subsequent use for soil-gas testing, would use small truck-mounted equipment. Wells that may be required for CO_2 monitoring activities would be minimal compared to that from HEC's current commercial oil field operations.

DOE expects that project-related construction activities at the West Ranch oil field would not conflict with established water rights or local aquifer management plans or affect the available capacity or quality of groundwater resources. Taking into account the BMPs that would be employed to minimize the risk of spills affecting groundwater resources, DOE anticipates that impacts to groundwater resources from construction activities at the West Ranch oil field would be minor.

3.6.3.2 Operational Impacts

3.6.3.2.1 CO_2 Capture Facility

Based on usage rates during 2010 and 2011, the W.A. Parish Plant uses approximately 1.6 to 2.3 mgd of groundwater (NRG 2012a). Groundwater used at the W.A. Parish Plant is obtained from six existing wells (i.e., wells 6535302 through 6535304 and 6535306 through 6535308), which are screened in the Chicot and Evangeline Aquifers and have total depths ranging from 702 to 859 feet bgs (NRG 2012). Preliminary estimates indicate that operation of the proposed CO_2 capture facility would require an increase of approximately 4 to 5 mgd of additional water supply, including approximately 0.2 to 0.3 mgd from their existing groundwater wells, which would be an approximately 13% increase in groundwater use at the plant as compared to current usage rates. As can be seen in Figure 3.6-2, the proposed project area is located to the southwest of the area that is most significantly impacted by aquifer drawdown and associated subsidence. As noted above, NRG's existing groundwater supply wells are capable of producing a total of approximately 6.7 mgd of groundwater (NRG 2012f), which is sufficient to supply the approximately 1.8 to 2.6 mgd that would be required by the W.A. Parish Plant, including operation of the proposed CO_2 capture facility. Since NRG's existing wells would sufficiently supply the additional amount of water to satisfy the water demands of the CO_2 capture facility, the Parish PCCS project would not be expected to conflict with established water rights or local aquifer management plans or affect the available capacity or quality of groundwater resources. Therefore, DOE would expect impacts to groundwater availability to be minor.

During operation of the CO_2 capture facility, accidental spills of process chemicals, such as MEA, onto the ground surface may occur and could potentially impact shallow groundwater resources. The potential for spills to impact groundwater is considered low as the facility would avoid or minimize potential impacts from spills according to the W.A. Parish Plant's existing SPCC plan, which would be updated to include the CO_2 capture facility. Taking into account the provisions of the SPCC plan that would be used to minimize the potential for spills to affect groundwater resources, DOE anticipates that potential impacts to groundwater quality from the operation of the CO_2 capture facility would be minor and similar to potential impacts from the plant's current operations.

3.6.3.2.2 Pipeline Corridor

Although there are no anticipated needs for groundwater supplies along the pipeline and no plans to discharge directly to groundwater during operations, there may be limited discharges of water to the ground (e.g., spent hydrostatic test water used for periodic testing of pipeline integrity), subject to the provisions of 16 TAC 3.8(d)(6)(G) and associated RRC guidance. During project operations, there is also some potential for spills to occur from operational equipment (e.g., hydraulic fluids, fuels, lubricants) during maintenance activities. These activities along the pipeline would be limited in scope and frequency. NRG would follow the BMPs discussed in Section 3.5 of this EIS (Physiography and Soils), as applicable, during maintenance activities to avoid or minimize potential impacts to groundwater resources from accidental spills of fuel, fuel constituents, and other materials. Taking into account the BMPs that would be used to minimize the potential for spills to affect groundwater resources, DOE anticipates that potential impacts to groundwater quality from the operation of the CO_2 pipeline would be minor. DOE expects that operation of the CO_2 pipeline would not impact the availability of groundwater resources.

As discussed in Appendix F to this EIS (Health Risk Assessment), based on the frequency of releases from similar pipelines in the U.S., a release of CO_2 due to a pipeline puncture or rupture is considered unlikely. If CO_2 were released from the pipeline, it would expand rapidly as a gas and could include both liquid and solid (i.e., dry ice) phases, depending on temperature and pressure. As the product in the pipeline is over 99.9% CO_2 with few impurities (i.e., primarily oxygen, nitrogen, argon, and water) and would not remain under sufficient pressure to dissolve into groundwater, it would have negligible adverse impact on groundwater quality in the unlikely event of a release.

3.6.3.2.3 West Ranch Oil Field

EOR operations are not expected to require additional groundwater supplies. Additional produced water generated during EOR operations would be used for production activities or would be disposed using existing produced water disposal wells. No new groundwater supply wells are planned as part of the proposed EOR or CO_2 monitoring activities at the West Ranch oil field.

Although current operations at the West Ranch oil field generate between 40,000 and 60,000 barrels per day (bpd) of produced water for reinjection or disposal, rates of produced water generation at the West Ranch oil field exceeded 100,000 bpd from 1978 to 2008 (HEC 2011b). TCV anticipates that the proposed EOR operations could generate up to 25% to 50% more produced water (i.e., an additional 10,000 to 30,000 bpd) than is currently generated at the West Ranch oil field. Consistent with current practices for ongoing oil production activities at the West Ranch oil field, residual produced water left after recovery of oil and gas from the EOR operations would be injected into the Catahoula Sandstone using existing produced water disposal wells or, if necessary, other deeper geologic formations. The Burkeville confining system, which overlies the Catahoula Sandstone and is located below the Evangeline Aquifer, would reduce the potential for injected or displaced fluids to reach overlying aquifers during or following EOR operations.

Groundwater supply aquifers are located in much shallower geologic intervals than the target geologic units for proposed CO_2 injection at the West Ranch oil field. The only active public water supply well in the vicinity of the oilfield (i.e., well 8012402, which is operated by the Vanderbilt Water District) is 1,235 feet deep. The 98-A, 41A, Glasscock, and Greta Formations have been identified as the target formations for proposed CO_2 injection and the shallowest of these formations is approximately 5,000 feet bgs. The proposed injection zone is capped by over 400 feet of low permeability calcareous shale with some occasional interlaminated sand lenses that make up the confinement zone (i.e., the Anahuac Formation). As discussed in Appendix I to this EIS, no known major faults occur within the West Ranch oil field, suggesting that the Anahuac Formation forms an unbroken barrier, at least at the scale of current observations. The confining properties of the Anahuac Formation were studied as part of the Frio Brine pilot study near Dayton, Texas (Hovorka, et al. 2005; NETL 2009), and results of that study demonstrate that this formation serves as an excellent seal for the study field. Additionally, based on core test data from a study near Beaumont, Texas, Tsang and Apps (2005) report the average permeability (to liquid) of the Anahuac Formation is 5.2×10^{-6} mD. At the West Ranch oil field, the Frio Formation has held large quantities of buoyant fluids (i.e., oil and gas) over geologic time, indicating that very little migration occurs, if any, through the overlying Anahuac Formation. The Anahuac Formation is, therefore, expected to serve as an effective confining layer for inhibiting migration of injected or displaced fluids from the oil and gas producing units into overlying geologic formations.

Leakage of injected or displaced fluids from one or more previously plugged and abandoned wells, oil-producing wells, injection wells, or observation wells might occur if any casing and/or cement placed in or around a well were to leak. Prior to initiation of CO_2 injection and EOR activities for this proposed project, a comprehensive site characterization and geologic/reservoir modeling efforts would be conducted, as discussed in Section 2.3.5 of this EIS (CO_2 Monitoring Program). To mitigate the potential for impacts related to casing or annular seal issues associated with wells in the proposed injection area, TCV and BEG would conduct a well integrity testing program prior to EOR operations and TCV would correct deficiencies prior to the use of such wells. These improvements to existing wells would result in a potential beneficial impact to groundwater resources by reducing the chance of leakage due to improperly sealed wells. Ongoing monitoring and modeling would serve as the primary means of reducing the potential for impacts to groundwater from the proposed project. Recent preliminary reservoir modeling conducted by the BEG, as discussed in Appendix H of this EIS, indicates that injected CO_2 would not be expected to migrate laterally outside of the target geologic units. As part of the proposed CO_2 monitoring program, TCV and BEG would conduct studies to detect migration of injected or displaced fluids, should migration occur, so that potential long-term impacts to groundwater resources may be minimized or avoided (e.g., by correcting deficiencies in well construction, adjusting injection and production rates or locations, or other appropriate mitigation strategies). The CO_2 monitoring program is described briefly in Section 2.3.5 of this EIS and will be described further in the monitoring plan that is scheduled to be developed in early 2013. Considering the proposed mitigation measures (i.e., the well integrity testing program and the CO_2 monitoring program), potential impacts related to migration of injected and displaced fluids through improperly sealed wells or unknown faults or fracture pathways are expected to be minor.

Although it is considered unlikely that CO_2 would leak from the injection zone, as discussed in Appendix F to this EIS (Health Risk Assessment), the possibility exists, in theory, for impacts to occur to shallower geologic units if leakage of CO_2 from the injection reservoir units were to occur. Increased groundwater acidity could result from elevated CO_2 concentrations under such a hypothetical leakage scenario. Decreases in aquifer water pH, if severe enough, could also, in theory, enhance desorption of potential trace elements (e.g., arsenic and other trace constituents) from adsorption sites on host rock mineral surfaces and promote their release into groundwater (Apps, et al. 2010; Little and Jackson 2010). The resulting increased concentrations of such mobilized trace elements could negatively impact groundwater quality. If severe enough, mineral dissolution could lead, in theory, to establishment of preferential flow pathways for migration of injected or displaced fluids through well construction materials (e.g., cement backfill) or into a portion of the caprock formation (Kharaka, et al. 2006). However, because CO_2 leakage from the target geologic units (i.e., within the Frio Formation) is considered unlikely, as discussed in Appendix F, the potential for adverse impacts related to mineral dissolution in overlying aquifers resulting from the proposed EOR activities is expected to be very low.

During operations at the West Ranch oil field, accidental spills of process chemicals (e.g., amine or glycol), oil or other petroleum products (e.g., fuel) onto the ground surface may occur and could potentially impact shallow groundwater resources. The facility would avoid or minimize potential impacts from spills according to the West Ranch oil field’s existing SPCC plan, which would be updated to include the EOR and CO_2 monitoring facilities. Taking into account the provisions of the SPCC plan that would be used to minimize the potential for spills to affect groundwater resources, DOE anticipates that potential impacts to groundwater quality from the operations at the West Ranch oil field would be minor and similar to potential impacts from the field’s current operations.

Based on the considerations discussed above, DOE would not expect EOR and CO_2 monitoring operations at the West Ranch oil field to conflict with established water rights or local aquifer management plans or affect the available capacity or quality groundwater resources. Therefore, DOE anticipates only a minor potential for impacts to groundwater related to operations at the West Ranch oil field.

3.6.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to groundwater resources.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013 and would use little or no ground water. The cogeneration plant would be a simple cycle combustion turbine utilizing fin fan coolers (dry cooling) for cooling the turbine, generator and ancillary equipment. Water usage on the site would be comprised of minor potable water usage for eyewash and washdown water. These streams would be intermittent and of insignificant volume.

3.7 SURFACE WATER

3.7.1 Introduction

This section identifies and describes the surface waters potentially affected by the construction and operation of the proposed Parish PCCS Project. This section also analyzes the potential effects of this project on the identified surface water resources.

3.7.1.1 Region of Influence

The ROI for surface water resources includes the W.A. Parish Plant CO_2 capture facility, the proposed pipeline corridor, the West Ranch oil field, and adjacent areas. The ROI varies slightly for each area due to different potential influences to surface water from the types of construction and operations at these locations.

CO_2 Capture Facility

The ROI for surface water in the vicinity of the CO_2 capture facility includes surface water features located within two miles of the proposed capture facility footprint and associated construction support areas along with the following additional water bodies: the Brazos River, which supplies water to Smithers Lake and ultimately receives water discharged from the W.A. Parish Plant's permitted outfalls; the supply canal that conveys water from the Brazos River to Smithers Lake; and Dry Creek, into which Brazos River water is discharged immediately before it entered Smithers Lake. This ROI includes surface water features that might be impacted by stormwater runoff occurring during construction or operation of the capture facility and surface water features that may receive increased direct amounts of wastewater and/or cooling water discharges as a result of CO_2 capture facility operations.

Pipeline Corridor

The ROI for surface water along the pipeline corridor includes surface water features that would be crossed by the pipeline or would potentially be influenced by construction or operation of the project. This ROI includes downstream and upstream segments of these waterbodies in which water use or quality may affect or be affected by project-related activities.

West Ranch Oil Field

The ROI for surface water in the vicinity of the West Ranch oil field includes surface water features located within two miles of the proposed EOR area. This ROI includes surface water features that might be impacted by stormwater runoff occurring during construction or operation of EOR and CO_2 monitoring facilities as well as any surface water features bounded by the groundwater ROI, as discussed in Section 3.6 of this EIS (Groundwater).

3.7.1.2 Method of Analysis

The impacts to surface water resources resulting from construction and operation of the proposed project facilities were evaluated based on a review of published Texas Water Development Board (TWDB) maps and GIS data, TWDB Regional Water Plans, the TCEQ's 2010 Texas Integrated Report [i.e., Texas' CWA Section 303(d) list of impaired waterbodies], TCEQ data regarding permitted discharges, and waterbody features (e.g., width, depth, bank height) collected wetland field study completed for the proposed pipeline route. The impacts assessment also considered an estimate of additional water needs and scenarios for additional water sources. Section 3.6 of this EIS (Groundwater) also discusses the impacts evaluation methodology used for assessing potential groundwater impacts related to additional water needs for the proposed project.

3.7.1.3 Factors Considered for Assessing Impacts

The potential for impacts to surface water were assessed based on whether the proposed project activities would directly or indirectly result in the occurrence of one or more of the following conditions:

- Potential changes in stormwater discharges, which could adversely affect drainage patterns, flooding, erosion, and sedimentation;
- Potential changes to infiltration rates, which could affect the volume of surface water that flows downstream;
- Activities that conflict with applicable stormwater management plans;
- Violation of any federal, state, or regional water quality standards or discharge limitations;
- Potential changes to the availability of surface water for current or future uses; or
- Potential changes to water quality such that water quality no longer meets water quality criteria or standards established in accordance with the Clean Water Act (CWA), state regulations, or permits.

3.7.2 Affected Environment

3.7.2.1 Regional Surface Water Availability and Use

As discussed in this section and Section 3.8 of this EIS (Wetlands and Floodplains), surface water bodies can be broadly classified as follows:

- **Perennial Streams/Rivers**: Waterbodies with no tidal influence in which some water flows throughout the year.
- **Intermittent Streams/Rivers**: Waterbodies in which water flows for only part of the year and may come from groundwater or runoff (e.g., from rainfall). When not flowing, surface water may remain in isolated pools or may be absent.
- **Ephemeral Streams/Rivers**: Waterbodies in which water flows only during and for a short duration after precipitation events in a typical year. Runoff from rainfall is the primary source of water for stream flow and groundwater is not a source of water.
- **Ditch/Canal**: Man-made waterbodies generally used for drainage or to convey stormwater (i.e., ditches and swales) or to provide water for irrigation or industrial use (i.e., canals).
- **Lakes and Ponds**: Naturally occurring or man-made waterbodies typically located in topographic low spots, that receive water from runoff (e.g., from rainfall) or other overland flow (e.g., creeks, streams, rivers) and/or from groundwater sources (i.e., springs and seeps) and generally do not flow.
- **Estuaries**: Tidally influences waterbodies where freshwater from rivers and streams mixes with saltwater and flows into marine waterbodies (e.g., bays or the Gulf of Mexico).
- **Bayou**: A slow-moving tributary to a larger waterbody. Bayous may be associated with freshwater streams or rivers or part of an estuarine environment with some tidal influence.

Wetland areas (i.e., areas that are generally inundated or saturated by water and that support vegetation typically adapted saturated soil conditions, such as swamps, marshes, bogs, and similar area) may also occur within or around the perimeter of surface waterbodies. Additional details regarding wetlands in the project area are provided in Section 3.8 of this EIS (Wetlands and Floodplains).

Surface water in the state of Texas is owned by the State of Texas in trust for the citizens of the state. Rights for surface water use may be acquired through a permitting process administered by the TCEQ under Chapter 11 of the Texas Water Code and associated TCEQ regulations in Title 30 of the Texas Administrative Code. (TCEQ 2009, 2012f)

In the project area, surface water is used primarily for water supply at the W.A. Parish Plant and for agricultural activities along the pipeline corridor. Since the water supply for oil and gas production operations at the West Ranch oil field is primarily from groundwater, the primary use for surface water at the West Ranch oil field is for raising livestock (i.e., cattle) within the oil field. Other waterbodies across the ROI also support recreational use, as discussed below.

The approximately **81**-mile-long pipeline corridor would traverse several Texas coastal river basins. Surface waterbodies drain these basins from the northwest to the southeast across the generally low topographic relief of coastal Texas towards the Gulf of Mexico. The three major rivers crossed by the proposed pipeline corridor are the San Bernard River, the Colorado River, and the Lavaca River, as shown in Figure 3.7-1. Tributaries to the Brazos River traverse the W.A. Parish CO_2 capture plant and its vicinity, but the river itself lies north of the project area. The pipeline corridor crosses the Lavaca River downstream of its confluence with the Navidad River; therefore, the pipeline corridor does not cross the Navidad River.

This section provides site-specific information on surface water supply sources and surface water availability and use for the regions surrounding the CO_2 capture facility, the pipeline corridor, and the West Ranch oil field.

3.7.2.1.1 CO_2 Capture Facility

The CO_2 capture facility would be constructed at the W.A. Parish Plant, which is located within the Brazos River Basin, immediately south of Smithers Lake. As shown in Figure 3.7-2, existing surface water features in the W.A. Parish Plant ROI include four canals/ditches, two lakes (i.e., Smithers Lake and Worthington Lake), and two bayous (i.e., Rabbs Bayou and Dry Bayou), along with the Brazos River and Dry Creek. The supply canal between the Brazos River and Dry Creek is shown in Figure 3.7-3.

Smithers lake is man-made (i.e., enlarged from an existing small lake) and was completed in July 1957. By discharging water from Smithers Lake to Rabbs Bayou through the dam on the east side of the lake, the water level in the lake is kept lower than the elevation of the W.A. Parish Plant to ensure wastewater drains to the lake. The lake has a capacity of about 18,000 acre-feet of water and a surface area of 2,430 acres. The drainage area above the dam is approximately 24.2 square miles in size. The lake serves as a reservoir for the plant's cooling water system and supplies cooling water to generating units 1 through 6 that use a once-through condenser cooling system. Cooling water is returned to the lake following use. Periodic water sampling is performed in accordance with conditions specified in the facility's Texas Pollutant Discharge Elimination System (TPDES) Permit and the W.A. Parish Plant Storm Water Pollution Prevention Plan (SWPPP), as described in the following paragraphs.

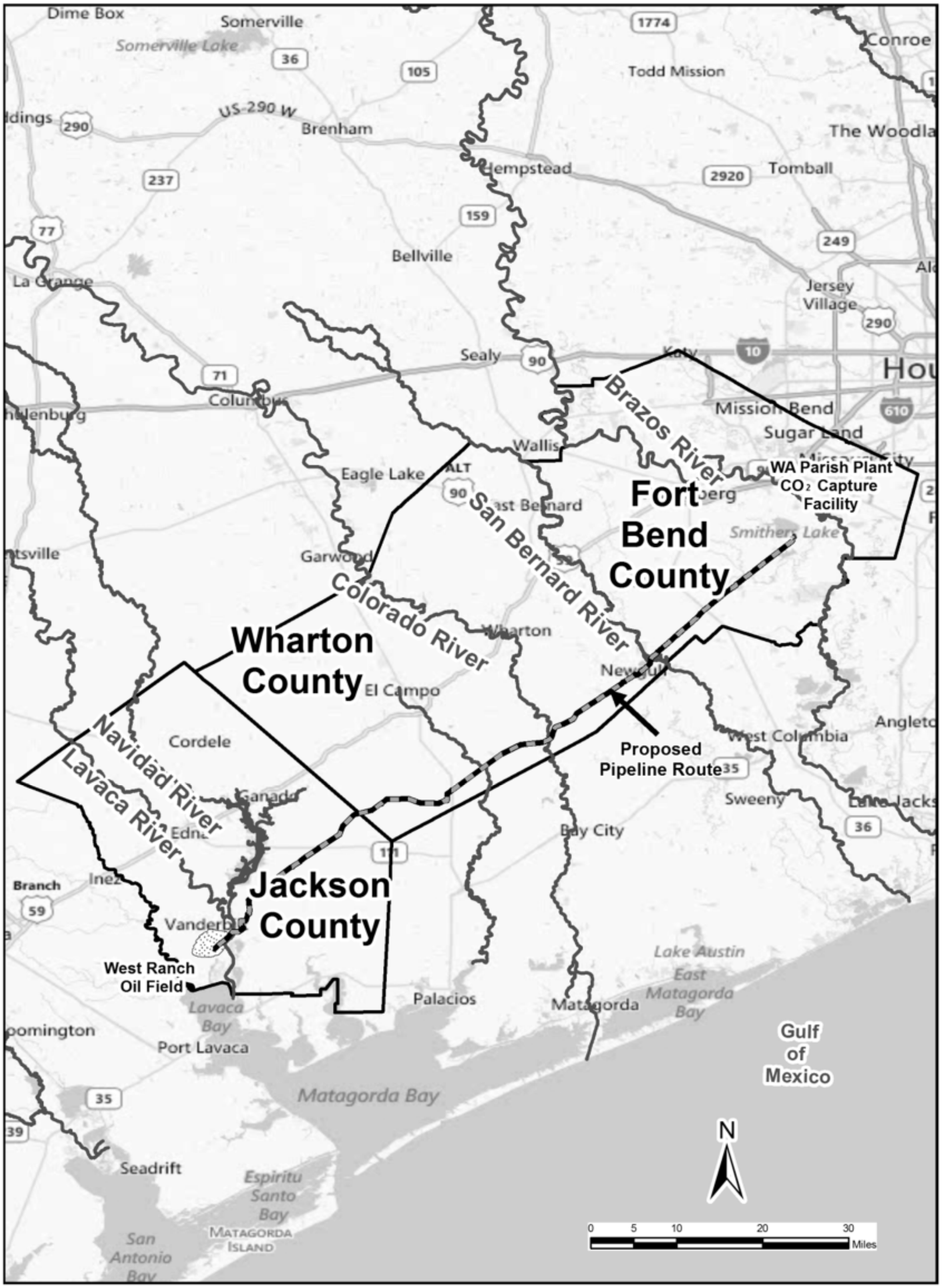

Figure 3.7-1. Major Rivers Crossed by the Proposed CO_2 Pipeline

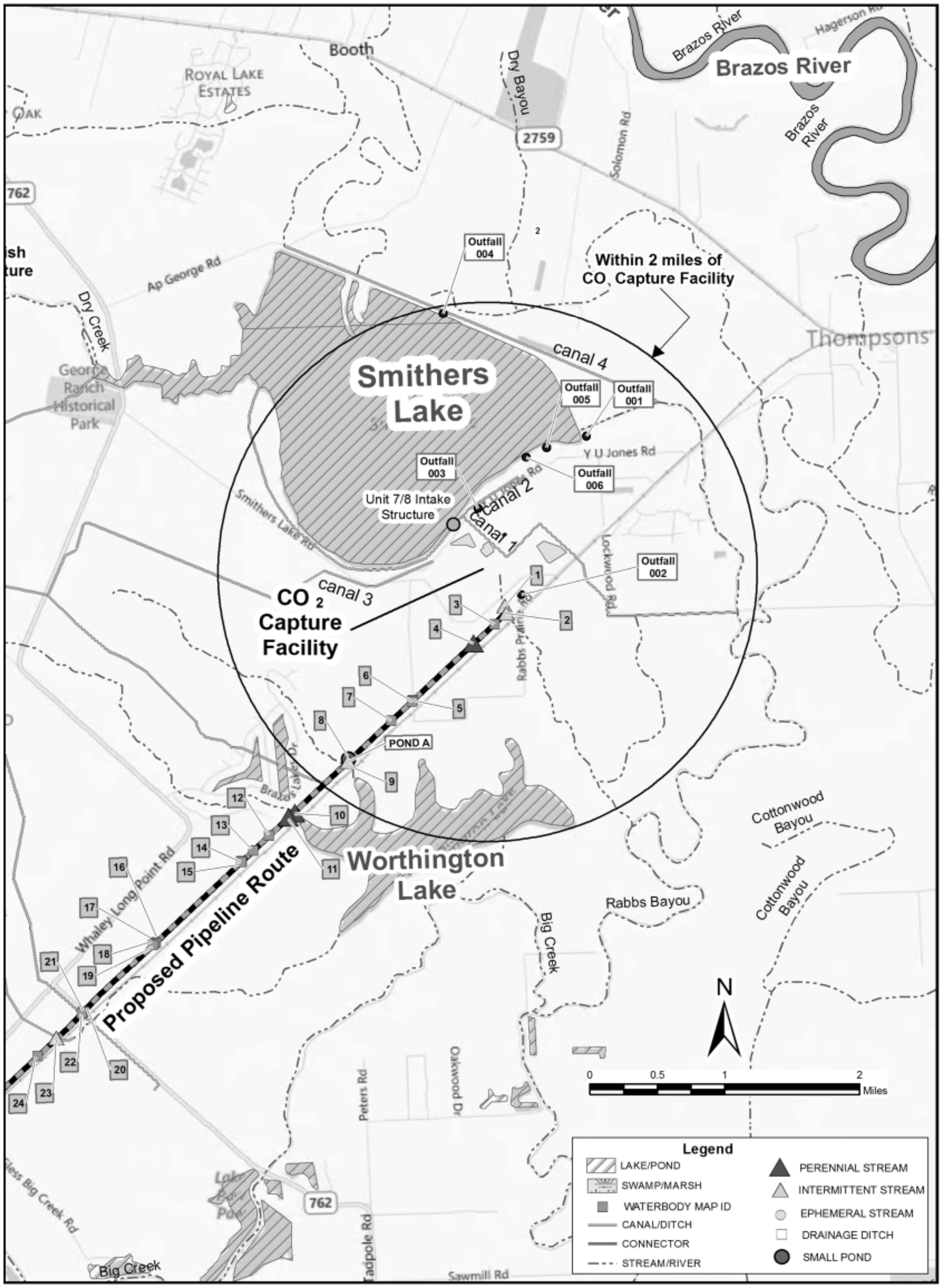

Figure 3.7-2. Surface Water Features in the Vicinity of the W.A. Parish Plant

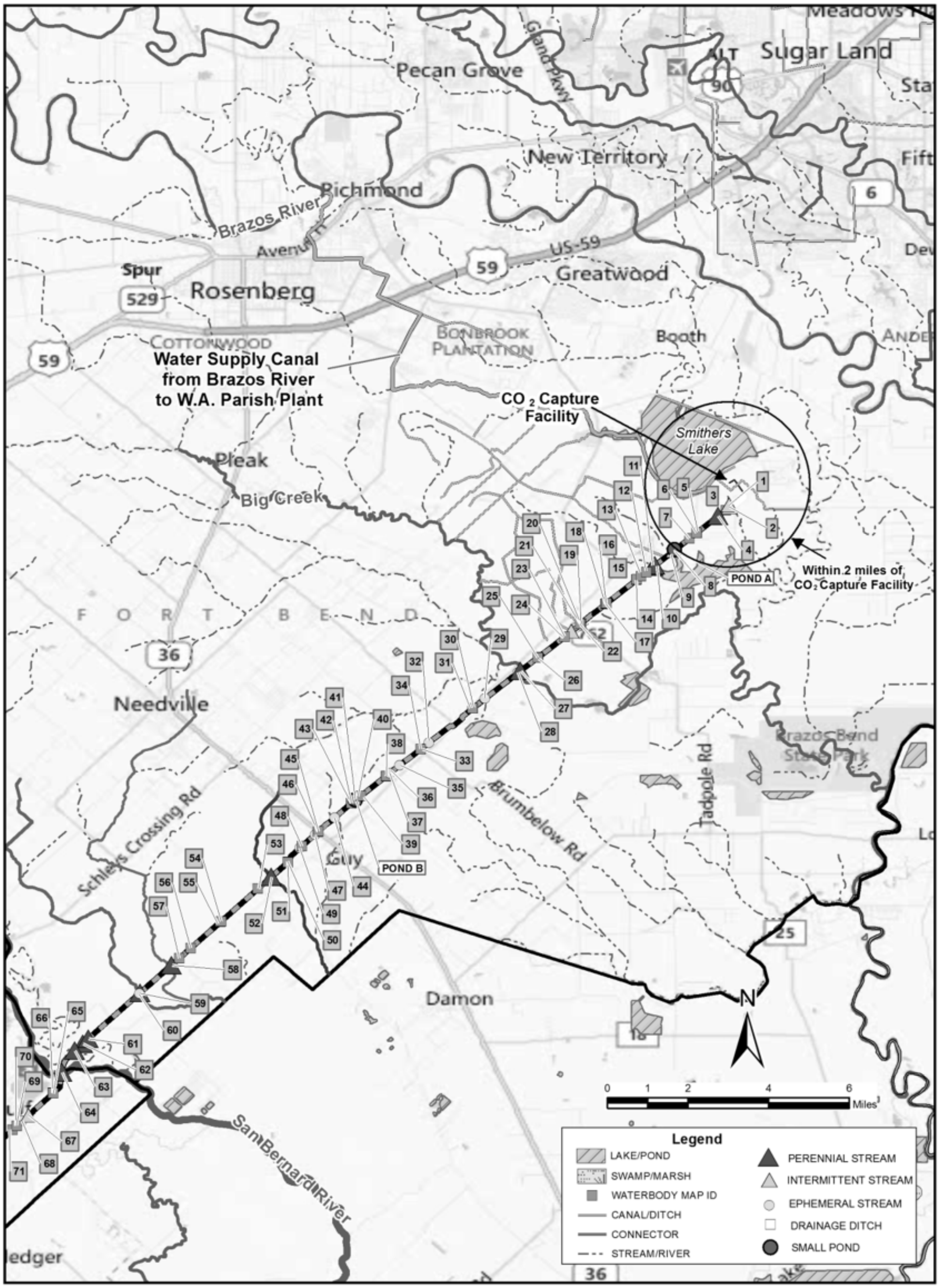

Figure 3.7-3. Surface Water Features Crossed in Fort Bend County by the Proposed Pipeline Route

In addition to drainage form the surrounding area, Smithers Lake also receives Brazos River water through Dry Creek, which is located on the west side of Smithers Lake, as shown in Figure 3.7-2. Dry Creek receives a portion of this water through a supply canal from a location on the Brazos River approximately 10 miles northwest of Smithers Lake, as shown in Figure 3.7-3. Water discharged from Smithers Lake flows to Rabbs Bayou, which flows south to Big Creek, and ultimately discharges into the Brazos River approximately nine miles southeast of Smithers Lake near the Brazos Bend State Park, as shown in Figure 3.7-3.

Smithers Lake receives stormwater and wastewater discharges from the W.A. Parish Plant as well as recycled cooling water. Water quality for these discharges is regulated by TPDES permits issued by the TCEQ. The TCEQ determines permit limits for monitored parameters based on USEPA's steam electric effluent guidelines and Texas Water Quality Standards (TWQS). The W.A. Parish Plant currently discharges treated wastewater to surface waters under TPDES Permit No. 01038, USEPA ID No. TX0006394.

The W.A. Parish Plant discharges noncontact cooling water and treated plant process water through 16 outfalls, including six external outfalls that discharge to waters of the State, as shown in Figure 3.7-2. Ten internal outfalls commingle and then discharge with the six external outfalls, as follows:

- Outfall 001 discharges Smithers Lake blowdown[1];
- Outfall 002 discharges water from the coal pile runoff pond;
- Outfall 003 discharges once-through cooling water for Units 1 through 6 and previously monitored effluents from eight internal outfalls (i.e., Outfalls 103, 203, 303, 403, 503, 803, 903, and 113);
- Outfall 004 discharges stormwater from the coal combustion by-products landfill;
- Outfall 005 discharges water from the gas side (Units 1 through 4) oily waste treatment system; and
- Outfall 006 discharges gas side (Units 1 through 4) auxiliary cooling tower blowdown.

Outfalls 003, 004, 005, and 006 discharge directly into Smithers Lake. Outfall 001 discharges to Rabbs Bayou and Outfall 002 discharges through an unnamed tributary of Rabbs Bayou to Rabbs Bayou. From Rabbs Bayou, water discharged from Outfalls 001 and 002 flows south into Big Creek, and ultimately discharges into the Brazos River approximately nine miles southeast of Smithers Lake near the Brazos Bend State Park, as shown in Figure 3.7-3. Internal outfalls 603 and 703 discharge to Canal 1 near the Unit 7/8 intake. As noted above, the other eight internal outfalls discharge to Outfall 003.

NRG's allocated water rights to support operations at the W.A. Parish Plant include 83,000 acre-feet per year (AF/yr) (74 mgd) of water from the Brazos River obtained through a contract with the Brazos River Authority (Water Right 235) and an additional 28,000 AF/yr (25 mgd) of diverted Brazos River water under a water right (Water Right 5320) that allows for storage of water in Smithers Lake and consumptive use from Smithers Lake (TCEQ 2012c). In addition to natural inflows to Smithers Lake, water inventories in Smithers Lake are pumped from a location on the Brazos River approximately 10 miles northwest of the lake, near the city of Richmond, Texas, (i.e., under Water Right 5320) and conveyed to Smithers Lake via a supply canal, as shown in Figure 3.7-3, to the location where Dry Creek enters the west side of Smithers Lake. From the west side of Smithers Lake, NRG's Canal 1, which follows the southern shore

[1] Blowdown is water that is released from a boiler or other industrial vessel to remove impurities and sediment. Periodically rinsing out the boilers helps limit the buildup of contaminants in the boiler water that may degrade boiler performance.

of Smithers Lake, as shown in Figure 3.7-2 and Figure 3.7-3, conveys the water to the Unit 7/8 intake structure.

Under Texas water appropriation doctrine, priority for water rights is based on the date the water rights were obtained, with older claimants having seniority (BRA 2012). NRG's Water Right 5320 has an October 23, 1926 seniority date. The W.A. Parish Plant was not adversely affected during the 2011 drought, which was the most severe one-year drought in Texas on record. However, the flow of the Brazos River was threatened during 2011 in north Texas (i.e., Knox County) due to very low flow rates (NOAA, 2012c).

Based on usage rates during 2010 and 2011, the W.A. Parish Plant uses approximately 38,000 to 56,000 AF/yr (34 to 50 mgd) of surface water from Smithers Lake. For comparison, the TCEQ's published harmonic mean flow rate (i.e., a measure of average flow) for the Brazos River in Fort Bend County (i.e., Segment 1202) is approximately 1.2 to 1.5 million AF/yr (1,000 to 1,300 mgd). Its critical low-flow rate (i.e., the seven-day, two-year low-flow rate, which is a statically derived flow rate that represents typical low flows in the river occurring for a duration of seven days with a frequency of two years) is approximately 500,000 to 540,000 AF/yr (440 to 490 mgd) (TCEQ 2010). Groundwater provides an additional 1.6 to 2.3 mgd to the W.A. Parish Plant, as discussed in Section 3.6 of this EIS (Groundwater).

Stormwater

Stormwater discharge at the W.A. Parish Plant is authorized by TPDES General Permit TXR050000 and site stormwater permit TXR05V666. The Plant's SWPPP identifies 21 outfalls that discharge stormwater associated with industrial activities at the W.A. Parish Plant. All of the stormwater eventually drains to Smithers Lake. Best management practices (BMPs) for stormwater management implemented by NRG under TCEQ stormwater permit TXR05V666 include routine inspections and sampling of water discharges to monitor water quality. BMPs to be employed during construction are described in Section 3.5 of this EIS (Physiography and Soils).

Wastewater

The W.A. Parish Plant's current TPDES wastewater permit (i.e., Permit No. 01038, USEPA ID No. TX0006394) was issued June 1, 2011 and is valid through July 1, 2014 (EPA 2012b). As discussed in Chapter 2 of this EIS, NRG's existing WWTP generally treats approximately 1,500 mgd of wastewater, but is permitted to treat 2,121 mgd. Treated wastewater from the WWTP is discharged through internal Outfalls 903 and 113 to Outfall 003, which discharges into Smithers Lake, as discussed above.

3.7.2.1.2 Pipeline Corridor

As discussed in Section 3.8 of this EIS (Wetlands and Floodplains), a wetlands field survey of **over 99**% of the pipeline construction ROW was conducted between January and **November** 2012. The survey identified a total of **211** waterbodies within the pipeline corridor ROI, as summarized in Table 3.7-1 and shown in Figure 3.7-3 through Figure 3.7-6. These waterbodies include: three small ponds; **80** other surface water features (i.e., streams/rivers and canals/ditches) greater than ten feet in width; and an additional **128** smaller (i.e., less than ten feet in width) surface water features which are grouped together in Table 3.7-2. All of these waterbodies are shown in Figure 3.7-3 through Figure 3.7-6 and the map series in Appendix D (Pipeline Corridor Map Views) of this EIS. Details from the wetlands survey are provided in Section 3.8 (Wetlands and Floodplains) of this EIS. Figure 3.7-3 through Figure 3.7-6 also show surface water features identified in the National Hydraulic Dataset (NHD), which is maintained by the Texas Tech Geospatial Data Center (TTGDC 2011), including waterbodies outside the field surveys area for this EIS.

Table 3.7-1. Count of Surface Water Features Crossed by the Proposed Pipeline Route
(see Figure 3.7-3 through Figure 3.7-6 for locations)

Pipeline Section	Number of Perennial Stream/River Crossings	Number of Intermittent Stream/River Crossings	Number of Ephemeral Stream/River Crossings	Number of Pond Crossings	Number of Canal/Ditch Crossings
Fort Bend County	11	4	10	**2**	**37**
Wharton County	**10**	3	8	**1**	**81**
Jackson County	**5**	**1**	**8**	0	**30**
Total	**26**	**8**	**26**	3	**148**

Field survey data for the **211** waterbodies identified within the pipeline corridor ROI are summarized in Table 3.7-2 below**.** These data show that the three major rivers crossed by the proposed pipeline route (i.e., the San Bernard River, Colorado River, and Lavaca River) are between 350 and 500 feet wide**.** There are five other perennial waterbodies that are 100 feet wide or wider**.** However, these waterbodies are relatively shallow, with none exceeding a depth of six feet at the time of field survey**.** The remaining streams were generally less than four feet deep at the time of survey, except for two drainage ditches **and a perennial stream** (i.e., unnamed tributaries to **East** Carancahua Creek**,** the Lavaca River**, and Menefee Lake -** Map ID numbers **164, 202, and 205**), which were approximately six **to** eight feet deep when surveyed**.** The pipeline would be buried approximately three feet below the ground surface along the majority of its traverse. As the pipeline is currently designed, the three major rivers (i.e., the San Bernard River, the Colorado River, and the Lavaca River) and three other waterbodies (Big Creek**, Menefee Bayou,** and Jones Creek) would be crossed using HDD construction techniques to bore under the waterbodies. The other waterbody crossings would involve pipeline installation within trenches that would be returned to pre-construction contours after pipeline installation.

In the state of Texas, regional water planning groups recommend stream segments for designation as Ecologically Significant Stream Segments (ESSSs), based on the following criteria: biological function, hydrologic function, riparian conservation areas, high water quality/exceptional aquatic life/high aesthetic value, and threatened or endangered species/unique communities (TPWD 2012a). As identified by the TPWD in a March 20, 2012 letter to the DOE, the ROI crosses the following ESSSs, as shown in Figure 3.7-3 through Figure 3.7-6: Big Creek (Map ID **27**), the San Bernard River (Map ID **64**), Cedar Lake Creek (aka Caney Creek, Map ID **76**), the Colorado River (Map ID **114**), West Carancahua Creek (Map ID **186**), and the Lavaca River (Map ID **204**). As per 16.051 (f) of the Texas Water Code, the ESSS designation means that the State of Texas may not finance the construction of a reservoir in a designated river or stream segment (TPWD 2012a).

Table 3.7-2. Description of Surface Water Features Crossed by the Proposed Pipeline Route

(see Figure 3.7-3 through Figure 3.7-6 for locations)

Map ID	Water Type	Name	Comment	Bank Width (feet)	Water Depth (feet)	Bank Height (feet)
FORT BEND COUNTY						
1	Intermittent	Tributary to Worthington Lake	Drain began at 36 " metal culvert	15	3	5
4	Perennial	Tributary to Worthington Lake	Modified perennial stream adjacent to ryegrass field.	15	1	3
10	Perennial	Tributary to Worthington Lake	Natural perennial stream	100	6	2
11	Perennial	Tributary to Worthington Lake	Modified perennial stream with thick aquatic vegetation	60	4	2
22	Drainage Ditch	Tributary to Worthington Lake	Irrigation water holding area.	50	0	7
24	Drainage Ditch	Tributary to Worthington Lake	Irrigation canal in cattle pasture.	14	0.25	3
27	Perennial	Big Creek	South side of Big Creek (ESSS)	110	6	15
29	Ephemeral	Tributary to Deer Creek	Drainage ditch receiving run off from the nearby field.	13	1	2.5
32	Ephemeral	Tributary to Deer Creek	Ephemeral stream within an overgrown pasture that carries water south into a larger tributary.	20	0	4
35	Ephemeral	Tributary to Deer Creek	Ephemeral stream within an overgrown pasture that carries water south into a larger tributary.	20	3	3
44	Ephemeral	Tributary to Mound Creek	Channelized waterbody in cattle pasture	30	0.5	8
45	Drainage Ditch	Tributary to Mound Creek	Man-made drainage ditch on north side of Highway 36	12	0	5
48	Drainage Ditch	Tributary to Mound Creek	Man-made drainage ditch on south side of 2 track road	18	0.5	0.75

Table 3.7-2. Description of Surface Water Features Crossed by the Proposed Pipeline Route

(see Figure 3.7-3 through Figure 3.7-6 for locations)

Map ID	Water Type	Name	Comment	Bank Width (feet)	Water Depth (feet)	Bank Height (feet)
49	Ephemeral	Tributary to Mound Creek		15	2	2
52	Perennial	Mound Creek	Perennial waterbody modified through pasture.	12	1	3
58	Perennial	Buffalo Creek	Large modified creek through existing right of way.	120	2	14
59	Perennial	Cedar Creek	Large modified creek. Banks vegetated at proposed right of way crossing.	110	2	12
60	Ephemeral	Cedar Creek	Modified drainage into larger creek.	15	0.2	5
61	Perennial	San Bernard River	Slough through existing right of way. (ESSS)	80	1.5	3
62	Perennial	San Bernard River	(ESSS)	80	2	3
63	Perennial	San Bernard River	(ESSS)	70	2	3
64	Perennial	San Bernard River	(ESSS)	350	5	30
2 through 57, not listed above	Intermittent/ Ephemeral/ Pond	Not applicable	42 additional features that are ≤10 feet in width	≤10	<1	1-5
WHARTON COUNTY						
67	Intermittent	Tributary to Linnville Bayou	Modified with a road crossing	100	4	1.5
68	Ephemeral	Tributary to Linnville Bayou	Modified ephemeral waterbody in a pasture	88	0.5	1
71	Drainage Ditch	Tributary to Linnville Bayou	Man-made water retention area	30	4	2
76	Drainage Ditch	Cedar Lake Creek (aka Caney Creek)	(ESSS)	40	0	15
88	Drainage Ditch	Water Hole Creek		30	0.5	18
91	Ephemeral	Tributary to Water Hole Creek	Small pool	15	0.3	1

Table 3.7-2. Description of Surface Water Features Crossed by the Proposed Pipeline Route

(see Figure 3.7-3 through Figure 3.7-6 for locations)

Map ID	Water Type	Name	Comment	Bank Width (feet)	Water Depth (feet)	Bank Height (feet)
92	Drainage Ditch	Tributary to Water Hole Creek	Field drainage	15	0	5
106	Drainage Ditch	Tributary to Water Hole Creek	Large drainage ditch in agricultural field.	20	0	4
107	Drainage Ditch	Tributary to Water Hole Creek		12	0.25	1
110	Drainage Ditch	Tributary to Colorado River	Large modified creek through agriculture.	75	2	12
113	Drainage Ditch	Tributary to Colorado River		40	0	4
114	Perennial	Colorado River	(ESSS)	250	NA	35
115	Perennial	Jones Creek		90	3	35
117	Drainage Ditch	Tributary to Jones Creek		12	0	4
118	Drainage Ditch	Dry Creek	Irrigation canal, mussels present	30	1	4
120	Perennial	Blue Creek		110	1	15
122	Drainage Ditch	Tributary to Blue Creek		15	0.25	1
123	Drainage Ditch	Tributary to Blue Creek		30	0	2
125	Perennial	Tributary to Blue Creek		20	2	5
126	Drainage Ditch	Tributary to Blue Creek		12	0.5	5
128	Perennial	Tres Palacios River		17	3	25
130	Drainage Ditch	Tributary to Tres Palacios River		18	0	8
131	Drainage Ditch	Tributary to Tres Palacios River		12	0	1
132	Perennial	Tributary to Tres Palacios River		15	1.6	2
138	Drainage Ditch	Tributary to Willow Creek	Field drainage	20	2	15
142	Perennial	Tributary to Juanita Creek		40	3	20
143	Perennial	Juanita Creek		50	3	20
144	Drainage Ditch	Tributary to Moccasin Creek		15	0	2
145	Drainage Ditch	Tributary to Moccasin Creek		15	0	4
146	Drainage Ditch	Tributary to Moccasin Creek		15	0	3
147	Drainage Ditch	Tributary to Moccasin Creek		12	0	1

Table 3.7-2. Description of Surface Water Features Crossed by the Proposed Pipeline Route

(see Figure 3.7-3 through Figure 3.7-6 for locations)

Map ID	Water Type	Name	Comment	Bank Width (feet)	Water Depth (feet)	Bank Height (feet)
149	Drainage Ditch	Tributary to Moccasin Creek		35	0	1
150	Perennial	Tributary to Moccasin Creek		15	1	2
151	Drainage Ditch	Tributary to East Carancahua Creek	Agricultural drain	35	0.5	6
152	Drainage Ditch	Carancahua Creek		50	1	25
154	Intermittent	East Carancahua Creek		15	0.5	5
156	Drainage Ditch	Tributary to East Carancahua Creek		17	0	6
160	Drainage Ditch	Tributary to East Carancahua Creek		15	0	2
162	Drainage Ditch	Tributary to East Carancahua Creek		16	0	1.5
163	Drainage Ditch	Tributary to East Carancahua Creek		12	0.25	3
164	Drainage Ditch	Tributary to East Carancahua Creek	Water in drainage way is due to recent flooding of nearby rice field	20	6	4
165	Drainage Ditch	Tributary to Little Carancahua Creek		30	0.5	3
167	Drainage Ditch	Tributary to Little Carancahua Creek		12	0	3
65 through 166, not listed above	Intermittent/ Ephemeral/ Pond	Not applicable	58 additional features that are ≤10 feet in width	≤10	<1	1-5
			JACKSON COUNTY			
176	Drainage Ditch	Looney Creek	Road field drainage	15	0	6
185	Drainage Ditch	Tributary to West Carancahua Creek	Field drainage	12	0	5
186	Perennial	West Carancahua Creek	Large drainage area (ESSS)	50	NA	25
190	Drainage Ditch	Tributary to West Carancahua Creek	Field drainage	20	0.5	8
191	Drainage Ditch	Tributary to West Carancahua Creek	Field drainage	15	0	3

Table 3.7-2. Description of Surface Water Features Crossed by the Proposed Pipeline Route

(see Figure 3.7-3 through Figure 3.7-6 for locations)

Map ID	Water Type	Name	Comment	Bank Width (feet)	Water Depth (feet)	Bank Height (feet)
192	Drainage Ditch	Tributary to Cox Creek	Field drainage	30	0	15
194	Drainage Ditch	Tributary to Cox Creek	Field drainage	15	0	8
202	Drainage Ditch	Tributary to Lavaca River		25	8	5
204	Perennial	Lavaca River	(ESSS)	350	NA	4
205	Perennial	Tributary to Menefee Lake		60	6	1
206	Drainage Ditch	Tributary to Menefee Lake		18	4	1.5
207	Perennial	Menefee Bayou		60	12	1
209	Ephemeral	Tributary to Venado Creek	Natural draw in cattle pasture.	17	0	4
210	Intermittent	Tributary to Venado Creek		30	0	7
211	Perennial	Tributary to Venado Creek	Forested creek south of Mobil Oil Road.	20	0	28
168 through 208, not listed above	Intermittent/ Ephemeral/ Pond	Not applicable	28 additional features that are ≤10 feet in width	≤10	<1	1-5

ESSS = Ecologically Significant Stream Segment; N/A = Not applicable; NA = Not available

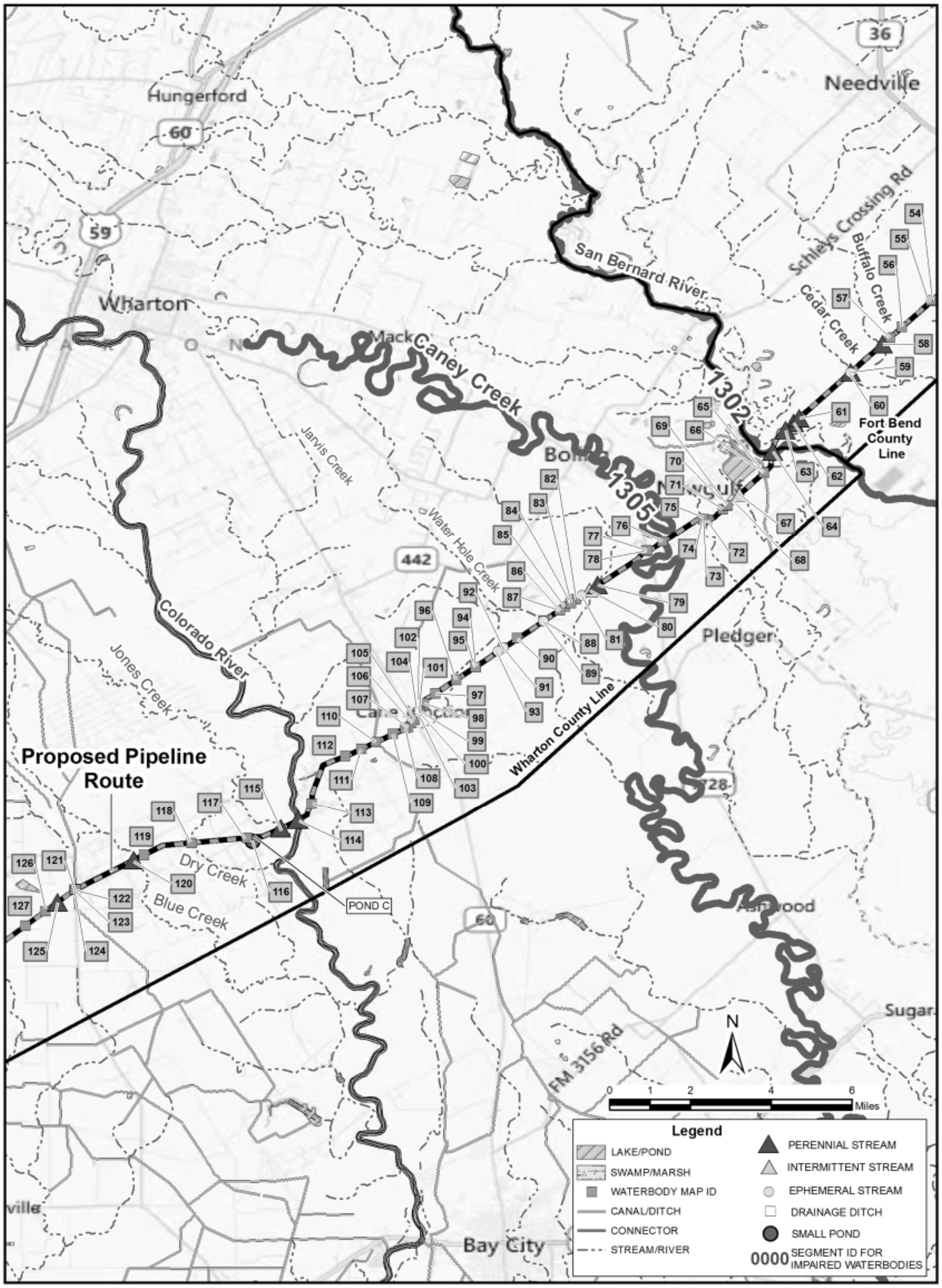

Figure 3.7-4. Surface Water Features Crossed in Northern Wharton County by the Proposed Pipeline Route

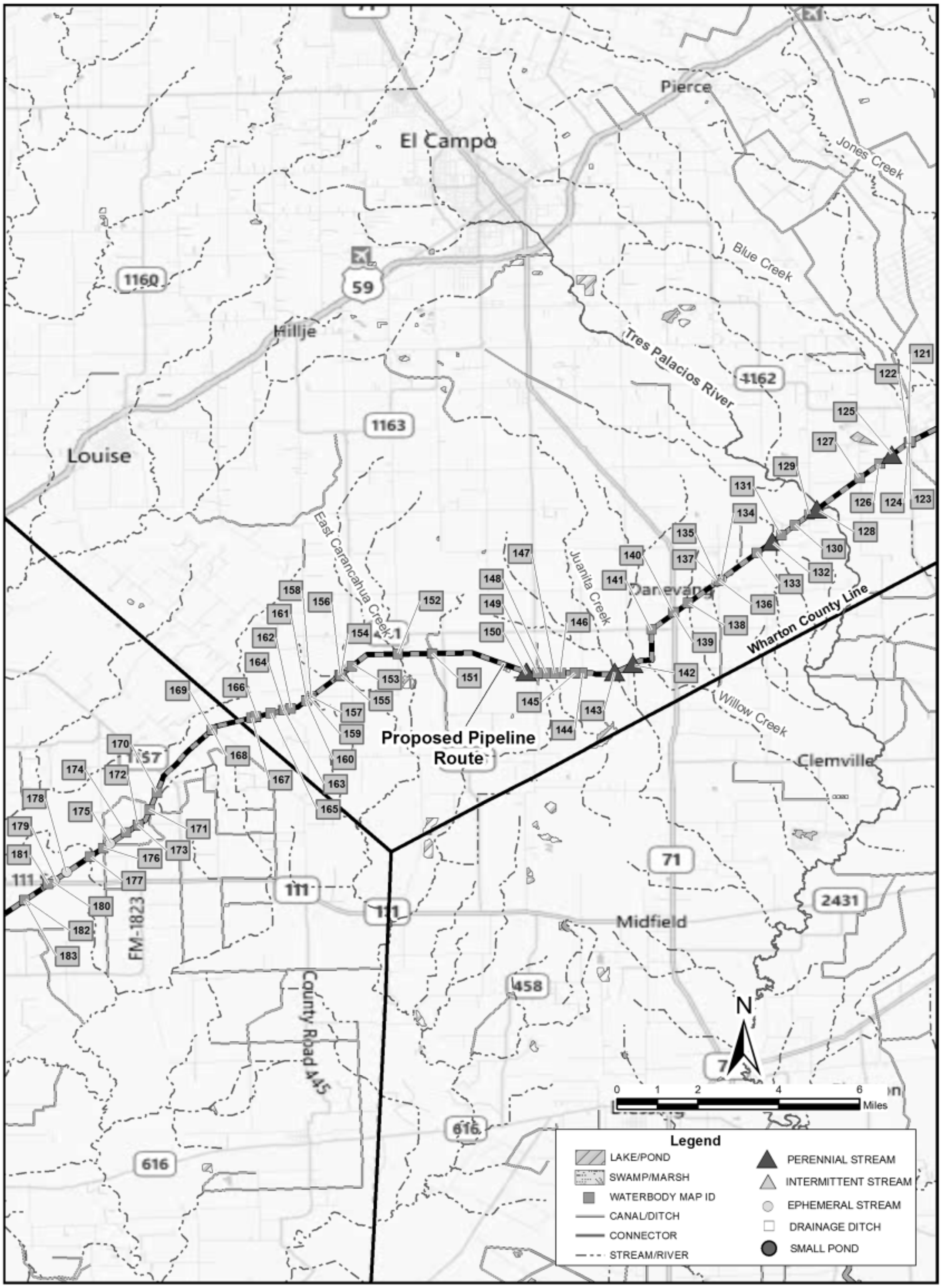

Figure 3.7-5. Surface Water Features Crossed in Southern Wharton County by the Proposed Pipeline Route

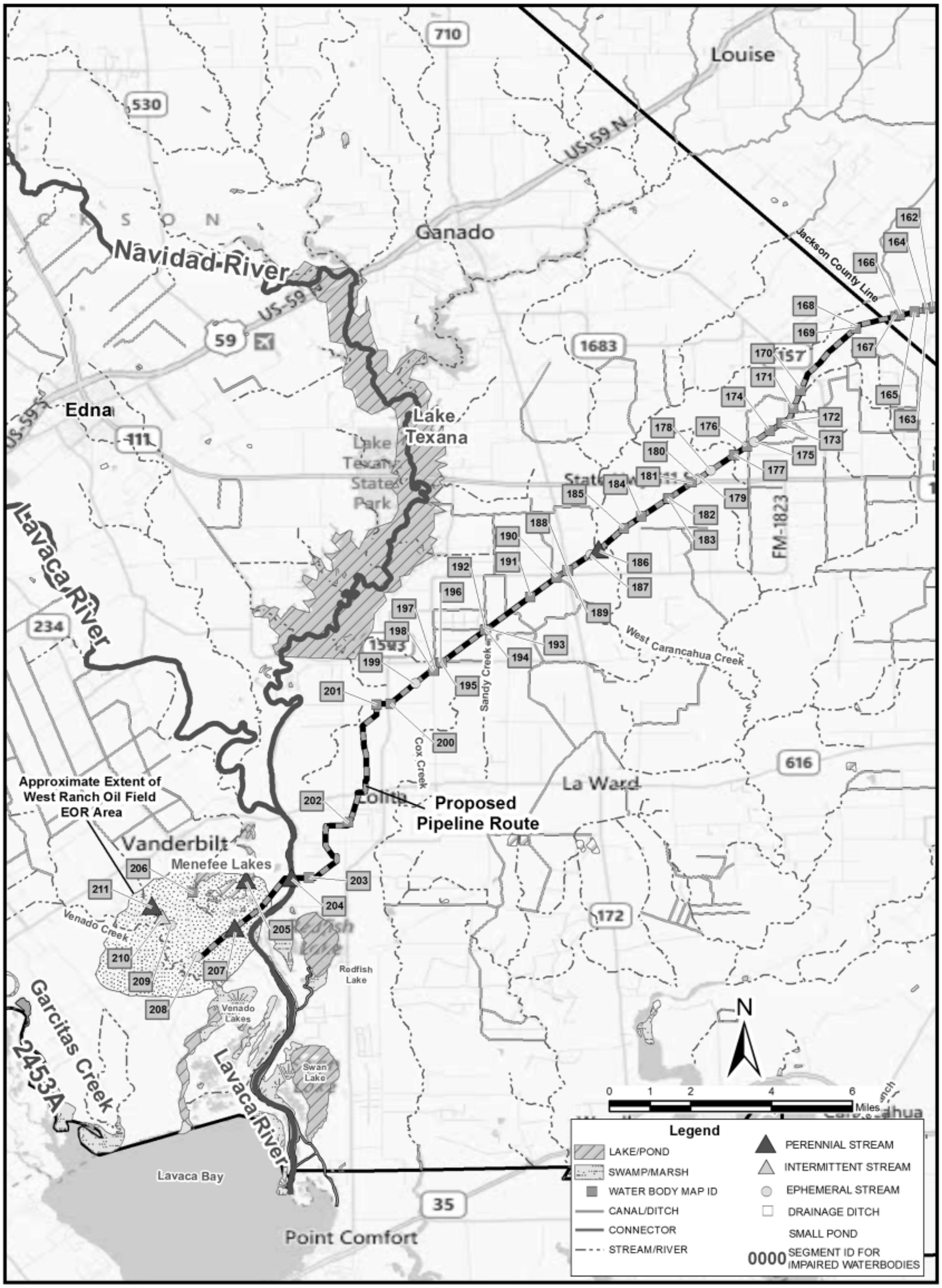

Figure 3.7-6. Surface Water Features Crossed in Jackson County by the Proposed Pipeline Route

3.7.2.1.3 West Ranch Oil Field

The West Ranch oil field is located near the juncture of the Lavaca, Lavaca-Guadalupe, and Colorado-Lavaca River Basins (TWDB 2012b), and within the Region P (Lavaca) Regional Water Planning Area. The Texana Lake/Reservoir is the only reservoir in the region and is the primary supply for beneficial use surface water within Jackson County and the Region P Planning area. The availability of surface water supplies within the Region P Planning Area in 2010 was estimated at approximately 1,832 AF/yr (TWDB 2012b).

There are several lakes within the West Ranch oil field ROI, including the Menefee Lakes, Redfish Lake, and the Venado Lakes (see Figure 3.7-7). Swan Lake is located just outside the ROI, downstream of the West Ranch oil field. The major rivers traversing the ROI are the Lavaca River and the Navidad River. Garcitas Creek traverses the western end of the oil field. All major and minor rivers, creeks, and tributaries within the West Ranch oil field ROI drain into Lavaca Bay.

3.7.2.2 Regional Surface Water Quality

The Texas Clean Rivers Act serves to maintain the integrity and quality of the state's water supply from a long-term perspective through the establishment and utilization of comprehensive water resources planning and management. The Texas Clean Rivers Act requires an ongoing assessment of water quality issues and management strategies statewide to guide Texas water resources policy and decision making. The goal of the Texas Clean Rivers Program, which is managed by the TCEQ, is to maintain and improve water quality across Texas.

The EPA and TCEQ regulate water quality under the Safe Drinking Water Act (SDWA) and the CWA. Section 303(d) of the CWA requires states to identify and develop a list of impaired waterbodies. Impaired waterbodies are considered too polluted or otherwise degraded to meet the water quality standards or designated uses set by the state. Section 305(b) of the CWA requires states to assess and report the quality of their waterbodies. The Texas Clean Rivers Act requires individual river management and planning agencies to submit Basin Summary Reports (BSRs) to the governor, the TCEQ, the Texas State Soil and Water Conservation Board, and the Texas Parks and Wildlife Department. Each BSR addresses water quality issues throughout the individual river basins. Completion of the BSR includes a public participation component. In addition to the BSRs compiled by the independent management agencies, the TCEQ completes a biannual Texas Integrated Report. The most current list Texas 303(d) list (TCEQ 2011), which was approved by the EPA on November 18, 2011, was reviewed for this report.

3.7.2.3 Local Surface Water Quality

The TCEQ designates certain streams, or segments thereof, as "classified" segments under Section 303(d) of the CWA to facilitate the development of surface water quality standards (SWQSs) specific to each stream or stream segment due to existing water quality impairments. Of the designated stream segments that would be crossed by the proposed pipeline, two segments have been identified as having water quality impairments on the most recent Texas 303(d) list (TCEQ 2011), as follows:

1. San Bernard River Above Tidal (Segment 1302) is listed for bacteria, and
2. Caney Creek Above Tidal (Segment 1305) is listed for bacteria and depressed dissolved oxygen.

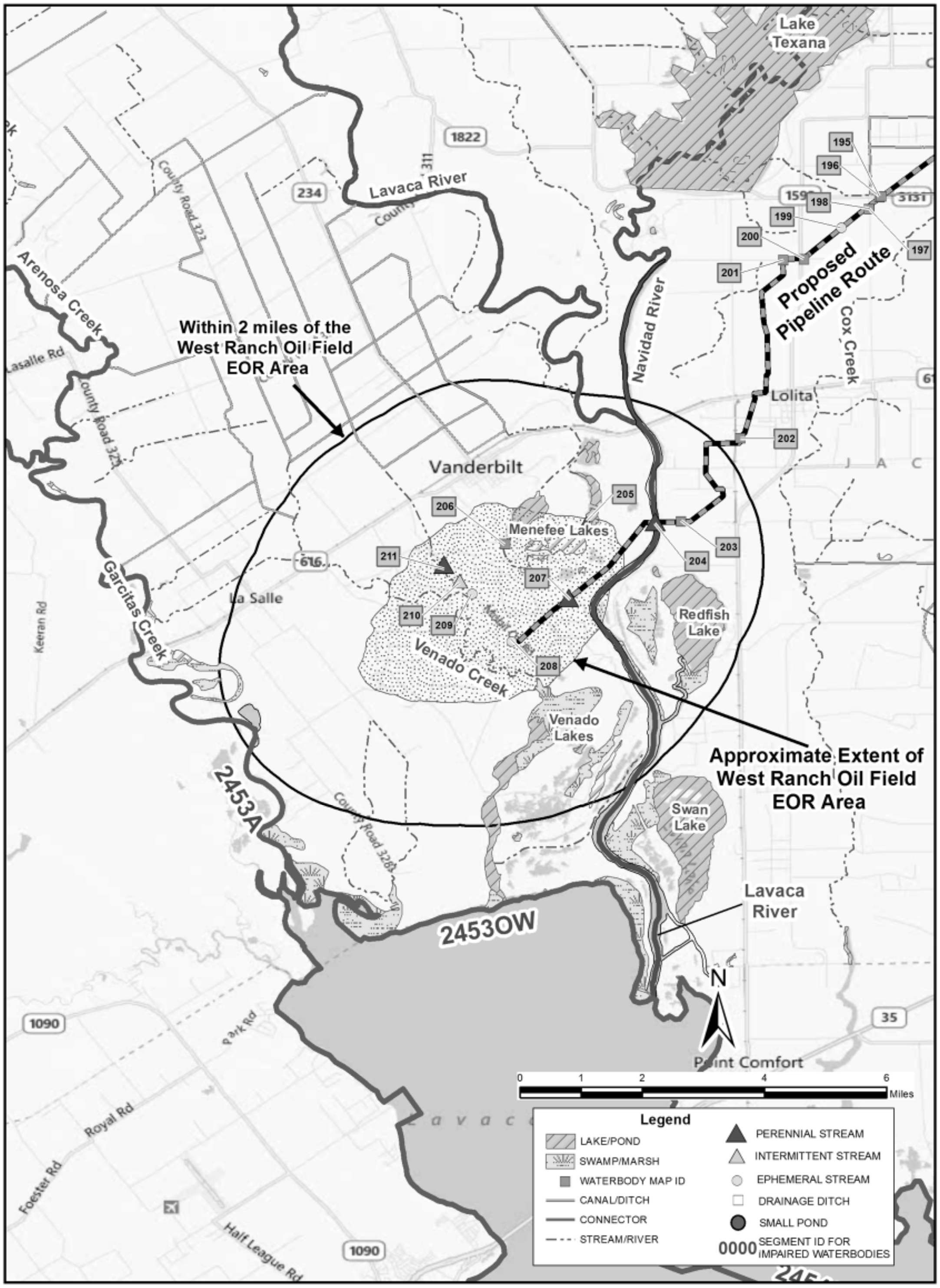

Figure 3.7-7. Surface Water Features near the West Ranch Oil Field

One additional impaired segment crosses the West Ranch oil field, and one impaired segment lies immediately downstream of the field, as follows:

1. Lavaca Bay/Chocolate Bay Estuary (Segment 2453) and associated tributaries such as Garcitas Creek Tidal (Segment 2453A) are listed for depressed dissolved oxygen, and
2. Segment 2453OW Lavaca Bay / Chocolate Bay (Oyster Waters) is listed for bacteria.

The above-described segments are annotated on Figure 3.7-3 through Figure 3.7-7 with their corresponding TCEQ Segment ID numbers. A description of the impairments or water quality parameters of concern are summarized in Table 3.7-3, which lists the surface water features identified as having surface water quality impairment. The types of impairments indicated for these segments in Table 3.7-3 may be related to agricultural runoff and/or wastewater discharges, which can increase the bacterial load to receiving waters and add nutrients (e.g., fertilizer) and organic carbon, increasing oxygen demand on the receiving waters and depleting the dissolved oxygen needed to support aquatic organisms in a healthy ecosystem.

Table 3.7-3. Impaired Surface Water Quality Segments in the Surface Water ROI

Name of Impaired Segment	Segment Description	Impairment(s)/ Parameters of Concern
Segment 1302 San Bernard River Above Tidal		
Area 1302_01	From the confluence with the Intracoastal Waterway in Brazoria County to confluence with Peach Creek	Bacteria
Area 1302_02	From the confluence with Peach Creek to the unnamed tributary at NHD RC 12090401001535 at N-96.03,W29.51	Bacteria
Area 1302_03	From the confluence with unnamed tributary at NHD RC 12090401001535 at N-96.03, W29.51 to the confluence with Coushatta Creek	Bacteria
Segment 1305 Caney Creek Above Tidal		
Area 1305_02	From the confluence with Hardeman Slough to the confluence with Snead Slough	Bacteria; Depressed dissolved oxygen
Area 1305_03	From the confluence with Snead Slough to the upper end of segment	Depressed dissolved oxygen
Segment 2453A Garcitas Creek Tidal (unclassified waterbody)		
Area 2453A_01	From the Lavaca Bay confluence to a point 13.7 km (8.5 mi) upstream of FM 616	Depressed dissolved oxygen
Segment 2453OW Lavaca Bay / Chocolate Bay (Oyster Waters)		
Area 2453OW_02	North-northeastern portion of the bay near Point Comfort	Bacteria (oyster waters)
Area 2453OW_03	Chocolate Bay area	Bacteria (oyster waters)

CO_2 Capture Facility

There are no impaired segments within the ROI of the CO_2 capture facility. The Brazos River is used to feed water to Smithers Lake, which provides industrial water to the W.A. Parish plant. Under a contract with the Brazos River Authority, water is pumped from the Brazos River to Smithers Lake via a supply canal, as shown in Figure 3.7-3, to the location where Dry Creek enters the west side of Smithers Lake. Surface water nutrients, dissolved minerals, and elevated fecal coliform levels have been identified in the

Lower Brazos River. Also of concern in the Lower Brazos River are seasonal low flows, which allow the tidal salt-wedge to reach municipal and industrial fresh water intakes in Freeport. Region H has not been found to have naturally occurring chlorides (TWDB 2011c).

Pipeline Corridor

As listed in Table 3.7-3, a portion of the San Bernard River (Segment 1302) and a portion of Caney Creek (Segment 1305), which is also known as Cedar Lake Creek in the vicinity of the proposed pipeline corridor, are the only surface water features within the pipeline corridor ROI with water quality impairments on the Texas 303(d) list (TCEQ 2011). Segment 1302 was listed for elevated bacteria. Segment 1305 was listed for elevated bacteria and depressed dissolved oxygen. Each of these impairments is classified as a Category 5b impairment on the 303(d) list, which means the TCEQ will conduct a review of the water quality standards for these waterbodies before a Total Maximum Daily Load (TMDL) is scheduled.

West Ranch Oil Field

The only impaired waterbodies within the West Ranch oil field ROI are the tidal portion of Garcitas Creek (Segment 2453A) and the oyster waters of Lavaca Bay and Chocolate Bay (Segment 2453OW). Garcitas Creek (Segment 2453A) is listed as an unclassified waterbody with a Category 5b impairment for depressed dissolved oxygen and its use is listed as primary contact recreation. The TCEQ will conduct a review of the water quality standards for this waterbody before a TMDL is scheduled (TCEQ 2011).

The Lavaca River, which drains the eastern portion of the West Ranch oil field, drains into Lavaca Bay, the perimeter of which is lined with oyster waters. Oyster waters, which are coastal waters used for the harvesting of shellfish, pose special water quality concerns because bacteria from human and animal waste may contaminate oysters and other shellfish, making them unsafe to eat, especially since some shellfish are eaten raw. The oyster waters in several Texas bays, including Chocolate Bay, are the subject of an ongoing TMDL study which aims to improve water quality so that the oyster beds are routinely safe for harvesting (TCEQ 2012d). The segments of Lavaca Bay and Oyster Bay near Point Comfort are listed for elevated bacteria. This impairment is classified as a Category 5a impairment on the 303(d) list, which means that a TMDL is underway, is scheduled, or will be scheduled (TCEQ 2011).

3.7.3 Direct and Indirect Impacts of the Proposed Project

This section presents potential impacts to surface water resources in the ROI based on whether the Parish PCCS Project would result in any effects to surface water quality and availability based on the criteria outlined in Section 3.7.1.3. Potential impacts to wetlands and flood plains are presented in Section 3.8.

3.7.3.1 Construction Impacts

Initial construction activities would consist of clearing any existing vegetation and grading areas, which would result in the disturbance and exposure of soils. Exposed soils would be more susceptible to erosion from stormwater runoff, which could result in increased sedimentation and turbidity to nearby surface waters, causing minor temporary adverse impacts to these waterbodies during construction. These impacts would be largely avoided through the use of the BMPs and adherence to permit requirements designed to capture sedimentation before it is discharged to surface waters. As stated above in Section 3.5, the soils present in the proposed project area are not highly erodible. Therefore, possible contamination from increased runoff that could occur due to local temporary disturbance of ground conditions at the project location is not expected to be a significant concern. The amount of impervious surface following construction would be essentially the same as before construction due to the use of BMPs and surface reclamation techniques, such as revegetation.

Additionally, potential surface water contamination from possible accidental spills of fuels, lubricants, and coolants used by heavy equipment during construction of the CO_2 capture facility, the pipeline, or the central CO_2 recycle facility at the West Ranch oil field could cause an impact to surface water quality during construction activities. To avoid or minimize potential impacts to surface waters during construction, stormwater runoff would be controlled by implementing BMPs that may be currently in use or may be established for project construction activities. These BMPs, which are listed in Section 3.5 of this EIS (Physiography and Soils) would be documented in a project-specific construction SWPPP, which would incorporate SPCC Plan elements as applicable, to provide guidance to construction personnel regarding potential spills. Adherence to the guidance in the stormwater and wastewater permits discussed above would also minimize potential impacts and ensure compliance with regulatory requirements during construction of the CO_2 capture facilities, the pipeline, and at the West Ranch oil field.

CO_2 Capture Facility

No unique impacts to surface water are anticipated to occur in the vicinity of the CO_2 capture facility at the W.A. Parish Plant that would not be controlled by BMPs and surface water permits discussed above. Construction of the laydown areas and new facilities needed for CO_2 capture would all be located within the current plant footprint. Negligible impacts to Smithers Lake, located immediately adjacent to the north side of the Parish Plant, are anticipated during construction due to water withdrawals **of approximately 12,000 gallons per day** for dust suppression, vehicle wash down, and other construction-related uses. Canal 1, located south of Smithers Lake, as shown in Figure 3.7-2, may experience a temporary increase in sediment load due to erosion of exposed soils during construction. Erosion would be controlled by the implementation of BMPs, as described above.

Pipeline Corridor

Construction of the proposed CO_2 pipeline would require **211** waterbody crossings, as summarized in Table 3.7-2 as well as the wetland crossings discussed in Section 3.8 of this EIS (Wetlands and Floodplains). Waterbody crossings conducted as part of the proposed CO_2 pipeline construction would require NRG to obtain a Section 10/404 permit from the USACE Galveston District prior to initiating construction activities. Based on the current project design and information collected to date regarding wetlands and waterbodies along the proposed pipeline corridor, DOE understands that the proposed CO_2 pipeline could be permitted under Nationwide Permit 12, Utility Line Activities (NWP-12).

Impacts that may affect surface water features due to pipeline construction include the following:

- Open-cut operations could temporarily affect drainage patterns and runoff rates on a localized scale for open cut areas. Temporary increases in sedimentation and/or temporary displacement of surface water features might also occur.
- Accidental discharge of liquids (e.g., diesel, gasoline, hydraulic fluid) from construction equipment and/or vehicles used during pipeline construction, as well as solid construction wastes.

Construction activities are expected to have the greatest potential to impact surface water where the pipeline crosses a surface water feature. For this analysis, it was conservatively assumed that surface water features within 50 feet either side of the centerline of the proposed pipeline and within a distance of 250 feet from the proposed pipeline centerline in the downstream flow direction within existing drainage ways, would be avoided to the extent practical. If it is determined that avoidance of a surface water feature is not practical, potential temporary impacts would be minimized using the BMPs described above. As requested in the TPWD's March 20, 2012 letter to DOE, additional BMPs (i.e., double silt fencing; avoiding clearing of stream bank and in-stream native vegetation; phasing work during dry periods; minimizing any stream bed disturbance; and siting equipment storage areas, valves, and pump stations beyond the floodplain) would be employed for ESSSs that are not crossed using HDD construction techniques. Based on the current project design, the wider ESSSs (i.e., Big Creek and the San Bernard, Colorado, and Lavaca Rivers, which are from 110 to 500 feet wide at the proposed crossing locations, as indicated in Table 3.7-2) would be crossed by HDD for constructability reasons. However, since open-cut crossings are feasible for the two smaller ESSSs (i.e., Cedar Lake Creek and West Carancahua Creek, which are 40 and 50 feet wide, respectively, at the proposed crossing locations), these ESSSs would be crossed using conventional open-cut crossing techniques with additional BMPs, as requested by the TPWD. Based on use of HDD construction techniques and the BMPs referenced above, impacts to ESSS crossings are expected to be short-term and minor.

Depending on flow and/or mixing conditions, possible impacts could also extend downstream of each waterbody crossing. However, the nature and extent of surface water impacts are primarily a function of the method of stream crossing. Stream crossing construction methods would be selected based on considerations of safety, environmental compliance, and constructability factors specific to each crossing. As the pipeline is currently designed, the three major rivers (i.e., the San Bernard River, the Colorado River, and the Lavaca River) and three other waterbodies (Big Creek**, Menefee Bayou,** and Jones Creek) would be crossed by HDD. **These larger waterbodies could be classified as traditional navigable waters by the USACE; the list of traditional navigable waters that would be crossed by the pipeline will be verified as part of the Section 10/404 permitting process.** NRG anticipates that open-cut methods would be used to cross the remaining smaller waterbodies and wetland areas.

Sections of the pipeline installation that would be performed using HDD would not impact surface water features except for the entry and exit locations. Directional drilling does present a remote potential for impacts to surface water through inadvertent drilling fluid releases. Drilling fluid, which is also known as drilling mud, consists primarily of water and bentonite, a naturally occurring clay. An unexpected release of drilling mud to the environment could occur if a natural fracture or other preferential pathway for migration is encountered in the soil between the borehole and the surface or overlying waterbody. Therefore primary factors in selecting the pipeline crossing profile include the type of soil or rock through which the HDD borehole would be advanced and the depth of cover material.

For the portions of the route in which the pipeline would be constructed using open cut methods, soil would be removed to create a trench, stockpiled along the trench, and placed back into the trench once the pipe is placed. Potential impacts to surface water features during construction of pipeline crossings using open-cut methods could include stream diversion or piping flows around the crossing, increased turbidity and sedimentation during any disturbance to the waterbody, and removal of stream bank vegetation. These are expected to cause temporary and potentially moderate impacts during the construction of the pipeline. Additionally, approximately **75%** of the pipeline route would be collocated along or within existing mowed and maintained power line and/or pipeline corridors to minimize potential environmental impacts by allowing NRG to use existing maintained ROW during construction. However, soils in these existing utility ROWs may have been previously disturbed and therefore may be slightly more likely to erode than undisturbed soils. Potential surface water impacts related to erosion would be avoided or minimized by implementing the BMPs discussed in Section 3.5 of this EIS (Physiography and Soils). Construction activities associated with oil and gas exploration, production, processing and treatment, and transmission facilities, including CO_2 pipelines related to EOR projects, are generally exempt from CWA Section 402 requirements for NPDES permitting by the 40 CFR Part 122 exemption for oil and gas exploration and production activities. However, NRG is committed to implementing BMPs to minimize impacts.

Disturbance of State-owned streambeds in Texas is regulated under 31 TAC Chapter 69, Subchapter H; and Texas Parks & Wildlife Code Chapter 86. If a stream is perennial, or is more than 30 feet wide between the banks (even if it is dry most of the time), the State of Texas claims the bed and the sand and gravel in it as State-owned. A permit from the TPWD is required to disturb or take streambed materials from a streambed claimed by the State. Crossings done by HDD would not impact the streambed and would not require a permit; however, the Parish PCCS Project includes approximately **35** crossings that would be constructed using open cut methods of streams that are likely to be considered State-owned. The Parish PCCS Project is expected to meet the criteria for a general permit, as described in 31 TAC 69.115 (TPWD 2012b). Unlike an individual permit, which may be required for less common projects (i.e., not related to pipeline construction or maintenance) or projects which would disturb or remove more than 1,000 cubic yards of sedimentary material, a public comment period and hearing (i.e., as described in 31 TAC 69.105) are not required for projects that meet the criteria for a general permit. Therefore, less time is required to obtain a general permit than an individual permit, which may take between 30 days and several months to obtain.

NRG would avoid or minimize the potential for accidental discharge of liquids (e.g., diesel, gasoline, hydraulic fluid) from construction equipment and/or vehicles used during pipeline construction, as well as solid construction wastes, by following the BMPs specified in the project-specific construction SWPPP.

The proposed pipeline corridor would cross two waterbodies that have been identified as having water quality impairments on the most recent Texas 303(d) list (TCEQ 2011), the San Bernard River and Caney Creek. The San Bernard River is listed for elevated bacteria levels and Caney Creek is listed for elevated bacteria levels and depressed dissolved oxygen. NRG plans to cross the San Bernard River by HDD, which should avoid any construction-related impacts. Caney Creek would be crossed using open cut methods, which could temporarily increase concentrations of suspended solids during construction but would be unlikely to affect concentrations of bacteria or dissolved oxygen. There are no special construction techniques or permits required for crossing listed waterbodies.

Water required for hydrostatic testing of the pipeline and other construction activities may be trucked in or obtained from surface waterbodies adjacent to the pipeline. Hydrotest water would be reused for subsequent pressure tests if practicable, which would reduce the amount of hydrotest water required for the project by approximately 50% (i.e., 1.25 million gallons instead of 2.5 million gallons). Assuming that the majority of hydrotest water can be reused, approximately 1.25 million gallons of water would be required for hydrostatic testing. Reused hydrotest water would be pumped from one pipe segment to the next or stored in portable tanks or tank trailers on the construction ROW for later reuse. Approximately 500,000 gallons of additional water would be required for other construction uses, such as dust control, equipment wash-down, drilling mud makeup, and other general use. Therefore, a total of approximately 1.75 million gallons of water may be trucked in, obtained from a municipal water source, or obtained from surface water during construction. If surface water is used for hydrotesting, water may be obtained from the Lavaca River, the Colorado River, or another major waterbody in the project area and TCEQ water appropriation permits would be obtained, as appropriate, prior to water uptake. If water is trucked in, the water would be obtained from a commercial vendor and would be delivered to the construction ROW in 20,000-gallon tank trailers. Even in times of drought, appropriation of less than 3.26 million gallons (10 acre-feet) of water is not expected to be problematic. Assuming the hydrotest water meets applicable discharge criteria, which would be listed in the RRC discharge permit (and EPA permit if discharging to a water of the U.S.), the water could be discharged back to the waterbody from which it was taken, if necessary.

Spent hydrotest water would be tested to properly characterize the waste prior to discharge. To the extent possible, NRG plans to discharge spent hydrotest water to upland areas. NRG would conduct hydrotest water discharges consistent with RRC guidelines, RRC discharge permits if applicable, and TCEQ BMPs for water management and erosion control, including use of appropriately designed discharge structures (e.g., silt fencing and/or hay bales). NRG would obtain applicable permits from the RRC, as appropriate, and from the EPA (i.e., if water would be discharged to waters of the U.S.) for the discharge of hydrotest water prior to conducting hydrotests.

The amount of impervious surface following construction would be essentially the same as before construction due to the use of BMPs and surface reclamation techniques such as revegetation. Since the pipeline would be built below grade (i.e., typically covered by a minimum of three feet of compacted soil and deeper, a minimum of four feet of soil, in cultivated areas), it would cross under existing surface water features. Impacts due to surface water disturbance could occur during construction at each of the surface water features crossed by the pipeline and, although possible, impacts are expected to be negligible (i.e., for HDDs) to moderate (i.e., for open cuts) and temporary and would be minimized by the implementation of BMPs. No long-term impacts to surface water features are anticipated to occur following completion of the pipeline installation and backfilling of the pipeline's open-cut sections to preexisting grades and contours.

West Ranch Oil Field

Waterbodies located within the West Ranch oil field EOR area include Venado Creek, Venado Lakes, Menefee Lakes, and the Lavaca River, all of which ultimately discharge to Lavaca Bay, as shown in Figure 3.7-7. The current project design anticipates that, to the maximum extent possible, existing wells would be converted for use during EOR and CO_2 monitoring activities. If new wells would be required, existing drill pads would be used, to the extent practical. During refurbishment and/or conversion of wells, and construction of any new wells if required, BMPs and policies currently used by HEC in its ongoing operations would be used to minimize discharge of any pollutants through surface water runoff. Adherence to standard drilling practices should result in short-term negligible impacts to surface water from the well drilling activities, if required. Existing roads would be used to the extent practical to access EOR and CO_2 monitoring areas within the West Ranch oil field. No new road construction is anticipated.

Negligible impacts to surface water features in the West Ranch oil field ROI are expected to occur as a result of construction of the new central CO_2 recycle facility in the West Ranch oil field. The central CO_2 recycle facility is proposed to be constructed on an existing disturbed area at the terminus of the proposed pipeline that was previously occupied by a gas processing facility. The soils present at the West Ranch oil field are not highly erodible, as discussed in Section 3.5 of this EIS (Physiography and Soils). For this reason, contamination from increased runoff that might occur as a result of EOR or CO_2 monitoring activities is not expected to be a significant concern. Other CO_2 monitoring program activities, such as seismic profile surveys and well integrity testing, are likewise expected to result in negligible impacts to surface water features.

There are no waterbodies in the proposed EOR area identified as having water quality impairments on the most recent Texas 303(d) list (TCEQ 2011); however, surface waterbodies in the area discharge to Lavaca Bay, which contained oyster waters that are listed for bacteria. Lavaca Bay estuaries and tributaries (e.g., Garcitas Creek) are also listed for depressed dissolved oxygen. Construction at the West Ranch oil field could temporarily increase concentrations of suspended solids discharged to these waterbodies but would be unlikely to affect concentrations of bacteria or dissolved oxygen. BMPs would be employed during construction to minimize the impact of surface water features.

Similar to the new construction proposed at the W.A. Parish Plant, construction activities at the West Ranch oil field could result in minor short-term, indirect impacts such as potential spills (e.g., gasoline, diesel fuel, hydraulic fluid) from construction equipment during site preparation work. Construction activities associated with oil and gas exploration, production, processing and treatment, and transmission facilities are generally exempt from CWA Section 402 requirements for NPDES permitting by the 40 CFR Part 122 exemption for oil and gas exploration and production activities. Wastewater or produced water produced during drilling activities would be collected, transported by truck, and re-injected into permitted Class II injection or disposal wells that are currently operated by HEC at the West Ranch oil field. Drilling muds that may be produced during HDD operations would be landfarmed on the construction ROW or in an adjacent property with landowner permission in accordance with the provisions of 16 TAC 3.8, in a location that conforms to RRC guidelines for site selection (e.g., not within a 100-year floodplain, slope less than or equal to 5%, with at least 20 inches of tillable soil). During landfarming, the drilling muds are blended into native soil as an amendment to improve water holding capacity and plant growth. Assuming HDDs are reamed to 24 inches in diameter and the combined length of all **six** planned HDDs (i.e., one inside the W.A. Parish Plant and **five that cross waterbodies**) is approximately **14,000** feet, approximately **1,630** cubic yards of HDD drilling mud would be generated during construction. If spread out to the maximum thickness allowed by the RRC (i.e., three inches), approximately **4.0** acres of land would be required for landfarming. TCV would obtain a RRC permit for landfarming of drilling muds prior to initiating landfarming activities. Also, BMPs, which would be specified in the project-specific SWPPP, would be employed during construction to minimize the impact of surface water features. Adherence to the facility's SPCC plan would ensure that any potential spills would be cleaned up before they reach nearby waterbodies.

After construction, temporarily disturbed areas would be returned to original grade and seeded with an appropriate grass mix to reestablish vegetative cover. The potential for long-term increases in sediment-laded surface water runoff from proposed construction areas would therefore be expected to be minimal. In summary, it is anticipated that the proposed construction activities, to be conducted using BMPs, established waste minimization practices, and established permit requirements (e.g., for any new CO_2 injection well or produced water re-injection or disposal well), would have negligible to minor short-term impact on existing surface water features. The amount of impervious surface following construction would be essentially the same as before construction due to the use of BMPs and surface reclamation techniques such as revegetation.

3.7.3.2 Operational Impacts

CO_2 Capture Facility

Approximately 4 to 5 mgd of additional plant process water (i.e., approximately 10% over current W.A. Parish Plant usage) would be required to support operation of the proposed CO_2 capture facility. Approximately 95% of this additional water (i.e., approximately 3.5 to 4.9 mgd) would be supplied from Smithers Lake via a new surface water intake point, and the remaining approximately 5% (i.e., approximately 0.2 to 0.3 mgd) would be extracted from existing groundwater wells. The new surface water intake point would be developed by installing a new pump in an unused bay of the existing Unit 7/8 intake structure to increase the capacity of the system. The Unit 7/8 intake water structure is located at the east end of NRG Canal 1, as shown in Figure 3.7-2.

Potential impacts to surface water related to increased surface water usage could include reduced water levels in Smithers Lake, Rabbs Bayou, Big Creek, Dry Creek, and the Brazos River or reduced availability of water from Dry Creek or the Brazos River for current or future uses, particularly in the event of a drought. The projected total surface water usage by the W.A. Parish Plant, including the proposed project facilities, would be approximately 38 to 55 mgd. This usage rate would be approximately 3% to 6% of the average Brazos River flow rate (i.e., 1,000 to 1,300 mgd) and approximately 8% to 13% of the Brazos River's critical low-flow rate (i.e., 440 to 490 mgd). The portion of this water that would be related to the proposed project (i.e., 4 to 5 mgd) would account for approximately 0.5% of the average Brazos River flow rate and approximately 1% of the Brazos River's critical low-flow rate. Therefore, the proposed project would be expected to result in a minor impact to surface water supply sources even during typical drought (i.e., low-flow) conditions. Additionally, despite the increased demand on surface water, the W.A. Parish Plant's surface water usage would remain well below NRG's current surface water right allocations of 74 mgd (83,000 AF/yr) of water from the Brazos River Authority and 25 mgd (28,000 AF/yr) of water from Dry Creek.

The CO_2 capture process also produces excess water from the flue gas cooling process as effluent. The absorption process is carried out at near ambient temperature, frequently requiring flue gas cooling upstream of the absorber. Water vapor that condenses out during flue cooling would be removed from the system. The condensed water would be of good quality and could be used as a feed stream to the demineralization plant or reused within the CO_2 capture process itself after minimal treatment (Reddy et al. 2008).

Pipeline Corridor

Normal operations of the proposed CO_2 pipeline are not expected to impact surface waters in the ROI. On occasion, maintenance or inspection activities may require excavation around segments of the pipeline. During maintenance operations, the BMPs discussed in Section 3.5 of this EIS (Physiography and Soils) would be used, as applicable, to avoid or minimize any indirect impacts (e.g., sedimentation and turbidity) to adjacent surface waters. During project operations, there is also some potential for spills to occur from operational equipment (e.g., hydraulic fluids, fuels, lubricants) during maintenance activities. These activities along the pipeline would be limited in scope and frequency. NRG would follow the BMPs discussed in Section 3.5 of this EIS (Physiography and Soils), as applicable, during maintenance activities to avoid or minimize potential impacts to groundwater resources from accidental spills of fuel, fuel constituents, and other materials. Taking into account the BMPs that would be used to minimize the potential for spills to affect surface water resources, DOE anticipates that potential impacts to surface water quality from the operation of the CO_2 pipeline would be minor. DOE expects that operation of the CO_2 pipeline would not impact the availability of surface water resources.

NRG plans to install 12 main line valves (MLVs) along the proposed pipeline to stop the release of CO_2 should a puncture or rupture occur. These valves, along with pipeline pressure monitoring equipment, would be linked to the CO_2 capture system operations control room, which would be staffed at all times when the CO_2 capture system is in operation. In the event of a pressure drop significant enough to indicate a pipeline rupture, the control room operator would shut down the CO_2 capture system and remotely activate the main line valves to prevent further damage to the pipeline and minimize impacts to the surrounding environment. Valves would be located on either side of the San Bernard River, Colorado River, Jones Creek, Blue Creek, and Lavaca River. In some areas where two waterbodies are located close together, a single pair of valves may be installed around more than one waterbody (e.g., around the Colorado River and Jones Creek).

As discussed in Appendix F to this EIS (Health Risk Assessment), based on the frequency of releases from similar pipelines in the U.S., a release of CO_2 due to a pipeline puncture or rupture is considered unlikely. If CO_2 were released from the pipeline, it would expand rapidly as a gas and could include both liquid and solid (i.e., dry ice) phases, depending on temperature and pressure. As the product in the pipeline is over 99.9% CO_2 with few impurities (i.e., primarily oxygen, nitrogen, argon, and water) and would not remain under sufficient pressure to dissolve into surface water, it would have negligible adverse impact on surface water quality in the unlikely event of a release, but could potentially decrease surface water temperatures in the vicinity of a release.

West Ranch Oil Field

As above with the pipeline corridor, if BMPs and SPCC plan procedures are followed and all surface water permits are adhered to, normal operations would have negligible impacts on surface waters. Maintenance operations are expected to occur infrequently and could potentially affect surface waters. As with any industrial activity, there is some minor potential for surface water contamination from spills of fuels, lubricants, and coolants used by vehicles or heavy equipment for maintenance and operations within the West Ranch oil field and at the central CO_2 recycle facility.

As discussed in Appendix F of this EIS (Health Risk Assessment), a possible impact from EOR operations may result from the extremely unlikely occurrence of an injection well blowout (i.e., a sudden loss of CO_2 from failure of an injection well during operation). If a CO_2 injection well blowout were to occur, the main adverse outcome to surface waters in the vicinity of the wellhead would be the potential for ejection of formation fluids from the wellhead, possibly as contaminants in dry ice particles (Skinner 2003), which could result in a release of formation fluids (e.g., oil or produced water) to an adjacent surface waterbody. The impacts from such a release to surface water would be similar to a conventional spill. Based on the fact that such a release is considered highly unlikely, as discussed in Appendix F, operation of CO_2 injection wells would be expected to have a minor impact on the surface water resources surrounding the well. Effects would be expected to be localized to the area around the affected wellhead and events of this type would be avoided or minimized by incorporating high pressure piping, overpressure protection (i.e., relief) valves, and blowout preventers into the design of the injection wells.

3.7.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for NRG’s proposed Parish PPCS Project. Although NRG and TCV might still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to surface water uses or quality.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. During construction, water would be utilized for dust suppression, and the construction site would be connected to the W.A. Parish potable water system for use in construction trailers. The level of dust suppression for construction activities is similar to that commonly performed in the area prior to construction. Accordingly, the incremental water used for dust suppression for the site is insignificant to the overall water utilized over the W.A. Parish Plant. Potable water usage by site personnel would also be an insignificant portion of water used within the overall facility, and is estimated to be below 75 gallons per day.

3.8 WETLANDS AND FLOODPLAINS

3.8.1 Introduction

This section identifies and describes wetlands and floodplains potentially affected by the construction and operation of the proposed Parish PCCS Project. This section also analyzes the potential effects of this project on these resources. In addition, this section provides the required wetland and floodplain assessment for public review in compliance with regulations promulgated at 10 CFR 1022, “Compliance with Floodplain and Wetland Environmental Review Requirements.” These regulations provide guidance for DOE compliance with Executive Order (EO) 11988, “Floodplain Management,” and EO 11990, “Protection of Wetlands.” EO 11988 requires federal agencies, while planning actions, to avoid to the extent possible adverse impacts associated with the modification of floodplains and to avoid support of floodplain development when there is a practicable alternative. EO 11990 requires that federal agencies, while planning actions, consider alternatives to affecting wetlands, if applicable, and limit adverse impacts to the extent practicable if they cannot be avoided.

3.8.1.1 Region of Influence

The ROI for wetlands and floodplains includes the proposed CO_2 capture facility, the approximately **81-**mile-long pipeline corridor, and the approximately 5,500-acre EOR area at the West Ranch oil field. A total of approximately 29 acres within the existing W.A. Parish Plant boundaries would be used during construction of the proposed CO_2 capture facility. The pipeline construction ROW is generally 100 feet in width, but would be reduced to a width of 75 feet in some areas, where practicable, to minimize impacts to wetlands. The total area of the pipeline construction ROW, which includes additional temporary work space that may extend outside the typical 100-foot-wide construction ROW **and access roads**, is approximately **1,197** acres. The permanent pipeline ROW would be approximately 30 feet wide when completed. The proposed EOR area at the West Ranch oil field includes a central CO_2 recycle facility that would be approximately 250 feet by 250 feet (1.5 acres) in size, which would be located within the approximately 16-acre area indicated in Figure 2-11.

3.8.1.2 Method of Analysis

Wetlands and waters of the U.S. in the ROI were located and delineated in the field using global positioning system (GPS) receivers between January and **November** 2012. Field wetland delineations were completed for **over 99**% of the pipeline construction ROW**, including access roads**. **The National Wetlands Inventory does not indicate the presence of any wetlands in the area where wetland delineations have not yet been conducted (USFWS 2011a).** The assessment of impacts to floodplains is based on the Federal Emergency Management Agency (FEMA) 100-year and 500-year floodplains as shown in Q3 Flood Data, as discussed in Section 3.8.2 (FEMA 1985, 1997, 2006). In locations where wetlands and floodplains would be impacted, qualitative assessments were made regarding what those impacts would be, based on the factors considered for assessing impacts described in Section 3.8.1.3. The potential impacts to wetlands and floodplains were quantified using GIS to calculate the acreages of potentially impacted areas using the field-delineated wetlands and mapped floodplains.

3.8.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to wetlands and floodplains based on whether the proposed Parish PCCS Project would directly or indirectly:

- cause filling of wetlands or otherwise alter drainage patterns that would affect wetlands;

- cause wetland type conversions due to alterations of land cover attributes;
- alter a floodway or floodplain or otherwise impede or redirect flows such that human health, the environment, or personal property could be affected;
- conflict with applicable flood management plans or ordinances; or
- conflict with FEMA's national standard for floodplain management (i.e., maximum allowable increase of water surface elevation of one foot for a 1% annual chance [100-year recurrence interval] flood event).

3.8.2 Affected Environment

Wetlands

Wetlands have unique characteristics that set them apart from other environments, providing the basis for wetland identification and classification. These unique characteristics include a substrate that is saturated or inundated with water for at least part of the growing season, soils that contain little or no oxygen, and plants adapted to wet or seasonally saturated conditions. Wetlands serve many functions, including the storage and slow release of surface water, rain, snowmelt, and seasonal floodwaters to surface waters. Additionally, wetlands provide wildlife habitat, sediment stabilization/retention functions, and perform an important role in nutrient (e.g., nitrogen and phosphorus) cycling. Wetlands also help to maintain stream flow during dry periods and often provide groundwater recharge.

> **Wetlands** are defined by the USACE as follows: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. (40 CFR 230)
>
> **Uplands** are areas that are not wetlands or waterbodies.

Wetlands are among the most productive environments in the world, comparable to rain forests and coral reefs. Many species of wildlife, including a large percentage of threatened and endangered species, depend on wetlands for their survival. Wetlands are important for their scientific and educational opportunities and can provide open space for recreation where public access is available.

Certain wetland features, called "waters of the U.S.," are regulated by the USACE under the CWA because they are important for the preservation of navigable waterways and interstate commerce. Waters of the U.S. are subject to federal jurisdiction and permitting under Section 404 of the CWA and include all navigable waterways, associated tributaries, as well as wetlands contiguous to and adjacent to those navigable waterways and tributaries. Isolated wetlands (i.e., those that have no surface hydrologic connection to waters of the U.S.) are not regulated under federal jurisdiction unless they are adjacent to waters of the U.S.

In Fort Bend, Wharton, and Jackson Counties, federal wetland regulations are enforced by the USACE Galveston District. Under Section 404 of the CWA, a USACE permit from the Galveston District would be required for the discharge of dredged or fill material into waters of the U.S. This authorization may be an Individual Permit issued by the Galveston District or verification from the Galveston District that the proposed project meets the criteria for an existing Nationwide Permit (NWP) or Regional General Permit. For example, the construction, maintenance, or repair of utility lines (e.g., pipelines) within waters of the U.S. that meet certain criteria may be authorized under NWP 12 (Utility Line Activities). In order to receive a permit from USACE, the potential land developer must submit a permit application to the Galveston District containing suitable information for the USACE to make a decision. NRG would coordinate with USACE at the appropriate time to determine the preferred approach to project permitting. Similar pipeline projects in the Galveston District have been permitted under NWP 12.

Wetland types are typically categorized using the U.S. Fish and Wildlife Service (USFWS) document *Classification of Wetlands and Deepwater Habitats of the United States* (hereafter referred to as the “Cowardin classification”) (Cowardin, et al. 1979). The Cowardin classification system describes wetland and deepwater habitats using ecological parameters, arranges them into a system useful to resource managers, furnishes units for mapping, and provides uniformity of concepts and terms. This classification system is used by the USFWS when categorizing wetland types to develop the NWI, a series of topical maps that show wetlands and deepwater habitats of the U.S. The classification hierarchy follows the order: System; Subsystem (which applies to riverine features [i.e., rivers, streams, creeks, bayous, and other open water bodies], but is not part of the palustrine [i.e., marsh or swamp] classification); Class; Subclass; and modifying terms.

Wetland delineations for NRG’s proposed project have been completed for **over 99**% of the pipeline construction ROW**, areas adjacent to the approximately 43 miles of access roads (i.e., within 15 feet of centerline)**, **and** additional temporary work space (**a total of 1,191** acres out of the **1,197** acres **of construction ROW**). Wetland delineations will be completed for the **remaining area of the** pipeline construction **corridor** prior to submittal of the USACE Section 404 permit application. Wetland delineations were not conducted for the CO_2 capture facility, because it would be located within the existing previously developed W.A. Parish Plant, or for the CO_2 recycle facility, which would be located within a previously developed area. The wetland delineation activities were conducted using the U.S. Army’s *Corps of Engineers Wetland Delineation Manual* (USACE 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region* (USACE 2010) guidelines based on the three parameter approach for identifying a wetland (i.e., presence of hydrophytic vegetation, hydric soils, and wetland hydrology). Survey personnel identified the locations of wetland features in the field and recorded them using a GPS device in accordance with the USACE Galveston District’s *Standard Operating Procedures for Recording Jurisdictional Determinations Using GPS* (USACE 2003). The map series in Appendix D-1 provides the locations of wetlands delineated to date within the proposed pipeline construction ROW. Appendix D-2 summarizes the type and acreage of wetlands identified in Appendix D-1.

> **Hydrophytic vegetation** is macrophytic (larger) plant life growing in water, soil, or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.
>
> **Hydric soils** are soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions within the major portion of the root zone.
>
> **Wetland hydrology** is the permanent or periodic inundation or soil saturation for a significant period during the vegetative growing season (USACE 1987).

The following sections describe wetland features within the ROI based on the Cowardin classification. During the wetland delineation effort, palustrine wetlands were classified to the Class level (System/Class) and riverine wetlands were classified to the Subsystem level (System/Subsystem). Table 3.8-1 provides descriptions of the classification hierarchy parameters that apply to potentially affected wetlands and other water types within the ROI. Features that were constructed for the purpose of drainage have been classified as “drainage ditches” and are not described using the Cowardin system.

Table 3.8-1. Cowardin Classification Codes Applicable to Potentially Affected Wetlands within the ROI

Classification Title	Description
Systems	
Riverine	Includes all wetlands contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts in excess of 0.5 parts per thousand. A channel is an open conduit, either naturally or artificially created, which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water. As per the Cowardin classification, riverine features are considered wetlands in this section unless the water depth is greater than 2 meters (6.6 feet). Section 3.7 of this EIS (Surface Water) uses the term “stream” to characterize the riverine wetland features.
Palustrine	Includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 20 acres; (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 6.56 feet at low water; and (4) salinity due to ocean-derived salts less than 0.5 parts per thousand. There are no Subsystems associated with this System. These features are considered wetlands.
Subsystems	
Upper Perennial	Gradient is high and velocity of the water fast. There is no tidal influence and some water flows throughout the year. The substrate consists of rock, cobbles, or gravel with occasional patches of sand. The natural dissolved oxygen concentration is normally near saturation. The fauna is characteristic of running water, and there are few or no planktonic forms. The gradient is high compared with that of the Lower Perennial Subsystem, and there is very little floodplain development. Associated with the Riverine System.
Lower Perennial	Gradient is low and water velocity is slow. There is no tidal influence, and some water flows throughout the year. The substrate consists mainly of sand and mud. Dissolved oxygen deficits may sometimes occur, the fauna is composed mostly of species that reach their maximum abundance in still water, and true planktonic organisms are common. The gradient is lower than that of the Upper Perennial Subsystem and the floodplain is well developed. Associated with the Riverine System.
Intermittent	The channel contains flowing water for only part of the year. During certain times, groundwater provides water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow. When the water is not flowing, it may remain in isolated pools or surface water may be absent. Associated with the Riverine System.
Ephemeral*	The channel contains flowing water only during and for a short duration after precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow. Associated with the Riverine System.

Table 3.8-1. Cowardin Classification Codes Applicable to Potentially Affected Wetlands within the ROI

Classification Title	Description
Classes	
Emergent	Characterized by erect, rooted, herbaceous hydrophytes (i.e., plants that grow only in water or very moist soil), excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed. Associated with the Palustrine System. See Figure 3.8-1.
Scrub-Shrub	Includes areas dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included. Associated with the Palustrine System. See Figure 3.8-2.
Forested	Includes areas dominated by woody vegetation 20 feet tall or taller. All water regimes except subtidal are included. Associated with the Palustrine System. See Figure 3.8-3.

Source: Cowardin, et al. 1979
ROI = region of influence; USACE = U.S. Army Corps of Engineers
*The ephemeral subsystem is technically included within the intermittent subsystem (described above) and is not considered a distinct subsystem in the Cowardin classification.

Figure 3.8-1. Typical Palustrine Emergent Wetland Area along Proposed Pipeline Corridor
(Location 012412_A_1_PEM1)

Figure 3.8-2. Typical Palustrine Scrub-Shrub Wetland Area along Proposed Pipeline Corridor
(Location 012312_A_1_PSS)

Figure 3.8-3. Typical Palustrine Forested Wetland Area along Proposed Pipeline Corridor
(Location 020712_S2_1_PFO1)

Floodplains

Since flooding events can cause very costly natural disasters, FEMA, through the National Flood Insurance Program (NFIP), enables qualifying property owners to purchase insurance protection against losses from flooding. Floodplain management activities of the NFIP include the development of Flood Insurance Rate Maps (FIRMs) for flood insurance rating purposes. A FIRM outlines flood risk zones within communities and is usually issued following a Flood Insurance Study (FIS) that summarizes the analysis of flood hazards within the subject community. FEMA provides FIRMs to a wide range of users including: private citizens, community officials, insurance agents and brokers, lending institutions, and other federal agencies.

A FIS includes detailed engineering studies to map predicted flood elevations at specified flood recurrence intervals. Generally, the FIS is concerned with peak discharges in streams and rivers for 100- and 500-year storm events and includes engineering analyses of predicted flood elevations for each flood recurrence interval. Based on the results of the engineering analyses, flood risk zones are assigned for insurance purposes. The 100-year floodplain is defined as areas that have a 1% annual chance of flooding. The 500-year floodplain is defined as areas that have a 0.2% annual chance of flooding. Floodplains in the area of the proposed Parish PCCS Project are mapped under three different categories:

- Zone A: 100-year floodplains without mapped base flood elevations (i.e., the elevation to which floodwaters would be expected to rise during a 100-year flood).
- Zones AE, AH, or AO: 100-year floodplains with mapped base flood elevations.
- Zone X500: Areas between 100- and 500-year floodplains, certain areas subject to 100-year floods with average flood depths of less than one foot or where the contributing drainage area is less than one square mile, or areas protected from 100-year floods by levees.

FEMA adopted a maximum allowable increase of water surface elevation of one foot for a 1% annual chance (i.e., 100-year recurrence interval) flood event as the national standard for floodplain management purposes.

Currently, FEMA is in the process of producing digital FIRMs of the State of Texas; however, data for Fort Bend, Wharton, and Jackson Counties are not yet available. Therefore, this analysis uses Q3 Flood Data (FEMA 1985, 1997, 2006). These Q3 Flood Data show special flood hazard areas identified by FEMA in hardcopy maps; however, when digitized, certain data deficiencies (e.g., map edge-matching errors) occur that have not yet been corrected. For Fort Bend County, Q3 Flood Data are the most recent data available and digital FIRMs are at the preliminary stage. For Wharton County, Q3 Flood Data are the only data available in digital format, and digital FIRMs are at the preliminary stage. For Jackson County, only Q3 Flood Data are available. FEMA 100-year and 500-year floodplains located along the proposed pipeline corridor are indicated on the maps in Appendix D-1.

3.8.2.1 CO_2 Capture Facility

Wetlands

There are no wetlands located within the land area proposed for the CO_2 capture facility and its supporting infrastructure, which would be built on a previously developed site. The NWI shows only Smithers Lake located to the northwest of the W.A. Parish Plant, and another lake located to the southwest of the W.A. Parish Plant (USFWS 2011**a**).

Floodplains

The land area proposed for the CO_2 capture facility and its supporting infrastructure is located outside of the FEMA 100-year and 500-year floodplains. Smithers Lake, to the northwest of the W.A. Parish Plant and its immediate vicinity, are within the 100-year floodplain, but the 100-year floodplain does not extend to the W.A. Parish Plant. As shown in Figure 2-5, some areas of the proposed CO_2 capture facility (i.e., the north laydown area, the relocated road, and the warehouse) would be located approximately 50 to 200 feet from Smithers Lake and associated canals.

3.8.2.2 Pipeline Corridor

Wetlands

Wetland delineations have been completed for **over 99**% of the pipeline construction ROW **and access roads**. Pictures of typical wetlands identified along the proposed pipeline construction ROW are provided in Figure 3.8-1 through Figure 3.8-3. **The NWI does not indicate the presence of any wetlands in the area where wetland delineations have not yet been conducted (USFWS 2011a). Based on NWI data and analysis of aerial photos, it is assumed that no wetlands will be identified in this approximately 7-acre area which is an active agricultural field.**

Approximately **82**% of the acreage of wetland features within the pipeline construction ROW is palustrine emergent wetlands (Table 3.8-2). Drainage ditches and perennial, ephemeral, and intermittent streams are also included as riverine wetlands in this assessment, and make up approximately **15**% of the delineated wetland area. Palustrine scrub-shrub wetlands make up approximately 2% of the delineated wetlands, and palustrine forested wetlands represent less than 1%. Additional information regarding riverine areas is provided in Section 3.7 of this EIS (Surface Waters).

Several of the large palustrine emergent wetland areas are fallow rice fields. Other palustrine emergent wetlands are low areas that are likely the result of previous pipelines that have been installed in the corridor. The proposed pipeline corridor also crosses a large gulf cordgrass (*Spartina spartinae*) marsh between the Lavaca River and the West Ranch oil field (Appendix D-1, Figures 21 and 22).

Table 3.8-2. Delineated Wetlands within the Pipeline Construction ROW

	Palustrine emergent	Palustrine scrub-shrub	Palustrine forested	Riverine	Drainage ditch	Total
Delineated Wetlands (acres)	**79.4**	**2.2**	**0.3**	**8.7**	**5.8**	**96.4**

Floodplains

The proposed pipeline corridor crosses FEMA 100-year and 500-year floodplains in **25** locations, as summarized in Table 3.8-3 Floodplain crossings include: Colorado River, Lavaca River, Blue Creek, Juanita Creek, San Bernard River, and Tres Palacios River (Appendix D-1).

3.8.2.3 West Ranch Oil Field

Wetlands

Figure 3.8-4 shows the locations of NWI wetlands within the EOR area at the West Ranch oil field. The northern portion of the EOR area at the West Ranch oil field includes the area near the Menefee Lakes, which is classified as estuarine and marine deepwater and estuarine and marine wetland by the NWI (USFWS 2011**a**). Venado Creek crosses the EOR area at the West Ranch oil field, and is classified by the NWI as estuarine and marine wetland and freshwater emergent wetland. The only other features identified by the NWI within the EOR area at the West Ranch oil field are several small freshwater ponds and a small estuarine and marine deepwater habitat. As indicated in Table 3.8-4, a total of 1,556 acres of wetlands identified by the NWI **occur** within the EOR area at the West Ranch oil field.

There are no wetlands within the approximately 16-acre area (as shown in Figure 3.8-4) **surrounding** the proposed **site for the** 1.5-acre CO_2 recycle facility. The NWI shows emergent wetlands located approximately 500 feet to both the east and west of the proposed site, but no wetlands are located within this previously developed site (USFWS 2011**a**). The absence of wetlands has been confirmed by a site visit, during which the location of the proposed CO_2 recycle facility was observed to contain concrete pads and foundations from the gas processing facility formerly located in the area.

Table 3.8-3. Floodplains Located within the Proposed Pipeline ROW

Name of Watercourse Associated with Floodplain	100-year Floodplain Area				500-year Floodplain Area			
	Milepost Start	Milepost End	Within Construction and Permanent ROW (acres)	Within Permanent ROW (acres)	Milepost Start	Milepost End	Within Construction and Permanent ROW (acres)	Within Permanent ROW (acres)
Tributary to Worthington Lake	N/A	N/A	N/A	N/A	0.0	0.1	4.0	0.3
Tributary to Worthington Lake	1.6	1.7	1.9	0.6	1.5	2.1	4.3	1.4
Tributary to Worthington Lake	2.2	2.3	1.9	0.6	2.1	2.6	4.3	1.4
Big Creek	5.8	6.3	6.5	1.6	N/A	N/A	N/A	N/A
Tributary to Deer Creek	9.6	9.6	0.5	0.2	N/A	N/A	N/A	N/A
Tributary to Mound Creek	11.5	11.6	0.5	0.2	N/A	N/A	N/A	N/A
Mound Creek	13.5	13.6	0.8	0.3	N/A	N/A	N/A	N/A
Buffalo Creek	16.5	16.6	1.7	0.6	N/A	N/A	N/A	N/A
Cedar Creek	17.5	17.6	0.6	0.2	N/A	N/A	N/A	N/A
San Bernard River	19.1	21.3	26.1	7.7	N/A	N/A	N/A	N/A
Cedar Lake Creek (aka Caney Creek)	23.7	23.7	0.4	0.1	N/A	N/A	N/A	N/A
Gardner Slough	25.4	25.9	5.7	1.7	N/A	N/A	N/A	N/A
Water Hole Creek	26.8	27.1	3.3	1.0	N/A	N/A	N/A	N/A
Colorado River	30.9	39.5	112.8	31.1	N/A	N/A	N/A	N/A
Tres Palacios River	42.0	42.8	10.1	3.0	N/A	N/A	N/A	N/A
Juanita Creek	47.9	48.9	12.9	3.8	N/A	N/A	N/A	N/A
Tributary to East Carancahua Creek	53.5	53.7	3.4	1.0	N/A	N/A	N/A	N/A
East Carancahua Creek	54.6	55.5	10.2	3.0	N/A	N/A	N/A	N/A
West Carancahua Creek	66.0	66.2	1.8	0.6	65.9	66.3	4.2	1.3
Tributary to West Carancahua	67.2	67.4	3.5	1.0	N/A	N/A	N/A	N/A

Table 3.8-3. Floodplains Located within the Proposed Pipeline ROW

Name of Watercourse Associated with Floodplain	100-year Floodplain Area				500-year Floodplain Area			
	Milepost Start	Milepost End	Within Construction and Permanent ROW (acres)	Within Permanent ROW (acres)	Milepost Start	Milepost End	Within Construction and Permanent ROW (acres)	Within Permanent ROW (acres)
Creek								
Cox Creek	75.3	75.8	5.4	1.8	N/A	N/A	N/A	N/A
Lavaca River	N/A	N/A	N/A	N/A	78.0	78.0	0.3	0.1
Lavaca River	78.2	80.2	28.8	7.2	N/A	N/A	N/A	N/A
Tributary to Venado Creek	N/A	N/A	N/A	N/A	80.9	90.0	0.3	0.1
Tributary to Venado Creek	81.2	81.3	9.0	0.3	81.2	81.3	12.2	0.4

N/A = Not applicable (i.e., this floodplain type is not found in this area)

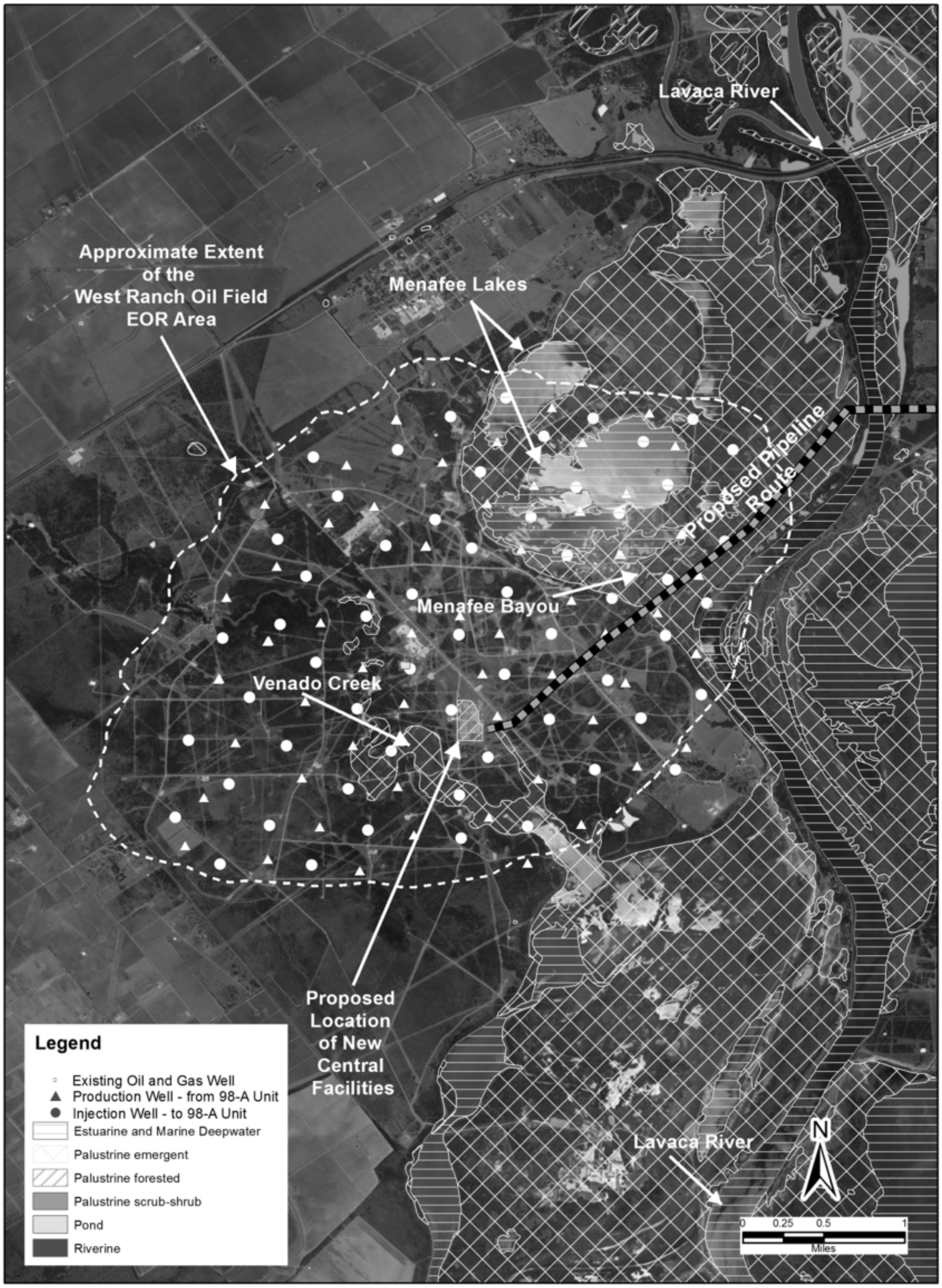

Figure 3.8-4. NWI Wetlands within Proposed EOR Area at West Ranch Oil Field
Source: USGS 2012

Table 3.8-4. Summary of NWI Wetlands within EOR Area at the West Ranch Oil Field

Wetland Type	Total Area (acres)
Estuarine and marine deepwater	546
Palustrine emergent	995
Palustrine forested	6
Palustrine scrub-shrub	6
Pond	3
Total	**1,556**

Floodplains

The EOR area at the West Ranch oil field includes the FEMA 100-year and 500-year floodplains of Venado Creek, the Lavaca River, the Menefee Lakes, and Menefee Bayou. The approximately 16-acre area in which the proposed CO_2 recycle facility would be located (Figure 2-11) is outside of the FEMA 100-year floodplain, but includes less than 0.01 acre of the 500-year floodplain (i.e., in the northeastern portion of the area). The northeastern portion of the 16-acre area is approximately 100 feet west of the 100-year floodplain and the southwestern edge of the area is approximately 400 feet east of the 100-year and 500-year floodplains. The FEMA 100-year floodplain of Venado Creek is located approximately 500 feet to the west of the area of the CO_2 recycle facility, and a tributary of Venado Creek is located approximately 100 feet to the east; however, the area of the CO_2 recycle facility is outside of the 100-year floodplain (Appendix D, Figure 22) (FEMA 1985).

3.8.3 Direct and Indirect Impacts of the Proposed Project

DOE assessed the potential for impacts to wetlands and floodplains in the ROI based on whether the proposed Parish PCCS Project would result in any of the factors identified in Section 3.8.1.3. Potential impacts to wetlands are focused on project attributes that could potentially require a permit from the USACE, such as the placement of fill material and the installation of the proposed CO_2 pipeline. Therefore, this section discusses the potential for impacts related to the loss of resources (i.e., filling impacts), type conversions (e.g., converting a forested wetland to herbaceous vegetation), and surface disturbances within waters of the U.S. Each of these actions ultimately affects the function and value of surface water and wetland resources (e.g., flood flow attenuation and providing habitat for fish and wildlife). Section 3.7 of this EIS (Surface Water) addresses impacts to surface waters, focusing on water quality and availability of the resource for its intended use.

Floodplain impacts were assessed for the placement of fill material or structures within a floodplain in a manner that would expose people or structures to increased levels of flood hazards or violate FEMA's national standard for floodplain management.

3.8.3.1 Construction Impacts

3.8.3.1.1 CO_2 Capture Facility

Wetlands

There are no wetlands located within the land area proposed for construction of the CO_2 capture facility. The NWI shows only Smithers Lake located to the northwest of the W.A. Parish Plant, and another lake located to the southwest of the W.A. Parish Plant (USFWS 2011**a**). Any potential wetlands associated with these lakes would not be directly disturbed during construction; however, minor, indirect, short-term impacts of sedimentation could occur as a result of land grading activities. Sedimentation impacts would be minimized through implementation of the SWPPP required for NPDES permitting, which would include BMPs to control eroded sediments (e.g., use of filter fencing). Because no filling of wetlands is expected to be required at either the CO_2 capture facility, the DOE does not anticipate that a permit would be required from the USACE for this component of the proposed project.

Floodplains

The land area proposed for construction of the CO_2 capture facility and related infrastructure is located outside of FEMA 100-year and 500-year floodplains (FEMA 1985). No floodplain impacts are anticipated due to construction of the CO_2 capture facility.

3.8.3.1.2 Pipeline Corridor

Wetlands

Estimated areas of wetlands that could be impacted during construction activities within the pipeline construction ROW are listed by wetland type in Table 3.8-5. Individual palustrine wetlands are shown in Appendix D-1 and listed in Appendix D-2. Additional information regarding riverine areas is provided in Section 3.7 of this EIS (Surface Waters). Impacts to large riverine features and any adjacent wetlands would be avoided through the use of HDD. As discussed in Section 2.3.3.3 of this EIS, NRG's current project design would use HDD construction techniques in **six** sections of the proposed pipeline corridor, including the section between the CO_2 capture facility and the CenterPoint ROW, **and five crossings of waterbodies** (i.e., Big Creek, San Bernard River, Colorado River **and** Jones Creek **[as one HDD]**, Lavaca River**, and Menefee Bayou)**. HDD construction techniques would minimize surface disturbances between the entry and exit points. Impacts to palustrine scrub-shrub and palustrine forested wetlands are also expected to be avoided to the extent practicable by HDD or reductions in the construction corridor to limit any permanent impacts to these wetland types to less than 0.1 acre per crossing.

During construction, the construction ROW would be cleared of woody vegetation and the ground surface would be disturbed, primarily by the movement of equipment, digging of trenches, and stockpiling of excavated soils. These activities would cause soil disturbances and compaction, which could alter wetland hydrology. Within riverine wetlands, the temporary disturbances would represent minor, direct short-term impacts.

Table 3.8-5. Estimated Wetland Impacts from Pipeline Construction

Type	Total Wetlands Delineated (acres)	Estimated Temporary Wetland Impacts (acres)	Estimated Permanent Wetland Impacts (acres)	Estimated Wetland Impacts Avoided* (acres)
Palustrine emergent	**79.4**	**69.5**	**1.2**	**8.7**
Palustrine scrub-shrub	2.2	0	2.2	0
Palustrine forested	**0.3**	0	**0.3**	0
Riverine	**8.7**	**5.3**	0	3.4
Drainage ditch	**5.8**	**5.8**	0	0
Total	**96.4**	**80.6**	**3.7**	**12.1**

* Impacts to large riverine features and any adjacent wetlands would be avoided through the use of HDDs.

Within the pipeline corridor, no proposed activities would permanently place fill material into wetlands or waters of the U.S. NRG plans to locate main line valves (MLVs) in upland areas to the extent practicable; however, if a valve must be located in a wetland area, the impact would be limited to an approximate 100-square-foot area (i.e., approximately 10 feet by 10 feet). Should this occur, the 100-square-foot area would be considered filled (i.e., the wetland area would no longer function as a wetland). The two proposed meter stations would be located in upland areas and there are no other planned aboveground facilities associated with the proposed CO_2 pipeline. The placement of pipeline location markers or cathodic protection test posts in wetland areas, if required, would result in negligible wetland impacts since each post/marker would result in less than one square foot of impact. Overall, the majority of pipeline construction impacts to wetlands would be temporary and minor, consisting of short-term disturbances during pipeline construction. Per USACE permitting requirements, the pipeline construction ROW would be restored to its pre-construction contours following construction activities. Based on the current project design and field survey data collected to date, DOE anticipates that the proposed pipeline corridor would meet the criteria for permitting under NWP 12. Therefore, to obtain authorization for construction from the USACE, NRG would likely be required to submit an application to the Galveston District in the form of a pre-construction notification (PCN) to obtain verification that NWP 12 applies to the proposed project (i.e., the pipeline corridor).

In wetland areas, topsoil would be stored separately (i.e., segregated) from other excavated material. In general, NRG would attempt to reduce the width of the construction ROW in wetland areas from 100 feet to 75 feet. However, since NRG would be collocating the proposed pipeline with a number of other utilities and would be required to maintain an adequate distance from its construction activities to those existing utilities, NRG's options to minimize wetland impacts may be limited in some areas. If a reduction in ROW width to 75 feet achieves only minor reductions in wetlands impacts (e.g., less than 0.01 acre) or in areas where topsoil may be inundated, and therefore difficult to segregate effectively in a 75-foot-wide ROW, NRG plans to use a 100-foot-wide construction ROW along with topsoil segregation and/or use of timber mats or low ground pressure equipment, as discussed below, to minimize wetland impacts.

Following construction, the beds, banks, and contours of riverine features would be restored to preexisting conditions to the extent practicable as required by permit conditions. Following trench digging and pipeline installation in wetland areas, excavated wetland soils would be backfilled into the trenches so that the deepest soils excavated are returned as the deepest soils backfilled. This method of wetland soil backfilling would help maintain pre-construction wetland soil characteristics following construction. In riverine wetlands, the original substrates of the features would be returned to the channels at the surface to restore the preexisting river beds of these features. In palustrine wetlands, topsoil would be returned at the surface to promote revegetation of disturbed areas and to restore the preexisting soil conditions.

Within palustrine scrub-shrub and forested wetlands, additional impacts could consist of wetland type conversions. Common type-conversion impacts, identified as the conversion from one wetland type into another (i.e., primarily forested and scrub-shrub wetland conversion into emergent systems with herbaceous vegetation), would occur within the construction ROW. The potential for conversion would occur due to the removal of woody vegetation within the construction ROW, which does not involve the removal of below ground biomass (i.e., roots) or disturbance of soil below the surface. Initially, wetlands would either be converted from one vegetative class into another or to an un-vegetated, bare-soil state due to construction-related surface disturbances (e.g., equipment movement). Palustrine emergent wetlands could be temporarily affected if turned into a bare soil state. Herbaceous emergent vegetation in previously disturbed areas (i.e., mowed and maintained areas within existing utility ROWs) would reestablish to its current condition quickly, likely within one growing season. In undisturbed areas, reestablishing herbaceous emergent vegetation to its current condition may take up to approximately three years.

Except in cultivated fields, unless requested by the landowner, areas of disturbed soil along the pipeline construction ROW would be planted following construction with an appropriate mix of seeds for perennial grasses and forbs native to the area, as requested by the TPWD in its March 20, 2012 letter to DOE, or with a seed mixture requested by the landowner to reduce the potential for soil erosion and establishment of invasive plant species. Depending on the season in which construction is completed, NRG may also seed with a cold-weather annual grass species, such as Gulf Coast ryegrass (*Lolium multiflorum*), to establish a temporary vegetative cover until conditions become favorable for growth of perennial grasses and forbs.

Within the permanent, 30-foot-wide ROW, scheduled mowing and vegetation clearing may result in a permanent conversion of wetland cover types. Within the portions of construction ROW outside of the permanent ROW, permanent wetland type conversions would not occur; however, the type conversion impacts would be considered long term, especially in forested areas, as it could take a considerable length of time for the vegetation to reestablish. Consequently, the types and magnitude of wetland functions would change. Typical examples of changed wetland functions could include alterations to wildlife habitat, flood flow attenuation, and sediment stabilization and retention functions.

Overall, minor direct impacts to palustrine wetlands would be expected as impacts to palustrine scrub-shrub and palustrine forested wetlands would be avoided to the extent practicable, and palustrine emergent wetlands would either be avoided or restored to pre-construction contours. Prior to construction, NRG would be responsible for obtaining a USACE NWP 12 verification from the Galveston District for authorization to construct the pipelines through wetland areas that would be considered waters of the U.S. The NWP 12 pre-construction notification would include a brief mitigation plan that would summarize the mitigation measures that NRG would take to reestablish wetland areas following construction, including reestablishment of pre-construction contours and wetland vegetation within the pipeline construction ROW.

NRG plans to redesign the additional temporary work space area near MP 0.0 to avoid the 0.23 acres of permanent impacts to the palustrine forested wetland identified as 042412_Z_1_PFO1 or to minimize impacts in that area to less than 0.1 acre. In the three other palustrine forested wetlands that have been delineated (i.e., near MP 0.2, 20.1, and 24.0), permanent impacts would be less than 0.1 acres. Regarding the three palustrine scrub-shrub wetlands that would be impacted by project construction (i.e., near MP 12.6, **51.6**, and **51.9**), the USACE Galveston District generally categorizes the temporary conversion of scrub-shrub wetlands into emergent systems as temporary impacts not requiring compensatory mitigation. NRG would mitigate impacts to these scrub-shrub wetlands during construction by leaving roots intact during clearing to the extent practicable. In wetlands where soft soil conditions would cause rutting from construction equipment greater than approximately six inches in depth, NRG would lay timber mats or use low ground pressure equipment to protect the root structures of wetland vegetation. **The potential permanent impacts to palustrine emergent wetlands shown in** Table 3.8-5 **would be due to improving access roads by widening existing access roads that are adjacent to wetlands. These potential wetland impacts would be avoided by limiting improvements to these access roads to within the existing road footprint in areas with adjacent wetlands.**

Under NWP 12, wetland impacts are assessed separately for each "single and complete project." In this context, single and complete project does not refer to the entire Parish PCCS Project. **The USACE defines a single and complete linear project as follows (USACE 2012):**

> **A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term "single and complete project" is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the United States (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for purposes of NWP authorization. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.**

The USACE requires compensatory mitigation, which generally includes establishment of new wetlands outside of the construction ROW to compensate for the filling of wetlands or loss of wetland function within the construction ROW, for permanent wetland impacts greater than 0.1 acres per **single and complete project**. Based on the current project design and field survey data collected to date, DOE does not anticipate that any compensatory mitigation would be required for NRG's proposed project. However, if **unavoidable** permanent impacts were to exceed 0.1 acres in **any single and complete project**, NRG would **use a functional assessment to determine the magnitude of the impacts and create a mitigation plan to fully compensate for the loss of wetland function. Mitigation options include purchasing** credits from a wetland mitigation bank or **working** with the USACE to fund a project (or projects) to create or improve the function of wetlands in the same watershed as the impacted wetland area.

<u>Floodplains</u>

The pipeline route would cross FEMA 100-year and 500-year floodplains in **25** locations (Table 3.8-3). During construction there may be minor direct temporary impacts to floodplain areas caused by the installation of the pipeline. Construction of the pipeline through small stream crossings would likely be performed using an excavated trenching method, and larger waters would be crossed by HDD. Five **crossings of waterbodies would be done using HDD construction techniques** (i.e., Big Creek, San

Bernard River, Colorado River **and** Jones Creek **[as one HDD], Menefee Bayou,** and Lavaca River)**.** Floodplain impacts in these areas, if any, would be confined to the work areas around the HDD entry and exit points. For other waterbody crossings, the excavated trenching method would include development of a diversion channel, with appropriate sediment controls in place (e.g., filter fencing and riprap), to maintain stream flow. The pipeline trench would be approximately three feet deep and five feet wide. Trench development within the streambed and adjacent floodplain itself would not be expected to increase flood hazards in the area because the trenches would not cause an increase in flood elevations and the diversion channels would be in place to maintain stream flow. However, the temporary presence of construction equipment and spoil piles would cause a minor temporary direct impact of placing materials within the floodplain that could redirect flood flows in the event a flooding incident occurred during construction in the floodplain. It is not expected that this impact would reach a level of endangering human health or property or conflict with any state, local, or federal floodplain ordinances as equipment and soil piles would be contained within the construction ROW and would represent relatively small, short-term obstructions as compared to the overall area of the floodplain. In addition, construction personnel would monitor weather forecasts in the area and, if a large storm were anticipated to occur while equipment was located in the floodplain, would move the equipment out of the floodplain prior to any incidents of flooding. Following installation of the pipeline, excavated soils would be backfilled into the trench and disturbed land areas and streambeds would be returned to the original topography to the extent practicable. Exposed soil areas would be revegetated, as discussed above, to reduce the potential for soil erosion and establishment of invasive plant species.

Five main line valves would be constructed within the FEMA 100-year floodplain in Wharton County (i.e., in the floodplains of Blue Creek**,** Jones Creek**, and the Colorado River**). Each valve would have an approximately 10-foot by 10-foot concrete base. Changes to the flood elevation or the flow of water in the floodplain as a result of these valves would be negligible. Negligible impacts to the floodplain are anticipated as a result of installation of the valves. The placement of pipeline location markers or cathodic protection test posts in floodplain areas, if required, would result in negligible impacts to floodplains since each post/marker would result in less than one square foot of impact. Consultation would be conducted with the Wharton County floodplain administrator and all applicable ordinances would be followed. No other aboveground facilities associated with the proposed CO_2 pipeline are planned within 100-year or 500-year floodplain areas.

3.8.3.1.3 West Ranch Oil Field

Wetlands

As indicated in Figure 3.8-4 and Table 3.8-4, there are a total of 1,556 acres of wetlands identified by the NWI within the proposed EOR area at the West Ranch oil field. Existing wells would be used (i.e., refurbished or deepened as needed) to the extent practicable to minimize the number of new wells required for EOR and CO_2 monitoring. New injection wells would be drilled if the existing wells cannot be reworked for injection. New wells would be installed on existing well pads to the extent practicable. Additionally, existing piping corridors and access roads would be used to the extent practicable to minimize impacts from construction activities at the West Ranch oil field. Existing access roads and well pad sites are not expected to contain wetlands, and any new construction areas would be evaluated for the presence of wetlands prior to construction. If proposed construction areas contain wetlands, construction plans would be revised or rerouted through upland areas, if possible, or otherwise designed to avoid or minimize wetland impacts (e.g., conducted using low ground pressure equipment or timber mats). If impacts to wetlands are not avoidable, the construction would be performed under a separate NWP, as applicable. The CO_2 recycle facility would be built in an area of the West Ranch oil field that was previously occupied by an oil field gas processing facility, which was demolished by HEC in 2011. Based on NWI maps and site observations, there are no wetlands located within the area proposed for the CO_2

recycle facility (USFWS 2011**a**). Based on the use of existing oil field areas (i.e., existing well pads, piping corridors, and access roads), the DOE anticipates that any impacts to wetlands associated with construction in the proposed West Ranch oil field EOR area would be similar to impacts from construction activities currently conducted as part of existing operations at the West Ranch oil field.

Construction activities may result in increased sediment loading to downstream wetlands from stormwater runoff. These potential impacts would be minimized through implementation of a SWPPP, which would include BMPs to control eroded sediments (e.g., use of silt fencing), as discussed in Section 3.5 of this EIS (Physiography and Soils). Therefore, negligible wetlands impacts are anticipated due to construction in the proposed West Ranch oil field EOR area. Because no filling of wetlands or waters of the U.S. is expected to be required within the proposed EOR area, the DOE does not anticipate that a permit would be required from the USACE for construction activities in the West Ranch oil field. If construction is required in a wetland area and impacts to wetlands are not avoidable, the construction would be performed under a separate NWP, as applicable.

Floodplains

As discussed above regarding wetlands, the DOE anticipates that any impacts to floodplains associated with construction in the proposed West Ranch oil field EOR area would be similar to impacts from construction activities currently conducted as part of existing West Ranch oil field operations. The proposed CO_2 recycle facility would be located outside of the FEMA 100-year floodplain. The northeastern portion of the approximately 16-acre area in which the CO_2 recycle facility would be located includes less than 0.01 acre of the 500-year floodplain and is approximately 100 feet west of the 100-year floodplain; the southwestern edge of the facility is approximately 400 feet east of the 100-year and 500-year floodplains. As no new aboveground features in the proposed West Ranch oil field EOR area would be located in the 100-year floodplain, the DOE anticipates that no impacts to floodplains would occur due to construction activities at the West Ranch oil field.

3.8.3.2 Operational Impacts

3.8.3.2.1 CO_2 Capture Facility

Wetlands

There are no wetlands located within the land area proposed for the CO_2 capture facility and its supporting infrastructure. Therefore, no impacts to wetlands would occur as a result of CO_2 capture facility operations.

Floodplains

The land areas proposed for the CO_2 capture facility and its supporting infrastructure are located outside of the FEMA 100-year floodplain (FEMA 1985). Therefore, no impacts to the floodplain would occur as a result of CO_2 capture facility operations. The nearest floodplain to the CO_2 capture facility is the Smithers Lake floodplain, located approximately 50 feet to the north.

3.8.3.2.2 Pipeline Corridor

Wetlands

Table 3.8-6 presents the areas of delineated wetlands that would be contained within the 30-foot permanent ROW of the pipeline route. **The** total acreage of wetland areas within the permanent ROW **is**

approximately 31.3 acres. The majority of impacts to wetlands would result from the construction activities already described. Individual palustrine wetlands are shown in Appendix D-1 and listed in Appendix D-2.

Table 3.8-6. Summary of Delineated Wetlands within 30-foot Permanent ROW

Wetland Type	Delineated Wetlands in 30-foot Permanent ROW (acres)
Palustrine emergent	**26.1**
Palustrine scrub-shrub	0.7
Palustrine forested	**< 0.1**
Riverine	2.6
Drainage ditch	1.9
Total	**31.3**

Within palustrine wetlands, localized permanent impacts would consist of wetland type conversions as described for construction activities within the permanent ROW (approximately 30 feet wide). The potential for conversion would occur due to the continual clearing of woody vegetation within the permanent ROW, which does not involve the removal of below ground biomass (i.e., roots) or disturbance of soil below the surface. Maintaining the ROW free of woody vegetation is necessary to preserve access to the ROW for pipeline inspection and maintenance activities, and as prescribed for any collocated utilities in the ROW. Initially, wetlands would be converted from one vegetative class into another in forested and scrub-shrub palustrine wetlands, though emergent wetlands with herbaceous vegetation would generally be maintained in their present state, as herbaceous vegetation would likely be able to persist to some degree. However, continual mowing of the ROW would limit the sizes to which plants could grow and could make these areas unsuitable for some existing species. Consequently, within all affected palustrine wetlands, the types and magnitude of wetland functions would likely change. Typical examples of changed wetland functions could include alterations to wildlife habitat, flood flow attenuation, and sediment stabilization and retention functions. These changes could be considered a diminishing of wetland value in some respects (e.g., converting a forested wetland to grassland may reduce an area’s long term ability to absorb water after a flood event); however, they can also increase wetland value in some respects (e.g., providing habitat for grassland or forest edge wildlife, such as grassland birds and many bat species). Minor direct permanent impacts to palustrine wetlands would be expected as impacts to palustrine emergent wetlands would be similar to their current condition, and impacts to palustrine scrub-shrub and palustrine forested wetlands would be avoided to the extent practicable.

There would be no permanent filling of wetland areas associated with pipeline operations; however, the movement of vehicles and heavier equipment (e.g., backhoes) through palustrine wetlands during pipeline maintenance activities (e.g., replacing a section of pipe that is located within a wetland area) could cause compaction of wetland soils or result in temporary filling of wetlands (e.g., a spoil pile for a maintenance activity within a wetland area) in some locations, which could cause a minor direct impact by altering wetland hydrology. To the extent practicable, TCV, the operator of the proposed pipeline, would avoid having vehicles or heavy equipment traverse palustrine wetlands. Additionally, TCV would avoid traversing riverine wetlands with vehicles or heavy equipment, to the extent practicable, because of the need to maintain the bed and bank morphologies of these features. In the event that a section of pipeline that is located within a wetland required maintenance that necessitated excavation to expose the pipe, the impacts would be the same as those described under Section 3.8.3.1.1. This type of activity would not result in permanent impacts to wetlands, but may result in temporary wetland impacts. If necessary, these activities would be conducted under a separate USACE permit (e.g., NWP 5 for maintenance activities).

Floodplains

The pipeline route would cross FEMA 100-year and 500-year floodplains in **25** locations (Table 3.8-3). Following construction, floodplain, and streambed areas disturbed during pipeline installation would be restored to the original topography to the extent practicable. The only aboveground features that would be in the floodplain would be pipeline location markers and cathodic protection test posts, if required in floodplain areas, and three main line valves. These new permanent features would cause negligible changes to flood elevations or redirection of flood flows. Therefore, negligible impacts to floodplains would occur during operations of the proposed CO_2 pipeline.

3.8.3.2.3 West Ranch Oil Field

Wetlands

As indicated in Figure 3.8-4 and Table 3.8-4, there are a total of 1,556 acres of wetlands identified by the NWI within the proposed EOR area at the West Ranch oil field. Operations activities at the West Ranch oil field related to these EOR and CO_2 monitoring facilities would be conducted using existing wells, well pads, piping corridors, and access roads to the extent practicable. If proposed operational areas contain wetlands, operations and maintenance activities would be relocated to upland areas, if possible, or otherwise designed to avoid or minimize wetland impacts (e.g., conducted using low ground pressure equipment or timber mats). Additionally, the CO_2 recycle facility would be located in an area of the West Ranch oil field that was previously occupied by an oil field gas processing facility, which was demolished by HEC in 2011. Based on NWI maps and site observations, there are no wetlands within the approximately 16-acre area in which the proposed CO_2 recycle facility would be located (USFWS 2011**a**). Therefore, the DOE anticipates that any impacts to wetlands associated with operations in the proposed West Ranch oil field EOR area would be similar to impacts from current operations and maintenance activities at the West Ranch oil field.

Operations and maintenance activities may result in increased sediment loading to downstream wetlands from stormwater runoff. These potential impacts would be minimized through implementation of a SWPPP, which would include BMPs to control eroded sediments (e.g., use of silt fencing), as discussed in Section 3.5 of this EIS (Physiography and Soils). Therefore, negligible wetlands impacts are anticipated due to operations in the proposed West Ranch oil field EOR area.

Floodplains

As discussed above regarding wetlands, the DOE anticipates that any impacts to floodplains associated with operations and maintenance activities in the proposed West Ranch oil field EOR area would be similar to impacts from construction activities currently conducted as part of existing West Ranch oil field operations. Maintenance activities would not require placing any fill within the 100-year or 500-year floodplain. The proposed CO_2 recycle facility would be located outside of the FEMA 100-year floodplain. The northeastern portion of the approximately 16-acre area in which the CO_2 recycle facility would be located includes less than 0.01 acre of the 500-year floodplain and is approximately 100 feet west of the 100-year floodplain; the southwestern edge of the facility is approximately 400 feet east of the 100-year and 500-year floodplains. As no new aboveground features in the proposed West Ranch oil field EOR area would be located in a floodplain, the DOE anticipates that no impacts to floodplains would occur due to operations and maintenance activities at the West Ranch oil field.

3.8.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost- shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to wetlands or floodplains.

3.9 BIOLOGICAL RESOURCES

3.9.1 Introduction

This section identifies and describes the biological resources potentially affected by the construction and operation of the proposed Parish PCCS Project. This section also analyzes the potential effects of this project on these resources.

3.9.1.1 Region of Influence

The ROI for biological resources includes the CO_2 capture facility, the approximately **81-**mile-long pipeline corridor, and the approximately 5,500-acre EOR area at the West Ranch oil field. A total of approximately 29 acres within the existing W.A. Parish Plant boundaries would be used during construction of the proposed CO_2 capture facility. The pipeline construction ROW is generally 100 feet in width, but would be reduced to a width of 75 feet in some areas where practicable to minimize impacts to wetlands. The total area of the pipeline construction ROW, which includes ATWS that may extend outside the typical 100-foot-wide construction ROW, is approximately **1,197** acres. The permanent pipeline ROW would be approximately 30 feet wide. The proposed EOR area at the West Ranch oil field includes a central CO_2 recycle facility that would be approximately 250 feet by 250 feet (1.5 acres) in size.

3.9.1.2 Method of Analysis

The following information was considered for this analysis regarding aquatic and terrestrial habitats and biota that may be affected by the proposed project: consultation with USFWS and TPWD; review of available lists and databases of protected species and habitats, including the TPWD's Texas Natural Diversity Database (TXNDD); NatureServe Explorer Ecological System records; and invasive species databases, including the Early Detection & Distribution Mapping System developed by the University of Georgia – Center for Invasive Species and Ecosystem Health. In addition, **over 99**% of the pipeline construction ROW was surveyed on foot from January through **November** 2012, as discussed in Section 3.8 of this EIS (Wetlands and Floodplains), to observe ecological conditions within the ROI. Plant communities were recorded, and the potential for the occurrence of threatened and endangered species or presence of their habitat was assessed. This information was used to provide a holistic view of the potentially affected environment in terms of the vegetative and aquatic communities, species, and habitats present.

Quantitative estimates of potential impacts were calculated using GIS and land cover data. Qualitative assessments were made based on the potential effects to species and habitats from expected attributes of the project.

3.9.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to biological resources based on whether the proposed Parish PCCS Project would directly or indirectly:

- cause substantial loss of vegetation communities and distribution of vegetation within the ROI (e.g., unique communities not in regional abundance, tracts of non-fragmented forested habitat);
- cause a decline in native wildlife populations;
- promote the spread of invasive, non-native species;

- degrade biological habitat or interfere with the movement of native or migratory terrestrial or aquatic species;
- encroach on or degrade critical or protected habitat for sensitive, threatened, or endangered species;
- violate federal or related state regulations, including the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act, and EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds;
- conflict with applicable management plans for wildlife and/or wildlife habitat, including aquatic communities;
- alter drainage patterns and fish species movement;
- diminish the value of habitat for fish species and native fish populations;
- cause loss of wetland habitat; or
- indirectly affect biological resources (e.g., noise, population fragmentation, traffic).

3.9.2 Affected Environment

The following section provides a general description of terrestrial and aquatic habitats, typical species present, and the potential for protected species to occur within the ROI. Sections 3.9.2.2 through 3.9.2.4 provide more detailed descriptions of these resources within the CO_2 capture facility, pipeline corridor, and West Ranch oil field, respectively.

3.9.2.1 Terrestrial Vegetation and Habitats

The ROI is located within the Western Gulf Coastal Plain EPA Level III Ecoregion (EPA 2012c). This ecoregion is described as follows:

> The principal distinguishing characteristics of the Western Gulf Coastal Plain are its relatively flat coastal plain topography and mainly grassland potential natural vegetation. Inland from this region the plains are older, more irregular, and have mostly forest or savanna-type vegetation potentials. Largely because of these characteristics, a higher percentage of the land is in cropland than in bordering ecological regions. Urban and industrial land uses have expanded greatly in recent decades, and oil and gas production is common.

The U.S. National Vegetation Classification System and land cover data (NatureServe 2012) were used to characterize the terrestrial vegetation communities and habitats within the ROI. This system was developed by The Nature Conservancy and NatureServe in collaboration with partners from the academic, conservation, and government sectors. This system provides consistent classification on a scale fine enough to be useful for the conservation of specific sites and has been adopted by the Federal Geographic Data Committee for use by all U.S. federal agencies.

The ROI supports two broad categories (or systems) of vegetation communities: natural systems (e.g., forested, riparian/floodplain) and human altered/disturbed systems (i.e., agricultural, developed land, and existing maintained ROW). Sections 3.9.2.1.1 through 3.9.2.1.5 below describe typical vegetation and habitat associated with these two broad systems, including each system’s associated vegetation communities based on the U.S. National Vegetation Classification System (NatureServe 2012). The distribution percentage of these systems within the ROI is presented in Sections 3.9.2.2 through 3.9.2.4. Recent aerial photography (i.e., from 2011) was used to delineate existing utility ROWs.

Some of the plant communities defined by the U.S. National Vegetation Classification System that are mapped within the ROI are included in the TPWD Rare Plant Community List (TPWD 2012f). The list was developed for the revised Texas Conservation Action Plan, and defines 210 natural community types. Each community type is given a global (range-wide) and state rank based on their respective rarity. The conservation status of a plant community is designated by a number from one to five, preceded by a letter reflecting the appropriate geographic scale (G=Global, S=State). Numbers have the following meaning: 1) critically imperiled, 2) imperiled, 3) vulnerable, 4) apparently secure, and 5) secure.

3.9.2.1.1 Natural Systems

The ROI includes the following natural systems (NatureServe 2012), as indicated in the map series in Appendix D-3:

- **Atlantic and Gulf Coastal Plain Freshwater Tidal Marsh –** This ecological system includes tidal marshes strongly influenced by freshwater. These areas typically represent small patches along bay margins near the mouths of inflowing rivers from Galveston Bay in Chambers County, Texas, south to approximately Corpus Christi Bay. **This community is not listed in the TPWD Rare Plant Community List.**
- **Central and South Texas Coastal Fringe Forest and Woodland –** This system includes oak-dominated forests woodlands, shrublands and savannas. Topography varies from larger dunes to smaller ridges and swales. Vegetation of this physiognomically variable and dynamic system primarily includes patches (mottes) of forests, woodlands and shrublands dominated by Texas live oak (*Quercus fusiformis*). Associated species vary in a north/south manner across the range of this system. **This community is listed in the TPWD Rare Plant Community List as G2 and S2.**
- **Central and Upper Texas Coast Dune and Coastal Grassland** – This system consists of wetland and upland herbaceous and shrubland vegetation of barrier islands and near-coastal areas in the northern Gulf of Mexico along the upper Texas coast, at least to Galveston Bay. Plant communities of primary and secondary dunes, interdunal swales and adjacent mainland are included. Salt spray, saltwater overwash, and sand movement are important ecological forces. **This community is listed in the TPWD Rare Plant Community List as G2 and S1.**
- **Open Water** – Areas of standing water that are either unvegetated or have only submergent vegetation. **This community is not listed in the TPWD Rare Plant Community List.**
- **Tamaulipan Calcareous Thornscrub –** This xeric thornscrub ecological system is restricted to areas along the Bordas Scarp in southern Texas and northeastern Mexico. It has a shorter, more open shrub canopy (usually less than 2 meters) when compared to more typical thornscrub growing on more favorable sites. However, shrub cover is generally greater than 70% and often greater than 85%. Dominant species include Cenizo[1] (*Leucophyllum frutescens*), Guajillo (*Acacia berlandieri*), and Huisache (*Acacia farnesiana*) with many other shrub species that may be locally dominant. The sparse to moderately dense herbaceous layer is dominated by perennial graminoids. **This community is listed in the TPWD Rare Plant Community List as G3 and S1S2.**
- **Tamaulipan Mesquite Upland Scrub** – This ecological system occurs throughout much of the lower Rio Grande plains and plateaus of northeastern Mexico and southern Texas. It is dominated by thorn scrub that was limited to rocky, broken uplands and drainages. The vegetation is

[1] Common names from UT LBJWC 2012.

characterized by an open to dense tall-shrub layer dominated or codominated by Honey mesquite (*Prosopis glandulosa*) with many other species present to codominate. The herbaceous layer is generally sparse, but dense graminoids may dominate the herbaceous layer of stands with open shrub canopies or remnant patches of savanna. **This community is not listed in the TPWD Rare Plant Community List.**

- **Tamaulipan Mixed Deciduous Thornscrub –** This thornscrub ecological system occurs throughout much of northeastern Mexico and southern Texas. It occurs on a variety of substrates and landforms. Dominant species include Roundflower catclaw (*Acacia roemeriana*), Cenizo, and Honey mesquite. **This community is listed in the TPWD Rare Plant Community List as G3 and S2.**
- **Texas Saline Coastal Prairie –** This system encompasses grassland vegetation occurring on saline soils that are often saturated by local rainfall and periodically flooded by saline waters during major storm events. It is located along the Gulf Coast of Texas. Saline prairie continues to occupy extensive areas, though quality of the system is often degraded by the invasion of woody shrubs due to the absence of regular fire. This system is characteristically dominated by Gulf cordgrass (*Spartina spartinae*). This system includes depressions often dominated by Marsh-hay cord grass (*Spartina patens*). **This community is listed in the TPWD Rare Plant Community List as G1 and S1.**
- **Texas-Louisiana Coastal Prairie –** This system encompasses non-saline tallgrass prairie vegetation ranging along the coast of Louisiana and Texas. It is often characterized by a ridge-and-swale or mound-and-intermound microtopography and encompasses both upland and wetland plant communities. Upland dominants include Little bluestem (*Schizachyrium scoparium*), Brownseed paspalum (*Paspalum plicatulum*), Indiangrass (*Sorghastrum nutans*), and Big Bluestem (*Andropogon gerardii*). Wetland dominants in undisturbed occurrences include Switchgrass (*Panicum virgatum*) and Eastern gamagrass (*Tripsacum dactyloides*); disturbed occurrences may be dominated by Bushy bluestem (*Andropogon glomeratus*). **This community is listed in the TPWD Rare Plant Community List as G1 and S1.**
- **Texas-Louisiana Coastal Prairie Slough –** This system includes small streams and sloughs that course through the coastal prairie in Louisiana and Texas. They are typically wooded, in contrast to the adjacent prairie. Species composition varies with latitude and longitude, with eastern species being replaced by western ones in drier landscapes. This system is found in the coastal prairie region of Louisiana and Texas. Common species include: Brownseed paspalum, Little bluestem, and Goldenrod (*Solidago spp*). The introduced species Chinese tallow (*Triadica sebifera*) has become especially problematic, forming dense thickets or forests. **This community is not listed in the TPWD Rare Plant Community List.**
- **West Gulf Coastal Plain Large River Floodplain Forest –** This system represents a geographic subset of the Southern Floodplain Forest found west of the Mississippi River. Examples may be found along large rivers of the West Gulf Coastal Plain and Upper West Gulf Coastal Plain. Several distinct plant communities can be recognized within this system that may be related to the array of different geomorphic features present within the floodplain. Vegetation generally includes forests dominated by bottomland hardwood species and other trees tolerant of flooding, including bald-cypress and water tupelo. However, herbaceous and shrub vegetation may be present in certain areas as well. **This community is listed in the TPWD Rare Plant Community List as G3G4 and S3S4.**
- **West Gulf Coastal Plain Small Stream and River Forest –** This is a predominantly forested system of the West Gulf Coastal Plain associated with small rivers and creeks. In contrast to West Gulf Coastal Plain Large River Floodplain Forest, examples of this system have fewer major geomorphic floodplain features. Bottomland hardwood tree species are typically important and

diagnostic, although mesic hardwood species are also present in areas with less inundation, such as upper terraces and possibly second bottoms. As a whole, flooding occurs annually, but the water table usually is well below the soil surface throughout most of the growing season. **This community is listed in the TPWD Rare Plant Community List as G2 and S2.**

The natural vegetation communities described above provide the greatest amount of wildlife habitat diversity in the ROI due to the lower amounts of human disturbance and higher diversity of native plant species. As a result, these areas would be anticipated to support the greatest biological diversity in the ROI. Please refer to Section 3.8 of this EIS (Wetlands and Floodplains) for analysis of wetland- and floodplain-influenced systems.

3.9.2.1.2 Human Altered/Disturbed Systems

The ROI includes the following systems that have been altered or disturbed by human activities (NatureServe 2012)**; none of these communities are included in the TPWD Rare Plant Community List (TPWD 2012f)**:

- **Agriculture – Cultivated Crops and Irrigated Agriculture** – This system contains areas used for the production of crops, such as rice, cotton, and sugarcane, typically on an annual cycle. Agricultural plant cover is variable depending on season and type of farming. Other areas include more stable land cover of orchards and vineyards.
- **Agriculture – Pasture/Hay** – This system includes agricultural lands that typically have perennial herbaceous cover used for livestock grazing or the production of hay. There are obvious signs of management, such as irrigation and haying, that distinguish these areas from natural grasslands.
- **Developed, Low Intensity** – This system includes areas with a mixture of developed settings and vegetation. Impervious surfaces account for 20% to 50% of total cover. These areas most commonly include single-family housing units.
- **Developed, Open Space** – This system includes vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Impervious surfaces account for less than 20% of total cover. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.
- **Introduced Wetland Vegetation – Treed –** This system includes forested wetlands with semi-natural vegetation. This includes areas where wetland tree species have been planted.
- **Modified/Managed Southern Tall Grassland –** This system includes areas vegetated primarily with grasses that are managed to exclude woody species.
- **Successional Shrub/Scrub –** This system includes areas that have been previously disturbed and are in the process of revegetating to woody species.
- **Non-Specific Disturbed** – This system is defined in the NatureServe system as generic human alteration, no alteration type specified.
- **Ruderal Early Successional Grassland and Scrub/Shrub (i.e. Existing ROW)** – This system is not part of the NatureServe ecological land cover types; it was developed during this EIS analysis to categorize the existing utility ROWs that occur within the ROI. This classification includes areas that have experienced previous and ongoing vegetation control which involves a combination of clearing and herbicide application. Areas in agricultural use that are within the utility ROW are classified as agriculture. Clearing activities generally occur at least once every four years, but may be more frequent if necessary to maintain the reliability and performance of

the line. Between clearing periods, early successional communities, including grassland and scrub/shrub, become established within the ROWs. Due to past disturbance, these areas are generally characterized by a combination of native species with areas of persistent exotic species. The early successional state of vegetation, along with the presence of exotic species, typically lowers the overall quality of habitat when compared to forested areas or natural open meadows. Compared to agricultural land and developed areas, existing ROW areas support a greater diversity of wildlife.

The mapped vegetation and habitats in the vicinity of the Parish PCCS Project are shown in the map series in Appendix D-3. Due to their small amount of cover near the project area, the following systems were combined into their National Vegetation Classification classes (in bold print below) in Appendix D-3:

- **Shrubland and Grassland** - Atlantic and Gulf Coastal Plain Freshwater Tidal Marsh, Central and Upper Texas Coast Dune and Coastal Grassland, Texas Saline Coastal Prairie, Texas-Louisiana Coastal Prairie, Texas-Louisiana Coastal Prairie Slough
- **Forest and Woodland** - Central and South Texas Coastal Fringe Forest and Woodland, Introduced Wetland Vegetation – Treed
- **Semi-desert** - Tamaulipan Calcareous Thornscrub, Tamaulipan Mesquite Upland, Tamaulipan Mixed Deciduous Thornscrub
- **Developed/disturbed** - Developed, Low Intensity; Non-Specific Disturbed

Human altered/disturbed systems typically have elevated levels of invasive and non-native (i.e., exotic) plant species. Not all exotic species are invasive; the more prone an exotic species is to spreading and proliferation over native species, the more invasive an exotic species is considered. EO 13112, *Invasive Species*, requires federal agencies, to the extent practicable and permitted by law, to prevent the introduction of invasive species; to provide for their control; and to minimize the economic, ecological, and human health impacts that invasive species cause.

According to the Early Detection & Distribution Mapping System database (University of Georgia 2012), 42 exotic plant species have been recorded in Fort Bend County, 14 exotic plant species in Wharton County, and 30 exotic plant species in Jackson County. Table 3.9-1 lists the exotic plant species observed within the ROI during the field survey conducted January 2012 to **November** 2012 and provides general characteristics of these species.

> **EO 13112, Invasive Species** defines invasive species as a species that is: 1) non-native (exotic) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Table 3.9-1. Exotic Plant Species Identified within the ROI

Common Name	Latin Name	Identification Method[a]	Characteristics
Chinese tallow	*Triadica sebifera*	Identified by TPWD and Observed in Field Studies	Chinese tallow is a deciduous tree reaching 60 feet in height and three feet in diameter. Leaves are alternate, heart-shaped, 2 to 3 inches long with a long, pointed tip. Flowering occurs from April to June. The flowers are yellowish and occur on dangling spikes. Three-lobed, greenish fruit are found in clusters at the end of branches. Chinese tallow invades wet areas such as stream banks and ditches but can also invade drier upland sites. Chinese tallow is a serious threat because of its ability to invade high quality, undisturbed forests. It can displace native vegetation as well as alter soil conditions due to the high amount of tannins present in the leaf litter. Chinese tallow is a native of China and was introduced into South Carolina in 1776 for ornamental purposes and seed oil production.
Bermuda-grass	*Cynodon dactylon*	Observed in Field Studies	Bermudagrass is a perennial grass that occurs on almost all soil types. This grass spreads by above ground and underground runners. Flowering occurs in late summer. Bermudagrass is native to eastern Africa and prefers moist and warm climates with high light. It was introduced into North America in the mid-1800s as a pasture grass. Bermudagrass is widely used as a turf grass.
Dallis-grass	*Paspalum dilatatum*	Observed in Field Studies	Dallisgrass is a perennial bunch grass forming dense, stiff clumps in the soil and spreading outward. It grows decumbent in a mat or erect to well over three feet tall. Its rapid growth and spreading rhizomes make it an invasive pest in Texas. Dallisgrass produces abundant amounts of seed, which are its primary means of dispersal.
Curly dock	*Rumex crispus*	Observed in Field Studies	Curly dock is a perennial flowering plant native to Europe and Western Asia. The mature plant is a reddish brown color, and produces a stalk that grows to about three feet high. It has smooth leaves shooting off from a large basal rosette, with distinctive waved or curled edges. On the stalk flowers and seeds are produced in clusters on branched stems. Curly dock grows in roadsides, all types of fields, and low-maintenance crops. It prefers rich, moist and heavy soils.
Japanese honey-suckle	*Lonicera japonica*	Identified by TPWD and Observed in Field Studies	Japanese honeysuckle is an evergreen to semi-evergreen vine that can be found either trailing or climbing to over 80 feet in length and invades a variety of habitats including forest floors, canopies, roadsides, wetlands, disturbed areas. Japanese honeysuckle can girdle small saplings by twining and around them, and it can form dense mats in the canopies of trees, shading everything below. A native of eastern Asia, it was first introduced into North America in 1806 in Long Island, NY. Japanese honeysuckle has been planted widely throughout the United States as an ornamental, for erosion control, and for wildlife habitat.

Table 3.9-1. Exotic Plant Species Identified within the ROI

Common Name	Latin Name	Identification Method[a]	Characteristics
Johnson-grass	*Sorghum halepense*	Observed in Field Studies	Johnsongrass is a tall (up to eight feet), rhizomatous, perennial grass that invades open areas throughout the United States. The two-foot-long, lanceolate leaves are arranged alternately along a stout, hairless, somewhat upward branching stem and have distinct, white midribs. Flowers occur in a loose, spreading, purplish panicle. Johnsongrass is adapted to a wide variety of habitats including open forests, old fields, ditches and wetlands. It spreads aggressively and can form dense colonies which displace native vegetation and restrict tree seedling establishment. Johnsongrass has naturalized throughout the world, but it is thought to be native to the Mediterranean region. It was first introduced into the United States in the early 1800s as a forage crop.
Macartney rose	*Rosa bracteata*	Observed in Field Studies	Macartney rose is an evergreen, thorny, climbing or trailing shrub that invades open, disturbed areas throughout the southern United States. Plants often grow in clumps. Stems are arching canes with recurved thorns. The alternate leaves are pinnately compound with serrated margins. Flowers are white with five petals and occur in small clusters from April to June. Fruit are small green to red rose hips and are present from July to December. Macartney rose can form dense, impenetrable thickets in open forests and pastures. Infestations restrict cattle and wildlife use of land and displace native species. Macartney rose is native to Asia and was first introduced into the United States as an ornamental.
Cogon grass	*Imperata cylindrica*	Identified by TPWD	Cogongrass is a perennial, colony-forming grass which can grow up to 6 feet tall. Leaves have an off-center, whitish midrib and finely serrated margins. Leaves are up to 6 feet long, 0.5 to 0.75 inches wide, stiff, and have a sharp, pointed apex. Rhizomes are whitish, branched, scaly and sharp at the tips. Cogongrass is best identified in the spring by the large fuzzy panicle of flowers and seeds, giving the plant a cottony or silky look. Flower heads are 2 to 8 inches long, silvery-white and cylindrical. Cogongrass is an extremely aggressive invader with the capability of invading a range of sites. It forms dense, usually circular infestations that exclude all other vegetation. Cogongrass is native to Southeast Asia and was accidently introduced into the southeast United States in packing material in the early 1900s. It was also intentionally introduced for erosion control and livestock forage.

Table 3.9-1. Exotic Plant Species Identified within the ROI

Common Name	Latin Name	Identification Method[a]	Characteristics
Chinese privet	*Ligustrum sinese*	Identified by TPWD	Chinese privet is a semi-evergreen shrub or small tree that grows to 20 feet in height. Trunks usually occur as multiple stems with many long, leafy branches. Leaves are opposite, oval, pubescent on the underside of the midvein and less than 2 inches long. Flowering occurs in late spring, when small, white flowers develop at the end of branches in 2 to 3 inches long clusters. Fruit are oval, fleshy, less than 0.5 inches long, ripen to a dark purple to black color and persist into winter. Several privet species occur and they are often hard to distinguish. Chinese privet commonly forms dense thickets in fields or in the understory of forests. It shades and out-competes many species and, once established, is very difficult to remove. Chinese privet was introduced into the United States in the early 1852 as an ornamental.
Deep-rooted sedge	*Cyperus entrerianus*	Identified by TPWD	Deeprooted sedge is a wetland sedge that invades disturbed areas throughout the southeastern United States. It is a robust, up to 40 inches tall, grass-like plant with deeply set, thick rhizomes and dark purple to black leaf bases. The leaves are basal, glossy, and flat or V-shaped. The terminal inflorescence has 5 to 11 elongate rays ending in densely clustered spikelets. Deeprooted sedge invades wet, disturbed areas such as highway ditches and field margins, where it can displace native vegetation. Construction, agricultural activities, and roadside mowing are spreading the seeds and dispersing this plant to new areas. Deeprooted sedge is native to South America and was accidentally introduced into the United States around 1990.
Purple loosestrife	*Lythrum salicaria*	Identified by TPWD	Purple loosestrife is a tall, multi-stemmed (30-50 per plant), perennial forb that can grow up to 10 feet in height. The opposite or whorled leaves are dark-green, lance-shaped, sessile, 1.5 to 4 inch long and round or heart-shaped at the base. Flowering occurs in July to October, when pink to purplish flowers develop in 4 to 16 inches long spikes at the tops of the stems. Flowers have 5 to 7 petals and twice as many stamens as petals. Fruits are capsules that are enclosed in the hairy sepals. Purple loosestrife is a serious invader of many types of wetlands, including wet meadows, prairie potholes, river and stream banks, lake shores, tidal and non-tidal marshes, and ditches. It can quickly form dense stands that displace native vegetation. Purple loosestrife can spread very rapidly due to its prolific seed production; one plant can produce as many as 2 million seeds per year. Purple loosestrife is native to Europe and Asia. It was first introduced into North America in the early 1800s for ornamental and medicinal purposes. It has also been used as a nectar plant for bee-keeping.

Source: Invasive Plant Atlas of the United States 2012.

[a] Species indicated as "Observed in Field Studies" were recorded during an overall characterization of vegetation within the ROI from January to **November** 2012. No detailed surveys were conducted regarding the identification, location and distribution of invasive species within the ROI. Species indicated as "Identified by TPWD" were identified by the TPWD in a March 20, 2012 letter to DOE as invasive species with potential to invade disturbed areas and/or portions of the project ROW.

Compared to natural systems, human altered/disturbed systems (i.e., agricultural land and developed areas) and existing ROW support less wildlife diversity. Wildlife found within these areas typically includes species adjusted to human disturbance, including raccoons (*Procyon lotor*), white-tailed deer (*Odocoileus virginianus*), striped skunks (*Mephitis mephitis*), coyote (*Canis latrans*), and various rodents (Order *Rodentia*) such as mice, shrew, and squirrels. These areas typically consist of fragmented or open grassland habitat, which is favorable for the mammal species mentioned above. The quality of bird species habitat with human altered/disturbed systems, such as developed portions within the W.A. Parish Plant property, is also generally considered less than that of natural systems. Many invasive bird species, such as rock pigeon (*Columba livia*) and European starling (*Sturnus vulgaris*) use this type of land. There are a few native grassland bird species that use croplands, such as the American crow (*Corvus brachyrhynchos*). Farmed areas offer fewer habitat options in terms of stopover habitat for migratory birds; however, they do provide forage during migration and winter to some species.

In its March 20, 2012 letter to DOE, TPWD recommended the following measures be taken to promote revegetation and control invasive species:

> For revegetation, TPWD recommends selection of species that are suited to the site conditions and intended uses and to consider native species that have multiple benefits and provide species diversity. Native perennial grass species recommended by TPWD for permanent cover include Switchgrass (*Panicum virgatum*), Eastern Gamagrass (*Tripsacum dactyloides*), Virginia Wildrye (*Elymus virginicus*), Canada Wildrye (*E. canadensis*), Yellow Indiangrass (*Sorghastrum nutans*) and Little Bluestein (*Schizachyrium scoparium*). Other species appropriate for the area can be found by accessing the TPWD Texas Plant Information Database. During the easement acquisition process, each landowner should be offered a native seed mix.
>
> To verify successful revegetation and to determine the need for additional restoration, TPWD recommends the applicant conduct at least two years of post-construction monitoring. In wetlands, TPWD recommends that vegetation be allowed to reestablish naturally with a three year monitoring plan to determine success. TPWD recommends that unsuccessful wetland revegetation be accompanied by active planting with native wetland herbaceous and woody plant species in consultation with a professional wetland ecologist.
>
> A revegetation and maintenance plan should be prepared to monitor and control invasive species within the construction and operation ROWs. Occurrences of [the Chinese tallow tree (*Triadica sebifera*), cogon grass (*Imperata cylindrica*), Chinese privet (*Ligustrum sinese*), deep-rooted sedge (*Cyperus entrerianus*), Japanese honeysuckle (*Lonicera japonica*), and purple loosestrife (*Lythrum salicaria*)] should be treated and controlled.

Except in cultivated fields, unless requested by the landowner, NRG would plant areas of disturbed soil along the pipeline construction ROW following construction with an appropriate mix of seeds for perennial grasses and forbs native to the area, as requested by the TPWD, or with a seed mixture requested by the landowner to reduce the potential for soil erosion and establishment of invasive plant species. Depending on the season in which construction is completed, NRG may also seed with a cold-weather annual grass species, such as Gulf Coast ryegrass (*Lolium multiflorum*), to establish a temporary vegetative cover until conditions become favorable for growth of perennial grasses and forbs.

3.9.2.1.3 Aquatic Habitats

Section 3.7 of this EIS (Surface Water) discusses the surface waters and water quality of streams that potentially support aquatic resources within the ROI. The tributary watersheds within the ROI are typified by low-gradient streams. **Perennial** surface water resources within the ROI include Big Creek, Mound

Creek, Buffalo Creek, Cedar Creek, the San Bernard River, Gardner Slough, the Colorado River, Jones Creek, Blue Creek, the Tres Palacios River, Juanita Creek, Moccasin Creek, West Carancahua Creek, and the Lavaca River. None of these surface waters are part of the National Wild and Scenic Rivers System. These streams have substrates that are sand or mud, with woody debris providing habitat for benthic species. Sandy substrates provide habitat for worms (subclass Oligochaeta), mayfly (order Ephemeroptera) and dragonfly (order Odonata) larvae, a few caddis (order Trichoptera) species, and sometimes larval lamprey (order Petromyzontiformes) (Hynes 1970). Mud substrates occur in areas that are often deficient in oxygen but high in organic matter, as is common within the ROI. Mud substrates provide habitat for burrowing mayflies, alderflies (family Sialidae), stoneflies (order Plecoptera), Oligochaete worms, midges (family Chironomidae), and some dragonfly species (Hynes 1970). Woody debris is often densely populated, especially if it offers the only hard substrate in otherwise soft, fine sediments, as are found in the ROI. Taxa commonly found in woody debris include: midges, caddisflies, beetles (order Coleoptera), beetle larvae, true fly (order Diptera) larvae, and some stoneflies (Hynes 1970). A study of fish species of the San Bernard River by the USGS found that the most common species are: mosquito fish (*Gambusia sp.*), green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), longear sunfish (*Lepomis megalotis*), warmouth (*Lepomis gulosus*), and bullhead minnow (*Pimephales vigilax*; USGS 2003).

In the state of Texas, regional water planning groups recommend stream segments for designation as Ecologically Significant Stream Segments (ESSSs), based on biological function, hydrologic function, riparian conservation areas, high water quality/exceptional aquatic life/high aesthetic value, or threatened or endangered species/unique communities (TPWD 2012b). As identified by the TPWD in a March 20, 2012 letter to the DOE, the ROI crosses the following ESSS, as shown in Figures 3.7-3 through 3.7-6 in Section 3.7 of this EIS (Surface Water),: Big Creek (Map ID **27**), the San Bernard River (Map ID **64**), Cedar Lake Creek (aka Caney Creek, Map ID **76**), the Colorado River (Map ID **114**), West Carancahua Creek (Map ID **186**), and the Lavaca River (Map ID **204**). As per 16.051 (f) of the Texas Water Code, the ESSS designation means that the State of Texas may not finance the construction of a reservoir in a designated river or stream segment (TPWD 2012a). In its March 20, 2012 letter to DOE, TPWD recommended the following measures be taken in crossing ESSS:

> If ground or water disturbing activities are to occur in or near an ESSS, every effort should be undertaken to preserve the biological, hydrological, aquatic life and aesthetic qualities that support the ESSS. Best management practices (BMPs) to avoid erosion, sedimentation, turbidity, stream bank, stream bed and vegetative disturbance should be developed and implemented to the greatest extent practicable. Such measures would include strict adherence to the Texas Commission on Environmental Quality Section 401 CWA Water Quality Certification, the Section 402 CWA Storm Water Pollution Prevention Plan and the USACE Nationwide 14 Permit terms and conditions for mitigation, erosion and sediment control during the construction phase. Those controls include the use of double silt fencing in construction areas near creek drainages, avoiding clearing of stream bank and instream native vegetation, phasing work during dry periods, crossing ESSSs by horizontal directional drilling, minimizing any stream bed disturbance, and siting equipment storage areas, valves, and pump stations beyond the floodplain of streams and rivers including ESSS.

Disturbance of State-owned streambeds in Texas is regulated under 31 TAC Chapter 69, Subchapter H; and Texas Parks & Wildlife Code Chapter 86. If a stream is perennial, or is more than 30 feet wide between the banks (even if it is dry most of the time), the State of Texas claims the bed and the sand and gravel in it as State-owned. A permit from the TPWD is required to disturb or take streambed materials from a streambed claimed by the State (TPWD 2012c). A description of potential State-owned streambeds that would be impacted by the pipeline installation is provided below in Section 3.9.3.1.2.

The following fish species were identified by the Colorado and Lavaca Rivers and Matagorda and Lavaca Bays Basin and Bay Stakeholder Committee (BBASC) and Basin and Bay Expert Science Team (BBEST) as focal species in the Colorado and Lavaca River basins to address specific ecological needs in these river basins (TCEQ 2012e). This list is based on species' historic and current abundance, habitat use, life history, sensitivity to change (hydrologic and water quality), and/or sport fish value:

- Guadalupe roundnose minnow (*Dionda nigrotaeniata*)
- Dusky darter (*Percina sciera*)
- Mimic shiner (*Notropis volucellus*)
- River carpsucker (*Carpiodes carpio*)
- Blue sucker (*Cycleptus elongatus*)
- Smallmouth buffalo (*Ictiobus bubalus*)
- Gray redhorse (*Moxostoma congestum*)
- Channel catfish (*Ictalurus punctatus*)
- Flathead catfish (*Pylodictis olivaris*)
- Bluegill (*Lepomis macrochirus*)
- Burrhead chub and shoal chub (*Macrhybopsis spp.*)
- Largemouth bass (*Micropterus salmoides*)
- Guadalupe bass (*Micropterus treculii*)
- Texas logperch (*Percina carbonaria*)
- *Macrobrachium spp*
- American eel (*Anguila rostrata*)
- Ribbon shiner (*Lythrurus fumeus*)
- White crappie (*Pomoxis annuaris*)
- Slough darter (*Etheostoma gracile*)
- Pugnose minnow (*Opsopoedus emiliae*)

Streams in the project area would support communities of aquatic benthic macroinvertebrate species and are commonly dominated by aquatic insects (including larval and nymph forms). Over 40 species of freshwater mussels have been reported in the project area watersheds based on current and historical records (Brazos, Colorado, and Lavaca watersheds) (Winemiller et al. 2010). Eleven of the mussel species reported to occur in the project area watersheds are listed as State threatened. In its March 20, 2012 letter to DOE, TPWD recommended the following management practices be employed to minimize the potential for impacts to state-listed mussel species:

> TPWD recommends potentially impacted waterways within the range of state listed mussels be assessed for rare mussel habitat. Where suitable habitat is present, mussel surveys should be conducted if construction would be conducted in waters associated with mussels. Direct disturbance of habitat and degradation of water quality should be avoided where threatened mussels or their habitat are found. If mussel populations are present within the limits of the proposed project area, those populations should be protected from disturbance to the greatest extent possible. If disturbance of mussel beds cannot be avoided, the TPWD Wildlife Habitat Assessment Program should be contacted for guidance on mitigation.
>
> TPWD recommends use of BMPs for riparian areas to minimize impacts on mussels as well as fish species which are the mussel larval host. BMPs would include measures such as: 1) avoiding impact to perennial waters and their associated riparian areas by using horizontal directional drilling techniques, 2) avoiding construction during fish and mussel spawning periods, 3) completing construction through the streambed during periods of drought when the stream is dry, and 4) use of double silt fences and doubling soil stabilization measures along the banks to avoid increasing the turbidity of the creek.

Based on consultation with TPWD, a preliminary survey was conducted in October and November of 2012 in all perennial waterbodies near proposed pipeline crossing locations to determine presence/absence of mussels. Evidence of the presence of mussels was found in four waterbodies: the Colorado River (Map ID 114), Juanita Creek (Map ID 143), Carancahua Creek (Map ID 152), and Menefee Bayou (Map ID 207). In November 2012 a detailed survey was conducted in those four

waterbodies to identify the species of mussels present. Using SCUBA equipment, biologists conduct timed area searches of the substrate for rare and state-listed mussel species. The area to be surveyed included all wetted streambed between 2 meters (approximately 6 ½ feet) upstream to 8 meters (approximately 26 feet) downstream of the proposed pipeline centerline. Mussels were collected in mesh bags and brought to shore for identification. Five live and zero dead smooth pimplebacks (*Quadrula houstonensis*) were discovered during a search of 50 square meters (approximately 538 square feet) and covered approximately 10% of the total area to be surveyed of the Colorado River crossing. The smooth pimpleback is a candidate species for listing on the federal threatened and endangered species list, and is listed as threatened in Texas by TPWD (Appendix E). Because the goal was to establish presence or absence of rare and state-listed species, surveys were discontinued at the Colorado River once presence of the state-listed smooth pimpleback was well established (approximately one smooth pimpleback per 10 square meters [approximately 108 square feet] surveyed). No rare mussel species were found at Juanita Creek, Carancahua Creek, or Menefee Bayou. Potential impacts and measures to be taken to avoid and reduce impacts to rare mussels are described in Section 3.9.3.1.2**.**

The ROI contains numerous intermittent and ephemeral streams. An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow. An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow. Such "periodic" streams typically provide minimal aquatic habitat. During periods of constant flow within intermittent streams, these streams can support a variety of aquatic macroinvertebrates (e.g., insects and segmented worms). However, species of fish are unlikely to establish populations due the seasonality of water. Amphibian species (e.g., American toad [*Bufo americanus*] and rare species such as the Houston toad [*Anaxyrus houstonensis*]) may use these areas and possibly perennial surface waters if they provide suitable breeding habitat and other wildlife, such as bird and mammal species, may use them as sources of water (TPWD 2012d).

3.9.2.1.4 Protected Species

The ESA of 1973 provides a program for the conservation of threatened and endangered species and the habitats in which they are found. The ESA regulations prohibit the "take" (i.e., to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct) of any listed species, as well as the destruction or modification of its "critical habitat" (i.e., habitat that is essential to the survival of the species). DOE sent coordination letters to the USFWS and TPWD on February 7, 2012 (Appendix C) regarding any records of occurrence or the potential for occurrence of ESA-protected species and their habitats within the ROI. A response dated February 2012 was received from the USFWS, which noted that federal agencies should review a habitat assessment of the project and determine the potential for effects to listed species. According to the USFWS website, there are three federally listed endangered species and no federally listed threatened or candidate species that potentially occur in Fort Bend, Jackson, or Wharton Counties**; however, the TPWD lists six candidate species for federal listing that could occur in these counties (see** Table 3.9-2**). USFWS conducted a study that included the four candidate mollusk species and found that listing those species is warranted, and that listing is only currently precluded by higher priority actions (USFWS 2011b).** The TPWD responded on March 20, 2012 with recommendations regarding ESA, MBTA, and Bald and Golden Eagle Protection Act compliance along with other comments related to state-listed species. Correspondence with the USFWS and the TPWD is included in Appendix C of this EIS.

Table 3.9-2. Federally Protected and Candidate Species Potentially Occurring within the ROI

Group	Species	Federal Status	Typical Habitat
Birds	Whooping crane (*Grus americana*)	Endangered	Potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties
Birds	**Sprague's Pipit (*Anthus spragueii*)**	**Candidate**	**Only in Texas during migration and winter, mid-September to early April; short to medium distance, diurnal migrant; strongly tied to native upland prairie, can be locally common in coastal grasslands, uncommon to rare further west; sensitive to patch size and avoids edges**
Mammals	West Indian manatee (*Trichechus manatus*)	Endangered	Gulf and bay system; opportunistic, aquatic herbivore
Plants	Texas prairie dawn-flower (*Hymenoxys texana*)	Endangered	Texas endemic; in poorly drained, sparsely vegetated areas (slick spots) at the base of mima mounds in open grassland or almost barren areas on slightly saline soils that are sticky when wet and powdery when dry; flowering late February-early April
Fishes	**Sharpnose shiner (*Notropis oxyrhynchus*)**	**Candidate**	**Endemic to Brazos River drainage; also, apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom a combination of sand, gravel, and clay-mud**
Mollusks	**Smooth pimpleback (*Quadrula houstonensis*)**	**Candidate**	**Small to moderate streams and rivers as well as moderate size reservoirs; mixed mud, sand, and fine gravel, tolerates very slow to moderate flow rates, appears not to tolerate dramatic water level fluctuations, scoured bedrock substrates, or shifting sand bottoms, lower Trinity (questionable), Brazos, and Colorado River basins**
Mollusks	**Texas fawnsfoot (*Truncilla macrodon*)**	**Candidate**	**Little known; possibly rivers and larger streams, and intolerant of impoundment; flowing rice irrigation canals, possibly sand, gravel, and perhaps sandy-mud bottoms in moderate flows; Brazos and Colorado River basins**
Mollusks	**Texas pimpleback (*Quadrula petrina*)**	**Candidate**	**Mud, gravel and sand substrates, generally in areas with slow flow rates; Colorado and Guadalupe river basins**
Mollusks	**Texas fatmucket (*Lampsilis bracteata*)**	**Candidate**	**Streams and rivers on sand, mud, and gravel substrates; intolerant of impoundment; broken bedrock and course gravel or sand in moderately flowing water; Colorado and Guadalupe River basins**

Source: USFWS 2012 **and TPWD 2012**

Whooping Crane

The whooping crane (*Grus americana*) was federally listed as endangered on March 11, 1967 (32 FR 4001). Critical habitat has been designated in Aransas, Calhoun, and Refugio counties in Texas, and includes the Aransas National Wildlife Refuge (NWR). The main factors for the decline of the whooping crane were loss of habitat to agriculture, human disturbance of nesting areas, uncontrolled hunting, and collisions with power lines (NatureServe 2012). Biological factors, such as delayed sexual maturity and small clutch size, prevent rapid population recovery. Drought during the breeding season presents serious hazards to this species (Campbell 1995). Whooping cranes are vulnerable to loss of habitat along their long migration route (NatureServe 2012), along which they are still subject to cataclysmic weather events, accidental shooting, collision with power lines, and predators. They are susceptible to avian tuberculosis, avian cholera and lead poisoning (Campbell 1995). Exposure to disease is a special problem when large numbers of birds are concentrated in limited areas, as often happens during times of drought.

While in Texas, the main population is at risk from chemical spills along the Gulf Intracoastal Waterway (GIWW), which passes through the center of their winter range (Campbell 1995). The presence of contaminants in the food base is another potential problem on their wintering grounds, and a late season hurricane or other severe weather event could be disastrous to this concentrated population (Campbell 1995).

Nesting habitat in Canada is freshwater marshes and wet prairies (NatureServe 2012), interspersed with numerous potholes and narrow wooded ridges. Whooping cranes use a variety of habitats during migration (Campbell 1995). They feed on grain in croplands, and large wetland areas are used for feeding and roosting. Riverine habitats, such as submerged sandbars, are often used for roosting. The whooping crane's principal winter habitat in Texas includes brackish bays, marshes, and salt flats; however, whooping cranes sometimes feed in upland sites characterized by oak mottes, grassland swales, and ponds on gently rolling sandy soils (Campbell 1995).

Summer foods include large insect nymphs or larvae, frogs, rodents, small birds, minnows, and berries. During the winter in Texas, they eat a wide variety of plant and animal foods. Blue crabs, clams, and berries of Carolina wolfberry (*Lycium carolinianum*) comprise the diet. Foods taken at upland sites include acorns, snails, crayfish, and insects (Campbell 1995).

Whooping cranes were originally found throughout most of North America. In the nineteenth century, the main breeding area ranged from the Northwest Territories to the prairie provinces in Canada, and the northern prairie states to Illinois. A nonmigratory flock existed in Louisiana, but is now extirpated. Whooping cranes wintered from Florida to New Jersey along the Atlantic Coast, along the Texas Gulf Coast, and in the high plateaus of central Mexico. They now breed in isolated, marshy areas of Wood Buffalo National Park, Northwest Territories, Canada. They winter primarily in the Aransas NWR and adjacent areas of the central Texas Gulf Coast (Campbell 1995). During migration they use various stopover areas in western Canada and the American Midwest.

The natural wild population of whooping cranes spends its winters at the Aransas NWR, Matagorda Island, Isla San Jose, portions of the Lamar Peninsula, and Welder Point on the east side of San Antonio Bay (NatureServe 2012). The main stopover points in Texas for migrating birds are in the central and eastern panhandle (Campbell 1995).

The ROI does not include designated critical habitat for the whooping crane. A large wetland habitat occurs within the proposed pipeline route between the West Ranch oil field and the Lavaca River which has the potential to provide habitat for the whooping crane. However, this area is adjacent to an active oil field, which would make it less attractive for use by whooping cranes than other wetland habitats in the vicinity. The TXNDD does not report any occurrences of whooping cranes within the ROI or vicinity of the proposed project (TPWD 2012b). No whooping cranes were observed during field surveys of the ROI.

West Indian Manatee

The USFWS listed the West Indian manatee (*Trichechus manatus*) as endangered on March 11, 1967 (32 FR 4001). The largest known human-related cause of manatee mortality is collisions with hulls and/or propellers of boats and ships. The second-largest human related cause of mortality is entrapment in floodgates and navigation locks. Other known causes of human-related manatee mortality include poaching and vandalism, entrapment in shrimp nets and other fishing gear, entrapment in water pipes, and ingestion of marine debris (USFWS 2001). Hunting and fishing pressures were responsible for much of its original decline because of the demand for meat, hides, and bones, which resulted in near extirpation of the species (USFWS 2001).

A prominent cause of natural mortality in some years is cold stress. Major die-offs associated with the outbreaks of red tide have also occurred, where manatees appear to have died because of ingestion of filter-feeding marine species that had accumulated the neurotoxin-producing plankton (dinoflagellates) responsible for causing the red tide (USFWS 2001). Their typically low reproductive rate, coupled with habitat loss, make it difficult for manatee populations to recover.

The West Indian manatee inhabits shallow coastal waters, estuaries, bays, rivers, and lakes. Throughout most of its range, it appears to prefer rivers and estuaries to marine habitats, although manatees inhabit marine habitats in the Greater Antilles (USFWS 2001). It is not averse to traveling through dredged canals or using quiet marinas. Manatees are apparently not able to tolerate prolonged exposure to water colder than 68 degrees Fahrenheit (°F) (20 degrees Celsius [°C]). In the northern portions of its range, during October through April, they congregate in warmer water bodies, such as spring-fed rivers and outfalls from power plants. Manatees prefer waters at least 3 to 6 feet in depth; along coasts, they are often in water 9 to 16 feet deep. They usually avoid areas with strong currents (NatureServe 2012).

Manatees primarily depend on submergent, emergent, and floating vegetation for food, with the diet varying according to plant availability. They may opportunistically eat other foods such as acorns in early winter in Florida or fish caught in gill nets in Jamaica (USFWS 2001).

The manatee currently ranges from the southeastern U.S. and coastal regions of the Gulf of Mexico, through the West Indies and Caribbean, to northern South America. U.S. populations occur primarily in Florida (NatureServe 2012), where they are effectively isolated from other populations by the cooler waters of the northern Gulf of Mexico and the deeper waters of the Straits of Florida (USFWS 2001).

In Texas, the West Indian manatee historically inhabited the Laguna Madre, Gulf of Mexico, and tidally influenced portions of rivers. It is currently, however, extremely rare in Texas waters, and the most recent sightings are likely individuals migrating or wandering from Mexican waters. Historical records show manatees have been found in Texas waters (USFWS 2001). Because the West Indian manatee is a marine species, its occurrence in the ROI is very unlikely. The TXNDD does not report any occurrences of West Indian manatees within the ROI or vicinity of the proposed project (TPWD 2012b). No West Indian manatees were observed during field surveys of the ROI. The only pipeline crossing of a large river that is near an estuary is the Lavaca River, which would be crossed by HDD and, therefore, would not be directly impacted by the proposed Parish PCCS Project. Potential indirect impacts to the Lavaca River resulting from project activities (e.g., discharge or sediment in stormwater runoff) would be mitigated using the BMPs discussed in Section 3.5 of this EIS (Physiography and Soils). Therefore, NRG's proposed project is not expected to disturb habitat that would be used by the West Indian manatee.

Texas Prairie Dawn

The Texas prairie dawn (*Hymenoxys texana*) is federally listed as an endangered species. It is a small, tap-rooted, annual plant in the sunflower family (*Asteraceae*) with existing populations known only from western Harris County and extreme eastern Fort Bend County, west of the city of Houston, Texas (USFWS 1989). The Texas prairie dawn is found in small, sparsely vegetated areas, described as slick spots, on the lower sloping portion of pimple (mima) mounds or on the level land around the mound's base. The soils that comprise the pimple mounds are sandier than the soils of the surrounding flat areas and are sticky when wet, and powdery when dry. The Texas prairie dawn blooms from late February to early April, and may be the dominant plant in its microhabitat in late winter and early spring. Plants may be senescent during the summer. According to the USFWS recovery plan, the primary threat to the Texas prairie dawn is habitat destruction owing to housing development and roadway construction in western and northwestern Harris County. No suitable habitat for Texas prairie dawn (i.e., pimple mounds) was observed during field surveys or is identified in the TXNDD within the ROI (TPWD 2012b). Therefore, this species does occur in the ROI and does not have the potential to be impacted by the proposed Parish PCCS Project.

Texas Natural Diversity Database

A search of the TXNDD showed that the proposed pipeline corridor intersects five TXNDD element occurrence polygons, as shown on the map series in Appendix D-1 of this EIS. Element occurrence polygons represent records of an area of land and/or water in which a species, natural community, or other significant feature of natural diversity is currently or was historically present. The TXNDD is maintained by TPWD.

Four polygons are based on the historic presence of bald eagle (*Haliaeetus leucocephalus)* nests, and one represents a colonial waterbird rookery (TPWD 2012b). The colonial waterbird rookery is a nesting colony of cattle egrets (*Bubulcus ibis*) and anhingas (*Anhinga anhinga*) located near the W.A. Parish Plant, identified as colony number 600-320. This colony was first observed in 1978 and last observed in 1988. This colony was not observed during field surveys of the ROI. The two polygons located near the W.A. Parish Plant represent TPWD bald eagle nests #079-1 and #079-2. Nest #079-1 was inactive in 2003, after which no data are available. Nest #079-2 was inactive in 2002, after which no data are available. The polygon located in Fort Bend and Wharton Counties represents TPWD bald eagle nest #241-4. This nest was first identified in 2001, was inactive in 2003 and 2004, and no information exists after 2004. The polygon located in Jackson County represents TPWD bald eagle Nest #120-2. The nest was found to have fallen in 2004, and no information is available after 2004. None of the four bald eagle nests reported in the TXNDD were not observed during field surveys of the ROI. However, an active bald eagle nest was observed in February 2012 adjacent to the pipeline corridor in Wharton County near the crossing of Jones Creek during field surveys conducted for this EIS. DOE recognizes that the bald eagle is afforded Federal protection under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act; and is also protected by the State of Texas. The Bald and Golden Eagle Protection Act prohibits unauthorized take of bald and golden eagles or their nests.

State-Listed Species

State-listed rare, threatened, and endangered species from TPWD for Fort Bend, Wharton, and Jackson Counties are listed in Table 3.9-3. Additional descriptions, including preferred habitat, are provided in Appendix E. State-listed species may only be handled by persons with a scientific collection permit obtained through TPWD and there are no provisions for take (incidental or otherwise) of state-listed species.

The only state-listed species observed during field surveys of the ROI **are the smooth pimpleback mussel and** the bald eagle, discussed above. **The smooth pimpleback mussel is also a candidate species for federal listing.** TPWD made the following recommendations regarding state-listed species:

> TPWD recommends that NRG consult the TPWD county lists to determine if habitat for state-threatened species occurs within the project area. An on-the-ground survey by a qualified biologist should be performed in areas of suitable habitat to determine if species are present. If present, NRG should incorporate actions into the project to avoid impacts to these species.
>
> Potential adverse impacts should be identified and conservation measures to offset harm should be incorporated into the project mitigation plan. If rare, threatened, and endangered species are to be adversely affected, TPWD should be contacted for further coordination.

Table 3.9-3. State-Listed Protected Species Potentially Occurring within the ROI

Species	Federal [a] Status	State Status	County(ies)
AMPHIBIANS			
Houston toad (*Anaxyrus houstonensis*)	LE	E	Fort Bend
BIRDS			
American Peregrine Falcon (*Falco peregrinus anatum*)	DL	T	Fort Bend, Wharton, Jackson
Arctic Peregrine Falcon (*Falco peregrinus tundrius*)	DL	R	Fort Bend, Wharton, Jackson
Attwater's Greater Prairie-Chicken (*Tympanuchus cupido attwateri*)	LE	E	Fort Bend, Wharton
Bald Eagle (*Haliaeetus leucocephalus*)	DL	T	Fort Bend, Wharton, Jackson
Brown Pelican (*Pelecanus occidentalis*)	DL	R	Jackson
Henslow's Sparrow (*Ammodramus henslowii*)	R	R	Fort Bend, Wharton, Jackson
Interior Least Tern (*Sterna antillarum athalassos*)	LE	E	Fort Bend, Wharton, Jackson
Mountain Plover (*Charadrius montanus*)	R	R	Jackson
Peregrine Falcon (*Falco peregrinus*)	DL	T	Fort Bend, Wharton, Jackson
Reddish Egret (*Egretta rufescens*)	R	T	Jackson
Snowy Plover (*Charadrius alexandrines*)	R	R	Jackson
Sooty Tern (*Sterna fuscata*)	R	T	Jackson
Southeastern Snowy Plover (*Charadrius alexandrinus tenuirostris*)	R	R	Jackson
Sprague's Pipit (*Anthus spragueii*)	C	R	Fort Bend, Wharton, Jackson
Western Burrowing Owl (*Athene cunicularia hypugaea*)	R	R	Fort Bend, Wharton, Jackson
White-faced Ibis (*Plegadis chihi*)	R	T	Fort Bend, Wharton, Jackson
White-tailed Hawk (*Buteo albicaudatus*)	R	T	Fort Bend, Wharton, Jackson
Whooping Crane (*Grus americana*)	LE	E	Fort Bend, Wharton, Jackson
Wood Stork (*Mycteria americana*)	R	T	Fort Bend, Wharton, Jackson
CRUSTACEANS			
A crayfish (*Cambarellus texanus*)	R	R	Wharton
FISH			
American eel (*Anguilla rostrata*)	R	R	Fort Bend, Wharton, Jackson
Blue sucker (*Cycleptus elongates*)	R	T	Wharton
Sharpnose shiner (*Notropis oxyrhynchus*)	C	R	Fort Bend, Wharton

Table 3.9-3. State-Listed Protected Species Potentially Occurring within the ROI

Species	Federal [a] Status	State Status	County(ies)
Smalltooth sawfish (*Pristis pectinata*)	LE	E	Jackson
MAMMALS			
Louisiana black bear (*Ursus americanus luteolus*)	LT	T	Fort Bend, Wharton, Jackson
Plains spotted skunk (*Spilogale putorius interrupta*)	R	R	Fort Bend, Wharton, Jackson
Red wolf (*Canis rufus*)	LE	E	Fort Bend, Wharton, Jackson
West Indian manatee (*Trichechus manatus*)	LE	E	Jackson
MOLLUSKS			
Creeper (squawfoot) (*Strophitus undulatus*)	R	R	Wharton
False spike mussel (*Quadrula mitchelli*)	R	T	Fort Bend, Wharton
Smooth pimpleback (*Quadrula houstonensis*)	C	T	Fort Bend, Wharton
Texas fatmucket (*Lampsilis bracteata*)	C	T	Jackson
Texas fawnsfoot (*Truncilla macrodon*)	C	T	Fort Bend, Wharton
Texas pimpleback (*Quadrula petrina*)	C	T	Wharton
REPTILES			
Alligator snapping turtle (*Macrochelys temminckii*)	R	T	Fort Bend
Green sea turtle (*Chelonia mydas*)	LT	T	Jackson
Gulf Saltmarsh snake (*Nerodia clarkia*)	R	R	Jackson
Kemp's Ridley sea turtle (*Lepidochelys kempii*)	LE	E	Jackson
Loggerhead sea turtle (*Caretta caretta*)	LT	T	Jackson
Texas diamondback terrapin (*Malaclemys terrapin littoralis*)[b]	R	R	Jackson
Texas horned lizard (*Phrynosoma cornutum*)	R	T	Fort Bend, Wharton, Jackson
Texas scarlet snake (*Cemophora coccinea lineri*)	R	T	Jackson
Texas tortoise (*Gopherus berlandieri*)	R	T	Jackson
Timber/Canebrake rattlesnake (*Crotalus horridus*)	R	T	Fort Bend, Wharton, Jackson
PLANTS			
Shinner's sunflower (*Helianthus occidentalis ssp plantagineus*)	R	R	Jackson
Texas prairie dawn (*Hymenoxys texana*)	LE	E	Fort Bend
Threeflower broomweed (*Thurovia triflora*)	R	R	Fort Bend, Jackson
Welder machaeranthera (*Psilactis heterocarpa*)	R	R	Jackson

Source: TPWD 2012e
[a] Federal status is listed as reported by the TPWD. According to the USWFS, the only federally protected species in the ROI are the whooping crane, West Indian manatee, and Texas prairie dawn.
[b] According to the TXNDD, the closest sighting of the Texas diamondback terrapin is along northern Matagorda Bay, approximately five miles from the West Ranch oil field (TPWD 2012b).
LE, LT - Federally Listed Endangered/Threatened; C - Federal Candidate for Listing; formerly Category 1 Candidate; DL - Federally Delisted; E, T – State-Listed Endangered/Threatened; R - Rare, but with no regulatory listing status

3.9.2.2 CO_2 Capture Facility

The area for the proposed CO_2 capture facility and related infrastructure includes approximately 29 acres within the existing W.A. Parish Plant property. This site has been previously disturbed (i.e., cleared and graded) and consists of a human altered/disturbed system vegetation community (i.e., developed, open space industrial land cover and grassy areas, as shown in Figure 2-4). The existing level of disturbance and high level of human activity within the proposed project areas provides poor habitat quality for most wildlife species, with the exception of those species adapted to high levels of human activity and disturbance (e.g., rodents, raccoons, starlings).

3.9.2.3 Pipeline Corridor

The pipeline would be collocated along or within existing mowed and maintained utility corridors for approximately 75% of its length, which are maintained a minimum of once every four years (see Table 3.9-4, Figure 3.9-1, and Figure 3.9-2). Table 3.9-4 identifies the approximate percentage of each vegetation community within the pipeline construction ROW based on the U.S. National Vegetation Classification System. Table 3.9-5 identifies vegetation communities within the proposed permanent ROW (NatureServe 2012). Over 60% of the pipeline construction ROW is currently classified as agriculture (i.e., cultivated crops/irrigated agriculture and pasture/hay). Ruderal Early Successional Grassland and Scrub/Shrub is the next most common land cover, with 15% cover. This community's dominance is due to the prior and ongoing disturbance of the existing utility ROW located within the proposed pipeline corridor. The majority of the pipeline construction ROW is currently human altered and disturbed systems, and only approximately **11**% of the proposed pipeline construction ROW classified as natural systems.

Based on the U.S. National Vegetation Classification System, approximately **9.5**% of the pipeline construction ROW is classified as scrub/shrub or forested. This includes approximately **69** acres (**6.6**%) classified as scrub/shrub, with the majority being successional shrub/scrub, and the remaining areas are semi-desert habitat (tamaulipan mixed deciduous thornscrub, tamaulipan calcareous thornscrub, and tamaulipan mesquite upland scrub); and approximately **55.6** acres (**5.3**%) classified as forested (west gulf coastal plain large river floodplain forest, west gulf coastal plain small stream and river forest, introduced wetland vegetation – treed, and central and south Texas coastal fringe forest and woodland) (NatureServe 2012).

Based on the TPWD Rare Plant Community List (TPWD 2012f), approximately 90.9% of the pipeline construction ROW consists of plant communities that are not listed as rare on a global or state level (Table 3.9-4**). Approximately 1.9% of the construction ROW is listed as S1 (critically imperiled in Texas); 0.9% as S1S2 (imperiled to critically imperiled in Texas); 2.1% as S2 (imperiled in Texas); and 4.1% as S3S4 (vulnerable to apparently secure in Texas).**

The proposed pipeline corridor would cross surface water features, discussed in Section 3.7 of this EIS (Surface Water), including perennial, intermittent, and ephemeral streams (see Table 3.7-2). Section 3.8 of this EIS (Wetlands and Floodplains) discusses the occurrence of wetlands within the pipeline corridor. Most of these crossings would occur within existing previously disturbed ROW areas where water quality is likely to be somewhat degraded. Streams within existing ROW areas lack riparian cover and have a relatively slow stream flow velocity. Generally streams with these characteristics have low levels of dissolved oxygen, which would reduce the diversity of aquatic species within these stream segments. Potential impacts to larger streams would be avoided through the use of HDD crossing techniques. Stream segments within the existing ROW that lack riparian cover are likely to have reduced woody debris, which limits the potential habitat types and species diversity. Species likely to be found in these stream segments are described in Section 3.9.2.1.3.

Based on the current conditions and characteristics of habitat within the pipeline corridor, these areas would not offer suitable habitat for federally protected species that have the potential to occur within the project area (i.e., whooping crane, West Indian manatee, and Texas prairie dawn). Whooping cranes use large wetland habitats. The only large wetland area that would be crossed by the pipeline is between the Lavaca River and the West Ranch oil field. Impacts to this wetland habitat would be temporary, because the land would be restored to pre-construction contours; and no direct impacts to whooping cranes are anticipated. West Indian manatees require large bodies of water, such as large rivers or bays, and are a marine species. The only large river crossed by the pipeline near a marine habitat is the Lavaca River, which would be crossed by HDD and would, therefore, not be directly impacted by the proposed project. No suitable habitat for Texas prairie dawn (i.e., pimple mounds) occurs in the ROI.

Table 3.9-4. Vegetation Communities within the Proposed Pipeline Construction ROW

Vegetation Community	TPWD Rare Plant Community List Status	Acres	Percent
Agriculture – Cultivated Crops and Irrigated Agriculture	Not Listed	382.5	36.8
Agriculture – Pasture/Hay	Not Listed	257.6	24.8
Ruderal Early Successional Grassland and Scrub/Shrub (Existing ROW)	Not Listed	154.9	14.9
Successional Shrub/Scrub	Not Listed	69.1	6.6
West Gulf Coastal Plain Large River Floodplain Forest	G3G4 S3S4	43.2	4.2
Modified/Managed Southern Tall Grassland	Not Listed	27.1	2.6
Developed-Open Space	Not Listed	27.6	2.6
Texas Saline Coastal Prairie	G1 S1	12.6	1.2
Tamaulipan Mixed Deciduous Thornscrub	G3 S2	11.7	1.1
West Gulf Coastal Plain Small Stream and River Forest	G2 S2	10.2	1.0
Tamaulipan Calcareous Thornscrub	G3 S1S2	9.7	0.9
Tamaulipan Mesquite Upland Scrub	Not Listed	8.9	0.9
Developed-Low Intensity	Not Listed	7.7	0.7
Open Water	Not Listed	4.8	0.5
Central and Upper Texas Coast Dune and Coastal Grassland	G2 S1	4.3	0.4
Texas-Louisiana Coastal Prairie	G1 S1	3.2	0.3
Atlantic & Gulf Coastal Plain Freshwater Tidal Marsh	Not Listed	3.0	0.3
Introduced Wetland Vegetation – Treed	Not Listed	2.0	0.2
Non-Specific Disturbed	Not Listed	0.6	0.1
Central and South Texas Coastal Fringe Forest and Woodland	G2 S2	0.2	<0.1
Texas-Louisiana Coastal Prairie Slough	Not Listed	0.1	<0.1
Total		1040.8	
Summary	Acres		Percent
Human Altered/Disturbed Systems	929.0		89.3
Natural Systems	111.7		10.7

Source: U.S. National Vegetation Classification System (NatureServe 2012)

Figure 3.9-1. Previously Disturbed Vegetation Community Occupying Existing ROW in Jackson County

Figure 3.9-2. Typical Previously Disturbed Vegetation Community Occupying Existing ROW in Fort Bend County

3.9.2.4 West Ranch Oil Field

The West Ranch oil field is currently used for oil and gas production and cattle pasture. As indicated in Figure 3.11-3 in Section 3.11 of this EIS (Land Use and Aesthetics), the dominant land cover types in the West Ranch oil field EOR area are pasture/hay/grassland/herbaceous, shrub/scrub, developed (open space/low density), emergent herbaceous wetlands, and woody wetlands. Existing wells would be used (i.e., re-refurbished or deepened, as needed) to the extent practicable. New injection wells would be drilled if the existing wells cannot be reworked for injection. New wells would be installed on existing well pads to the extent practicable. Additionally, existing piping corridors, access roads, and well pads would be used for construction activities at the West Ranch oil field to the extent practicable.

The CO_2 recycle facility would be built in an area of the West Ranch oil field that was previously occupied by an oil field gas processing facility, which was demolished by HEC in 2011 (Figure 3.9-3). The proposed CO_2 recycle facility site supports a previously disturbed, human altered/disturbed vegetation community.

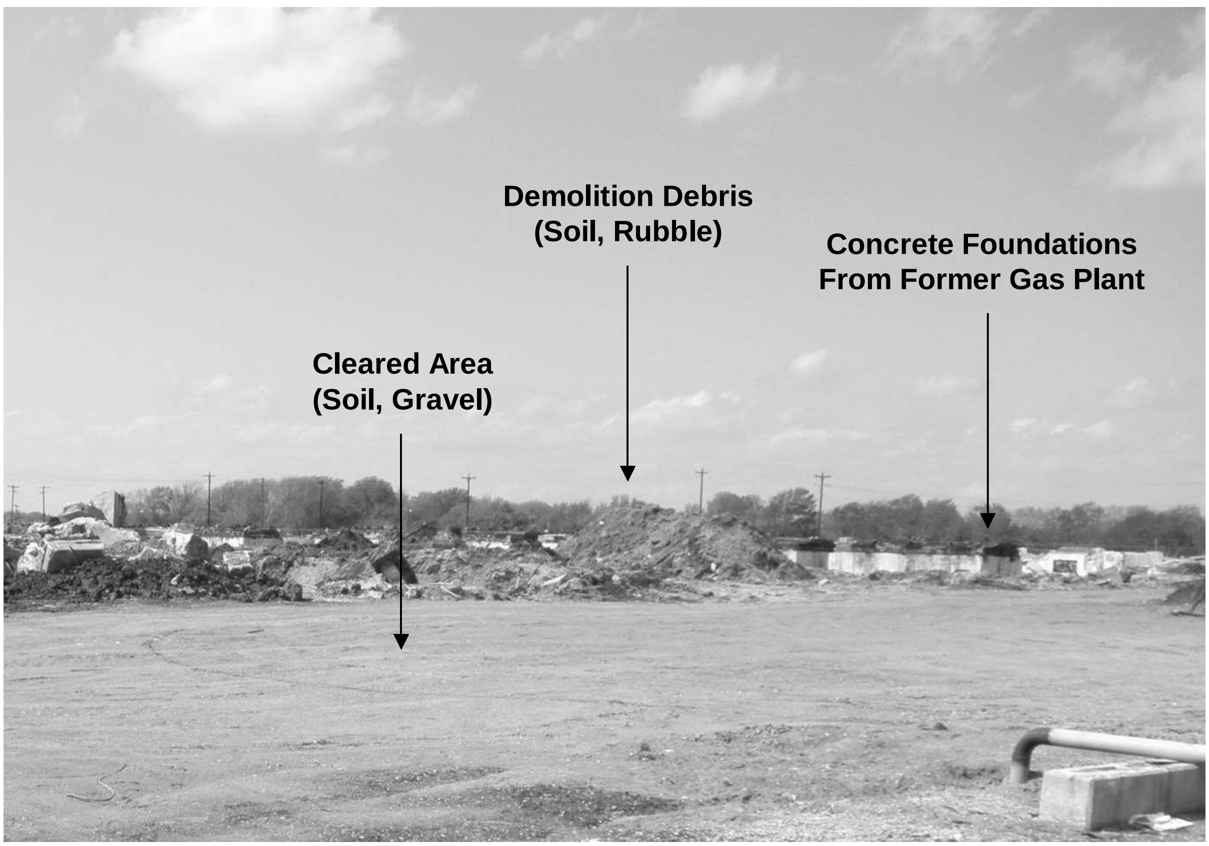

Figure 3.9-3. Current Use of Proposed CO_2 Recycle Facility Location at the West Ranch Oil Field

3.9.3 Direct and Indirect Impacts of the Proposed Project

DOE assessed the potential for impacts to biological resources in the ROI based on whether the proposed Parish PCCS Project would result in any of the effects identified in Section 3.9.1.3.

3.9.3.1 Construction Impacts

Generally, construction of the project would have the potential to result in short-term, negligible to minor impacts to biological resources. Some moderate impacts, however, may be expected due to construction in portions of the pipeline corridor. These moderate impacts would be due to forest vegetation removal**, potential impacts to streambed mussel habitat,** and the potential for introduction of invasive species. NRG would implement construction BMPs (i.e., as defined in the SWPPP that would be developed for the proposed project) to minimize biological resources impacts.

3.9.3.1.1 CO_2 Capture Facility

Construction of the CO_2 capture facility would have the potential to impact approximately 29 acres of previously disturbed, industrial developed, open space land (see Figure 2-4). As stated in Section 3.9.2.2, this site has been extensively disturbed (i.e., cleared and graded with areas of impervious surface). Overall, construction impacts to this area would result in negligible impacts to biological resources. It is unlikely that migratory birds would use this area as nesting habitat. Federally listed threatened and endangered species habitat is not found on the facility.

3.9.3.1.2 Pipeline Corridor

Pipeline construction would cause impacts to vegetation communities within the construction and permanent ROWs. Table 3.9-4 identifies acreages of vegetation communities (i.e., habitat) within the pipeline construction ROW. During construction, each of the affected vegetation communities would be disturbed and vegetation removed, causing minor to moderate short-term impacts to biological resources.

With the exception of areas constructed using HDD or conventional boring construction techniques, all of the land within the approximately 100-foot-wide pipeline construction ROW would be cleared of shrubs and trees to allow for digging of pipeline trenches, spoil management, construction equipment and materials staging, and construction traffic. A 30-foot-wide permanent ROW would be maintained free of woody vegetation during pipeline operations, as discussed below regarding operational impacts. Vegetation from land clearing activities would be burned within the construction ROW or chipped or shredded and spread out over the ROW as mulch to support soil stabilization and re-growth of vegetative cover.

The vast majority of potentially affected areas support either human altered/disturbed systems (primarily agricultural) or existing mowed and maintained utility ROWs. Approximately **11**% of the proposed construction ROW (i.e., approximately **112** acres) contains natural systems. These areas are expected to return substantially to their current state, which is predominantly human altered disturbed vegetation adjacent to an existing ROW. Potential impacts to areas within the permanent ROW are described below. As the majority of the ROI is located within existing ROW (i.e., previously disturbed areas with relatively low species diversity and habitat quality) or agricultural areas, the overall adverse impacts to existing habitat quality from construction disturbance would primarily be minor and temporary. Agricultural areas would be expected to return to agricultural use following pipeline installation. Please refer to Sections 3.7 and 3.8 of this EIS for a discussion of surface water and wetland and floodplain resources, and potential impacts to these resources.

As stated in Section 3.9.2, construction disturbance increases the potential for introduction and spread of invasive species, allows the propagation of non-native plant species, and increases the potential for adverse impacts to native vegetation and habitat quality. Table 3.9-1 identifies the primary invasive species observed during field surveys conducted between January and **November** 2012. Establishment and propagation of invasive plant species along the newly established pipeline corridor would reduce the overall diversity of native plant species and likely reduce the quality of habitat. As the majority of the ROI is located within existing ROW (i.e., which has been previously disturbed with relatively low species diversity and habitat quality) or agricultural areas that would remain in agricultural use, the overall adverse impacts to existing habitat quality from construction disturbance would be minor. An increased potential for the introduction of invasive species would exist in newly disturbed areas (i.e., areas of forest clearing) as these areas would be adjacent to the existing ROWs, which contain areas of invasive species.

The potential would exist for invasive species to colonize newly disturbed areas following site stabilization and prior to reestablishment of vegetative cover. If established, these species could preclude the regeneration of forest and scrub/shrub vegetation, resulting in long-term moderate adverse impacts to biological resources.

Overall, impacts to wildlife from construction of the pipeline corridor would be negligible to minor. Approximately **75%** of the proposed pipeline corridor would be constructed within or immediately adjacent to existing mowed and maintained utility corridors. Also, approximately **640** of the **1,040** acres (over 60%) of the pipeline construction ROW is in agricultural use, some of which is located within the existing utility corridors that the proposed pipeline would parallel. These existing uses would minimize the overall effect to wildlife and fragmentation of wildlife habitat. Construction activities, including land clearing, would cause a negligible loss of wildlife habitat. This would primarily include loss of ruderal early successional grassland and scrub/shrub habitat located within the existing ROWs and loss of forest edge or successional scrub/shrub communities directly adjacent to these existing ROWs. As the **terrestrial** habitats within the pipeline corridor are common within the vicinity of the project (i.e., are not unique or critical habitat), overall impacts to wildlife from land clearing would be minor and many species would be able to move to and use adjacent, similar habitat types. Certain species with limited range or mobility such as small rodents, reptiles, and amphibians would be more susceptible to potential direct impacts of mortality due to collisions with vehicles and equipment. Other, more mobile species, such as larger mammals and birds would be less susceptible to these impacts; however, ground-nesting bird nests and their eggs could potentially be disturbed or destroyed during the land clearing process. NRG would limit land-clearing activities in previously undisturbed areas to periods outside of the nesting season, to the extent practicable, to minimize the potential for MBTA-related impacts. **Consultation with TPWD indicated that the primary migratory bird nesting season is March through August. If clearing vegetation during the nesting season is unavoidable, previously undisturbed areas within the construction area would be surveyed prior to construction to identify and flag nests with eggs or young that could otherwise be disturbed by construction activities.**

Permanent conversion of approximately **25** acres of scrub/shrub areas (successional shrub/scrub, tamaulipan mixed deciduous thornscrub, tamaulipan calcareous thornscrub, and tamaulipan mesquite upland scrub) to grasslands would occur due to clearing of permanent ROW areas (Table 3.9-5). Species typically using scrub/shrub areas are common to both grassland areas and forest edges. Therefore, the overall impact from the permanent loss of scrub/shrub habitat would be minor.

Table 3.9-5. Vegetation Communities within the Proposed Pipeline Permanent ROW

Vegetation Community	TPWD Rare Plant Community List Status	Acres	Percent
Agriculture – Cultivated Crops and Irrigated Agriculture	Not Listed	113.6	38.2
Agriculture – Pasture/Hay	Not Listed	74.9	25.4
Ruderal Early Successional Grassland and Scrub/Shrub (i.e., Existing ROW)	Not Listed	44.7	15.2
Successional Shrub/Scrub	Not Listed	19.8	6.7
West Gulf Coastal Plain Large River Floodplain Forest	G3G4 S3S4	11.5	3.9
Modified/Managed Southern Tall Grassland	Not Listed	8.4	2.8
Developed-Open Space	Not Listed	7.5	2.5
Texas Saline Coastal Prairie	G1 S1	2.9	1.0
Tamaulipan Mixed Deciduous Thornscrub	G3 S2	2.8	0.9
Tamaulipan Mesquite Upland Scrub	Not Listed	2.3	0.8
West Gulf Coastal Plain Small Stream and River Forest	G2 S2	2.2	0.7
Open Water	Not Listed	1.4	0.5
Central and Upper Texas Coast Dune and Coastal Grassland	G2 S1	0.9	0.3
Atlantic & Gulf Coastal Plain Freshwater Tidal Marsh	Not Listed	0.7	0.2
Introduced Wetland Vegetation – Treed	Not Listed	0.6	0.2
Developed-Low Intensity	Not Listed	0.5	0.2
Texas-Louisiana Coastal Prairie	G1 S1	0.5	0.2
Non-Specific Disturbed	Not Listed	0.2	0.1
Tamaulipan Calcareous Thornscrub	G3 S1S2	0.1	<0.1
Texas-Louisiana Coastal Prairie Slough	Not Listed	0.1	<0.1
Central and South Texas Coastal Fringe Forest and Woodland	G2 S2	0.1	<0.1
Total		295.7	
Summary	**Acres**		**Percent**
Human Altered/Disturbed Systems	270.2		91.4
Natural Systems	25.5		8.6

Source: U.S. National Vegetation Classification System (NatureServe 2012).

Permanent conversion of an estimated approximately **14.4** acres of forested areas (i.e., **11.5** acres of West Gulf Coastal Plain Large River Floodplain Forest, **2.2** acres of West Gulf Coastal Plain Small Stream and River Forest, **0.6** acres of Introduced Wetland Vegetation – Treed, and **0.1 acres of** Central and South Texas Coastal Fringe Forest and Woodland) to grasslands would occur due to clearing of permanent ROW areas (Table 3.9-5). Some of these impacts **would** be avoided by HDDs that would be performed for larger waterbody crossings. Permanent forest removal would result in forest fragmentation. As a majority of the pipeline corridor occurs along existing ROWs or roads, overall impacts from forest fragmentation in these areas would be minor.

In general, habitat fragmentation can have the effect of reducing the genetic diversity of a population should they become geographically isolated from other populations of the same species. Although the pipeline ROW would not necessarily create impassable barriers to wildlife movement, from a behavioral perspective, some species may not cross a location because the area was disturbed, habitat was altered, etc. In addition, habitat fragmentation can reduce the overall size of accessible habitat to a population, which may result in the area no longer being viable to support that population at its existing numbers (e.g., food resources could become too limited). Habitat fragmentation within these areas could reduce the number of species that are present, resulting in a moderate localized impact to wildlife habitat. Forest fragmentation can also lead to edge effects, influencing the microclimate of the forest with increases in light, temperature, and wind. These changes in microclimate can change the remaining adjacent forest vegetation and wildlife habitat dynamics by reducing the quality of habitat for species that require interior habitat. Fragmentation effects could be most detrimental in the case of forest interior dwelling, ground-nesting songbirds and Neotropical migrants (i.e., species that breed in North America during summer months and spend winters in Mexico, Central America, South America, or the Caribbean islands) in particular. As previously stated, impacts would be minimized by routing the pipelines within or adjacent to existing ROWs and avoiding impacts to forested wetlands.

The creation of grassy linear corridors through once forested areas can create open areas by which predatory species (e.g., raccoon) could access forest interior landscapes and prey on the eggs of ground-nesting birds. Conversely, the creation of these corridors could benefit these predatory species by allowing them greater access to food resources. The creation of linear corridors through forested landscapes can also increase the potential for brood parasitism of ground-nesting bird nests. Parasitic bird species (e.g., cowbird [*Molothrus ater*] and swallows [*Tachycineta spp.*]) can affect a brood of fledgling birds by laying eggs in the nests of other bird species and leaving the chick-rearing responsibilities to the other bird parents; often the parasitic chicks will outcompete the host chicks for food and in some cases, may push them out of the nest. These detrimental fragmentation effects may extend up to 2,000 feet into a forest (EPA 1994). Overall, the loss of forested habitat itself would have a minimal effect on migratory bird species as abundant, comparable habitat is available throughout the region. As stated above, impacts to intact forested areas are avoided through routing adjacent to existing ROWs. Less than 5% of the pipeline construction ROW (approximately **56** acres) is classified as forested, and these areas are typically edges of existing corridors. Clearing to accommodate the proposed pipeline would result in a loss of forested terrestrial habitat on a scale of 20 to 30 years within the temporary construction ROW, while a permanent loss of forest would occur within permanent ROW (see Table 3.9-4). As currently designed, the project would not create any grassy linear corridors through forested areas because approximately **75**% of the proposed route is collocated with existing mowed and maintained utility ROWs and construction in greenfield areas would be performed along existing roads or in/adjacent to cultivated fields.

Noise generated by construction activities would likely cause wildlife species to avoid the construction site. As this disturbance would be temporary, impacts to wildlife from construction noise would be short term and minor. As discussed below, consistent with USFWS recommendations for construction activity near bald eagles (USFWS 2007), potential noise impacts to the bald eagle nesting site located near the pipeline would be avoided or minimized by maintaining a distance of at least 660 feet between construction equipment and the nesting site.

Construction of the pipeline corridor could result in short-term, minor adverse impacts to aquatic resources, as discussed in Sections 3.7 (Surface Water) and 3.8 (Wetlands and Floodplains) of this EIS. Use of HDD construction techniques would avoid direct impacts to the larger surface water features. For construction not involving directional drilling, a trench would be excavated and dewatered in accordance with applicable federal, state, and local regulations and Section 404 (of the CWA) permitting requirements. During construction, NRG would implement measures to avoid, minimize, and mitigate impacts to aquatic habitat, as necessary. For example, staging areas would be limited to upland areas to the extent practicable. Additionally, the temporary construction ROW would be narrowed to a width of 75 feet in some areas, where practicable, within wetland and aquatic environments. Aquatic habitat, including streambanks and streambed substrate, would be restored to original grade following instream trenching activities. Streambanks would be restored using appropriate stabilization measures and revegetated following specifications outlined in Section 404 permitting. Aquatic habitats would likely recover shortly after construction activities, resulting in a short-term, minor adverse impact. Sections 3.5 (Physiography and Soils) and 3.7 (Surface Water) of this EIS discuss BMPs used during construction for protection of surface waters and required construction permitting.

Waterbody crossings completed using HDD construction techniques would not impact the streambed and would, therefore, not require a TPWD permit to disturb State-owned streambeds. However, the proposed Parish PCCS Project includes approximately **35** crossings that would be constructed using open cut methods of streams that are perennial and/or more than 30 feet wide, which would be considered State-owned. The Parish PCCS Project is expected to meet the criteria for a general permit as described in 31 TAC 69.115 (TPWD 2012c). The permit requires a description of the disturbance and measures that would be taken to minimize the harm to aquatic and riparian habitat within the streambed during and after construction. Unlike an individual permit, which may be required for less common projects (i.e., not related to pipeline construction or maintenance) or projects which would disturb or remove of more than 1,000 cubic yards of sedimentary material, a public comment period and hearing (i.e., as described in 31 TAC 69.105) are not required for projects that meet the criteria for a general permit. Therefore, less time is required to obtain a general permit than an individual permit, which may take between 30 days and several months to obtain.

The pipeline corridor and ROI cross the following ESSSs: Big Creek, San Bernard River, Cedar Lake Creek (aka Caney Creek), Colorado River, West Carancahua Creek, and Lavaca River. NRG plans to avoid impacts to Big Creek, San Bernard River, Colorado River, and Lavaca River by employing HDD construction techniques for these crossings. Cedar Lake Creek (aka Caney Creek) and West Carancahua Creek would be crossed using open cut methods as described above. Section 3.5 (Physiography and Soils) summarizes BMPs that NRG would use to avoid or minimize impacts to water bodies. As discussed in Section 3.7 of this EIS (Surface Water), additional BMPs (e.g., double silt fencing; avoiding clearing of stream bank and in-stream native vegetation; phasing work during dry periods; minimizing any stream bed disturbance; and siting equipment storage areas, valves, and pump stations beyond the floodplain) would be used during crossings of ESSSs that are not crossed using HDD construction techniques. Based on use of HDD construction techniques and the BMPs referenced above, impacts to ESSS crossings are expected to short-term and minor.

Excavation in waterways would temporarily remove the affected area (i.e., typically an area up to 30-feet wide, associated with the permanent ROW) as viable habitat for aquatic life, as the area would be dewatered. This could result in the temporary removal of breeding habitat for certain amphibian species during construction. Disturbance of bank and bottom sediments could cause some degree of temporary downstream sedimentation, which could have negative effects to aquatic life primarily because the sediments can fill in open spaces within the steam bed that provide habitat for aquatic macroinvertebrates (e.g., insects). Therefore, instream construction activities could cause a localized and temporary decline in insect populations, reducing available food resources for larger species (e.g., fish) within the affected segment of the stream. As sediments are a common stream occurrence within the ROI and existing aquatic species have adapted to such conditions, only minor impacts to aquatic species would be expected. Section 404 permitting requirements and associated BMPs would further avoid or minimize impacts to aquatic habitat and species.

Smooth pimpleback mussels were found in the Colorado River at the proposed crossing location. The Colorado River would be crossed by HDD, so the potential for impacts to the streambed would be minimized and existing mussel habitat would be preserved. Potential impacts at the Colorado River crossing would be limited to geotechnical borings, water uptake during HDD installation, and potential for inadvertent release of drilling fluid (frac-out).

Geotechnical borings would be collected from several points in the river to determine the appropriate depth for installation of the HDD. The geotechnical boring depths would be approximately 110 feet. The depth of the pipeline below the Colorado River would be determined by the soil characteristics identified by the geotechnical study. NRG's design for the HDD crossing of the Colorado River specifies that the pipeline be installed at least 50 feet below the bed of the river.

During HDD installation, hoses would be placed in the Colorado River to supply water for the drilling operation. Measures would be taken to minimize sedimentation impacts from the water uptake and geotechnical borings, such as installation of silt fences. Qualified biologists would determine the presence/absence of smooth pimpleback or other rare mussel species at the proposed boring and water uptake locations and any other areas that would be impacted prior to work being conducted. To the extent practicable, areas of disturbance within the Colorado River would avoid impacts to rare mussel species. In consultation with TPWD, permits to relocate state-listed mussels would be obtained and mussels would be relocated from areas of potential disturbance to appropriate sites upstream if necessary.

The potential exists for a frac-out to occur during the HDD crossing of the Colorado River. A frac-out occurs when drilling fluid is inadvertently released from the drill hole to the surface of the soil or streambed. Drilling fluid is primarily water with bentonite clay added. Bentonite is a non-toxic fine clay material that enhances the lubricating, spoil transport, and caking properties of the drilling fluid. The primary areas of concern for inadvertent releases occur at the entrance and exit points where the drilling equipment are at shallower depths. The likelihood of inadvertent return decreases as the depth of the pipe increases. To reduce the potential of a frac-out affecting the streambed, the entrance and exit points for drilling would be located at least 500 feet from the bank of the Colorado River. A frac-out has a low likelihood of occurring, so no impacts from the HDD crossing are anticipated. Both a frac-out spill containment plan and HDD contingency plan would be prepared in consultation with the selected HDD contractor before initiating work. In general terms, in the event of a frac-out, an on-site assessment would quickly determine the course of action needed to minimize impacts. Commonly, thickening the drilling fluid stops the release, enabling completion of the crossing. If the drilling fluid release cannot be sealed to continue operations, the bore would be abandoned in accordance with the established contingency plan and the HDD relocated or redesigned. If a frac-out occurs within the Colorado River, mussel habitat could be impacted through sedimentation and burial. An assessment of the impacts and required mitigation would be conducted in consultation with TPWD if this unlikely event occurs.

The proposed pipeline route would cross the whooping crane's migratory pathway; however, no impacts to nesting areas are anticipated. Whooping cranes migrate through the area in mid-September and in late March to early April. There is potential for whooping cranes to occur within the pipeline construction corridor or the West Ranch oil field for short periods of time during their migration through the area. A large wetland habitat occurs within the proposed pipeline route between the West Ranch oil field and the Lavaca River which has the potential to provide habitat

for the whooping crane. However; potential impacts to this wetland would be avoided by HDD. A bird survey will be conducted prior to construction. Any areas used by whooping cranes during their migration will be avoided while individuals are present. No impacts to whooping cranes or their critical habitat are anticipated. There is no critical habitat within the proposed project ROI. The nearest critical habitat for whooping cranes is located over 30 miles south of the West Ranch oil field and the southern end of the pipeline corridor (USFWS 2013).

As stated in Section 3.9.2.3, habitats within the pipeline corridor are unlikely to support protected species. Therefore, construction of the pipeline segments is unlikely to affect species protected under Section 7 of the ESA. The West Indian manatee is found in the gulf and bay system, which would not be impacted by the pipeline corridor. Whooping crane habitat is large coastal marshes, which would not be impacted**, and impacts to whooping cranes would be avoided during their potential migration through the pipeline construction corridor and the West Ranch oil field**. The Texas prairie dawn flower is only known to occur in about 50 sites, mostly in western Harris County, and would therefore not be impacted by the pipeline.

The TXNDD includes records of occurrences of state-listed species and the only occurrence identified by the TXNDD within the ROI is the bald eagle, as shown in the map series in Appendix D-1. An active bald eagle nest was identified adjacent to the pipeline corridor in Wharton County near the crossing of Jones Creek in February 2012, as shown on Sheet 10 of 22 in Appendix D-1 of this EIS. For construction of linear utilities, the USFWS recommends maintaining a distance of at least 660 feet between construction activity and bald eagle nests (USFWS 2007). NRG would install the pipeline using HDD in the vicinity of the active bald eagle nest. As the HDD is currently designed, construction activities would be approximately 750 feet from the nest site; therefore, no impacts to bald eagles would be anticipated. Other than the bald eagle nest, no state-listed species were identified during field surveys. Therefore, no adverse impacts to state-listed species would be anticipated.

Following construction, habitats disturbed by construction within the temporary ROW would be re-contoured, stabilized, and revegetated, reducing the overall permanent loss of habitat (see Section 3.9.2.3 for a description of permanent operational impacts). Agricultural lands within the temporary ROW would likely be returned to agricultural production by existing land owners. Grassland areas would likely recover within one year following the end of construction, whereas forested areas would take up to 30 years to fully recover. Although the forested and scrub/shrub communities within the temporary ROW areas have the potential to recover in the long-term, impacts to these systems are considered moderate due to the length of recovery and the potential for introduction and spread of invasive species.

3.9.3.1.3 West Ranch Oil Field

Existing wells within the West Ranch oil field would be used (i.e., re-refurbished or deepened, as needed) to the extent practicable. New injection wells would be drilled if the existing wells cannot be reworked for injection. New wells would be installed on existing well pads to the extent practicable. Additionally, existing piping corridors, access roads, and well pads would be used for construction activities to the extent practicable. Therefore, the DOE anticipates that any impacts associated with operations in the proposed West Ranch oil field EOR area would be similar to impacts from existing operations at the West Ranch oil field.

The CO_2 recycle facility site is located on a developed industrial area and developed open space; therefore negligible biological resource impacts would occur due to construction on this site. Indirect impacts to nearby water resources would be avoided through use of BMPs. Noise generated by construction would have the potential to cause wildlife species, including migratory birds, to avoid the construction areas.

Given the relatively small areas involved, the lack of unique biological resources, and the ability of wildlife species to move to other, less disturbed areas in the region, these impacts would be negligible.

3.9.3.2 Operational Impacts

3.9.3.2.1 CO_2 Capture Facility

Overall, negligible biological resources impacts would be expected from the operation of the CO_2 capture facility. As the proposed site is located within a disturbed industrial site with high levels of human activity, no impacts to biological resources (i.e., beyond those described for construction) would be anticipated. No long-term noise, light and glare, or air quality impacts to biological resources would be anticipated.

3.9.3.2.2 Pipeline Corridor

During operations, biological resource impacts within the proposed pipeline corridor would be limited to regular maintenance activities within the permanent ROW. Maintenance activities would involve clearing activities at a frequency necessary to maintain the reliability and performance of the line (generally at least once every four years). Table 3.9-5 provides a summary of the vegetation communities that would be within the permanent ROW based on the U.S. National Vegetation Classification System (NatureServe 2012). These impacts were addressed in Section 3.9.3.1.3.

Minimal additional ROW maintenance beyond current, baseline conditions is expected to be required. Potential impacts from the maintenance activities on biological resources are expected to be minor.

During ROW maintenance activities, wildlife could be displaced or otherwise impacted by maintenance equipment (e.g., mowing, digging for inspections) or vehicles used for inspections. Given the relatively small areas involved, the lack of unique biological resources, and the ability of wildlife species to move to other areas during maintenance activities, these impacts would be minor. ROW maintenance activities are not expected to impact federally listed threatened and endangered species because habitat within the pipeline corridor would not offer suitable habitat for these species (i.e., West Indian manatee, whooping crane, and Texas prairie dawn). TCV operation and maintenance personnel would continue to follow USFWS guidelines for avoiding and minimizing disturbance of bald eagles (USFWS 2007), so there would be no operational impacts to bald eagles, the only state-listed species observed during field surveys of the ROI.

3.9.3.2.3 West Ranch Oil Field

Minimal additional maintenance beyond current, baseline conditions is expected to be required in the EOR area. Operation of the CO_2 recycle facility and associated maintenance activities could result in noise or lights from equipment used during well workovers or other maintenance or traffic from vehicles used by operations and maintenance personnel, which may disrupt wildlife in adjacent areas. However, due to a lack of suitable habitat in these previously disturbed areas, direct and indirect impacts to biological resources related to operation of the CO_2 recycle facility are expected to be negligible.

3.9.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to biological resources.

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3.10 CULTURAL RESOURCES

3.10.1 Introduction

This section identifies and describes the cultural resources that could potentially be affected by the construction and/or operation of the proposed Parish PCCS Project This section also analyzes the potential impacts of the proposed project on these resources.

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires that the lead federal agency with jurisdiction over a federal undertaking must consider adverse effects to historic properties before that undertaking occurs. Undertakings are defined as projects, activities, or programs funded by a federal agency or that require a federal permit, license, or approval. Historic properties are defined as any district, archaeological site, building, structure, or object that is either listed, or eligible for listing, in the National Register of Historic Places (NRHP). The National Register Criteria for Evaluation (36 CFR 60.4 [a-d]), assess whether the specific historic properties possesses integrity of location, design, setting, materials, workmanship, feeling and association and the following qualities of significance:

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

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

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

Under this definition, other cultural resources may be present within a project's Area of Potential Effect (APE), but are not historic properties if they do not meet the eligibility requirements for listing in the NRHP, as specified in 36 CFR 60.4(a-d). To be considered eligible for the NRHP, a property generally must be greater than 50 years of age, although there are provisions for listing cultural resources of more recent origin if they are of "exceptional" importance.

The intent of Section 106 is for federal agencies to take into account adverse effects on any historic properties situated within the APE of the proposed undertaking; and to afford the Advisory Council on Historic Preservation (ACHP), State Historic Preservation Officers (SHPOs), federally-recognized tribal offices, and any other interested parties an opportunity to comment on the proposed project within a reasonable period. The implementing regulation of Section 106 is 36 CFR Part 800. This regulation establishes a process of identifying NRHP-eligible or listed historic properties that may be affected by the proposed undertaking; assessing the undertaking's effects on those resources; and engaging in consultation that seeks ways to avoid, reduce, or mitigate any adverse effects on NRHP-listed or -eligible properties. Adverse effects include, but are not limited to, destruction or alteration of all or part of a property; isolation from or alteration of its surrounding environment; introduction of visual, audible, or atmospheric elements that are out of character with the property or that alter its setting; transfer or sale of a federally owned property without adequate conditions or restrictions regarding preservation, maintenance, or use; and neglect of a property resulting in its deterioration or destruction (36 CFR 800.5).

ACHP regulations in 36 CFR 800 specify that certain parties must be consulted during the Section 106 process. These parties include each SHPO whose state would physically include any portion of the APE. The SHPO is appointed by each state to protect the interests of its citizens with respect to issues of cultural heritage. Section 101(b)(3) of the NHPA provides each SHPO a prominent role in advising the responsible federal agencies and ACHP in their efforts to carry out Section 106 requirements. The SHPO, as well as the federal agencies, have an obligation to work with state and local governments, federally recognized tribes and pertinent private organizations during the initial planning and development of the Section 106 process. Federal agencies usually consult with the SHPO when developing methodologies related to cultural resource investigations and are required to notify the SHPO when making findings related to the establishment of an APE, NRHP eligibility of identified cultural resources, project effects, and resolution of adverse effects. On non-tribal lands, the lead federal agency, in consultation with the SHPO and other consulting parties, assesses the need for cultural resources investigations in the project APE, generates and approves methodologies for completing such investigations within the state, and evaluates the preliminary NRHP status of any cultural resources located within the APE. The SHPO also assists the lead federal agency and ACHP in assessing any potential adverse effects to historic properties and works with the project applicant, lead federal agency, ACHP, and Native American tribes (among others) to mitigate any negative impacts that could occur to NRHP-eligible or -listed properties.

Section 106 also recognizes the importance of consulting with Native American tribes for federal undertakings that are proposed within Native American ancestral territories. Specifically, 36 CFR 800.2(c)(2)(ii) notes, "Section 101(d)(6)(B) of the NHPA requires the agency official to consult with any Indian tribe or Native Hawaiian organization that attaches religious and cultural significance to historic properties that may be affected by an undertaking. This requirement applies regardless of the location of the historic property." In addition, Subpart B of the same statute says the "Federal Government has a unique legal relationship with Indian tribes set forth in the Constitution of the United States, treaties, statutes, and court decisions. Consultation with Indian tribes should be conducted in a sensitive manner respectful of tribal sovereignty. Nothing in this part alters, amends, repeals, interprets or modifies tribal sovereignty, any treaty rights, or other rights of an Indian tribe, or preempts, modifies or limits the exercise of any such rights."

Section 106 regulations state that each SHPO (or Tribal Historic Preservation Office [THPO], if they have assumed the SHPO's role) is generally required to respond within 30 days of receiving a request to review a proposed project or a request to make a finding or determination regarding historic properties located within the project APE. In the event that the SHPO/THPO does not respond within this timeframe, 36 CFR 800.3(c)(4) states that the lead agency can decide to (1) proceed to the next step in the application process based on any earlier findings or determinations that have been made up to that point; or (2) consult directly with the ACHP in lieu of the SHPO/THPO. If, after this step is followed, the SHPO or THPO decides to reenter the Section 106 process, 36 CFR 800.3(c)(4) further states that the lead agency official may continue the consultation proceeding without being required to reconsider previous findings or determinations.

DOE has followed the Section 106 process outlined above for the proposed Parish PCCS Project. The designated SHPO agency for the state of Texas is the Texas Historical Commission (THC). Consultations with the THC on March 6, 2012 resulted in the identification of the following eight Native American tribes that were contacted for the project: Alabama-Coushatta Tribe of Texas, the Apache Tribe of Oklahoma, the Comanche Nation of Oklahoma, the Coushatta Tribe of Louisiana, the Kiowa Indian Tribe of Oklahoma, the Mescalero Apache Tribe of the Mescalero Reservation, the Tonkawa Tribe of Indians of Oklahoma, and the Tunica-Biloxi Indian Tribe of Louisiana. Copies of consultation letters are provided in Appendix C of this EIS. DOE made it clear in its initial consultation letters that it intends to coordinate its Section 106 requirements with the NEPA process.

3.10.1.1 Region of Influence

For Section 106 purposes, the APE for archaeological resources is defined as all project areas where ground **could** potentially be **directly affected by** new construction. For NRG's proposed project, this **direct effect** APE includes the 29 acres associated with the CO_2 capture facility at the W.A. Parish Plant; the approximately **1,197-**acre construction ROW for the **approximately 81-**mile **long** CO_2 pipeline and approximately **43** miles of associated access roads; and the approximately 5,500-acre EOR area at the West Ranch oil field. For architectural resources, the APE **applied included potential direct effects** from new construction, as described above, plus an additional distance of 164 feet (50 meters) **from the identified project boundaries**, including areas underlying or in the immediate vicinity of the proposed project infrastructure. **This extended area took into account potential indirect effects of the project from visual or vibration disturbances.** In a letter dated February 23, 2012 (Appendix C), the THC approved the APE for the proposed pipeline corridor. The THC approved the APE for proposed project infrastructure that would be located within the W.A. Parish Plant and the West Ranch oil field on July 11, 2012 (Appendix C). For this EIS, the ROI for potential impacts to cultural resources includes the APEs for both archaeological and architectural resources, as described above.

3.10.1.2 Method of Analysis

Each project component was evaluated by cultural resource staff who met the Secretary of the Interior's standards for archaeology or architectural history professionals. Based on their evaluation of the potential for the project to affect historic properties, desktop studies and work plans were developed that were submitted to the DOE and the THC for approval. These reviews followed the guidelines, plans, and procedures outlined in the following documents: the NHPA; the Antiquities Code of Texas and the THC's Rules of Practice and Procedure for the Antiquities Code of Texas; the THC's Statewide Plan for Texas; the Council of Texas Archeologists standards for cultural resource surveys; the Archaeological and Historic Preservation Act of 1974; and the Secretary of the Interior's Guidelines for Archeology and Historic Preservation.

Phase I survey of the proposed construction ROW and access roads was performed between January **and December** of 2012 **(Poche et al. 2012; Handly and Lackowicz 2012a; Handly and Lackowicz 2012b)** to identify potentially significant archaeological resources. The survey**s were** conducted in accordance with the methods presented in a February 10, 2012 letter that DOE sent to the THC. The THC approved the proposed methodology on February 23, 2012. Copies of these consultation letters are provided in Appendix C of this EIS.

The Phase I **archaeological** survey**s were** comprised of linear transect surveys involving systematic pedestrian surveys augmented by systematic shovel testing within the entire project corridor. In general, one survey transect was placed within the middle of the 100-foot-wide (30-meter) survey corridor. Shovel tests were excavated at the following intervals based on the perceived archaeological site potential along the corridor: (a) High archaeological site potential – 164-foot (50-meter) intervals; (b) Moderate archaeological site potential – 328-foot (100-meter) intervals; Low archaeological site potential – 1,312-foot (400-meter) intervals. Similar shovel tests intervals were used for the assessment of proposed access roads and additional temporary work space areas that extend beyond the typical 100-foot-wide (30-meter) survey corridor. **Archaeological site potential determinations in each area were made using the desktop review results in conjunction with field staff observations.**

Shovel tests displayed an average excavated diameter of 12 inches and they were excavated to at least 20 inches (50 centimeters) below surface (i.e., sterile subsoil), unless impenetrable subsoils or ground water was encountered. Shovel tests were excavated in natural soil layers at 4-inch or 8-inch (10 or 20 centimeters) intervals and excavated soils were screened through ¼-inch mesh unless composed of water-saturated or compacted clay, in which case they were hand sorted by trowel. Munsell® soil color charts were used to describe soil color and standard soils nomenclature was used in the description of the excavated sediments associated with each shovel test. The above information concerning each shovel test location was recorded on standardized shovel test forms. Excavated shovel tests were backfilled immediately upon the completion of the excavation process.

Recovered cultural materials were recorded in the field using electronic standardized field collection techniques on an electronic field data collection device. GPS data collectors with sub-meter accuracy were used to record the beginning and endpoint of survey transects, pipeline inflexion (PI) points, survey areas, access roads, site datum locations, and the corners of any standing structures encountered during the course of this investigation. Digital photographs were taken of survey areas to document current conditions and detailed pace-and-compass maps for encountered cultural resources were also produced. Artifacts recovered from shovel tests or ground surface were retained for laboratory analysis.

Phase I historic architectural survey**s** of the proposed pipeline construction ROW and associated access roads **were** also performed between January and May 2012 **(Poche et al. 2012) and September and November of 2012 (Handly and Lackowicz 2012a)** to identify potentially significant **above-ground cultural** resources. The survey**s were** conducted in accordance with the methods presented in a February 10, 2012 letter sent by DOE to the THC**, who** approved the proposed methodology on February 23, 2012. Cultural resources staff assessed whether any buildings, bridges, structures, cemeteries, Texas Historic Landmarks, and/or State Archeological Landmarks were visually located within 164 feet (50 meters) of the pipeline construction ROW or associated access roads. Both straight-on and corner photographs of historic structures and/or engineering elements over approximately 50 years in age were taken, where possible from public rights-of-way or from within the permitted survey area. Specific information related to building materials, foundation type, structural form, architectural style, associated outbuildings, and observed alterations, was collected to assist in assessing if the structure should be eligible, not eligible, or not assessed for the purposes of the NRHP criteria for evaluation (36 CFR 60.4 [a-d]).

Each project component was evaluated by cultural resource and GIS staff using available pertinent information, including: the Texas Archaeological Site Atlas (THC 2012) for data on previous cultural resource surveys, known archaeology sites and identified historic structures; the NRHP database maintained by the National Park Service for NRHP-listed historic properties (NPS 2012); USGS topographic maps and aerial photography; and NRCS soil data (NRCS 2012b) to establish the potential of project lands to contain unrecorded archaeological sites. Determinations of each project component's ability to adversely affect historic properties were made by a professional archaeologist using these factors to demarcate areas of Low, Moderate, and High cultural resource potential on the project design plans.

3.10.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to cultural resources based on whether the project would directly or indirectly:

- cause the potential for loss, isolation, or alteration of an archaeological resource that is listed or eligible for NRHP listing;
- cause the potential for loss, isolation, or alteration of the character of a historic site or structure that is listed or eligible for NRHP listing or introduce visual, audible, or atmospheric elements that would adversely affect a historic resource eligible for NRHP listing;

- cause the potential for loss, isolation, or alteration of Native American resources, including graves, remains, and funerary objects or introduce visual, audible, or atmospheric elements that would adversely affect the resource's use;
- cause the potential for loss, isolation, or alteration of a paleontological resource eligible for listing as a National Natural Landmark; or
- cause the potential for loss, isolation, or alteration of a cemetery.

3.10.2 Affected Environment

3.10.2.1 CO_2 Capture Facility

3.10.2.1.1 Archaeological and Historic Resources

DOE conducted a desktop cultural resources study (Handly 2012) for the proposed CO_2 capture facility and submitted the results to the THC. The specific components of the proposed CO_2 capture facility and its related infrastructure would cover approximately 29 acres, as indicated in Figure 2-**4**. The desktop study identified no State Archeological Landmarks, Texas Historic Landmarks, National Register historic buildings, or historic structures located within the ROI. However, three prehistoric lithic artifact scatters (Sites 41FB225, 41FB226, and 41FB227) are situated within one mile of the W.A. Parish Plant. These sites are positioned along the southern shore of Smithers Lake and/or Dry Creek/Rabbs Bayou and none were considered eligible by THC for listing in the NRHP. Based on the extent of previous land disturbance and the lack of significant cultural resources found in the area, DOE stated an opinion in a letter dated June 19, 2012 that a very low likelihood exists of unrecorded historic properties being situated within the W.A. Parish Plant ROI. On July 11, 2012, the THC responded, concurring with the DOE's determination of No Historic Properties Affected. The DOE letter and SHPO response are included in Appendix C of this EIS.

3.10.2.2 Pipeline Corridor

The Section 106 APE for the new CO_2 pipeline includes property within and immediately adjacent to the proposed pipeline corridor, including areas used temporarily during construction or permanently throughout operations. The DOE determined that a Phase I cultural resource survey and inventory investigation meeting federal and Texas standards was the appropriate level of effort for Section 106 compliance for the pipeline corridor. The DOE sent a letter to the THC on February 10, 2012, notifying them of the NRG pipeline component and supplying a scope of work for the proposed study. THC responded that they accepted the scope on February 23, 2012, with the addition of mechanized trenching near river crossings in order to verify that no deeply buried archaeological deposits were present. The DOE submitted a scope of work for mechanized trenching to the THC on April 25, 2012 and THC responded on May 14, 2012 accepting the proposed scope of work. A total of **seven** 10-foot-long, 3-foot-wide, by 4-foot-deep trenches **were** excavated perpendicular to the pipeline corridor adjacent to water bodies that would be crossed using HDD construction techniques. Based on the potential for deeply buried cultural resources to be present in proposed HDD construction areas, these trenches **were** located **in the following crossings and banks: Big Creek – West; San Bernard River – East and West; Colorado River – East and West; Lavaca River – West; and Menefee Bayou – East**. **No archaeological materials and/or subsurface features were noted during the trenching process at these seven locations;** the results **are** summarized in **an** addendum **report (Handly and Lackowicz 2012a)** (Appendix G) submitted **to the THC in December 2012** for review. **The THC concurred with these results on January 17, 2013.**

No known historic buildings or features are recorded within the proposed survey corridor, although four cemeteries (Guy **family**, Lolita **family**, Zemanek **family**, and an unnamed **family** cemetery) and two state historic markers (i.e., Marker 172 for the Ansgar Evangelical Lutheran Church and Cemetery, and Marker 1163 for Danevang, Texas) are located within the one-mile study area. Based on a review of the online National Park Service database, no above-ground properties listed on the NRHP are situated within one mile of the proposed survey corridor. None of the above cultural features were located within 164 feet (50 meters) of the pipeline construction ROW or associated access roads.

According to the Texas Archeological Site Atlas, seven archaeological sites have been recorded within one mile of the proposed pipeline centerline (i.e., Site numbers 41WH82, 41JK35, 41JK38, 41JK39, 41JK115, 41JK128, and 41J136). Of these sites, only Site 41JK128 is crossed by the proposed pipeline **and** is located within the ROI of NRG's proposed project. Site 41JK128 is a prehistoric period lithic site located along the Lavaca River in Jackson County that was not assessed by the THC for its eligibility to be listed in the NRHP. The remaining six sites within the one-mile study area include five sites along the Lavaca River in Jackson County and one site (i.e., 41WH82) in Wharton County, all of which are prehistoric period lithic and/or ceramic scatter sites. Five were not assessed for their eligibility to be listed in the NRHP, while a single site (41JK115) was considered not eligible for listing in the National Register by the THC.

As of **December 19**, 2012, the entire proposed pipeline construction ROW and associated access roads have been surveyed for cultural resources. In total, the Phase I investigation assessed **114.96** miles (**185.00** kilometers) of preferred and alternate pipeline corridor; **86** access roads, measuring **56.4** miles (**90.75** kilometers) in length**, including approximately 13 miles that were proposed but abandoned**; and **54** additional temporary work space areas, totaling **99.33** acres (**40.2** hectares) in extent. A total of **1,858** shovel tests were excavated and six archaeological sites and 12 historic standing structures were identified within the project area, as discussed below. The DOE submitted the results of the completed field study (**Poche** et al. 2012) on August 2, 2012 **and in December 2012 (Handly and Lackowicz 2012a; Handly and Lackowicz 2012b) to THC**. To ensure that known historic and prehistoric period archaeological site locations are protected, a redacted copy of **these** cultural resources survey **reports** is included as Appendix G to this EIS. **The THC concurred with these results on January 18, 2013.**

3.10.2.2.1 Archaeological Resources

Six archaeological sites were identified during the Phase I inventory stud**ies; however, two of these sites (41WH105 and 41WH106) were subsequently removed from the current pipeline ROI based on route re-alignments**. **For the four remaining sites, the** artifacts indicated **that one** site **was** prehistoric and **three** sites were from historic periods. **Two** of the sites were recorded in Wharton County and two sites were recorded in Jackson County. None of the archaeological sites **were determined** by the DOE as being eligible for listing in the NRHP. **The THC concurred with these determinations.** Summary information on the **remaining four** sites is presented below.

Site 41WH103 is located near MP 45.0 within Wharton County. The historic period site was identified within a recently tilled agricultural field. The site is approximately 4.9 acres in extent and appears to date to the late 19^{th} to mid-20^{th} century. A total of 64 shovel tests were excavated within the site boundary and none of these contained buried cultural materials. A systematic surface collection within the site area identified a surface scatter that was comprised of 806 artifacts, including 503 glass, 187 historic ceramics, 95 brick fragments, and 21 metal items. Based on the artifact recoveries, the site appears to be the remains of an agricultural farmstead.

Site 41WH104 is situated within Wharton County near MP 44.7. The historic period site was located in a recently tilled agricultural field. The site measures approximately 5.2 acres in extent and appears to date to the late 19th to mid-20th century. A total of 38 shovel tests were excavated within the site boundary and none of these returned buried cultural materials. The systematic surface collection within the site area identified a historic surface scatter comprised of 181 artifacts, including 95 historic ceramics, 75 glass, 10 brick fragments, and one metal item. Based on the artifact recoveries, the site appears to be the remains of an agricultural farmstead.

Site 41JK192 is located within Jackson County near MP 70.2. The prehistoric period site was identified within a recently tilled agricultural field. The site measures approximately 0.2 acres in size and is represented by an isolated, brown chert, projectile point blade/tip fragment. The point fragment potentially dates from the Late Archaic Period (ca. 4,000 to 2,200 years ago). A total of 9 shovel tests were excavated within the site boundary and none of these contained any additional cultural materials. Based on the limited artifact recoveries, the site appears to be the remains of a prehistoric lithic isolated find.

Site 41JK193 is located near MP 70.8 within Jackson County. The historic period site was identified within a recently tilled agricultural field. The site is approximately 1.1 acres in extent and appears to date to the late 19th to mid-20th century. A total of 56 shovel tests were excavated within the site boundary, of which only one contained cultural material below the surface. A systematic surface collection within the site area identified 319 artifacts, which included 126 brick fragments, 96 glass, 81 historic ceramics, 15 metal items, and a single animal bone fragment. Based on the artifact recoveries, the site appears to be the remains of an agricultural farmstead.

3.10.2.2.2 Historic Above-Ground Resources

A total of 12 buildings greater than 45 years of age were **initially** identified within 164 feet (50 meters) of the pipeline construction ROW or associated access roads during the Phase I inventory **studies; however, three of these structures (HSS-WH-1, HSS-WH-2, and HSS-JK-1) were subsequently removed from the current pipeline ROI based on project re-alignments. The remaining structures included** six in Fort Bend County **and three** in Wharton County. The buildings were dominated by **four** National-style structures, but also included **one** structure of undetermined design (due to inaccessibility) and single examples of a barn, a Spanish Eclectic structure, a railroad bridge, and an I-house. Most of the structures were built between ca. 1930 and the 1950s, with single examples noted from the 1890s to 1900s and 1920s to 1930s. None of these historic standing structures are recommended by the DOE as being eligible for listing in the NRHP **and the THC concurs with these determinations**. Summary information on the **nine** structures is presented below.

HSS-FB-1is located near MP 0.0 in Fort Bend County. The abandoned residential building appears to have been constructed between ca. 1930 and 1940 in the National style. Characteristic features of the National style are present in the form of a gabled massed plan and simple details. The one story building is wood framed and sits on brick piers.

HSS-FB-2 is situated near MP 9.5 within Fort Bend County and is described as an abandoned transverse crib barn with a shed addition that appears to have been constructed between ca. 1930 and 1940. The one story building is wood framed and sits directly on the ground.

HSS-FB-3 is positioned near MP 12.8 within Fort Bend County and it is described as an abandoned single-family residence that appears to have been constructed between ca. 1940 and 1950 in the National style. Characteristic features of the National style are present in the form of a gabled massed plan and simple details. The one story building is wood framed and sits on a concrete slab.

HSS-FB-4 is located near MP 12.8 within Fort Bend County. The single-family residence appears to be abandoned and constructed between ca. 1940 and 1950 in the Spanish Eclectic style. Characteristic features of the Spanish Eclectic style are present in the form of exposed rafter tails, stucco façade, and terra cotta shingles that run along the roof ridges. The one-story building is wood framed and sits on a concrete slab.

HSS-FB-5 is an abandoned single-family residence that appears to have been constructed between ca. 1930 and 1940 in the side-gabled National style; it is located near MP 13.2 within Fort Bend County. Characteristic features of the side-gabled National style are present in the form of side gables and a massed plan. The two-story building is wood framed and sits on concrete piers.

HSS-FB-6 is located near MP 20.3 within Fort Bend County. The structure is a subdivided, Warren through truss-type railroad bridge that appears to have been constructed ca. 1930. It is situated on an abandoned railroad line. Characteristic features of a subdivided warren through truss are alternating diagonal supports with vertical supports at each connection. The substructure is supported by two concrete piers.

HSS-WH-3 is located near MP 45.0 within Wharton County and is an abandoned, wood-framed, single family residence that appears to have been constructed between ca. 1890 and 1900 in the I-house form. Characteristic features of the I-house are present in the form of a massed plan one room deep and two rooms wide. The two-story building is wood framed and sits on concrete piers.

HSS-WH-4 is situated within Wharton County along a proposed access road. The occupied residential building appears to have been originally constructed between ca. 1940 and 1950, but contains significant modern additions and does not display a specific building style. The one-story building is wood framed and sits on concrete blocks.

HSS-WH-5 is located within Wharton County near MP 51.4. The abandoned, single-family home appears to have been constructed between 1930 and 1940 in the massed plan National style. Characteristic features of the National style are present in the form of a gabled massed plan and simple details. The one-story building is wood framed and sits on concrete block piers. There are two outbuildings on the property. Both buildings are front gabled with metal roofs and clad in metal siding.

3.10.2.3 West Ranch Oil Field

DOE conducted a desktop cultural resources study (Handly 2012) of the proposed West Ranch oil field project area that was submitted to the THC. The specific components of the proposed West Ranch oil field would be located within an approximately 5,500-acre area, as indicated in Figure 2-11.

NRG expects EOR and CO_2 monitoring activities within the West Ranch oil field to be limited to existing developed areas to the extent practicable; therefore, minimal to no new land impacts are expected for this phase of the project. The CO_2 recycle facility would be constructed in a brownfield area of the West Ranch oil field, previously occupied by an oil field gas processing facility that was demolished by HEC in 2011. Existing wells at the West Ranch oil field would be used to the extent practicable. New injection wells would be drilled if the existing wells cannot be reworked for injection. New wells would be installed on existing well pads to the extent practicable. Existing built roads would be used to access EOR and CO_2 monitoring areas within the West Ranch oil field. Currently, no new road construction is anticipated, but existing roads could be improved. Any new CO_2 distribution piping would also be installed, to the extent practicable, along the existing piping corridors. All of these project areas are currently situated within lands that have been extremely disturbed by ongoing oil field site operations, including well pad leveling and construction, road construction, pipeline emplacement, and facility maintenance.

According to a desktop review of the online Texas Archeological Sites Atlas and NRHP, no State Archeological Landmarks, Texas Historic Landmarks, National Register historic buildings or historic structures have been identified within one mile of the West Ranch oil field. **Twenty-three (23) archaeological sites are listed as being within one mile of the study area. Only nine of these lie** within the ROI (i.e., Sites 41JK128 and 41JK130 through 41JK137). Most of these sites are located along the boundaries of Venado Creek, with a single site associated with Menefee Lake (i.e., 41JK128). Given the above distribution of previously recorded prehistoric period archaeological sites, it would appear that the natural levees of the Lavaca River, Venado Creek, and the shorelines of Menefee and Redfish Lakes would be considered to display high archaeological site potential. All of these sites are identified as prehistoric lithic scatters, except for Site 41JK128, which also contained prehistoric ceramics. None of the site forms contained information on eligibility for listing on the NRHP. **However, these sites would not be impacted by the proposed project activities. NRG would conduct additional archaeological investigations in the event that the project design plans change and come into conflict with these known site areas.**

On July 11, 2012, the THC responded, concurring with the DOE's determination of No Historic Properties Affected at the West Ranch oil field. The DOE letter and SHPO response are included in Appendix C of this EIS.

3.10.2.4 Native American Tribes

On April 5, 2012, DOE submitted a summary of the proposed Parish PCCS Project, including a description of project components, and a request for comments to the eight Native American tribes identified by the THC, as discussed above. To date, no Native American tribe has responded to the consultation request. A copy of the Phase I archaeological and above-ground inventory study cultural resources survey report is included as Appendix G to this EIS for review and comment.

3.10.3 Direct and Indirect Impacts of the Proposed Project

3.10.3.1 Construction and Operational Impacts

All of the archaeological and historic above-ground cultural resources (e.g., cemeteries, buildings, bridges) identified for the proposed project have either been determined by DOE to not be historic properties or are situated beyond the project's ROI and would not be affected by its implementation. As no NRHP-listed or NRHP-eligible resources, Native American resources, **cemeteries or** paleontological resources eligible for listing as a National Natural Landmark have been identified within the ROI, **DOE and THC have agreed that there** would be a low potential for loss, isolation, or alteration of these resources during the construction or operational phases of the proposed Parish PCCS Project. Therefore, based on cultural resources data collected to date, as described below, DOE expects that negligible **potential for adverse effects would occur to Section 106 defined historic properties by the** construction and operations activities associated with the Parish PCCS Project. Consultation with THC is ongoing regarding **recent** project **adjustments** along the pipeline corridor, but **will** be concluded before DOE issues the ROD.

3.10.3.1.1 CO_2 Capture Facility

Based on the level of existing ground disturbance within the W.A. Parish Plant, which includes extensive grading as well as facility, road, and building construction, and the lack of significant cultural resources in the area, the DOE has concluded that a very low likelihood exists of unrecorded historic properties being situated within the ROI for the proposed CO_2 capture facility. Therefore, DOE has determined that the activities proposed to occur within the W.A. Parish Plant would not impact historic properties meeting the criteria of significance for listing on the NRHP. On June 19, 2012, DOE submitted documentation to the THC explaining the reasoning for this determination and requesting concurrence. On July 11, 2012, the THC responded, concurring with the DOE's determination of No Historic Properties Affected.

3.10.3.1.2 Pipeline Corridor

In August 2012, DOE submitted documentation to the THC explaining DOE's determination that no historic properties eligible for listing on the NRHP would be affected by project activities within the proposed pipeline construction ROW or on associated access roads. At the **four** archaeological sites identified during **the** field surveys **that are currently within the ROI of the proposed pipeline corridor**, all of the recovered cultural materials except for two pieces of brick were located on the surface of recently tilled agricultural fields. Due to the lack of intact stratigraphic integrity, none of these sites were considered by DOE to be eligible for listing in the National Register and no additional archaeological assessment of these sites was recommended by DOE. **On September 14, 2012, the THC responded, concurring with the DOE's determination that these four archaeological sites were ineligible for inclusion in the NRHP.**

Additionally, **the 10** historic standing structures identified during field surveys **that are within the indirect effects APE used for the architectural Phase I survey but currently outside of the ROI of the proposed pipeline corridor** would not be affected by project construction activities. The historic standing structures retain the integrity of location, setting, feeling or association, and materials, but they do not retain their integrity of design or workmanship. In addition, they do not retain sufficient integrity to relate to their historic significance and do not embody distinctive characteristics of a type, period, method of construction, or the work of a master. Therefore, DOE considered these **10** structures to be ineligible for listing in the National Register and no additional architectural assessment of these structures was recommended by the DOE. **On September 14, 2012, the THC responded, concurring with the DOE's determination for eight of the historic standing structures, indicating that they were ineligible for inclusion in the NRHP. The THC agreed that historic standing structure HSS-FB-6 (railroad bridge) and HSS-WH-3 (ca. 1890 to 1900 I-house) would not be impacted by project construction; therefore, the THC was not requiring any additional information be provided for these two resources. However, if proposed alignment changes were proposed near these two areas that could adversely impact these cultural resources, then additional information would be required by THC to clarify their NRHP eligibility and document any project related impacts. NRG would not make design changes that could impact these two identified historic structures without first conducting the additional review required by THC.**

3.10.3.1.3 West Ranch Oil Field

On June 19, 2012, DOE submitted documentation to the THC explaining DOE's determination that no cultural resources eligible for listing on the NRHP would be affected by construction and operations activities in the proposed EOR area of the West Ranch oil field. Based on the proposed project activities and their location within already disturbed lands, it is the opinion of DOE that NRG's proposed project as currently defined has a very low likelihood of impacting **Section 106 defined** historic properties within the West Ranch oil field APE. As noted previously, project activities that would occur in already disturbed lands (i.e., existing well sites, roadways, and piping corridors) would have little to no potential to effect cultural resources. Activities in previously undisturbed areas are not planned at this time; however, such activities (if they occurred) would have the potential to impact unidentified or unknown cultural resources. DOE also stated that if new well pads, access roads, or distribution piping become required for the proposed project within the West Ranch oil field that TCV would consult with the THC, as appropriate, prior to the undertaking of such activities to determine whether any further cultural resources investigations are necessary. On July 11, 2012, the THC responded, concurring with the DOE's determination of No Historic Properties Affected.

3.10.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to existing cultural resources.

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3.11 LAND USE AND AESTHETICS

3.11.1 Introduction

This section identifies and describes the existing land uses that could be affected by the construction and operation of the proposed Parish PCCS Project. It describes existing land uses in the project area, potential impacts of the proposed project on land use in and near the proposed project areas, potential impacts from the proposed project on the ability to access nearby lands, and consistency with comprehensive land use plans and regulations.

3.11.1.1 Region of Influence

The ROI includes the areas within 0.5 miles (2,640 feet) of the W.A. Parish Plant boundary, the construction ROW for construction and operation of the CO_2 pipeline, and within 0.5 miles surrounding the locations of EOR and CO_2 monitoring activities (i.e., at the West Ranch oil field). The distance from the proposed activities was chosen as the area in which existing land use could be affected by plant construction or operations and to account for potential indirect impacts from increased vehicle traffic, impediments to access, and impacts to existing land uses that would extend beyond the project area.

3.11.1.2 Method of Analysis

DOE reviewed existing and future land use data collected from agency and local governmental land use plans and conducted a GIS comparison of compatible and non-compatible uses to determine what land uses would be most affected by the Parish PCCS Project. For example, if an industrial land use activity was proposed to be conducted in an area that is predominantly residential, that would be an incompatible land use. In addition, federal, state, and county regulatory land use requirements were also reviewed.

Since the Parish PCCS project would be located in the Town of Thompsons and unincorporated areas of three counties, it cannot be evaluated for compatibility with any existing land use plans, zoning ordinances, or comprehensive plans as these plans do not exist. Therefore, land cover types and land ownership information were used to infer the current land uses in the study area. Impacts to land use were evaluated using GIS imagery to calculate direct project impacts.

3.11.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to land use based on whether the project would:

- maintain compatibility with land uses within the subject properties;
- maintain compatibility with land uses on adjacent properties;
- conflict with regional or local land use plans and zoning; and
- result in land use restrictions on adjacent properties.

The evaluation of potential impacts to aesthetic resources considered whether the proposed project would directly or indirectly affect a protected resource. While there may be aesthetic qualities that are valued locally within the viewshed, federal and state laws do not typically protect unmanaged viewshed locations. However, local viewsheds and the proximity of residences to potential new structures are important to the affected parties. The analysis of aesthetic impacts considered the potential for the following effects:

- a blocked or degraded scenic vista or viewshed;
- degrading or diminishing of a federal, state, or local scenic resource;
- a change in area visual resources;
- glare or illumination that would be obtrusive or incompatible with existing land use; and
- creating visual intrusions or visual contrasts affecting the quality of a landscape.

3.11.2 Affected Environment

This section describes the existing land use conditions that could be affected by the proposed project, which would be constructed and operated in Fort Bend, Wharton, and Jackson Counties, Texas. Land cover in these three counties is listed in Table 3.11-1. Land cover information is useful because it indicates how the land is likely used. The low to high density developed land cover category indicates residential and industrial land uses. Fort Bend County has a much higher percentage of residential and industrial land use, 14.8%, when compared with Wharton and Jackson Counties, 2.0% and 1.3% respectively. This is representative of the more rural nature of Wharton and Jackson Counties. The expansion of the Houston metropolitan area into areas such as Fort Bend County has resulted in the conversion of agricultural and open lands into suburban residential and commercial uses. The dominant land use in all three counties is agriculture as indicated by the 61.8 to 79.9% cultivated/pasture/hay/grassland cover type.

Table 3.11-1. Existing Land Cover in Fort Bend, Wharton, and Jackson Counties

Land Cover Type	Fort Bend County	Wharton County	Jackson County
Low to High Intensity Developed and Developed Open Space	14.8%	2.0%	1.3%
Cultivated, Pasture/Hay and Grassland	61.8%	79.9%	67.3%
Forest	3.9%	4.8%	11.1%
Scrub and Shrub	5.1%	4.9%	10.3%
Wetland and Estuary	12.1%	7.7%	6.9%
Water	1.5%	0.5%	3.0%
Bare Land and Unconsolidated Shore	0.9%	0.2%	0.3%

Source: NOAA 2006
Note: Percentage values are approximations due to rounding

3.11.2.1 CO_2 Capture Facility

The proposed CO_2 capture facility would be constructed on lands within the existing W.A. Parish Plant property in Fort Bend County. The entire Parish Plant property is established as industrial use, although some of the lands are currently unoccupied and serve as a buffer area surrounding the electric generating facilities and related buildings and equipment. The footprint of the CO_2 capture facility and its supporting infrastructure would occupy 29 acres of land, as listed below, within the approximately 4,880 acres owned by NRG or its subsidiaries at the W.A. Parish Plant:

- *CO_2 Capture Area*: Approximately 400 feet by 400 feet (3.3 acres)
- *Combustion Turbine/Heat Recovery Steam Generator (CT/HRSG) area*: Approximately 100 feet by 200 feet (0.44 acres);

- *Two Laydown Areas*: Approximately 22 acres; and
- *Other project areas:* Relocated warehouse, relocated road, rail unloading area, CO_2 compressor, pipe rack, flue tank and pump, switchyard (3.2 acres).

The tallest structure in the proposed CO_2 capture facility would be the absorber column/vent stack, which would be less than 300 feet tall. The stack for the proposed cogeneration plant would not be more than 150 feet high and the proposed cooling tower would not be more than 50 feet high. The tallest existing structures at the W.A. Parish Plant are the vent stacks for Units 5 and 6, which are each 600 feet tall.

Land use near the W.A. Parish Plant is generally rural and agricultural, with small portions used for industrial and residential purposes. Two small residential areas are located approximately 0.5 miles east of the site and 1.5 miles southwest of the site as shown in Figure 3.13-1 in Section 3.13 of this EIS (Noise). Several schools and churches are located within the surrounding communities, with the closest school located approximately 3.5 miles to the northwest and the closest church approximately 2.5 miles to the northeast. Additionally, the George Ranch Historical Park is located approximately 2.5 miles west of the plant and Brazos Bend State Park is located approximately 5 miles southeast of the plant. Industrial uses at the project site currently consist of power plant operation with coal train traffic and unloading and use of heavy industrial vehicles. Various utility and oil and gas companies have easements for access to subsurface oil and gas resources on the lands surrounding the proposed CO_2 capture facility.

Fort Bend County has no zoning ordinances, although individual municipalities within the county may have zoning laws (Fort Bend County 2010b). There are 18 incorporated areas in Fort Bend County, including Richmond (County Seat), Arcola, Beasley, Fresno, Fulshear, Houston (also in Harris County), Katy (also in Harris County), Kendleton, Meadows, Missouri City (also in Harris County), Needville, Orchard, Pleak, Rosenberg, Simonton, Stafford, Sugar Land, and Thompsons. Residential growth in the area is increasing and agricultural land use is decreasing with a consistent trend toward increasing urbanization (RGK Center 2006)).

The land proposed for the CO_2 capture facility is currently occupied by open space, a road, and a warehouse, all of which are located within the W.A. Parish Plant. The plant site is adjacent to Smithers Lake, the primary source for cooling water and plant process water for the W.A. Parish Plant.

The primary visual features in the vicinity of the W.A. Parish Plant are the plant and the flue gas stacks, Smithers Lake, and high-voltage electric transmission lines. Four existing stacks at the plant are prominent visual features; two of the stacks are 500 feet high and two are 600 feet high. Electric transmission lines connect the existing W.A. Parish Plant to the power grid for eventual distribution to electricity users. Figure 2-1 shows the W.A. Parish Plant site and the immediate surrounding area.

There are no designated scenic vistas or otherwise protected view points in the vicinity of the proposed CO_2 capture facility.

The W.A. Parish Plant is well illuminated for security and worker safety reasons. All of the existing facilities and fenced entrances have security lighting that operates during all nighttime hours.

3.11.2.1.1 Land Use Plans and Regulations

The proposed CO_2 capture facility would be located in Fort Bend County. The county has no land use plan, zoning, or development standards that would be applicable to the proposed site of the CO_2 capture facility (Fort Bend County 2010b).

3.11.2.1.2 Public Access Areas and Recreation

There are no recreational areas at the proposed plant site. Recreational use is not allowed at the adjacent Smithers Lake. This lake is used primarily for water supply to the W.A. Parish Plant.

3.11.2.1.3 Airspace

The CO_2 capture facility ROI is within the Houston air traffic control area designated by the Federal Aviation Administration (FAA). However, there are no military airspaces designated above the ROI. The FAA restrictions state: "Any temporary or permanent structure, including all appurtenances, that exceeds an overall height of 200 feet (61m) above ground level (AGL) or exceeds any obstruction standard contained in 14 CFR part 77, should normally be marked and/or lighted" (FAA 2000).

3.11.2.2 Pipeline Corridor

The proposed CO_2 pipeline would cross lands used for utility and energy ROWs, livestock grazing, cultivated agriculture, and open space in Fort Bend, Wharton, and Jackson Counties, Texas. The ROW does not cross lands used for residential purposes. NRG proposed the route, which primarily follows existing pipeline or electric transmission line ROWs. The approximately **81**-mile-long pipeline would have a construction ROW width of 100 feet along most of the pipeline but would narrow to 75 feet in some wetland areas. River and road crossings constructed using HDD or conventional boring techniques would require staging areas larger than the nominal construction ROW width on both sides of the crossing. The permanent ROW width would typically be 30 feet.

Table 3.11-2 lists the land cover types in the pipeline corridor ROI. Land cover types indicate general categories of land uses. **NRG has made minor realignments to its proposed route to accommodate landowner concerns or to allow for better access for directional drilling to place the proposed pipeline under a paved road. These minor realignments account for the changes to the acreage of land cover types in the pipeline ROI compared to the values presented in the Draft EIS.**

Table 3.11-2. Land Cover Type Acreage in the Pipeline ROI

Land Cover Type	Acres	Percent
Developed (Low/Medium/High Density including residential or Open Space)	**9.2**	0.9
Cultivated, Pasture, Hay, Grassland or Herbaceous	**801.5**	**77.0**
Forest	**24.6**	**2.4**
Shrub/Scrub	**92.0**	**8.8**
Wetlands (Palustrine and Estuarine)	**108.7**	**10.4**
Water	**1.7**	0.2
Bare Land/ Unconsolidated Shore	**3.1**	**0.3**
Total	**1040.8**	**100**

Source: NOAA 2006

The pipeline ROW closely follows the existing ROWs for electric transmission lines and other pipelines. The existing transmission towers are visually prominent and extend above the tree canopy in areas where trees are present, as shown in Figure 3.11-1. The pipeline route crosses open areas with views that extend for more than one mile during favorable weather conditions.

The existing ROW has no night time security lighting except for at electric substations.

Figure 3.11-1. Typical View of the Proposed Pipeline ROW Along the CenterPoint ROW (Looking Southwest near FM 762)

3.11.2.2.1 Land Use Plans and Regulations

The proposed pipeline ROI crosses unincorporated parts of Fort Bend, Wharton, and Jackson Counties. The counties have no land use plans, zoning, or development standards that would be applicable to the proposed pipeline.

3.11.2.2.2 Public Access Areas and Recreation

The proposed pipeline would not cross any federal, state, or county park lands. Several waterbodies that may be used for recreational purposes would be crossed by the pipeline using HDD, including the San Bernard River, the Colorado River, and the Lavaca River, as well as a number of smaller rivers, creeks, and bayous. See Section 3.7 of this EIS (Surface Water) for details. The nearest boat ramp on the San Bernard River is east of the W.A. Parish Plant at the end of McKeever Road. In Wharton County there is one canoe launch on the Colorado River. Recreation access is available to the Lavaca River at one developed boat ramp near Lolita and at other undeveloped points along the river.

3.11.2.2.3 Airspace

The east part of the pipeline ROI is within the Houston air traffic control area designated by the FAA. However, there are no military airspaces designated above the pipeline ROI.

3.11.2.3 West Ranch Oil Field

The West Ranch oil field is an active oil production field and was historically used for cattle ranching. Limited cattle grazing is currently allowed within the oil field. Oil was discovered in this area in 1938, after which oil and gas activities became the area's dominant land use. Over 200 oil and gas wells occur within the land use ROI, as well as a crude oil pipeline and one natural gas pipeline system. Many of the wells in the ROI, however, are no longer in production.

RRC records indicate that there are numerous existing oil and gas wells and produced water injection and disposal wells at the West Ranch oil field, as shown in Figure 3.4-4 through Figure 3.4-7 in Section 3.4 of this EIS (Geology). A network of oil gathering pipelines is present at the oil field. Oil produced is transported from the oil field via a crude oil pipeline. A natural gas pipeline crosses the oil field on the southern end.

No residences are located in the West Ranch oil field. The nearest residential community is the town of Vanderbilt, located approximately 0.5 miles north of the closest proposed drilling area at the West Ranch oil field which is within the ROI. Industrial High School and approximately one half of the Town of Vanderbilt (including approximately 80 residences) are within the 0.5 mile ROI as shown in Figure 3.11-2. An average vacancy rate of 19.2% for Jackson County in 2010 according to the U.S. Census as reported in Table 3.18-2 of this EIS (Socioeconomics) indicates approximately 65 occupied residences are within the ROI. Vanderbilt is also 2.3 miles north of the location of the proposed CO_2 recycle facility. In 2010, Vanderbilt had a population of 395 (2010 US Bureau of Census).

Current land uses at the West Ranch oil field are industrial for oil production with limited livestock grazing. Wildlife make use of some of the lands and open water areas although the area is not managed for wildlife. Areas along the Lavaca River to the southeast of the oil field are undeveloped wetland areas. Figure 3.11-3 is a typical view of some of the existing oil field equipment.

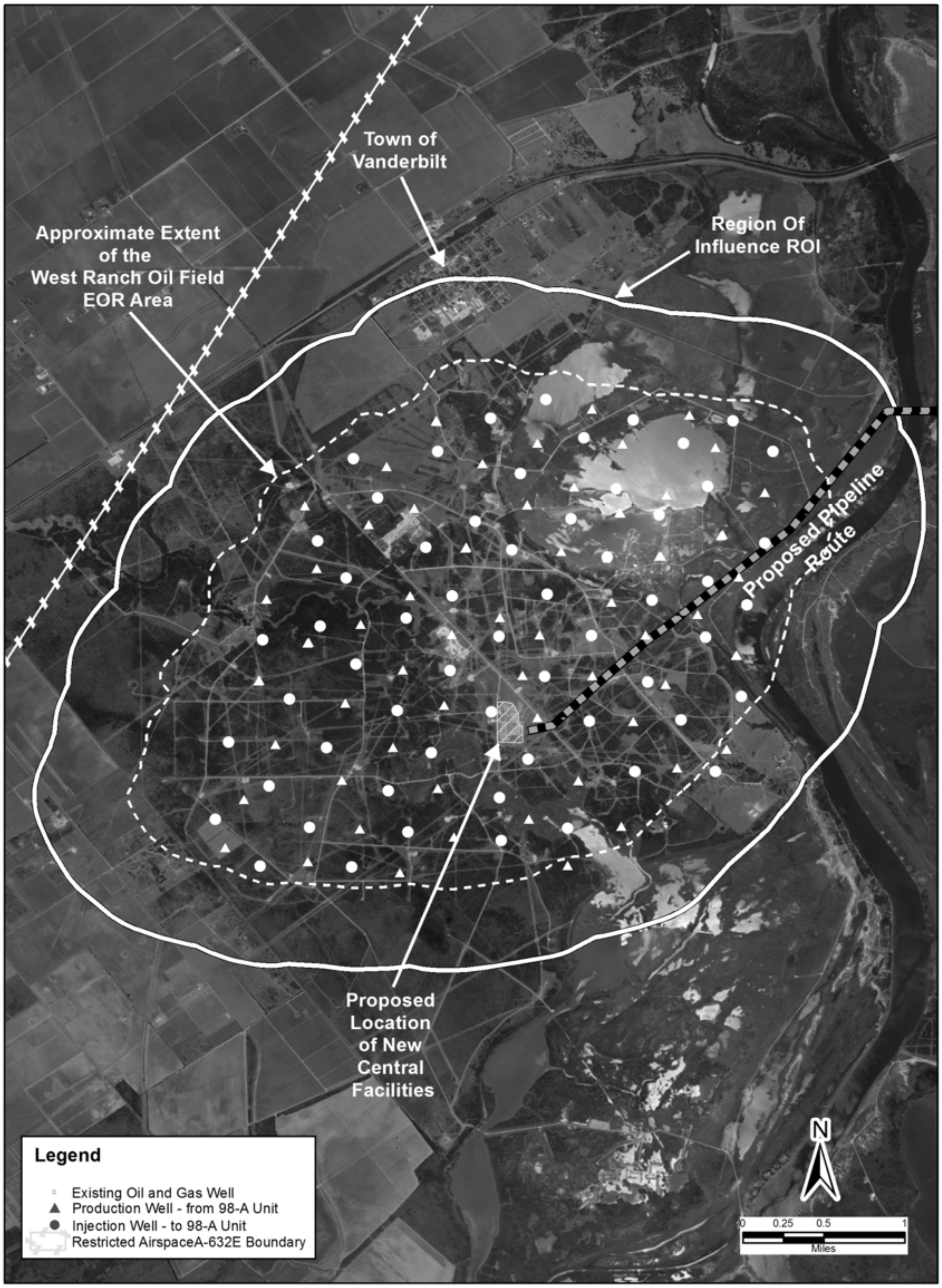

Figure 3.11-2. West Ranch Oil Field Land Use ROI

Figure 3.11-3. Existing Oil Field Equipment

The West Ranch oil field extends from the northwest edge of the Lavaca River onto higher land toward the Town of Vanderbilt and west into forested and open land. From the higher ground, views of the broad Lavaca River valley can be seen looking toward the south and southeast. Menefee Lake and Menefee Flat occupy the area between the main part of the West Ranch oil field and the Lavaca River. The large Interplast Plastics industrial complex is visible on the horizon from the higher ground when looking toward the south (approximately 3.7 miles east of the proposed CO_2 recycle facility), as shown in Figure 3.11-4. Views to the west and southwest of the West Ranch oil field are limited due to little variation in topography and some forested areas. Industrial structures common to oil fields are present at the West Ranch oil field, including steel tanks, well head pumps, pipelines, and buildings where operations are monitored.

Some of the existing facilities at the West Ranch oil field are illuminated at night with security and work lights. When oil drilling or workover rigs are active, bright work lights are used at night for safety reasons.

Figure 3.11-4. View from West Ranch Oil Field toward Menefee Lake, the Lavaca River and the Interplast Plastics Plant

3.11.2.3.1 Land Use Plans and Regulations

The West Ranch oil field is located in an unincorporated part of Jackson County. The county has no land use plan, zoning, or development standards that would be applicable to the proposed EOR and CO_2 monitoring activities at the West Ranch oil field.

3.11.2.3.2 Public Access Areas and Recreation

The Lavaca River is near the east side of the West Ranch oil field. The Lavaca River is used for wildlife habitat and for public recreation, including fishing. Menefee Lake is within the fenced boundary of the West Ranch Oilfield so recreation use is limited. Recreation access is available to the Lavaca River at one developed boat ramp near Lolita and at other undeveloped points along the river.

3.11.2.3.3 Airspace

The northwest part of West Ranch oil field is within FAA Military Restricted Airspace Area A-632E. Naval Air Station Kingsville is responsible for the Kingsville Military Operations Area and maintains records pertaining to its use by all military facilities. Naval Air Station Kingsville (approximately 140 miles southwest of the West Ranch oil field) has reported approximately 10,000 operations per year for the entire Military Operations Area, which are characterized by the FAA as "Alert Area A-632E concentrated student jet training." The U.S. Navy uses the designated area for flight training from 6,000 feet to 9,000 feet above ground level. (FAA 2012)

3.11.3 Direct and Indirect Impacts of the Proposed Project

DOE assessed the potential for impacts to land use and aesthetic impacts in the ROI based on whether the proposed Parish PCCS Project would result in any of the effects identified in Section 3.11.1.3.

3.11.3.1 Construction Impacts

3.11.3.1.1 CO_2 Capture Facility

As previously discussed, construction of the CO_2 capture facility and its supporting infrastructure within the W.A. Parish Plant site would not conflict with any designated zoning plans because there are no zoning plans in effect at the plant site. The 29-acre project area is characterized as previously- disturbed, undeveloped industrial open space (grassy areas), and lands with existing industrial uses (i.e., an existing road and warehouse). Immediately adjacent developed and previously disturbed lands contain industrial structures associated with power generation. The additional facilities proposed for construction would be compatible with those on the surrounding lands, which are also owned by NRG.

Construction of the CO_2 capture facility would have a negligible adverse impact on land use in the immediate area. The W.A. Parish Plant site offers the space and much of the infrastructure required to support the construction of the CO_2 capture facility. Construction at the W.A. Parish Plant would have a negligible impact on neighboring property owners because the nearest residence is located approximately 0.5 miles east of the proposed location of the CO_2 capture facility. Potential impacts on residential properties during construction of the CO_2 capture facility are described in other sections of this EIS, particularly Sections 3.12 (Traffic and Transportation); 3.13 (Noise); and 3.15 (Human Health and Safety). Construction of the CO_2 capture facility would have a negligible impact on aesthetic resources and viewsheds in the immediate area. The project site is located at an existing power plant facility and the proposed facilities would be visually compatible with the existing plant facilities.

Noise, truck traffic, and dust could be contributing factors for potential aesthetic impacts to residences located within 0.5 miles of the site. However, the closest residence to the CO_2 capture facility is more than 0.5 miles away, such that the impacts would be negligible. The CO_2 capture facility construction site would not be visible from the nearest road (i.e., Smithers Lake Road) due to buildings and other features of the existing power plant complex.

As described in Section 3.5, of this EIS (Physiography and Soils), the NRCS classified some of the soils at the W.A. Parish Plant, where the CO_2 capture plant would be constructed, as prime farmland. However, all of the W.A. Parish Plant lands were converted to industrial use years ago so there would be no impact to prime farm land.

Aesthetic conditions of the residences and users along Smithers Lake Road are not expected to experience substantial direct adverse impacts during construction due to the distance from the construction area to these adjacent areas and the existing industrial landscape surrounding the site.

Security and work lighting would be installed at the proposed CO_2 capture facility. This is consistent with the lighting practices at the existing W.A. Parish Plant. Security and work lighting would create no impacts.

3.11.3.1.2 Pipeline Corridor

Construction of the proposed pipeline would have both short-term and long-term impacts on land use. If it becomes necessary for the pipeline corridor to bisect a property, the design would include a suitable crossing of the pipeline to support vehicle crossings and maintain property owner access throughout the entire property during construction. Land within the permanent ROW would be disturbed for the excavation of pipeline trenches, and adjacent land within the temporary construction ROW would be disturbed for access and construction staging. Following construction, land within the temporary construction ROW could revert back to its original use. As such, disturbance of the area within the entire construction easement would result in temporary loss, and possible permanent loss, of small areas of natural land cover (i.e., forest, grasslands, and wetlands) and temporary loss of agricultural land along the pipeline corridor.

Table 3.11-3 quantifies the acreages of potential permanent and temporary impacts to land use type as a result of construction along the pipeline corridor. The maximum width of the construction ROW (100 feet) plus areas for HDD river crossings and staging was used to calculate the acreages of potential temporary impacts to land use as it represents a conservative upper bound.

The pipeline corridor would be located along existing pipeline and transmission line ROWs to the extent possible. Early planning indicates that approximately **75**% (i.e., **60** miles) of the pipeline corridor would be collocated with existing utility ROWs. Adjacent properties consist mainly of undeveloped land with natural ground cover (e.g., forests, grasslands, and wetlands) and agricultural land.

Construction of the pipeline would cause temporary minor to moderate aesthetic impacts to adjacent property owners, depending on their proximity to the construction easement. Table 3.11-3 identifies the number of residences located along the pipeline route. These impacts would be short-term and related to construction noise; truck traffic; emissions, mainly fugitive dust (i.e. particulate matter); and vegetation clearing.

Table 3.11-3. Potential Pipeline Route Construction Disturbances to Land Use

Resource Impact Type	Impact	Impact Rating
Permanent Loss of Natural Land Cover (forests, grasslands, etc.)	0 acres	Negligible
Temporary Loss of Natural Land Cover (forests, grasslands, etc.)	**641** acres	Minor
Total Construction Disturbance to Natural Land Cover Grassland and Shrub/Scrub	**641** acres	Minor
Permanent Loss of Agricultural Land	0 acres	Negligible
Temporary Loss of Agricultural Land	**386** acres	Minor
Total Construction Disturbance to Agricultural Land	**386** acres	Minor
Number of Residences within 1,000 feet of the Pipeline Route	123	Minor
Length of New ROW Created	**21** miles	Minor

As shown in Table 3.11-3, the proposed project would result in temporary loss of agricultural land and natural land cover during construction of the CO_2 pipeline. A total of approximately **386** acres of agricultural lands would be temporarily impacted by pipeline construction, but no permanent loss of agricultural lands would occur. As described in Section 3.5 of this EIS (Physiography and Soils), approximately **68**% of the soils in the proposed CO_2 pipeline ROW are classified by the NRCS as prime farmland. Section 3.5 also states that disturbances to these soils would be minor and temporary, and that BMPs would be used to minimize the extent and magnitude. Minor to negligible long-term impacts to the surface soils along the pipeline would include the conversion of land use in a number of localized areas along the pipeline route for the installation and use of one approximately 0.25-acre meter station near the West Ranch oil field and approximately **12** aboveground valves (i.e., MLVs).

Where pipeline construction would run along an existing transmission line or pipeline easement, construction impacts would be short term and negligible because land use within the original easement would remain as ROW. However, areas of currently maintained ROW may be expanded, as necessary, to provide access for routine inspection and maintenance of the proposed pipeline. The land use on adjacent property within the temporary construction ROW could revert back to forest or pastureland after construction. For agricultural land, the acreages of available pastureland or cropland would be minimized during construction, and then restored after construction. While the soils within the construction ROW would be returned to production if farmed, they could be less productive due to increased compaction and some loss of soil from erosion. However, the removal and preservation of topsoil during construction and replacement after construction ceases would help mitigate the impact of the construction disturbance. Impacts on potential crop production could be further reduced if construction of pipelines would occur outside the planting and growing season.

In cases when pipeline construction would require the acquisition of a new easement where none existed, construction impacts would be minor, because land use would be disrupted within the entire construction ROW, and then restored to its original use to the extent practicable after construction.

As discussed earlier, there are rural residential properties scattered throughout the pipeline ROW, as indicated in Table 3.11-3. Although no residential land or residential structures would be directly impacted during construction of the pipeline corridors, there are residences near the pipeline route. Construction impacts to residential land use would be primarily related to dust, traffic, and noise, as discussed in Sections 3.2 (Air Quality and Climate), 3.12 (Traffic and Transportation), 3.13 (Noise) of this EIS.

During construction, night time security and work lights would be used to ensure safety of workers. Security lighting would not be installed at the pipeline ROW for use during operations with the exception of the meter station that would be constructed on the east side of the Lavaca River. Lighting installed at the meter station would be down shielded to avoid interference with wildlife. The impact of lighting during construction would be temporary and minor. The impact of lighting for operations at the proposed meter station would be minor.

3.11.3.1.3 West Ranch Oil Field

A combination of existing wells (where practical) and new wells would be used for EOR and CO_2 monitoring operations. New wells and associated equipment would be installed on existing well pads to the extent practical to minimize land development for EOR and CO_2 monitoring operations. Well construction if required, would temporary impact land use due to clearing of vegetation, equipment movement, and well construction activities. Each well site would require approximately 0.5 acres for drilling activities during construction (i.e., for temporary lay-down areas, water management, etc.). Well construction would primarily disturb previously disturbed land cover within the existing oil field.

In general, construction of the CO_2 pipeline within the West Ranch oil field would result in temporary negligible impacts to land use. These project features would be located within the limits of existing facility operations. Existing roads would be used to the extent practical to access EOR and CO_2 operation areas within the West Ranch oil field. No new road construction is anticipated at this time.

As described in Section 3.5, Physiography and Soils, the NRCS classified some of the soils at the West Ranch oil field as prime farmland, including the area proposed for the recycle facility. Impacts to soils from construction of the new, approximately 1.5-acre CO_2 recycle facility would be considered negligible because this facility would be located in an area that was previously occupied by a gas processing facility. Most of this area was previously disturbed during construction of the facility and again when most of the facility's infrastructure was demolished. Impacts to other soils classified as prime farmland at the West Ranch oil field would also be negligible because the lands are currently used (and have been historically used since the 1930s) for industrial oil extraction with occasional cattle grazing and those land uses would continue during the EOR and CO_2 monitoring activities.

Minor and temporary impacts (i.e., construction noise) to nearby residential properties would be expected during construction. The nearest residences to the injection well sites are approximately 0.5 miles north of the northern end of the West Ranch oil field. The noise levels would be similar to the existing noise levels at the West Ranch oil field. Refer to Section 3.13 of this EIS (Noise) for additional details about construction noise at the West Ranch oil field.

The structures constructed at each well site would likely be less than ten feet in height. The construction equipment and drill rigs would extend higher, but would not remain on the site after construction is completed. Construction activities would be visible to few residences, if any, and would generally have minor, short-term impacts. Construction impacts to residential land use would include an increase in dust, traffic, and noise, as discussed in Sections 3.2 (Air Quality and Climate), 3.12 (Traffic and Transportation), 3.13 (Noise) of this EIS.

3.11.3.2 Operational Impacts

3.11.3.2.1 CO_2 Capture Facility

The operation of the CO_2 capture facility would have a negligible impact on the industrial land use within the W.A. Parish Plant. The CO_2 capture facility and its supporting infrastructure would be compatible with the industrial land use of the immediately surrounding lands, also owned by NRG. Operation of the CO_2 capture facility would also have a negligible impact on neighboring property owners because the nearest residences are located approximately 0.5 miles from the CO_2 capture facility. Additionally, operation of the new facility would be substantially similar to and compatible with the industrial activities already conducted at the site. Potential impacts on residential properties during operation of the CO_2 capture facility are described in other sections of this Chapter, particularly Sections 3.12 (Traffic and Transportation); 3.13 (Noise); and 3.15 (Human Health and Safety).

Long-term direct effects to existing viewsheds would primarily occur from a permanent change in the landscape resulting from the introduction of new industrial structures and facilities. The CO_2 capture facility would not substantially alter the landscape in the area. The current W.A. Parish Plant is a large heavily developed, industrial site that includes existing boilers, cooling towers, approximately 500-foot-tall and 600-foot-tall stacks, and other industrial structures. The tallest proposed structures for the CO_2 capture facility (i.e., the absorber column/vent stack) would be much shorter than the tallest structures in the W.A. Parish Plant. As noted above, the tallest structure in the proposed CO_2 capture facility would be the absorber column/vent stack, which would be less than 300 feet tall, approximately one-half the height of the 600-foot-tall vent stacks for Units 5 and 6.

New facilities and structures that would be constructed as part of the proposed project would be consistent with the existing industrial nature of the W.A. Parish Plant site. As these new structures would not alter the aesthetics of the facility and would not be readily visible from nearby residential properties, no aesthetic related impacts are anticipated. The proposed CO_2 capture facility would be constructed on lands that are not subject to land use plans or zoning so the potential use of the lands would have no impact to zoning and land use ordinances.

3.11.3.2.2 Pipeline Corridor

Long-term impacts to land use are not expected to occur from the permanent conversion of natural land cover in some areas (i.e., forest, grasslands, and wetlands) and agricultural land in others to mowed/maintained ROW for the CO_2 pipeline. As summarized in Table 3.11-3, the acreages of permanent ROW required for the potential pipeline are upper bound estimates of the acres of land that would be affected.

Operation of the CO_2 pipeline would have negligible long-term impacts to pastureland and cropland. Any potential impacts would be mitigated by allowing the current land use to resume after construction, provided that there is adherence to ROW restrictions that allow access for maintenance and limit construction of permanent structures within the permanent pipeline easement. Impacts on potential crop production could be further minimized if maintenance activities within the pipeline corridors could be performed outside the planting and growing seasons.

Where the pipeline corridor would be collocated with existing mowed/maintained utility ROWs, long-term impacts to land use would be negligible, since land use within the original easement would remain as permanent ROW. However, where new ROW would be created along the pipeline corridor, the long-term impact to land use would be minor in areas where the land is currently used for cultivated crops. Most land cultivation would be able to continue after construction of the pipeline is complete. Long term impact to lands currently used for other purposes would be negligible. Land that is currently forest would be permanently changed to ROW and land use would be subject to restrictions within the permanent easement for the pipeline. The pipeline corridor may cross private properties and impact land use options within the permanent easement. In cases where a new pipeline corridor would bisect a property, impacts could occur if the pipeline would obstruct current or future access within the property (i.e., road crossings and vehicle access). This impact, however, would be unlikely as the pipeline would be placed underground and engineered to withstand the weight of typical residential, farm, or ranch vehicles (i.e., cars, trucks, tractors).

Rural residential properties are scattered throughout the study area. Although no residential land or residential structures would be directly impacted during construction of the pipeline corridors, residences are present near the pipeline route.

Table 3.11-3 identifies the approximate number of residences within approximately 1,000 feet of the pipeline corridor. Potential impacts would be minimized through conformance with pipeline siting regulations, including 49 CFR 195, Transportation of Hazardous Liquids by Pipeline. Applicable pipeline siting requirements include Section 195.210, Pipeline Location:

- Pipeline ROWs must be selected to avoid, as far as practicable, areas containing private dwellings, industrial buildings, and places of public assembly.
- No pipeline may be located within 50 feet of any private dwelling, or any industrial building or place of public assembly in which persons work, congregate, or assemble, unless it is provided with at least 12 inches of soil cover in addition to that prescribed in 49 CFR 195.248 (Cover Over Buried Pipeline).

Potential short-term impacts to residential land use during operations are also discussed in Section 3.15 of this EIS (Human Health and Safety).

Since the potential pipeline would be buried, and the land returned to its previous use, with the exception of vegetation maintenance within the permanent ROW, negligible long-term impacts to scenic resources from pipelines would occur. Aesthetic impacts to the adjacent property owners from operation of the pipeline segments would be characterized as negligible to minor. As previously discussed, the pipeline route includes the creation of new permanent ROW would cause the impacts to adjacent property owners; however, these impacts would remain minor as the pipeline would be buried. The installation of a meter station, **12** aboveground valves (i.e., MLVs), and placement of underground utility signs along the pipeline corridors would have minor impacts to aesthetics in locations of newly established ROW. Long term land use activities within the proposed ROWs would be limited for activities involving excavation. Although the pipeline would be buried at a nominal depth of 24 inches, the land owner would be required to call the 811 One Call Center of the Common Ground Alliance when excavation activities fall outside the scope of normal farming activities. Normal farming activities include:

- Fence post installation
- Terracing projects
- Tilling

The pipeline route crosses lands that are not subject to land use plans or zoning so the potential use of the lands for the pipeline operations would have no impact to zoning and land use ordinances.

3.11.3.2.3 West Ranch Oil Field

EOR and CO_2 monitoring operations and use of the CO_2 pipeline and access roads at the West Ranch oil field would result in the potential permanent loss of scrub and grasslands at some locations. All land disturbing activities and changes in land use would be contained within the West Ranch oil field, and thus would have no land use or aesthetic impact on adjacent properties. Additionally, proposed activities would be consistent and compatible with existing activities and land uses within the West Range Oil Field. As a result only negligible to minor impacts related to the potential conversion of small areas of scrub and grasslands to either access roads or well pads would occur.

Each injection well site would occupy a 0.5-acre site when completed, which would be located as close as possible to existing roads to minimize the length of an access road necessary for maintenance vehicles. New wells and associated equipment would be installed on existing well pads to the extent practical to minimize land development for EOR and CO_2 monitoring operations.

For land use in the surrounding areas, the potential long-term impact of operations at the injection well sites would also be negligible. Since the areas of EOR and CO_2 monitoring operations are situated outside of municipalities in Jackson County, and no existing zoning plans or ordinances exist for these areas, the potential use of the properties would cause no impacts to zoning and ordinances.

EOR operations and CO_2 monitoring at the West Ranch oil field would have negligible to minor impacts to residential properties in Vanderbilt, because they would be 0.5 miles or more from the nearest facilities. The potential for increase in noise at residential receptors is described in Section 3.13 of this EIS (Noise). Potential long-term impacts to residential land use during operations of the injection well sites are also discussed in Section 3.15 of this EIS (Human Health and Safety).

The potential EOR activities associated with the project are all located within HEC-owned or leased property, and would be similar in appearance to the existing oil field equipment and buildings. No conflicts with visual receptors at the site would be expected. Natural ground cover outside of the properties would remain and provide screening to minimize aesthetic impacts.

Operations at the West Ranch oil field would have no impact on the restricted airspace on the northwest side of the oil field.

3.11.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost- shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to land use and aesthetic resources.

3.12 TRAFFIC AND TRANSPORTATION

3.12.1 Introduction

3.12.1.1 Region of Influence

The ROI for transportation resources is described in terms of the existing transportation network in the vicinity of the W.A. Parish Plant, the CO_2 pipeline corridor, and the West Ranch oil field. This includes travel routes for workers commuting to the job site and delivery of equipment and goods. Project related sites and associated project components are located in southeast Texas, within approximately100 miles of Houston, either in Fort Bend, Wharton, or Jackson County. With respect to roadways, discussions of traffic impacts are limited to the vicinity of the W.A. Parish Plant and the West Ranch oil field. In addition, the proposed CO_2 pipeline and its impacts to local traffic are discussed and specific roads along the pipeline are identified.

3.12.1.2 Method of Analysis

DOE analyzed impacts to vehicular traffic on the local roadway network based on estimated future traffic volumes related to the proposed project, as compared to existing traffic volumes and roadway conditions, using methods outlined in the Transportation Research Board's 2000 Highway Capacity Manual (TRB 2000). Existing traffic volumes generated by the W.A. Parish Plant and the West Ranch oil field were determined by evaluating existing operating characteristics, including the number of personnel; operating shifts; and estimates of existing deliveries, waste disposal, and other truck or rail traffic to and from these facilities. Existing roadway information and traffic data, including annual average daily traffic counts and estimated peak hour traffic for key roadways near the plant, along the pipeline route, and near the West Ranch oil field were obtained from the Texas Department of Transportation (TXDOT). DOE used these data along with other known roadway characteristics to assess current operating conditions. In addition, DOE considered transportation infrastructure upgrades required to implement the proposed project. Level of service data for highways within the ROI has not been determined and was not available for use in the traffic analysis.

3.12.1.3 Factors Considered for Assessing Impacts

The evaluation of potential impacts on transportation resources considered whether the proposed project, or any alternatives, would cause any of the following conditions within the ROI:

- Increase in traffic volumes so as to degrade traffic conditions to unacceptable levels (e.g., increase traffic delays and cause significant congestion);
- Result in a noticeable reduction in the functionality of roadways, alter traffic patterns, change existing roadway or intersection infrastructure, or force the permanent closure of roadways;
- Increase rail traffic noticeable when compared to existing conditions at the W.A. Parish Plant rail yard; or
- The proposed project would conflict with any local or regional transportation plan.

3.12.2 Affected Environment

This section addresses existing regional transportation system, average daily traffic within the ROI, and transportation involving the roadway network and rail system.

3.12.2.1 Regional and Local Roadway System

The W.A. Parish Plant is located in Thompsons, Texas (Figures 2-2 and 2-4), which is in Fort Bend County near the southwestern edge of Houston, Texas. The primary north-south route in Houston is I-45, and the primary east-west route is I-10. U.S. Highway 59 (the Southwest Freeway) runs east-west approximately seven miles north of the plant, providing access to Houston and its network of highways. Highway access to the plant from the west is via Farm-to-Market Road (FM) 762 and Smithers Lake Road. Access from the east is via FM 2759, North Thompson Road, and Y U Jones Road (Figure 3.12-1).

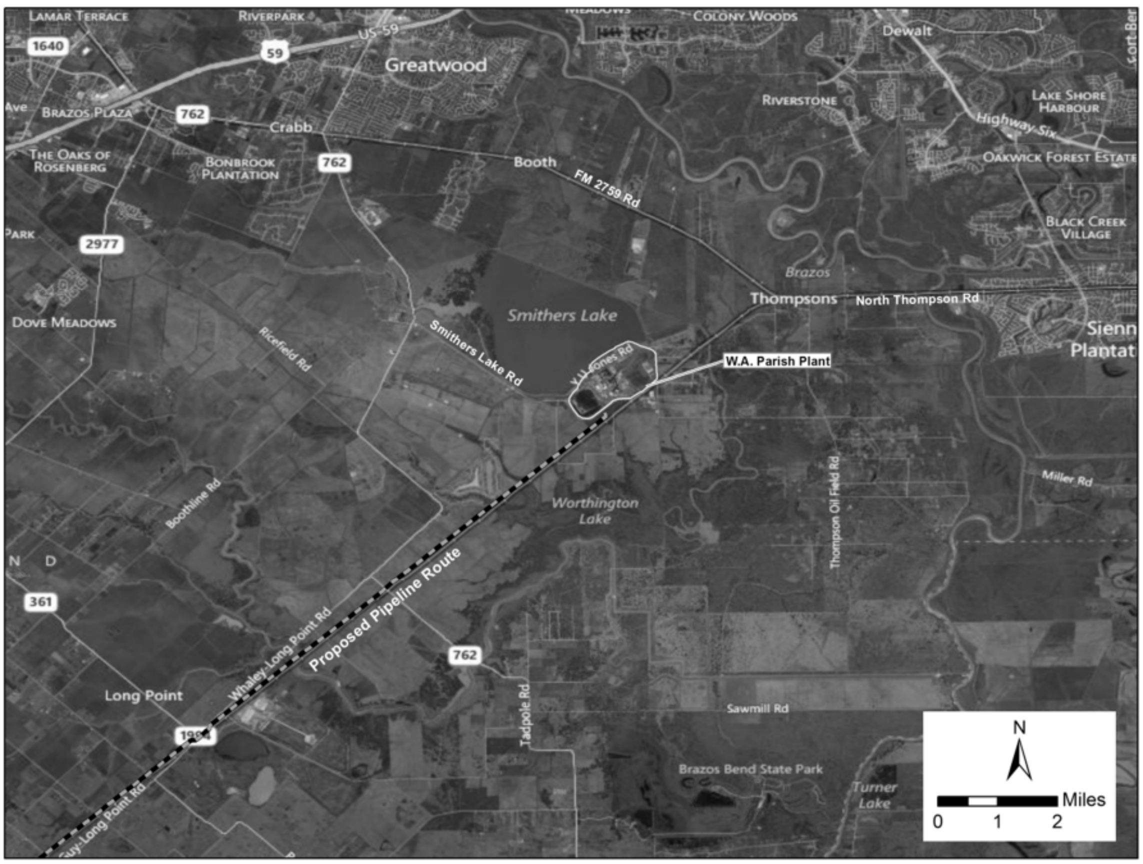

Figure 3.12-1. W.A. Parish Plant Area Roads

There are approximately 565 total workers (385 employees and 180 contractors) at the W.A. Parish Plant, of which the majority of the staff works a standard 40-hour week through various combinations of 10-hour shifts, nine-hour shifts, and the more traditional eight-hour shifts, five days per week, with some workers operating on various 12-hour shift rotations on seven-day workweeks. During major maintenance outages, the full-time permanent workforce can be complimented by up to 500 contractors with various work schedules. The major maintenance outages are planned to coincide with the major scheduled outages for the host unit every 30 months. Considering the various shift schedules, DOE assumes the facility workers would account for approximately 353 vehicle round trips per day during normal operation, and 673 round trips per day during major maintenance outages. In addition, between 50 and 59 trucks per day access the plant to remove ash and deliver materials. Due to diverse schedules and 24-hour-a-day operations, worker and truck trip schedules can vary greatly and are not normally concentrated within a single time period.

The West Ranch oil field is located south of the town of Vanderbilt, Texas (Figures 2-2 and 2-10), which is in the southern portion of Jackson County, approximately 100 miles southwest of Houston, Texas. Highway access to the West Ranch oil field is via U.S. Highway 87 S to FM 616 from the west or via FM 234 S to FM 616 from the east (Figure 3.12-2). Mobil Oil Road provides direct access to the field from FM 616. There is a network of tertiary roadways throughout the oil field providing access to the wells and on-site support facilities. The West Ranch oil field operates with six-person crews 24 hours a day, seven days a week, and 365 days a year. Employees commute with their own vehicles. During routine operations, one to two heavy trucks per day make deliveries to the site. This accounts for approximately 18 worker trips, and one to two delivery trucks per day, during normal operations.

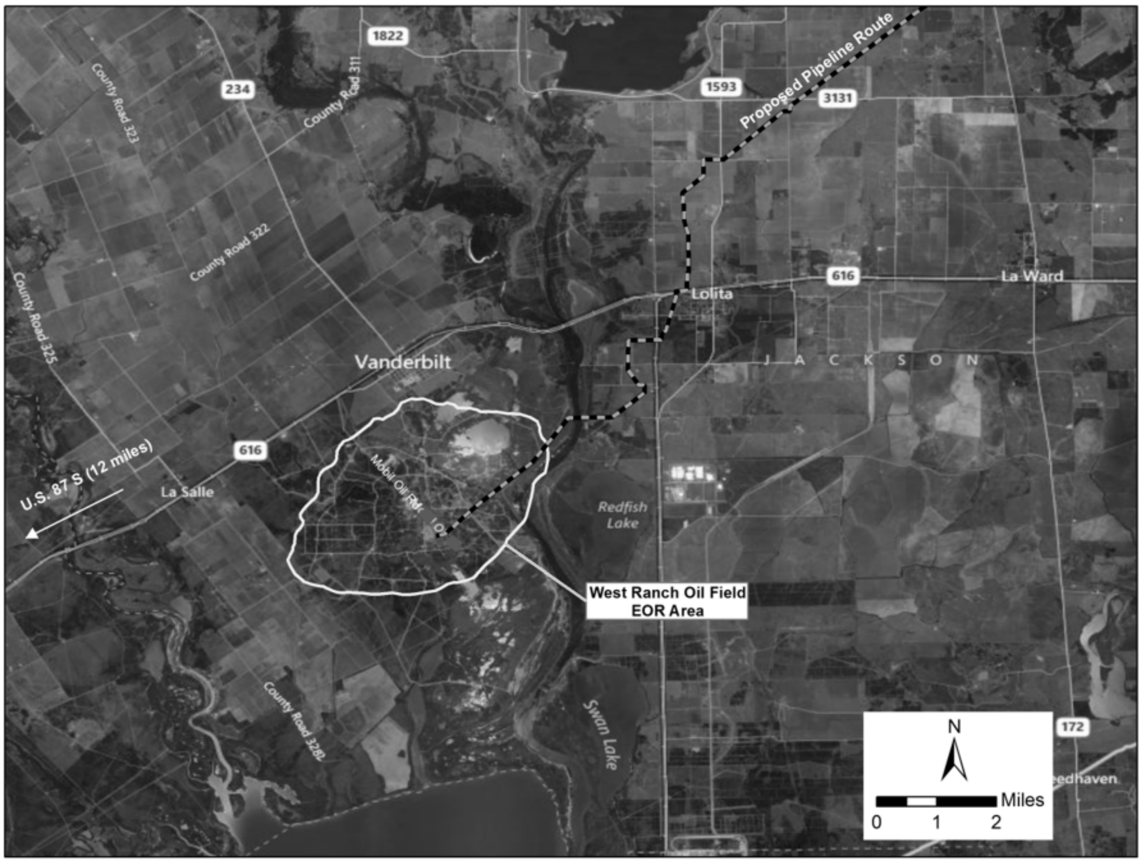

Figure 3.12-2. West Ranch Area Roads

The proposed pipeline would begin at the W.A. Parish Plant and continue southwest approximately **81** miles through Fort Bend, Wharton, and Jackson Counties, intersecting several public roadways along the way, as shown in Figure 3.12-3. Table 3.12-1 presents TXDOT annual average daily traffic counts and estimated peak hour traffic for the key roadways near the plant, along the pipeline route, and near the West Ranch oil field. All of these roadways have two lanes, with peak hour traffic volumes well below a single lane's capacity of approximately 1,700 vehicles per hour (TRB 2000). These roadways operate in a free-flowing manner with little congestion. Due to the relatively low traffic volumes in this mostly rural area, these roads have not been analyzed for level of service (LOS) according to the Regional Transportation Plan for the Houston-Galveston Area (HGAC 2010).

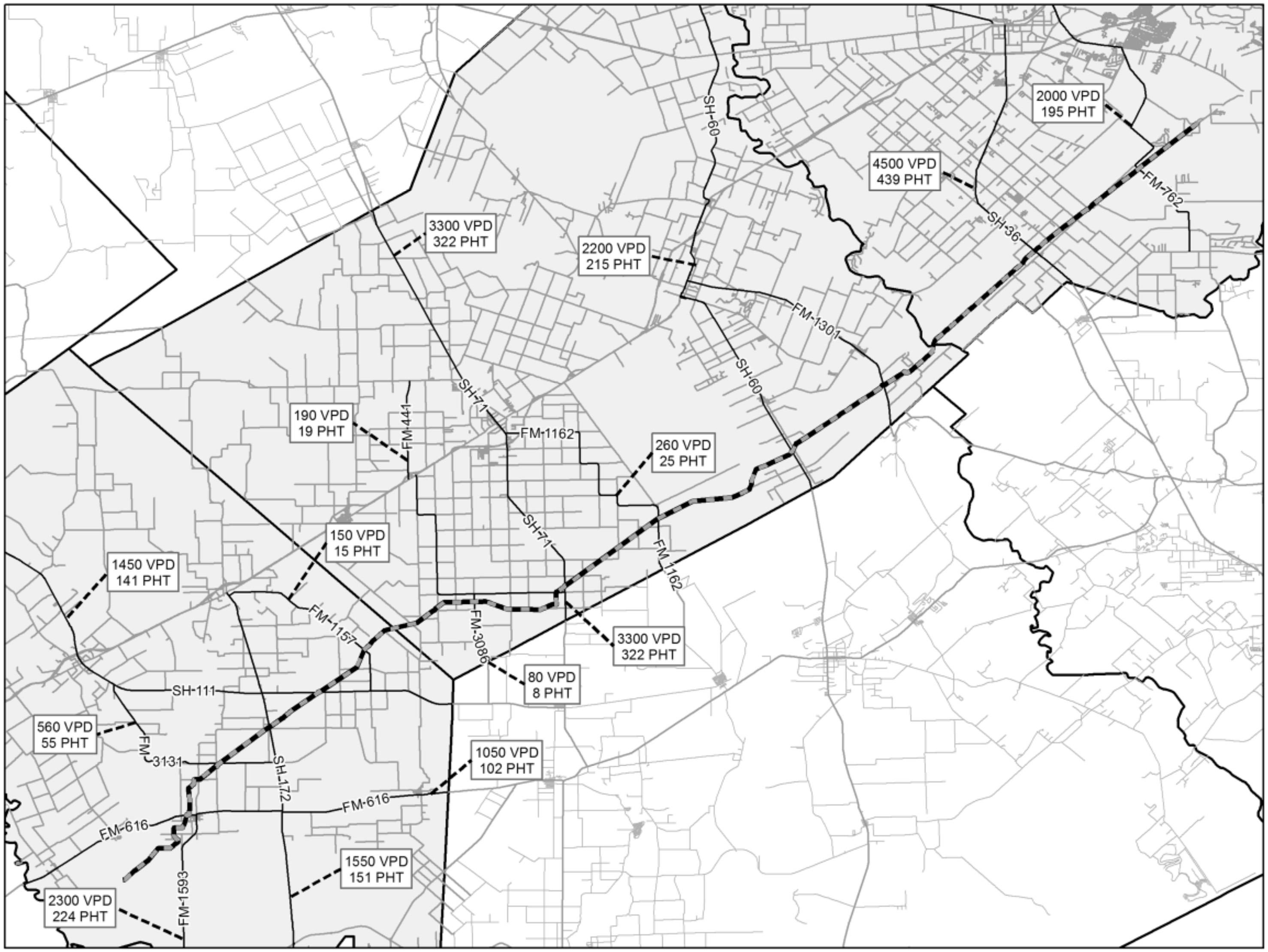

Figure 3.12-3. Roads in the Vicinity of the Proposed Pipeline Corridor

Source: TXDOT 2010
VPD = vehicles per day; PHT = peak hour traffic

Table 3.12-1. Daily and Peak Hour Traffic for Nearby Roadways

Road Crossings	County	Annual Average Daily Traffic (vehicles per day)	Peak Hour Traffic in Prevailing Lane (vehicles per hour)	Estimated Additional Capacity Assuming 1700 vph per lane (vehicles per hour)
Farm to Market Road 762	Fort Bend	2,000	195	1505
Farm to Market Road 2759	Fort Bend	820	82	1618
State Route 36	Fort Bend	4,500	439	1261
Farm to Market Road 1301	Wharton	2,200	215	1485
State Route 60	Wharton	3,300	322	1378
Farm to Market Road 1162	Wharton	260	25	1675
State Route 71	Wharton	3,300	322	1378
Farm to Market Road 441	Wharton	190	19	1681
Farm to Market Road 3086	Wharton	80	8	1692
Farm to Market Road 1157	Jackson	150	15	1685
State Route 111	Jackson	1,450	141	1559
State Route 172	Jackson	1,550	151	1549
Farm to Market Road 234	Jackson	1,850	185	1515
U.S. Highway 87 S	Jackson	9,000	900	800
Farm to Market Road 3131	Jackson	560	55	1645
Farm to Market Road 1593	Jackson	2,300	224	1476
Farm to Market Road 616	Jackson	1,050	102	1598

Source: TXDOT 2010
vph = vehicles per hour

3.12.2.2 Rail Transportation

The W.A. Parish Plant uses its rail facilities primarily for coal delivery. On average, the Plant unloads two to three trainloads of coal each day, with each train averaging approximately 128 rail cars. The BNSF Railway transports coal from mines in the Powder River Basin, Wyoming to the Texas Gulf Coast. The cycle time averages eight days to travel the 3,100 mile round trip. Trains unload coal to short-term storage by using one of the two on-site rotary car dumpers. Additionally, 15 rail cars of limestone are delivered to the W.A. Parish Plant each month on average.

3.12.3 Direct and Indirect Impacts of the Proposed Project

DOE anticipates that NRG's proposed project would have short-term minor and long-term negligible adverse effects on traffic, road use, and transportation related infrastructure. Short-term effects would be primarily due to worker commutes, the delivery of equipment and supplies to the sites, and the potential for open-cut installation of pipeline segments across roads along the pipeline corridor. Long-term effects would be primarily due to small increases in worker and truck traffic at the W.A. Parish Plant and the

West Ranch oil field, as well as for monitoring and maintenance activities at the oil field and along the pipeline. Neither construction, nor operations, at the plant, along the pipeline, or at the oil fields would result in any of the adverse impacts listed under 3.12.1.3.

3.12.3.1 Construction Impacts

Traffic would increase at the W.A. Parish Plant, along the pipeline, and at the West Ranch oil field due to additional construction vehicles and traffic delays near the proposed sites. These effects would be temporary in nature and would end with completion of the construction phase at each site. The current condition of the local roadway infrastructure would be sufficient to support the anticipated increase in construction vehicle traffic. In addition, temporary road closures or detours to accommodate utility system work would be expected, creating short-term traffic delays. Such effects would be minimized by scheduling construction to begin earlier than traditional 8 a.m. to 5 p.m. work schedules and placing construction staging areas where they would minimize interference with traffic to the extent practicable. Construction vehicles would be equipped with back-up alarms, two-way radios, and Slow Moving Vehicle signs when appropriate.

W.A. Parish Plant

NRG estimates that site preparation and foundation construction would generate an average of 10 trucks per day, with the most frequent truck trips occurring from **January** to **April** of **2014**. Building fabrication and aboveground work would generate between 5 and 12 trucks per day, with the most frequent truck trips occurring from **February** to **August** of **2014**. Construction-related rail traffic would be minimized to reduce the potential for disruption of coal deliveries. The construction-related truck traffic would be very small when compared to existing traffic on surrounding roadways (Table 3.12-1). Since the roadways approaching the plant are free-flowing and below capacity, these small changes associated with the proposed project would have negligible effect on traffic conditions. One road within the W.A. Parish Plant site would be relocated as part of the Parish PCCS Project (Figure 2-4), but this would have negligible impact on public roadways.

The number of construction workers would vary during the two-year construction period beginning in **mid-2013**, ranging from 250 to 600 personnel during the various phases of construction, and averaging approximately **300** personnel at any given time. There would likely be one overlapping major maintenance event for one of the coal units during construction of the CO_2 facility. The peak in construction workers would occur approximately six months after starting construction of the mechanical and electrical systems. The majority of worker-related traffic would occur in the early morning and early evening, close to or during peak traffic periods. The roadways approaching the plant are free-flowing and well below capacity. However, due to the substantial number of worker trips during the peak of construction, these worker trips would have a minor adverse effect on traffic conditions particularly near the plant. These effects would diminish for roadways located farther from the facility. These activities would end with completion of the construction phase, and overall, the associated effects would be minor.

As many as 10 to 12 pieces of construction-related equipment and supplies would be delivered by heavy-haul trucks, or possibly rail, during construction of the CO_2 capture facility. The existing rail spur, as shown in Figure 2-4, is primarily used for coal delivery to supply the coal-fired electric generating units. Construction-related truck or rail deliveries would be infrequent when compared to existing rail operations. These small changes associated with the proposed project would have negligible effects on existing road or rail conditions at the plant and its vicinity.

All roadways in the area of the plant have the capacity to handle the anticipated construction traffic increases (Table 3.12-1). This analysis conservatively assumes all construction traffic would occur during the same hour, on the same roadway, and in the prevailing traffic lane. There would be a minor increase in traffic though the area at hotels, restaurants, and other commercial facilities. As traffic would occur at different times and be distributed throughout the area, the dispersion effects would lessen the traffic on roadways farther from the facility. The resultant traffic impacts would be minor.

Pipeline Corridor

NRG estimates the pipeline construction workforce would vary between 360 and **500** workers over the six-month period beginning in **July** 2014. Construction activities would generally be conducted 10 hours per day and six days per week. The majority of the trenching and pipe laying activities would be conducted during daytime hours, with the exception of HDD activities that may occur continuously over 24 hours until the pipes are installed at those particular locations. Trenching and pipe laying activities would cause temporary increases in traffic near the construction areas. At certain locations where traffic or road-use restrictions would affect the construction schedule, construction would proceed during late evening hours. Equipment would not be fixed in one location for long durations, but would progress along the construction ROW. Trenching and pipe laying related traffic would be temporary, and would subside at any particular location as construction progresses to subsequent segments of the pipeline.

The pipeline would extend primarily throughout rural areas, and the roadways throughout the area are free-flowing and well below designed capacity (Table 3.12-1). However, due to the substantial number of worker trips during the peak of construction, these worker trips would have a minor adverse effect on traffic conditions, particularly near the construction areas. These effects would diminish for roadways located farther from the pipeline construction locations. These activities would end with completion of the construction phase, and overall, the associated effects would be minor.

All roadways along the pipeline corridor have the capacity to handle the anticipated construction traffic (Table 3.12-1). This analysis conservatively assumes all construction traffic would occur during the same hour, on the same roadway, and in the prevailing traffic lane. As traffic would occur at different times and be distributed throughout the area, the dispersion effects would lessen on roadways farther from the ROW. Parking may be a concern among some portion of the pipeline corridor. However, adverse parking conditions would subside at any particular location as construction progresses to subsequent segments of the pipeline, and would end upon its completion. These resultant traffic impacts would be minor.

Existing roads would be used to the extent practicable, and upgraded as necessary, to access pipeline construction areas. During pipeline installation, construction across or beneath roads, railways, and utility easements would be accomplished in accordance with applicable permits and approval requirements. Trenchless pipe-boring techniques (i.e., conventional boring) would be used for most road crossings to place pipes beneath roads while minimizing the impact to traffic conditions. Open-cut installation may be used at minor roads along the pipeline corridor, after which the road would be restored to preconstruction conditions. Where open-cut road crossings are used, provisions would be made to enable traffic flow during construction. Therefore, no road closures are planned at this time.

West Ranch Oil Field

Drilling of the new wells for injection of CO_2 and production of oil would take place primarily during the early part of the project, most likely during the first year of operation. A typical well drilling rig would require two crews of five workers each per 12-hour shift, with one crew on shift and one crew off. The CO_2 recycle facility would be constructed using skid-mounted equipment and would require a work force of approximately 12 workers during well construction. During drilling and well construction activities, there may be 20 to 25 heavy trucks traveling to and from the oil field each day. Due to the limited number of workers and trucks, roadways would not experience congestion-related delays. These activities would diminish after the completion of the initial construction and drilling phase (i.e., after approximately one year), and their overall effects would be minor.

Existing roads would be used to the extent practicable to access areas within the West Ranch oil field. Hilcorp would improve existing access roads to each injection well as needed. Gravel and road base would be used for the access roads, material storage areas, and parking areas. Access roads would generally be between 12 and 15 feet wide, with approximate five-foot drainage ditches on each side. Access roads would accommodate trucks up to 40 tons. Preparation and road development on access roads would have minor impacts due additional construction vehicles and worker commutes. These effects would be negligible.

All roadways in the area of the EOR field have the capacity to handle all anticipated construction traffic (Table 3.12-1). This conservatively assumes all construction traffic would occur during the same hour, on the same roadway, and in the prevailing traffic lane. As traffic would occur at different times and be distributed throughout the area, the dispersion effects would lessen the traffic on roadways farther away. The resultant traffic impacts would be minor.

3.12.3.2 Operational Impacts

W.A. Parish Plant

NRG's proposed project would increase the operational staff at the W.A. Parish Plant by 10 to 15 workers. This would increase the total number of trips to and from the plant 2.7%, from 349 trips per day to 358 trips per day. The proposed project would increase the total number of truck trips to and from the plant between 3.2% and 4.3% (i.e., from between 50 and 59 trucks per day to between 52 and 62 trucks per day). As with existing operations, due to the diverse schedules and 24-hour-per-day operations, the schedule for worker and truck trips would vary greatly and would be concentrated during shift changes. All roadways in the area have the capacity for all operational traffic (Table 3.12-1). These incremental changes would have no appreciable effect on overall traffic in the area when compared to existing conditions. These effects would diminish for roadways located farther from the facility. These effects would be negligible. There would be no changes in use of rail during operation; therefore no effects on rail are expected.

Pipeline Corridor

The pipeline would not generate substantial traffic during its operation. The only traffic associated with the pipeline itself would be from field trucks and automobiles used to perform intermittent maintenance activities. Transportation-related effects associated with these maintenance activities would be negligible.

West Ranch Oil Field

The proposed project would not increase the operational staff at the West Ranch oil field. There would be no long-term or ongoing changes in traffic at the West Ranch oil field due to the proposed project. Thus, the operational effects would be negligible.

3.12.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to existing transportation resources.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. The construction work force is expected to peak at approximately 100 persons for the months of March and April and should diminish in May as construction activities come to an end and the project moves into the startup / commissioning phase of the project. The majority of worker-related traffic would occur in the early morning and early evening, close to or during peak traffic periods. The roadways approaching the plant are free-flowing and well below capacity. However, due to the substantial number of worker trips during the peak of construction, these worker trips would have a minor adverse effect on traffic conditions particularly near the plant. These effects would diminish for roadways located farther from the facility. These activities would end with completion of the construction phase, and overall, the associated effects would be minor. The operations of the cogeneration plant will be performed by existing W.A. Parish plant personnel. Additional personnel should not be required.

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3.13 NOISE

3.13.1 Introduction

3.13.1.1 Region of Influence

DOE determined the ROI for noise impacts related to the proposed project based on the estimated magnitude of noise generated by project components and estimated baseline noise levels, which would affect how far away the noise might be heard. The ROI includes the areas within 1 mile of the W.A. Parish Plant noise sources, within 1,000 feet of construction equipment and new stationary sources related to construction and operation of the pipeline, and anticipated locations of EOR and CO_2 monitoring activities at the West Ranch oil field; and areas through which project-related traffic would pass (Cowan 1994).

3.13.1.2 Method of Analysis

DOE analyzed noise levels generated by stationary and mobile sources for potential impacts to sensitive noise receptors. The stationary sources analyzed consisted of construction-related equipment and operational equipment related to the CO_2 capture plant and EOR and CO_2 monitoring activities. The mobile sources consisted of vehicles engaged in active construction or transporting materials and wastes during the construction and operational phases. Existing and project-related noise levels were estimated based on widely-accepted noise principles and references, as described in this section.

3.13.1.2.1 Noise Principles

Noise is defined as any unwanted sound. The human ear experiences sound as a result of pressure variations in the air. The physical intensity or loudness level of a noise source is expressed quantitatively as the sound pressure level. Sound pressure levels (SPLs) are defined in terms of decibels (dB), which are measured on a logarithmic scale. Sound can be quantified in terms of its amplitude (loudness) and frequency (pitch). Frequency is measured in Hertz (Hz), which is the number of cycles per second. The typical human ear can hear frequencies ranging from approximately 20 Hz to 20,000 Hz. Typically, the human ear is most sensitive to sounds in the middle frequencies (1,000 to 8,000 Hz) and is less sensitive to sounds in the low and high frequencies. Since the human ear cannot perceive all pitches or frequencies equally, measured noise levels in dB do not reflect the actual human perception of the loudness of the noise. Thus, the sound measures can be adjusted or weighted to correspond to a scale appropriate for human hearing. This adjusted scale, known as the A-weighted sound level (dBA), is useful for gauging and comparing the subjective loudness of sounds to humans. As shown in Table 3.13-1, the threshold of perception to the human ear is approximately 3 dB, a 5-dB change is considered to be clearly noticeable to the ear, and a 10-dB change is perceived as an approximate doubling (or halving) of the noise level (MPCA 1999). Sounds encountered in daily life and their approximate levels in dBA are provided in Table 3.13-2.

Table 3.13-1. Perceived Change in Decibel Level

Change in Sound Level	Perceived Change to the Human Ear
± 1 dB	Not perceptible
± 3 dB	Threshold of perception
± 5 dB	Clearly noticeable
± 10 dB	Twice (or half) as loud
± 20 dB	Fourfold (4x) change

Source: MPCA 1999
dB = decibel

Table 3.13-2. Sound Level and Loudness of Typical Noises

Noise Level (dBA)	Description	Typical Sources
140	---	Threshold of pain
125	Uncomfortably Loud	Automobile assembly line
120	Uncomfortably Loud	Jet aircraft
100	Very Loud	Diesel truck
80	Moderately Loud	Motor bus
60	Moderate	Low conversation
40	Quiet	Quiet room
20	Very Quiet	Leaves rustling
0-10	---	Threshold of human hearing

Source: Liu and Liptak 1997
dBA = A-weighted decibels

Ambient or background noise is a combination of various sources heard simultaneously. Noise levels for combinations of sounds are not combined by simple addition, but instead are based on the logarithmic scale (HUD 1985). For example, the addition of two noises, such as a garbage truck (100 dBA) and a lawn mower (95 dBA), would result in a cumulative sound level of 101.2 dBA, not 195 dBA.

Noise levels decrease (attenuate) with distance from the source. The decrease in sound level from any single noise source normally follows the "inverse square law." That is, the sound level change is inversely proportional to the square distance from the sound source. A generally accepted rule is that the sound level from a stationary source would drop approximately 6 dB each time the distance from the sound source is doubled. Sound level from a moving "line" source (e.g. a train or a roadway) would drop 3 dB each time the distance from the source is doubled. Noise levels may be further reduced by natural factors such as temperature and climate and are reduced by both manmade (e.g., sound walls) and natural barriers (e.g., forested areas, hills) (FTA 2006).

There are a variety of measures used to describe the noise environment that take into account changes in noise levels over time, the time of day the noise is occurring, as well as the percentage of time noise is at a particular level. For example, equivalent sound level (Leq) is a steady-state sound level over a given time interval. A day-night sound level (Ldn or DNL) is the 24-hour Leq but with a 10 dB penalty added to nighttime noise levels (10 p.m. to 7 a.m.) to reflect the greater intrusiveness of noise experienced during this time, and L50 and L90 represent the levels exceeded 50 or 90 percent of the time, respectively.

In 1974, the USEPA provided information suggesting that continuous and long-term noise levels in excess of Ldn 65 dBA are normally unacceptable for noise-sensitive land uses such as residences, schools, churches, and hospitals (EPA 1974).

3.13.1.2.2 Noise Regulatory Framework

No federal standards directly regulate offsite community noise. Noise control regulations and ordinances are primarily overseen by state, regional, and/or local regulatory agencies. However, no local, regional, or state noise ordinances or regulations are applicable for Fort Bend, Wharton, or Jackson Counties.

The U.S. Department of Housing and Urban Development (HUD) established guidelines for evaluating noise impacts on residential areas and categorized noise levels for proposed residential development as acceptable, normally unacceptable, and unacceptable, as shown in Table 3.13-3 (HUD 1985).

Table 3.13-3. U.S. Department of Housing and Urban Development Guidelines for Evaluating Sound Level Impacts on Residential Properties

Acceptability for Residential Use	Outdoor Guideline Levels
Acceptable	≤ 65 dBA
Normally Unacceptable	>65 dBA to ≤ 75 dBA
Unacceptable	> 75 dBA

Source: HUD 1985
dBA = A-weighted decibels

3.13.1.2.3 Stationary Noise Sources

Stationary sources include construction-related equipment and any noise-generating equipment used for operations. DOE estimated potential noise levels at sensitive receptor locations resulting from stationary sources during construction and normal operations by identifying sound levels from dominant noise-producing equipment, summing anticipated equipment noise contributions, and applying fundamental noise attenuation principles (FTA 2006; Lamancusa 2009).

The following logarithmic equation was used to predict noise levels at various distances:

$$SPL2 = SPL1 - 20 \text{Log} (D_2/D_1), \text{ where:}$$

- SPL1 is the known equipment noise level at a known reference distance (D_1);
- SPL2 is the noise level at a given distance (D_2) due to equipment operation;
- D_1 is the reference distance at which the equipment noise level is known; and
- D_2 is the distance from the equipment source for which the noise level (SPL2) is calculated

DOE did not consider the effects of meteorology, terrain, vegetation, or structures that can affect sound propagation (i.e., reduce sound levels) as these factors would be highly variable for each receptor location. Therefore, the results presented in this analysis are considered to be higher (conservative) predictions of noise impacts.

3.13.1.2.4 Mobile Noise Sources

Mobile sources include light-duty vehicles (i.e., cars, pickup trucks, and sport utility vehicles), medium trucks (i.e., two-axle, six-wheel trucks), and heavy trucks (i.e., three or more axles) transporting materials and wastes during the construction and operational phases. The level of highway traffic noise depends on numerous factors. Generally, the loudness of traffic noise is increased by heavier traffic volumes, higher speeds, and greater numbers of trucks. In addition, there are other, more complicated factors that affect the loudness of traffic noise, such as reduction in noise levels due to distance, terrain, vegetation, and natural and manmade obstacles. The established relationship between vehicle speed and noise level (in dBA at 50 feet) developed by the Federal Highway Administration is shown in Table 3.13-4.

Table 3.13-4. Typical Vehicle Noise Levels at 50 Feet Based on Speed

Speed (mph)	Vehicle Type		
	Automobile (dBA)[a]	Medium Truck (dBA)[a]	Heavy Truck (dBA)[a]
30	62	73	80
45	68	79	84
55	72	82	86

Source: Cowan 1994
mph = miles per hour; dBA = A-weighted decibels
[a] In dBA at 50 feet.

3.13.1.2.5 Vibration Principles and Regulatory Framework

Vibration refers to the oscillations or rapid linear motion of parts of a fluid or elastic solid whose equilibrium has been disturbed. Vibration can be caused by operating heavy farm or construction machinery, ground-breaking construction activities (e.g., drilling or excavating), trains on railways, operating equipment indoors, or slamming doors. Similar to noise, the sensitive receptors to outdoor vibrations include nearby residences, schools, hospitals, nursing home facilities, and recreational areas. Typically, the effects of vibration range from feeling the floor shake and rumbling sounds to minor structural damage. Vibration is typically expressed in terms of peak particle velocity (PPV) in units of inches per second, when used to evaluate human annoyance and building damage impacts.

There are no federal or local regulations regarding vibration levels; however various researchers and organizations have published guidelines. Table 3.13-5 presents guidelines to assess human perception and annoyance, and Table 3.13-6 presents guidelines for vibration damage to buildings.

Table 3.13-5. Guideline Vibration Annoyance Potential Criteria

Human Response	Maximum PPV (inches/second)	
	Transient Sources	Continuous/Frequent/Intermittent Sources
Barely perceptible	0.04	0.01
Distinctly perceptible	0.25	0.04
Strongly perceptible	0.9	0.10
Severe	2.0	0.4

Source: Caltrans 2004
PPV = peak particle velocity
Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent/intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment. DOE assumes that auger-boring and HDD operations would be categorized as continuous/frequent/intermittent sources.

Table 3.13-6. Guideline Vibration Damage Potential Threshold Criteria

Structure and Condition	Maximum PPV (inches/second)	
	Transient Sources	Continuous/Frequent/Intermittent Sources
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.2	0.4
Historic and some old buildings	0.5	0.25
Older residential structures	0.5	0.3
New residential structures	1.0	0.5
Modern industrial/commercial buildings	2.0	0.5

Source: Caltrans 2004
PPV = peak particle velocity
Note: Transient sources create a single isolated vibration event, such as blasting or drop balls. Continuous/frequent/intermittent sources include impact pile drivers, pogo-stick compactors, crack-and-seat equipment, vibratory pile drivers, and vibratory compaction equipment. DOE assumes that auger-boring and HDD operations would be categorized as continuous/frequent/intermittent sources.

The U.S. Department of Transportation Federal Transit Administration (FTA) published guidelines to perform vibration impact assessments for proposed projects that may involve transit activities. The methodology applies a screening approach based on the distance between sensitive receptors and the source of vibration. According to the FTA, if the distance between source and receptor is greater than 200 feet, it is reasonable to conclude that no further analysis of vibration impacts is necessary (FTA 2006).

3.13.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to sensitive receptors based on whether the proposed CO_2 capture facility, CO_2 pipeline, and EOR or CO_2 monitoring activities would directly or indirectly:

- conflict with any state or local noise ordinances;
- cause perceptible increases in ambient noise levels at sensitive receptors during construction of facilities - from either mobile or stationary sources;
- cause long-term perceptible increases in ambient noise levels at sensitive receptors during operation of the proposed facilities - either from mobile or stationary sources; or

- cause excessive ground-borne vibration to persons or property.

3.13.2 Affected Environment

3.13.2.1 CO_2 Capture Facility

The W.A. Parish Plant is located in the town of Thompsons, Texas in Fort Bend County. The nearest sensitive receptors include two small residential areas (see Figure 3.13-1) located approximately 0.5 miles east of the site and 1.5 miles southwest of the site. Several schools and churches are located within the surrounding communities, with the closest school located approximately 3.5 miles to the northwest and the closest church approximately 2.5 miles to the northeast. Additionally, the George Ranch Historical Park is located approximately 2.5 miles west of the plant and Brazos Bend State Park is located approximately 5 miles southeast of the plant. Industrial uses at the project site currently consist of power plant operation with coal train traffic and unloading and use of heavy industrial vehicles.

Land surrounding the W.A. Parish Plant and the ROI is primarily used for agriculture, cattle grazing, residential communities, and oil production. No ambient noise measurements in and around the ROI were available.

Noises commonly associated with coal-fired power plants include noises generated from boilers, turbines, generators, cooling towers, transformers, auxiliary equipment (such as fans and pumps), and heavy on- and off-road mobile sources. No site-specific noise measurements have been collected at the W.A. Parish Plant; however, field observations indicate that noise conditions associated within the W.A. Parish Plant generally consist of low-frequency background hum associated with plant equipment that is either located indoors or otherwise shielded. This background noise becomes less observable with distance and is not expected to contribute noticeably to the noise profile outside of the plant boundaries. In addition to enclosed plant equipment noise, noise from other heavy-equipment operated in open areas of the site may affect the noise profile of the power plant. To evaluate how these noise sources could affect the existing ambient noise, DOE considered the heavy equipment currently used at the W.A. Parish Plant and typical noise levels associated with that equipment (Table 3.13-7).

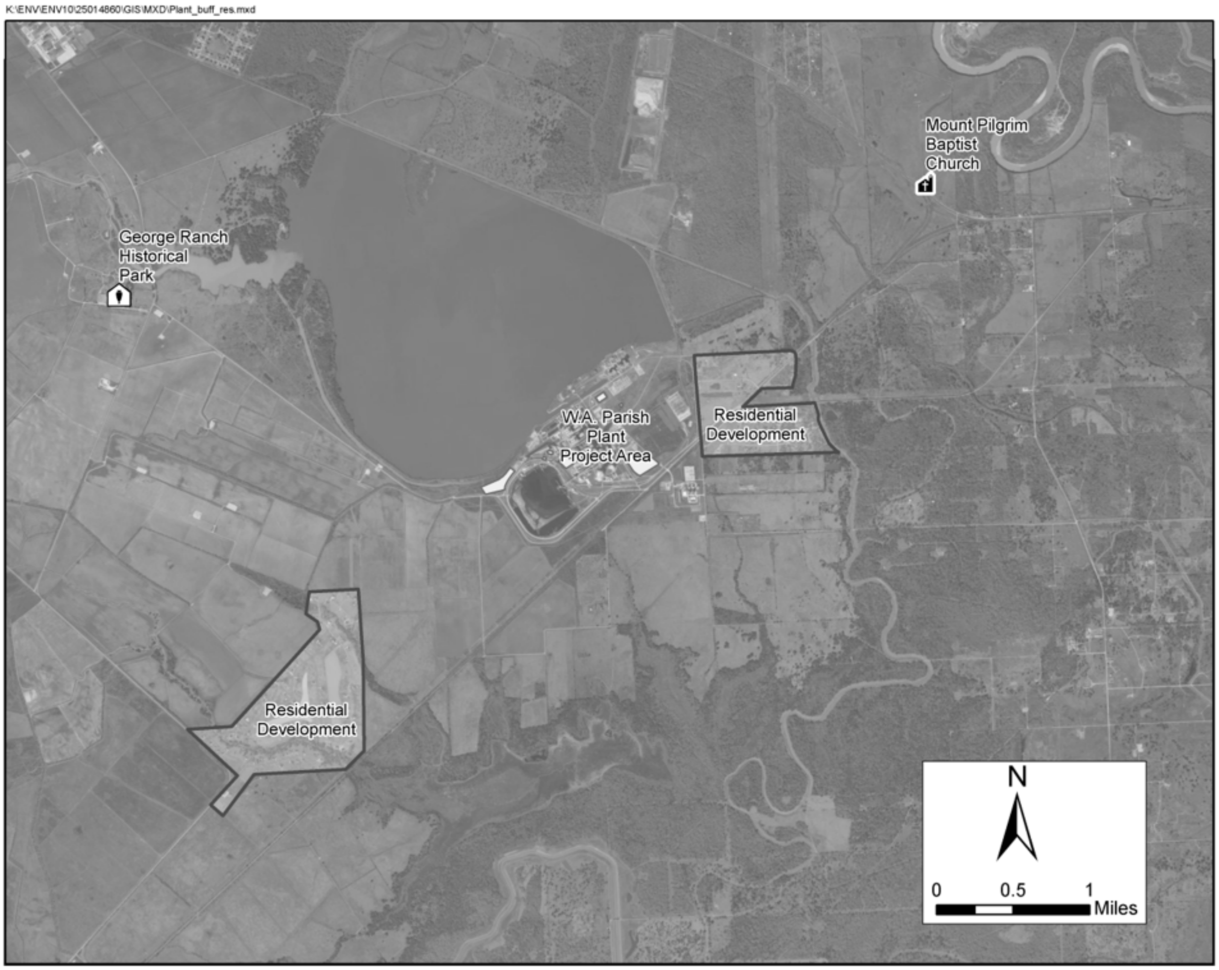

Figure 3.13-1. Receptors in Vicinity of W.A. Parish Plant

Table 3.13-7. Typical Noise Levels Generated by Heavy Equipment Currently in Use at the W.A. Parish Plant

Equipment Type	Quantity	Noise level at 50 feet for each piece of equipment (dBA)*
Dozers/Scrappers/Locomotives	5	82
Water Trucks/Sweepers	5	82
Cranes/Cherry Pickers	6	81
Forklifts	14	Not available
Manlifts	1	75
Tractors/Frontend Loaders/Backhoes	14	80
Diesel Trucks	36	75
Compressors/Pumps/Generators	18	73
Dump Truck	1	76

*Source: FHWA 2012a
dBA = A-weighted decibels

BNSF rail lines and the W.A. Parish Plant rail spur pass through the ROI. Noise generated from passing trains is expected to contribute to the existing ambient noise levels in and around the rail corridors of the ROI, as rail cars can generate sounds of up to 80 dBA at 50 feet. Additional periodic noise and vibrations are expected to be generated by railcar shakers used to remove coal from cars during fuel offloading. However, these activities are conducted within the W.A. Parish Plant property.

Residences, schools, churches, child care centers, and areas where people engage in outdoor activities that could be influenced by elevated noise levels are considered as sensitive receptors. The only sensitive receptors within a mile of the power plant are the few rural residences near the perimeter of the W.A. Parish property, with the closest residence approximately 0.5 miles east of the proposed CO_2 capture facility. The next nearest residential communities are located approximately 1.5 miles to the southwest of the project site, 3 miles to the east, and 3 miles to the northwest. The closest non-residential sensitive receptor is the Mount Pilgrim Baptist Church, which is located approximately 2.5 miles northeast of the project site. Figure 3.13-1 shows the noise ROI and the residential developments in relation to the W.A. Parish Plant.

Using noise additive principles, DOE estimates that the attenuated noise level from existing intermittent outdoor sources at the plant, would be as high as 67 dBA at the closest residence, located approximately 0.5 miles to the east. The residential community located approximately 1.5 miles to the southwest could experience plant noise at a level as high as 57 dBA. These noise levels fall within the HUD guidelines of normally unacceptable and acceptable, respectively (Table 3.13-3). There is no history of complaints from the surrounding community regarding noise generated at the W.A. Parish Plant (NRG 2012d).

3.13.2.2 Pipeline Corridor

The CO_2 captured at the W.A. Parish Plant would be transported via buried pipeline from the plant through Fort Bend, Wharton, and Jackson counties to the West Ranch oil field for use in EOR operations. The selected route would be approximately **81** miles in length, which includes approximately 20 miles in Fort Bend County, **37** miles in Wharton County, and 24 miles in Jackson County. The pipeline would **be collocated** along or within existing mowed and maintained utility **corridors** for approximately **75%** of its length. See Figure 2-2 for a map of the proposed pipeline route.

Ambient noise data along the pipeline corridors are not available; however, based on current land uses, a range of noise levels is expected. The pipeline would traverse primarily through agricultural and rural residential areas, in which typical ambient noise levels are estimated to range between 28 and 38 dBA in calm weather conditions (EPA 1971). However, average noise levels are expected to be higher near roadways due to noise generated by vehicle traffic (e.g., noise levels associated with heavy trucks passing at 55 mph can spike to 86 dBA [Cowan 1994]). The proposed route would cross state and local roads, and border the small town of Vanderbilt, where noise levels are also expected to be higher due to additional sources of noise associated with human activity that are not present in the more rural agricultural areas.

There are approximately **47** residences within 500 feet and 123 residences within 1,000 feet of the proposed pipeline route. There are no schools or churches within 1,000 feet of the proposed route. See Section 3.13.3.1.2 and Table 3.13-10 for further discussion on the sensitive receptor locations.

3.13.2.3 West Ranch Oil Field

EOR operations and CO_2 monitoring activities would be conducted at the West Ranch oil field in Jackson County, Texas, which has operated as an oil field since 1938. There are a few sparsely scattered rural residences located along the perimeter of the West Ranch oil field. The nearest residential community is the town of Vanderbilt located approximately 0.5 miles north of the closest portion of the oil field where wells would be installed. Vanderbilt is also 2.3 miles north of the proposed location of the central CO_2 recycle facility. The non-residential sensitive receptors in the town of Vanderbilt include the Industrial Independent School District Junior and Senior High Schools, the Vanderbilt Baptist Church, and the St. John Bosco Catholic Church. These receptors are currently located adjacent to an area with active oil extraction operations.

Currently, the West Ranch oil field operates with six-person crews 24 hours a day, seven days a week, and 365 days per year. The existing noise at the West Ranch oil field comes from a number of sources, including truck traffic, drilling and associated activities, and well pumps and compressors. Vehicle traffic is generated by employees driving to the site for their work shifts, and operators driving in and out from the well pads to monitor well production. Refer to Section 3.12 for further discussion on transportation and traffic conditions. HEC typically limits the number of vehicles within the facility to one or two pickups at any given time to minimize traffic. Estimated noise levels for various oil and gas activities as published by the Bureau of Land Management (BLM) are shown in Table 3.13-8.

Table 3.13-8. Estimated Noise Levels for Oil and Gas Activities

Activity Type	Noise Level at 50 feet (dBA)
Well Drilling	83
Pump Jack Operations	82
Produced Water Injection Facilities	71
Compressor Facilities	89

Source: Earthworks 2012
dBA = A-weighted decibels

Drilling activities at the West Ranch oil field have occurred continuously since 1938 at numerous locations throughout the property. Existing operational noises are likely not distinctly observable from outside the ranch property due to distance to the ranch boundaries and related noise attenuation.

3.13.3 Direct and Indirect Impacts of the Proposed Project

3.13.3.1 Construction Impacts

3.13.3.1.1 CO_2 Capture Facility

Construction of the CO_2 capture facility would generate additional noise within the vicinity of the W.A. Parish Plant. The construction is expected to take approximately two years and require 360 to 600 workers. During the construction phases, various mixes of construction equipment would be used and would thus generate different noise levels. The EPA has derived average noise levels for various phases of industrial construction projects, including ground clearing, excavation and grading, foundations, building construction, and finishing work. These construction activities are based on the number of each type of equipment typically present, the length of duty cycles of the equipment, and the combined average noise levels during construction activities (Bolt et al 1971). Table 3.13-9 presents common noise levels that would be associated with construction of the project at the W.A. Parish Plant.

Table 3.13-9. Common Noise Levels Associated with Outdoor Construction

Equipment	Typical Noise Level at 50 feet (dBA)
Ground Clearing	84
Excavation, Grading	89
Foundations	78
Plant and Building Construction	85
Finishing	89

Source: Bolt 1971
dBA = A-weighted decibel

As presented in Table 3.13-10, the loudest average levels during normal industrial construction activities would likely occur during excavation and grading, or during finishing work, at an estimated level of 89 dBA (at 50 feet), which attenuates to 55 dBA at the nearest residence located one half mile away. When this construction noise is added to the estimated existing noise from plant operations (67 dBA), the resultant level would be approximately 67.3 dBA at the nearest residence. Thus, during construction of the facility, the impact to noise levels would be an estimated increase of approximately 0.3 dB at the nearest sensitive receptor. The impact to noise levels perceived by sensitive receptors, which include nearby residential communities, schools, churches, and parks, would be equal to or less than 0.3 dB because the noise would be attenuated with distance from the source. As discussed in Section 3.13.1.2.1, the threshold of human perception to dB change is plus or minus 3 dB; therefore, the change in noise from these sources is not expected to be perceptible (MPCA 1999). Thus the impact to the noise environment from the construction activities (not including impacts from traffic) would be negligible to minor, and due to the nature of construction, the noise would be intermittent and temporary until completion of the 24-month construction phase.

Additionally, construction at the power plant would generate increased noise from construction trucks and worker vehicles. NRG estimates that site preparation and foundation construction would generate an average of 10 trucks accessing the site per day, with the most frequent trips occurring between **January 2014** and **April 2014**. Building fabrication and aboveground work would require between five and 12 truck deliveries per day. Twelve trucks per day would create a 20 percent increase over current truck traffic of approximately 59 trucks accessing the site. The peak construction traffic is anticipated to occur between **August 2014** and **September** 2014 and would typically occur during daytime hours. During peak construction, there could be up to 30 to 40 trucks per day entering the site for a few days, a 67 percent increase over current truck traffic. In either case, the volume of trucks would not be sufficient to appreciably change the average baseline noise levels along transportation corridors. However, the number of observed peak noise levels associated with passing trucks (i.e., 80 dBA to 86 dBA) would increase during daytime hours. DOE does not expect average noise levels to appreciably increase above baseline levels, and estimated increases in intermittent peak noise levels would be temporary and generally not occur during nighttime (i.e., 10 p.m. through 7 a.m.). Therefore, anticipated noise-related impacts on transportation corridors would likely be minor and short-term.

3.13.3.1.2 Pipeline Corridor

Construction within the proposed pipeline corridor would consist of site clearing, trenching, pipe laying, and finishing work. These activities would require the use of heavy-duty construction equipment (e.g., trenching equipment, trucks, graders, backhoes, excavators, and portable generators), and likely result in temporary increases in ambient noise levels in the immediate area of the construction sites. Where HDDs are required, the drilling machinery would operate continuously (i.e., 24 hours a day) for approximately three to four days for each location. Continuous operation would be necessary in order to maintain hole stability and to prevent damage to the specialized equipment. NRG's current project design would use HDD techniques in **construction** of the proposed pipeline corridor, including the section between the CO_2 capture facility and the CenterPoint ROW, five water body crossings (i.e., Big Creek, San Bernard River, Colorado River **and** Jones Creek **[as one HDD]**, Lavaca River**, and Menefee Bayou**), as shown in Appendix D-1. Additionally, NRG intends to use auger-boring techniques to install the pipe under most of the roads to minimize road closures and damage to the extent practicable. Construction of the entire pipeline is estimated to take approximately six months.

The sound levels resulting from pipeline construction activities would vary greatly depending on such factors as the types of activities being performed and equipment being used. The EPA has derived average noise levels from typical public works, sewer, and trench construction activities based on the number of each type of equipment typically present, the length of the duty cycles of the equipment, and the average noise levels during construction activities (Bolt 1971). Table 3.13-10 presents these common noise levels that would be associated with pipeline construction, as well as the number of sensitive receptors within 500 and 1,000 feet of the ROW.

Table 3.13-10. Common Noise Levels Associated with Pipeline Construction and Number of Sensitive Receptors along Proposed Pipeline Route

Equipment	Typical Noise Level at 50 feet (dBA)	Noise Level at 500 feet (dBA)	Noise Level at 1,000 feet (dBA)
Ground Clearing	84	64	58
Excavation, Grading	89	69	63
Rock Drilling (HDD)	98	78	72
Number of Sensitive Receptors within this Distance from Pipeline[a]	*0 residences*	***47** residences*	*123 residences*

Source: Bolt 1971
a. There are no schools or churches within 50, 500, or 1,000 feet from the pipeline ROW.
dBA = A-weighted decibel

As presented in Table 3.13-10, the loudest average levels during normal pipeline construction (excluding rock drilling) would range from approximately 84 to 89 dBA at 50 feet. Noise levels would range from 64 to 69 dBA at 500 feet and 58 to 63 dBA at 1,000 feet from the construction site. Trenchless pipe-boring techniques such as auger boring and HDD equipment may be required to construct the pipeline under water features, roadways, and other obstacles. Use of rock drills for these techniques could result in sound levels around 78 and 72 dBA at 500 and 1,000 feet, respectively. However, based on the projected depths of HDDs and bores and the regional geology, as discussed in Section 3.4 of this EIS, it is unlikely that rock drilling would be required since most HDDs and bores would likely be completed through unconsolidated sediment. Noise generated by construction activities of the pipeline may be naturally attenuated (i.e., reduced) by trees and vegetation and/or masked by noise from other manmade activities, such as traffic on adjacent roadways. Therefore, actual noise levels may be lower than predicted.

As shown in Table 3.13-10, there are **47** residences within 500 feet and 123 residences within 1,000 feet of the pipeline ROW. No schools or churches occur within these distances. Residences within 500 to 1,000 feet of the construction would experience a short-term increase in ambient noise from the construction activity; however, noise levels for ground clearing and excavation activities would generally be within levels acceptable for residential areas. Typical pipeline construction activities are expected to occur during six days per week, within a ten-hour day, limited to daytime hours to the extent practical.

Trenchless pipe-boring techniques (i.e., conventional boring) would be used for most road crossings and potentially other locations along the proposed pipeline route, and would produce louder, non-typical construction noise. Road crossings along the proposed pipeline corridor can be seen in Appendix D-1. Each conventional boring operation is anticipated to take less than 12 hours to install the pipeline at each of the proposed locations. Receptors near HDD locations could experience elevated ambient noise levels as high as 78 dBA; however, fewer receptors would be impacted, as drilling would only occur in a limited number of locations. In all cases, observable noise from construction activities would be short-term and expected to have a minor to moderate impact on existing receptors.

Additionally, increases in noise from mobile sources such as worker vehicles would occur along the transportation routes to and from the construction locations. Construction of the pipeline is expected to last for six months, during which time the location and traffic patterns would change relative to the progression of the construction activities along the proposed pipeline route.

Vibration levels generated by construction operations, including auger boring, would range between zero and 0.02 inches/second, measured at 200 feet from the source, depending on the equipment being used. As shown in Tables 3.13-5 and 3.13.6, vibrations from these activities could be perceptible to residents (i.e., since the vibrations would be continuous, frequent, or intermittent), depending on their distance from the source, but would be below limits for potential structural damage (Caltrans 2004). HDD operations at river crossings could generate vibrations at higher levels than normal construction activities. Any adverse effects that would occur would be of a temporary nature, and cease upon completion of HDD activities. Overall, vibration from construction activities would generate short-term, intermittent minor to moderate impacts based on the equipment and distance to the receptors.

3.13.3.1.3 West Ranch Oil Field

NRG proposes to use existing wells to the extent practicable for the EOR process and CO_2 monitoring. New injection wells would be drilled if the existing wells cannot be reworked for injection. New wells would be installed on existing well pads to the extent practicable. TCV also plans to use existing piping corridors and roads to the extent practicable. The proposed project would construct a primary central CO_2 recycle facility located along Mobil Oil Road in Jackson County, Texas, that would receive CO_2 from the pipeline, and process and distribute the CO_2 for EOR operations within the West Ranch oil field. The central facility would include equipment for CO_2 recycle, a single-stage separator (to separate liquids from the CO_2), an amine unit (dehydrator unit), a compressor, flow meters, and other instrumentation. Equipment in the central facility would be skid-mounted and located in a previously developed area within a footprint of 250 feet by 250 feet or less.

The closest sensitive receptors to the oil field are the schools in Vanderbilt, located approximately 0.5 miles away from the nearest drilling activity and 2.3 miles from the proposed central CO_2 recycle facility. Although TCV anticipates using existing wells for the CO_2 injection, if construction of a new well is necessary, DOE does not expect the overall noise level to increase for receptors off the property since well construction and pumping is currently occurring on the site. Similarly, any vibrations resulting from drilling activities would be similar to existing conditions, and due to attenuation with distance, vibrations from the construction would not be expected to be felt at the nearest sensitive receptors.

TCV estimates that construction of the central facility would require a D6 bulldozer, a support truck for moving equipment, and a small trackhoe. As a conservative estimate, if this equipment operated simultaneously, the noise would be heard at approximately 85 dBA at 50 feet away. This noise would be attenuated by distance and thus result in a noise level of approximately 37.3 dBA at the Vanderbilt school, if no other operational activities were occurring on the property. Adding this construction noise on top of the existing operations would generate a change to the receptors of approximately 0.8 dB over existing noise levels, which as shown in Table 3.13-1 would not be discernible by the receptors.

There would also be noise generated by mobile sources such as privately-owned vehicles and trucks accessing the construction sites. Construction of the central facilities at the West Ranch oil field would be expected to last for approximately three months. During construction, there would be an increase of an additional 12 privately-owned vehicles per day for the central facilities and possibly up to ten additional vehicles per day if drilling is required. These vehicles would be in addition to the current 18 vehicles accessing the site. Construction would require approximately 25 truck trips per day, over the current two truck trips. A heavy truck could generate intermittent noise levels between 80 and 86 dBA depending on its speed; however, the noise increase would be brief, occurring only as the truck passes the receptor. Due to the relatively low volume and frequency, this traffic would not be expected to noticeably change average noise levels. See Section 3.12 (Transportation and Traffic) for a discussion about the number of vehicles accessing the site. Construction activities would be temporary and would generate noise at levels below the normal operational noise of the oil field activities, and thus would cause only short-term, negligible to minor impacts to the noise environment.

3.13.3.2 Operational Impacts

3.13.3.2.1 Stationary Noise Sources

CO_2 Capture Facility

The proposed project would operate a CO_2 capture facility at the W.A. Parish Plant that would use a post-combustion chemical amine process technology to capture the CO_2 from a 250-MWe flue gas slipstream taken from Unit 8 at the W.A. Parish Plant. The project would also include installation and operation of a cogeneration facility (CT/HRSG) to supply the energy requirements to the CO_2 capture facility. The system would include various noise generating equipment such as a combustion gas turbine (General Electric Frame 7EA – 60 Hz or similar), natural gas compressor for the turbine, a CO_2 compressor, and a diesel generator to provide emergency power for use only during regular testing and emergencies (ERM 2011).

Specific equipment models or vendors have not yet been selected; however, it is assumed that the CO_2 capture facility and new cogeneration facility would have a noise profile similar to the existing operational equipment at the site. As a result, DOE does not expect sound levels associated with the capture facility to increase the overall current noise level at the plant, particularly since the majority of the equipment would be located within buildings or otherwise enclosed. Therefore, no discernible difference in noise at the closest residence, approximately 0.5 miles away from the project site, is expected.

During operations, NRG does not expect more than a 5% increase in either car or truck traffic over current conditions. Therefore, DOE anticipates minimal to negligible impacts from noise due to mobile sources during operations at the plant. See Section 3.12 (Transportation and Traffic) for discussion about the number of vehicles accessing the site.

Pipeline Corridor

The proposed pipeline would be buried except where it would be necessary to come to the surface for valves and metering. Venting during pipeline startup (i.e., filling of the pipeline with CO_2) would occur as a controlled vent within the boundaries of the West Ranch oil field, as discussed below. Mowing and maintaining the ROW would create noise due to the motorized equipment that would be used. This would be infrequent and would be similar to the noise generated by farm equipment that is commonly used in many of the areas that would be crossed by the ROW. Potential noise or vibration impacts from the underground pipeline or the aboveground pipeline equipment (i.e., valves and meter station) are anticipated to be negligible during operations.

West Ranch Oil Field

Venting during pipeline startup (i.e., filling of the pipeline with CO_2) would occur as a controlled vent within the boundaries of the West Ranch oil field and any noise generated would be similar to noise generated from existing oil field operations. Therefore, noise impacts related to pipeline startup would be negligible to minor.

The EOR operations at the oil field would generate noise from the central CO_2 recycle facility, the injection well operations, and any associated transport vehicles during EOR or CO_2 monitoring operations. The central CO_2 recycle facility at the West Ranch oil field would involve the operation of a single-stage separator to separate liquids from the CO_2; an amine-based dehydrator unit; a compressor, if needed to increase pressure of CO_2 fluid prior to injection; flow meters; a pig launcher/receiver; and associated instrumentation. DOE assumes the compressor equipment would dominate the noise profile during EOR operations. The compressor could generate operational noise at a level of 89 dBA (Earthworks 2012) at 50 feet if not provided with noise attenuation components.

As mentioned previously, the closest sensitive receptors to the West Ranch oil field are the schools in Vanderbilt, located approximately 2.3 miles from the CO_2 recycle facility. Assuming no drilling activities were occurring at the time, operational noise from the compressor at the facility would not be heard above ambient levels at the school. Adding this noise to existing operational noise levels at the oil field would result in an increase of approximately 0.8 dB, which would likely not be discernible by the human ear.

During operations, it is expected that there would be no increase in privately-owned vehicle or truck traffic to the West Ranch oil field, as there would be no need for additional employees, and truck traffic would likely remain at or near current levels. Therefore, DOE anticipates negligible impacts from noise due to mobile sources during EOR operations. See Section 3.12 (Transportation and Traffic) for discussion about the number of vehicles accessing the site.

3.13.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to the noise environment.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. The primary source of noise during construction would be heavy equipment used during construction which are consistent with the existing noise levels commonly heard from the operational facility with minimal incremental disturbances anticipated. Once in operation, plant equipment is designed not to exceed 85 dba at 3 feet from the equipment boundary. The turbine exhaust stack and inlet filter house are fitted with silencers to minimize near and far field noise for the unit. Noise levels at the boundary of the WA Parish facility should not be materially impacted due to the noise abatement measures taken on the unit equipment itself and the location of the plant in relation to the WA Parish facility boundary.

3.14 MATERIALS AND WASTE MANAGEMENT

3.14.1 Introduction

Waste management is the process in which unwanted materials (or wastes) are collected, processed, transported, and disposed of or recycled. Wastes can be generated in many ways and some have strict regulations as to their storage, transport and disposal. Wastes fall into several categories, including solid, recyclable, non-hazardous, hazardous and universal waste.

This section identifies and describes the existing materials used and stored at the W.A. Parish Plant and the West Ranch oil field and identifies the suppliers of materials and waste management facilities that are located at these facilities or in the region affected by the construction and operation of the proposed Parish PCCS Project. This section also analyzes the potential effects from this project on the availability of materials and the capacity of waste management facilities to accommodate the project while continuing to meet the needs of other users.

3.14.1.1 Region of Influence

The ROI for materials and waste management includes waste management facilities, facilities that could potentially use any by-products from the project, and the suppliers of construction materials and process chemicals that would be used in the construction and operation of the project.

Construction and operation of the project would require construction materials (e.g., concrete, reinforcing steel, and rock), construction equipment, process-related equipment and materials, access to markets for its by-products, and disposal of wastes generated. The extent of the ROI varies by material and waste type, as follows:

- The ROI for routine construction material suppliers and solid waste disposal facilities would generally include Fort Bend, Wharton, and Jackson Counties and in some cases may include the surrounding Texas Gulf Coast area. These types of resources are widely available within this area and suppliers within the ROI would likely be used given that the volume of materials needed and the amount of waste generated would be costly to transport over long distances.
- The ROI for hazardous waste Treatment, Storage and Disposal Facilities (TSDF) needed for the types and quantities of hazardous wastes that may be generated would be extended to include the Texas Gulf Coast area.
- The ROI for the specialized carbon capture equipment is expected to extend to the national level.
- Similarly, the ROI for process chemicals or equipment is expected to extend to the national level, if the cost or value of the chemical or equipment makes it economical to transport over a greater distance.
- However, the ultimate distance to suppliers may include international sources to the extent that equipment or chemicals are not readily available domestically.

3.14.1.2 Method of Analysis

DOE evaluated potential impacts by comparing the demands that would be posed by construction and operation of the proposed project to the capacities of materials suppliers, by-product purchasers, and waste management facilities within the ROI. In addition, DOE analyzed proposed operations and materials storage systems with respect to applicable federal, state, and local regulations.

DOE assessed the potential for impacts related to materials and waste management requirements based on whether the project would directly or indirectly:

- require materials not regionally available;
- 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 wastes for which there are no commercially available disposal or treatment technologies;
- create hazardous wastes in quantities that would require a treatment, storage, or disposal permit under the Resource Conservation and Recovery Act;
- affect the capacity of hazardous or solid waste collection services and landfills; or
- create reasonably foreseeable conditions that would increase the risk of a hazardous material or waste release.

3.14.2 Affected Environment

3.14.2.1 CO_2 Capture Facility

Construction Materials

NRG has established programs and processes in place to purchase the types of construction material equipment supplies and contractor services that would be required for construction of the proposed CO_2 capture facility and facilities and systems. Such projects require the use of common construction materials such as ready-mix concrete, gravel fill, reinforcing steel, equipment rentals, piping and welding materials, construction materials, heavy equipment, and office supplies, which are available from numerous in-state suppliers, with additional out-of-state suppliers as necessary.

Process Materials

Natural gas is used for operating Units 1, 2, 3, and 4 of the W.A. Parish Plant. The natural gas supply is provided by the Kinder Morgan pipeline system directly to the W.A. Parish Plant. A natural gas-fired auxiliary boiler provides steam for startup of Units 1, 2, and 4. The plant also has a natural gas-fired combustion turbine which is available to supply electricity in emergency situations. The plant uses a maximum of approximately 27,500 million cubic feet per hour (MMcf/hr) of natural gas. Coal is the main raw material stored and used for operating Units 5, 6, 7, and 8. The coal is transported in 14,000 ton unit trains from the Powder River Basin in Wyoming to the W.A. Parish Plant. The plant would continue to use on average of approximately 36,000 tons of coal per day. Coal supplies are stored on-site in a coal storage yard. The plant also uses large quantities of limestone as a reagent in the emission reduction process. The limestone is transported to the Parish site by both rail and truck and is stored on-site. An average of 15 railcars and 36 truckloads of limestone are delivered to the W.A. Parish Plant per month for a total of approximately 25,000 tons per year.

Process materials such as ammonia, hydrochloric acid, hydrogen chloride, and sulfuric acid are used in large quantities at the plant and are stored in above-ground storage tanks (ASTs) located in the immediate vicinity of the generating units. The ASTs are each equipped with secondary containment. Existing ASTs could be used for storing a portion of the process material that could be used during the operation and maintenance of the Parish PCCS project, such as ammonia. Additionally, there are also two ASTs that are used for storing used oil, as necessary. There are no underground storage tanks at the W.A. Parish Plant.

Smaller quantities of other materials are stored in approved Department of Transportation (DOT) 55-gallon drums or smaller tote containers and are stored in approved storage areas or protected facilities. Oil products, such as hydraulic oils, motor oils, and transformer oils, are normally delivered in 55-gallon drums and are stored in a protected areas designed and constructed for that purpose.

Non-Hazardous Solid Waste

Solid waste is industrial non-hazardous waste generated by normal, day-to-day operations. This category includes office waste, maintenance and construction waste, and other waste not regulated under Texas hazardous materials or hazardous waste programs.

NRG operates an on-site Class II non-hazardous landfill on an 800-acre deed-recorded tract within the W.A. Parish Plant site for the disposal of coal combustion by-products (CCBPs) and low volume waste generated by plant operations. CCBP's consists of fly-ash, bottom ash, economizer ash and flue gas desulfurization (FGD) sludge. The landfill is classified as an industrial landfill which does not receive any waste from off-site generators. The on-site landfill has a projected life of 20 to 30 years (i.e., lasting through 2032 or potentially through 2042) (Burch 2012b).

EPA announced a proposed rulemaking in 2010 and 2011 on the management of coal combustion residual materials (EPA 2010 and EPA 2011). "EPA proposes to regulate coal ash to address the risks from the disposal of the wastes generated by electric utilities and independent power producers. EPA is considering two possible options for the management of coal ash for public comment. Both options would be regulated under the Resource Conservation and Recovery Act (RCRA). Under the first proposal, EPA would list these residuals as special wastes subject to regulation under subtitle C of RCRA, when destined for disposal in landfills or surface impoundments. Under the second proposal, EPA would regulate coal ash under subtitle D of RCRA, the section for non-hazardous wastes. The Agency considers each proposal to have its advantages and disadvantages, and includes benefits which should be considered in the public comment period." NRG may be required to change the way it manages coal combustion residuals which could result in changes to the capacity of the existing landfill and would also change the future effective life of this landfill.

The annual waste disposal volumes for the major waste materials that were disposed of in 2011 at the landfill are presented in Table 3.14-1. The waste materials primarily consist of CCBPs with minor amounts of low-volume waste. The low-volume wastes include a variety of solid wastes associated with coal combustion, equipment maintenance, water treatment and material storage and handling.

Table 3.14-1. Waste Materials Disposed of in the Class II Non-Hazardous On-Site Landfill

Texas Waste Code	Waste Description	2011 Disposal Volume (tons)
02303042	Bottom Ash	131,848
02323042	Fly Ash	196,161
02315112	Scrubber Base	28,200
02303042	Economizer	18,060
02025192	Cooling Tower Sludge	0
02513192	Cooling Tower Fill	0
02153912	Water Treatment Sludge	21,000 (estimated)
02225192	Chemical Waste Treatment Sludge	0
02063192	Class II Blast Grit	119
02133192	Refractory Brick	0
02013902	Class II Construction Debris (calcium silicate insulation and fiberglass chevrons)	780 (estimated)
02174882	Creosote Treated Wood	4.82
02333042	Fly Ash and FGD Sludge	110,000 (estimated)
02653101	Coal and Fly Ash Filters	345

Source: Burch 2012a, Burch 2012b, Burch 2012c

Other non-hazardous wastes generated during operation of the W.A. Parish Plant include solid wastes or trash. These wastes are routinely collected and transported off-site by licensed waste transporter to one of NRGs two preferred landfills operated by Waste Management Incorporated (WMI):

- WMI Coastal Plains RDF, 2100 Highway 6, Alvin Texas
- WMI Conroe Landfill, 2525 Loop 336 East, Conroe, Texas

The following waste types and amounts of Class I non-hazardous solid waste resulting from plant operations and maintenance were disposed of at these off-site landfills in 2011 (Burch 2012a):

- Asbestos (67,680 lbs)
- Floor Drain Treatment Sludge (44,202 lbs)
- Hydrocarbon Contaminated Debris (32,900 lbs)
- PCB Capacitors and Ballast (500 lbs)[1]

As shown in Table 3.14-2, the remaining life of the two preferred landfills is reported to be between 13 years and 16 years (WMI 2012a, 2012b). Office waste is primarily disposed of at the Republic Services, Inc., Blue Ridge Landfill in Fresno, Texas.

[1] PCBs are managed as a special waste subject to regulations promulgated under the Toxic Substances Control Act (TSCA).

Fly ash generated by plant operations is collected in the on-site bag house and ash storage system. Some of the ash is subsequently sold commercially as an additive for concrete and road base. The remainder is sent to a landfill for disposal as noted in Table 3.14-1.

NRG has a solid waste recycling program in place that identifies solid wastes for recycling and proper management of these waste streams. NRG currently recycles paper, aluminum cans, scrap metal, lead-acid batteries and universal waste lamps.

Table 3.14-2. Landfill Capacity

Landfill Purpose	Landfill Name	Permitted Limit	2011 Annual Quantity Received	Approximate Remaining Life of Landfill
Carbon Capture Facility Construction and Operation	WMI Coastal Plains RDF	11.5 million tons	630,000 tons	2025
	WMI Conroe Landfill	8.57 million tons	425,000 tons	2028
Pipeline Construction and Operation	Construction wastes would be disposed of in local Subtitle D landfills. No hazardous wastes are expected.	Unknown	Unknown	Unknown
Construction and Operation of EOR and CO_2 Monitoring Facilities	VI Wolf El Campo, Texas or Inland Environmental, Columbus, Texas	Unknown	Unknown	Unknown

Hazardous Waste

Hazardous waste refers to a class of wastes specifically defined in the Resource Conservation and Recovery Act (RCRA). These wastes are generated by certain listed processes or have certain characteristics (e.g., toxicity, reactivity, ignitability, or corrosivity) that cause them to be a significant risk to the environment and/or human health. Certain operations and maintenance activities at the W.A. Parish Plant generate wastes that are required to be managed as hazardous waste materials. NRG has implemented a waste management program at the Plant that complies with federal, state, and local hazardous waste management requirements.

The W.A. Parish Plant is currently a conditionally exempt small quantity generator (i.e., generating less than 220 pounds of hazardous waste and less than 2.2 pounds of acutely hazardous waste per calendar month), but conforms to the requirements of a large quantity generator for consistency with other NRG facilities. NRG currently uses Veolia Environmental Services in Port Arthur, Texas for that purpose. The only hazardous or special waste that the W.A. Parish Plant disposed of in 2011 was 200 pounds of mercury contaminated debris (Burch 2012b).

The W. A. Parish Plant also produces effluent streams containing raw materials, chemicals, oil, or plant process water which are directed for treatment at the on-site WWTP, which is wholly owned by NRG and does not provide any utility services to others. Treated wastewaters are discharged to surface waters under an existing TPDES permit limits for the facility as further discussed in Section 3.7 of this EIS (Surface Water).

3.14.2.2 Pipeline Corridor

Approximately **75%** of the proposed pipeline corridor would be constructed within or immediately adjacent to existing electric transmission line and/or pipeline corridors. Current operations and activities in these existing ROWs are the responsibility of other utility companies, parties, or landowners and are generally limited to power line and pipeline maintenance activities and maintenance of the mowed ROW and access roads. The proposed project participants have no current operations or interests in the proposed ROW for the pipeline corridor. As such, they do not currently purchase or store any construction materials or process materials in the ROW, nor do they generate any non-hazardous solid waste or hazardous waste. Pipeline construction materials and supplies are readily available within the region in sufficient quantity to support projected demands for construction of the pipeline portion of the project. The project would be expected to utilize non-hazardous and hazardous waste disposal facilities already in use by the W.A. Parish Plant to the extent practical.

3.14.2.3 West Ranch Oil Field

Construction of EOR demonstration facilities and injection wells and CO_2 monitoring operations facilities and monitoring wells would occur at the West Ranch oil field. The oil field has been operational since the 1930s. Current activities include oil field operations, construction, and well drilling on a routine basis. Site needs are satisfied with a combination of on-site infrastructure, personnel, and with additional resources in place at the field and within the region.

Construction Materials

Project participants have established programs and processes in place to purchase the types of construction material, equipment, supplies and contractor services that would be required for construction of proposed EOR demonstration facilities and injection wells and CO_2 monitoring operations facilities and monitoring wells. These types of well drilling, oil recovery, and oil field maintenance activities routinely require the use of a variety of common oil field construction materials such as ready-mix concrete, gravel fill, reinforcing steel, equipment rentals, piping, fittings, valves, welding materials, well construction materials, heavy equipment, and maintenance supplies. These supplies and materials are readily available from numerous in-state suppliers and from out-of-state suppliers as necessary.

Process Materials

A variety of process materials are used to conduct routine oil field operations, well drilling, and maintenance. These chemicals include fuels, oils, lubricants, corrosion inhibitors, and additives purchased from established suppliers in the region and stored in appropriate containers. Process materials used for drilling and maintaining wells are transported to the work location in approved tanker trucks for use directly at the wellhead. There are established sources for obtaining oil field-related materials, chemicals, equipment, and supplies, which are readily available throughout the region.

Non-Hazardous Solid Wastes

The West Ranch oil field and its contractors currently operate under the waste management guidelines described in the HEC safety program. The safety program identifies the responsibilities, actions to be taken, and resources that would be applied and could be drawn upon for managing waste streams resulting from oil field operations and well drilling activities.

Non-hazardous solid wastes resulting from oil field operations and maintenance activities are collected and transported off-site to a designated off-site landfill. Recyclables are collected and sent to one of the numerous approved recycling facilities in the local area. HEC's preferred waste disposal vendors include the following facilities:

- VI Wolf, LLC, 386 Dam Rd. El Campo, Texas 77437, and
- Inland Environmental, P.O. Box 1090 Columbus, Texas 78934.

Hazardous Waste Treatment, Storage, Disposal

HEC does not generally generate hazardous waste at the West Ranch oil field. In the event any hazardous wastes would be generated, they would be properly collected, sampled, labeled, packaged, and temporarily stored in 55-gallon drums or other approved containers. The containers would be temporarily stored in an approved hazardous waste storage area, awaiting shipment by a licensed hazardous waste hauler to an approved off-site TSDF in coordination with HEC's preferred waste disposal vendors, as listed above. Releases of hazardous materials would be reported to the RRC and the EPA. HEC did not generate any reportable TRI releases in 2011 (Salinas 2012a).

3.14.3 Direct and Indirect Impacts of the Proposed Project

3.14.3.1 Construction Impacts

3.14.3.1.1 CO_2 Capture Facility

Construction Materials

Significant amounts of materials and equipment would be required to complete construction of the proposed CO_2 capture facility and its supporting infrastructure. This includes a new 80-MW natural gas-fired cogeneration plant that would be installed to provide the electricity and steam needed for operation of the CO_2 capture system. The turbine, a General Electric (GE) Frame 7EA generator or similar sized unit, would be equipped with emission reduction systems as discussed in Section 3.3 (Air Quality) and Section 3.4 (Greenhouse Gases) of this EIS.

The proposed CO_2 capture facility would utilize specialized process equipment, such as a compressor, coolers, absorbers, strippers, regenerators, pumps, heat exchangers, electrical switchgear, and the new combustion turbine, which would be purchased from identified domestic suppliers or manufacturers to the extent practical.

Construction materials and specialized construction equipment required by the project are available within the ROI. These materials and equipment could be delivered by truck and rail to the W.A. Parish Plant site on a schedule to accommodate construction work progress and needs. Within the existing W.A. Parish Plant property, a new secured material off-loading area and two large material and equipment laydown areas would be constructed to accommodate material and equipment deliveries by truck and rail.

Construction materials, equipment and supplies are readily available within the ROI and quantities required to support the proposed project are expected to be well within the capacity of material suppliers. Some specialized equipment may be required from the national ROI; however, it is expected that this equipment would also be within existing supplier capacities. As a result, impacts to regional or national construction material resources and special equipment suppliers would be negligible.

Waste Management

The storage and handling of toxic or flammable materials would be conducted in compliance with EPA and Occupational Safety and Health Administration (OSHA) regulations and the National Fire Protection Association's "Guide on Hazardous Materials" (NFPA 2010). The plant's SPCC Plan would be updated to encompass the project in compliance with federal and state regulations. Existing worker safety programs would continue to educate plant personnel regarding spill containment procedures and related EHS policies.

The plant's waste management plans and guidance documents would be updated, as necessary, to identify any changes in waste management operations and practices or needs for waste management services providers. NRG would obtain a TPDES construction storm water general permit covering the proposed construction activities and would update the plant's SWPPP, as necessary, to accommodate construction-related activities.

Wastes such as used oily rags, used oil, spent cleaners, and used hydraulic oil would be generated as a result of routine vehicle operation and maintenance during construction activities. These wastes would be collected in appropriate containers for recycling or disposal and transported off-site to an approved recycling or waste disposal facilities. Paper, plastic, aluminum, cardboard, scrap, and surplus materials would be recycled for reuse to the maximum extent possible.

The impact from disposal of non-hazardous solid waste streams generated from on-site clearing and building pad preparation associated with construction of the project would be considered negligible as NRG would recycle or reuse these types of soils and organic wastes on NRG property wherever practical.

Construction of the CO_2 capture facility would generate typical amounts of construction waste, including surplus spoil from earthworks (material unsuitable for reuse as fill based on material properties), packaging, surplus construction materials such as timber, concrete, gravel, metals and plastics. An estimate of waste volumes is not available at this time, pending the results of more detailed design. Generally, any unused construction debris collected would most likely be hauled to a recycling facility and it is assumed that this facility would be able to recover and recycle the majority of construction materials. Any additional non-recyclable materials would be collected and transported to a landfill for disposal.

In accordance with current NRG practices and agreements, solid wastes from construction of the capture facility would be routinely transported off site by a permitted waste transporter for disposal at either of two preferred landfills operated by WMI: WMI Coastal Plains RDF, located in Alvin, Texas or WMI Conroe, located in Conroe, Texas. An estimated volume of solid wastes that would be generated is not available at this time but would be prepared at a later stage of facility design.

As presented in Table 3.14-2, the combined permitted lifetime capacity of these landfills is approximately 20.07 million tons or approximately 1.05 million tons of non-hazardous solid waste annually. The remaining projected life of these landfills is reported to range from 16 to 23 years. These two WMI landfills have a combined capacity expected to be more than adequate to accept construction-generated non-hazardous solid waste as well as plant operations generated non-hazardous solid waste that could not be reused or recycled. Generation of non-hazardous solid waste streams would be short-term (i.e., during the 24-month construction period and approximately three-to-six-month startup and commissioning period). Project needs would not affect the ability of others in the ROI to dispose of their wastes.

Capture facility construction activities are not expected to generate any hazardous wastes. In the event any hazardous wastes are generated, they would be properly collected, sampled, identified, packaged, and temporarily stored in 55-gallon drums or other approved containers in an approved hazardous waste storage area. These hazardous wastes would be shipped by a permitted hazardous waste hauler to Veolia Environmental Services TSDF in Port Arthur, Texas for treatment and/or disposal.

3.14.3.1.2 Pipeline Corridor

Construction Materials

NRG proposes to construct an approximately **81**-mile-long, 12-inch-diameter carbon steel pipeline from the W.A. Parish Plant to the West Ranch oil field. To the extent practical, the pipeline contractor would purchase the necessary pipe, pumps, valves, fittings, process materials, and cathodic protection equipment to complete construction, testing, and commissioning from domestic suppliers that would meet design specifications and applicable regulations and codes. The pipeline contractor would be responsible for furnishing and maintaining construction and test equipment necessary to complete pipeline construction, perform hydrostatic testing, and enable pipeline commissioning.

During the construction period, there may be demand for pipeline materials and equipment in the ROI. This condition would be temporary and would not impact other projects in the region. The pipeline construction contractor would be tasked with providing an implementation plan and a schedule for construction materials acquisition and materials storage. The contractor plan would provide for adequate storage of materials (e.g., fuel, lubricants, transmission fluids, oils) necessary for the operation and maintenance of equipment and vehicles at the work sites. Hazardous materials would be stored in 55-gallon drums or other approved containers, and storage areas would have secondary containment and would be stored in a manner to minimize the potential for storm water contact.

The materials and equipment necessary to construct the pipeline are expected to be readily available and within the capacity of suppliers in the region. As the project is not expected to create any impacts on local and regional supplies impacts would be negligible.

Waste Management

During the construction, testing, and startup of the proposed pipeline, the pipeline contractor would be required to comply with requirements that provide for mitigation of damages and preservation of the pipeline ROW upon completion of the pipeline installation work. Wastes generated from the construction of the proposed pipeline would primarily consist of land clearing waste, spent hydrostatic test water, and drilling muds from horizontal directional drilling operations.

Organic land clearing debris (e.g., vegetation, shrubs, etc.) would be chipped or shredded on-site and burned within the proposed pipeline ROW controlled conditions. After pipeline installation is complete, the ROW would be revegetated. The proposed construction activities would be expected to generate approximately 159 to 238 tons of non-hazardous solid waste during the six-month construction period. Other non-hazardous wastes generated during construction (e.g., garbage generated by construction personnel) would also be routinely collected and transported off-site by a licensed waste transporter to the designated off-site solid waste disposal facilities within the ROI. Table 3.14-2 lists the landfills that would be used to dispose of solid waste and their respective capacity and life.

Routine operation and vehicle maintenance during pipeline construction activities would also generate used oil rags, used oil, spent cleaners, and used hydraulic oil. These wastes would be collected in appropriate containers for recycling or disposal at off-site recycling or disposal at an approved facility. Paper, plastic, aluminum, and cardboard and other recyclable materials would be collected and sent to an approved off-site recycling facility.

Hydrostatic pressure testing (hydrotest) water would be generated during pipeline construction. Hydrostatic test water would be collected and reused for subsequent hydrostatic tests to the extent practicable. Spent hydrotest water would be tested to determine if it exhibits hazardous characteristics. If hazardous or does not otherwise meet permit limits for discharge, the hydrotest water would be sent to a permitted off-site facility for proper treatment and disposal. If non-hazardous, spent hydrostatic testing water would be discharged at designated land or surface water locations along the pipeline corridor ROW in accordance with BMPs, applicable permits (i.e., RRC and/or EPA discharge permits), and landowner agreements. Prior to discharging any spent hydrostatic testing water, NRG or their contractor would characterize the water to verify that it meets the requirements of the applicable wastewater discharge permits.

After pipeline installation and testing is complete, the contractor would revegetate the ROW and any temporary access roads or materials storage areas.

The generation of these waste streams during pipeline construction would be short-term and primarily occur during the estimated six-month construction period and three-month startup and commissioning period of the project. Solid wastes would be sent to local landfills that have sufficient capacity for the anticipated quantities. The construction of the pipeline is not expected to generate any appreciable quantities of hazardous waste, and as such, it would not affect the ability of others in the ROI to dispose of their hazardous waste.

3.14.3.1.3 West Ranch Oil Field

Construction Materials

Oil-field-related construction material would be purchased to support project activities and transported to existing material storage locations or laydown areas at the West Ranch oil field. This would include pipe, casings, pumps, valves, manifolds, fittings, electrical controls, instrumentation, and cathodic protection equipment. These types of materials are considered to be commercially abundant and widely available within the region and at a national level. Their use would not affect local or regional supplies.

The project would also require construction materials and specialized equipment for a new CO_2 recycle facility that would include a new injection battery facility and equipment. As currently planned, the approximately 1.5-acre CO_2 recycle facility would include the following equipment, most of which would be skid-mounted: a single-stage separator to separate liquids out of the recycle gas stream, an amine unit to remove CO_2 from the recycle gas stream, a glycol contactor to dehydrate the CO_2 recycle stream, a compressor, flow meters and other instrumentation, supply and distribution headers, and a flare to control emissions in the event of an upset condition. Construction materials and equipment for the CO_2 recycle facility are generally available on a national basis from specialized suppliers. Specialty equipment suppliers would be surveyed in advance to determine available sources and delivery options.

Project construction materials and new equipment would be purchased from suppliers and manufacturers that meet design specifications and applicable regulations and codes. These materials are expected to be available from regional and national suppliers and manufacturers to meet project demands; therefore, any impacts should be negligible.

Materials that would be used during construction of CO_2 monitoring operations facilities and/or monitoring wells would be similar to those used during construction of the EOR and CO_2 monitoring facilities. These materials would be managed using the same or similar practices, programs, and resources as those used for construction of the EOR component of the project. Project construction materials and new equipment would be purchased from suppliers and manufacturers that meet design specifications and applicable regulations and codes. These materials are expected to be available from regional and national suppliers and manufacturers to meet project demands; therefore, any impacts should be short-term and negligible.

Waste Management

At the West Ranch oil field, waste management programs and resources are in place for the management, storage, and disposal or recycling of waste generated during the construction, testing, startup, and commissioning of the EOR and CO_2 monitoring components of the proposed project. HEC and their contractors would operate and perform construction activities under the waste management guidelines and practices described in the HEC safety program. The safety program identifies the responsibilities, actions to be taken and resources that would be applied and could be drawn upon for the management of waste streams resulting from oil field operations and well-drilling activities. Non-hazardous solid wastes resulting from construction activities would be collected and transported to an approved off-site landfill. Table 3.14-2 lists the landfills that would be used to dispose of solid waste and their respective capacity and remaining life. An estimated volume of solid waste that would be generated by construction at the West Ranch oil field and from the other components of the project would be prepared at a later stage of design.

The site preparation phase would take approximately one week to one month to complete, during which time the drill pads would be cleared and graded, if necessary; mud pits would be excavated and lined; and organic land clearing debris (e.g., vegetation, shrubs) would be chipped or shredded on site and used as mulch to support soil stabilization and to promote growth of ground cover in temporarily disturbed areas within the facility. The chipped or shredded organic land clearing debris would be stored on site until ready for use. Cleared debris that could not be reused would be appropriately disposed of at the designated landfill in use by HEC. Although the amount of waste generated during construction would vary depending on the number of new EOR injection wells and CO_2 monitoring wells and the actual length of pipelines, most of the solid waste generated during site preparation would be reused in-place or nearby in accordance with BMPs. Recyclables would be collected and sent to an approved recycling facility. These recycling and disposal facilities are widely available throughout the region.

At the EOR injection well and CO_2 monitoring well locations, well drilling operations could generate waste streams including drill cuttings, drilling mud, and produced water during well construction. Drill cuttings would be collected in constructed, temporary-lined mud pits located at the injection well site. Wastewater is not treated on-site. Produced water and light sediment would be pumped into trucks and hauled off-site for disposal by a licensed vendor within the ROI. Drill cuttings and excess drilling mud would be collected and stabilized in the mud pits and transported off-site to the designated landfill.

Large, tractor-trailer sized storage tanks would be used for temporary storage of drilling fluids or other fluids (i.e., produced water, formation fluids, and acid) and drilling mud that would be pumped from the well. These types of portable storage tanks could also be used for storage of non-potable water or produced water to support drilling operations and storage of fuels for equipment and vehicle operation. In the event any spills of reportable quantities for oil, gas, or other fluids occur, immediate response actions would be to provide notice to regulatory agencies and initiate cleanup efforts. These actions could potentially occur at any stage of construction.

Any impacts related to disposal of drill cuttings and treatment of the produced water generated during the construction of the EOR injection and CO_2 monitoring wells would be negligible and short-term, as there are existing receiving facilities with sufficient capacity for this material. As presented in Table 3.14-2 sufficient landfill capacity exists within the ROI to accept any non-reusable wastes generated by these construction activities. Generation of these wastes would be short-term during the projected construction, startup, testing and commissioning period of the project. Project needs should not affect the ability of others in the ROI to dispose of their wastes. Any impacts would be considered short-term and negligible.

3.14.3.2 Operational Impacts

3.14.3.2.1 CO_2 Capture Facility

Materials

During operation of the project, process-related chemicals would be transported from suppliers and stored at the W.A. Parish Plant in sufficient quantities to support the operational needs of the project and to ensure the reliability of supply. NRG would follow the chemical suppliers' recommendations and procedures in storing and handling all chemicals. Those chemicals are described in Table 3.14-3, which presents a description of the material, estimated usage, inventory, and storage vessel type. Some of these materials are considered hazardous substances and are already in use at the plant as indicated.

The existing ammonia supply at the plant would be used for generating a 29% aqueous ammonia solution for the NOx emission reduction system for the new combustion turbine. As such, there would be no increase in the existing ammonia storage capacity and minimal change in the aqueous ammonia delivery schedule. Operation of the CO_2 capture facility would require the use of some process materials that would increase the risk of a potential release to the environment as discussed in Section 3.15 of this EIS (Human Health and Safety). The plant's SPCC Plan would be updated to identify and address any new chemicals that would be stored on-site. For disposal purposes a waste profile would be developed for any new waste streams and the Notice of Registration would be amended and submitted to the TCEQ for approval.

Any new chemical proposed to be brought on-site would be evaluated by the plant Hazard Communication personnel with regards to worker exposure and W.A. Parish Emergency Response Team needs. Existing worker safety programs would continue to educate plant personnel regarding spill containment procedures and related EHS policies. NRG would implement BMPs to help assure that effective and compliant waste management practices would be implemented and all necessary permits would be obtained to minimize any potential impacts and to comply with regulatory requirements during operation of the capture facility.

The impact from the storage and use of these chemicals would be considered minor. Most of these materials are commercially abundant and widely used in industry. Some specialized solvents would be produced by specialty suppliers at the national level. As such, the planned usage of these materials should not impact local or regional users or suppliers and the impact is considered negligible.

There would be a minor increase in the amount of fuel, oil, and solvents needed to support the new equipment and operations. Any demand for natural gas supplies for operation of the new natural gas-fired cogeneration plant would be provided by existing supplier, Kinder Morgan. The project should not affect local or regional supplies.

Table 3.14-3. Estimated Chemical Inputs and Storage Quantities

Input	Usage Rate	Storage Inventory	Storage Type
Advanced amine-based solvent	Proprietary	15,000 gallons (130,000 lbs [a])	Above ground tank
Aqueous ammonia	170 lb/hr	304,000 gallons (2,300,000 lbs)	Four existing 80,000-gallon (carbon steel) ASTs outdoors[b]
10% carbohydrazide	0.04 gph	165 gallons	3 x 55 gallon drums
Ferric chloride coagulant	0.58 gph	1,200 gallons	Above ground tank
Polymer	0.01 gph	400 gallons	Plastic tote
Caustic	0.02 gph	400 gallons	Plastic tote
Sulfuric acid	1.7 gph	1,500 gallons	Above ground tank
Hypochlorite	22.4 gph	4,000 gallons	Above ground tank
Sodium bisulfate	0.04 gph	400 gallons	Plastic tote

[a] Calculated using a density of 1.018 g/ml at 20°C (8.5 lbs/gallon) (Lyondellbasell 2010)
[b] Capacity of each tank is administratively limited to 76,000 gallons.
gph = gallons per hour; lb/hr = pounds per hour; lbs = pounds
Source: Armpriester 2012, NRG 2007, Lauzze 2012

Waste Management

For any new waste streams that would be generated as a result of normal operation of the CO_2 capture facility, NRG would take steps to assure that these waste streams are properly identified and managed as an integral part of the W.A. Parish Plant Waste Management Program, and as such they would be properly managed and disposed of in accordance with applicable regulatory requirements and BMPs. For disposal purposes, a waste profile would be developed for each new waste stream and the Notice of Registration would be amended and submitted to the TCEQ for approval.

- **Non-Hazardous Solid Waste -** The operation of the CO_2 capture facility would contribute a negligible percentage of the non-hazardous solid waste already being generated by current W.A. Parish Plant operations and maintenance activities. The thickener being installed for treatment of makeup water would produce an additional amount of solid waste that would be landfilled. This waste stream is estimated to be in the range of 25 to 50 tons per year.

  Other solid waste would mainly include miscellaneous facility (worker) trash, including paper, cardboard, aluminum, and glass. It is estimated that the CO_2 capture facility would generate an additional seven tons of general trash per year (i.e., approximately 40 pounds per day). Solid waste containers would be sized appropriately to minimize the need for waste transportation-related trips to and from the W.A. Parish Plant. The WMI Conroe and Coastal plains landfills are currently being used by the plant to dispose of solid waste and have sufficient capacity to accept the small amount of additional waste that would be generated over the 20-year operational life of the project. As such, the impact is considered negligible.

Operation of the CO_2 capture facility would not result in an increase in the generation of CCBPs.

- **Hazardous Wastes –** As mentioned in Section 3.14.2.1, the W.A. Parish Plant is currently a conditionally exempt small quantity generator, but conforms to the requirements of a large quantity generator for consistency with other NRG facilities. The operation of the CO_2 capture facility would produce a hazardous waste stream that would be identified as reclaimer effluent, which would be generated at a rate of approximately 2,712 pounds per day. There would be 24 shipments of reclaimer effluent per year from the W.A. Parish Plant to the TSDF. The addition of this reclaimer effluent waste stream to the W.A. Parish Plant's operations would change the plant's status from conditionally exempt small quantity generator to large quantity generator. Because the plant currently conforms to the requirements of a large quantity generator, impacts related to hazardous waste generation and management would be moderate**.**

  In the event of a process malfunction, there could be some potential for a localized release of hazardous and non-hazardous materials or waste where cleanup and maintenance may be required. Hazardous wastes would also be managed under NRG's existing waste management programs and disposed of at the Veolia Environmental Services TSDF in Port Arthur, Texas.

All waste material generated as a result of CO_2 capture facility operations and maintenance activities would be handled according to applicable laws and regulations and W.A. Parish Plant operations and maintenance standards. Waste from NRG's proposed project is assumed to account for a small amount of the available capacity in identified landfills, treatment or disposal facilities, although not all of the potential waste volumes have been identified at this early stage of planning. Therefore, impacts are considered to be moderate.

3.14.3.2.2 Pipeline Corridor

During pipeline corridor operation, materials and chemicals would not be stored along the pipeline ROW. Any necessary materials required for servicing and monitoring of pipeline systems and components would be transported into the pipeline corridor ROW in service vehicles and used at the work location as needed. Materials would not be stored within the pipeline corridor ROW.

Maintenance activities pipeline corridor ROWs would typically require ground cover mowing, vegetation clearing, maintenance of access and service roads maintenance, and servicing and monitoring of pipeline system components. Vegetation cut along the pipeline corridor during long-term routine maintenance would likely be reused as mulch or compost on ROW property as agreed to by the landowner and would not require landfilling. If any spills of oil, gas, or other fluids occurred along the ROW, NRG would immediately initiate response actions already established for the project, provide notice to regulatory agencies as necessary, and initiate cleanup action.

Routine maintenance and monitoring activities along the proposed pipeline are not expected to produce any demands on the regional supply of materials or generate appreciable quantities of waste. Therefore the proposed project's potential impact would be considered negligible.

3.14.3.2.3 West Ranch Oil Field

The final number and locations of injection and production wells for the project would be determined based on the results of a geologic characterization study. It is assumed that the West Ranch oil field currently maintains an adequate supply and safe storage capability for the types of materials and chemicals that would be required for operations and maintenance of the EOR demonstration facilities and injection wells and related CO_2 monitoring wells and facilities. These materials and chemicals are typical of what are already used on-site for routine oil field operations. They include corrosion inhibitor, glycol dehydrate, crude oil, and amine. These materials are readily available within the region from numerous suppliers and there should be no impact on local supplies.

Any additional natural gas recovered as a result of EOR operations would be routed to the existing Kinder Morgan natural gas pipeline used for the same purpose. The pipeline has adequate capacity to receive the expected amount of additional natural gas that would be produced from EOR operations. There would be an adequate supply and safe storage capability for the types of materials and chemicals required for operations and maintenance of the CO_2 monitoring wells. These materials and chemicals are readily available within the region from numerous suppliers and as such there should be no impact on local supplies.

Long-term maintenance of EOR injection wells and CO_2 monitoring wells would include well work over, wellhead maintenance, and swabbing. Well maintenance would produce an acid and produced water mixture that would be pumped directly into tanker trucks and hauled off-site for recycling by a licensed transportation company to a licensed facility within the ROI. Swabbing operations would also produce fluids containing produced water, formation fluids, and potentially acid, which would be collected and treated at the existing waste separation facility that is used for the same purpose, and would be discharged in accordance with current practices and applicable regulations. Equipment taken out of service and replaced during maintenance would be hauled off-site for recycling or disposal to a licensed facility within the ROI.

In the event of any spills of oil, gas, or other fluids, immediate response actions would be initiated to provide notice to workers and regulatory agencies as necessary, and cleanup efforts would be initiated in accordance with established requirements.

The majority of the wastes directly generated by activities associated with the exploration, development, or production of crude oil or natural gas are exempt from regulation as hazardous wastes under RCRA Subtitle C and Texas Statewide Rule 98. This exemption is commonly referred to as the “Exploration and Production Exemption.” In order to be covered under this exemption, wastes from field operations must be considered to be unique to exploration and production operations. However, other wastes commonly generated in exploration and production operations may be used in other types of industries. For example, cleaning wastes, painting wastes, and waste lubricating oil are commonly generated in activities other than exploration and production and are, therefore, not covered by the exploration and production exemption because they are not unique to exploration and production activities. The wastes that EPA has determined are not covered under the exemption may be considered hazardous wastes subject to regulation under RCRA Subtitle C and Texas Statewide Rule 98.

The majority of wastes resulting from TCV’s proposed EOR and CO_2 monitoring activities at the West Ranch oil field are expected to be considered exempt, non-hazardous solid waste. However, TCV plans to closely monitor wastes that would be produced by operations, and ensure compliance with the disposal requirements of Rule 98 and RCRA regarding the disposal of hazardous and non-hazardous wastes. Solid non-hazardous waste generated during EOR injection well and CO_2 monitoring well maintenance activities would be recycled or landfarmed on-site or disposed into an existing on-site produced water injection or disposal well, as appropriate. Non-hazardous solid waste would be hauled off-site for disposal at an HEC designated landfill (e.g., VI Wolf or Inland Environmental). Suitable facilities are available within the ROI for treatment and disposal of these types of oil field wastes. In the event any hazardous wastes would be generated, they would be properly collected, sampled, labeled, packaged, and temporarily stored in 55-gallon drums or other approved containers. The containers would be temporarily stored in an approved hazardous waste storage area, awaiting shipment by a licensed hazardous waste hauler to an approved off-site TSDF in coordination with HEC's current preferred waste disposal vendors. Releases of hazardous materials would be reported to the RRC and the EPA.

Any impact on regional availability of materials and regional waste disposal capacity would be negligible.

3.14.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to the materials and waste management resource areas.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. Waste materials generated during the construction phase of the project would consist of crating materials and other typical construction waste, and no generation of hazardous waste is anticipated. This construction waste would be disposed of under the plant wide permit. Very minimal waste will be generated during the operation of the unit, and only during maintenance activities.

3.15 HUMAN HEALTH AND SAFETY

3.15.1 Introduction

This section identifies and describes potential impacts to human health and safety associated with the construction and operation of the proposed Parish PCCS Project. The health and safety impacts are evaluated in terms of the potential risks to workers and the public, including the risks from accidents that involve the pipelines, wells, or intentional destructive acts that could result in the release of hazardous material to on-site or off-site locations. The level of risk is estimated based on the current conceptual design of the project, applicable DOE Guidance (DOE 2002, 2004), applicable safety and spill prevention regulations, and expected operating procedures.

Federal, state, and local health and safety regulations, as well as industrial codes and standards, would govern work activities during construction and operation of the project to protect the health and safety of the workers and the public.

This section describes the potential human health and safety impacts associated with potential releases of CO_2 from the proposed pipeline and EOR facilities during the operational period. Potential releases from the amine-based solvent storage tank to be located on the power plant property are also evaluated. In addition, the potential for post-injection releases of CO_2 from the subsurface EOR target formations are evaluated. Additional information and a more detailed analysis of potential impacts that could result from the release of CO_2 are presented in Appendix F to this EIS (Health Risk Assessment).

3.15.1.1 Region of Influence

The ROI for human health, safety, accidents, and intentional destructive acts, is based on worst-case (catastrophic) release scenarios and the estimated area that could result in human health and safety impacts by such releases. The ROI for potential worst-case releases associated with the CO_2 pipeline ranges between approximately 2.1 miles to the north and south of the pipeline centerline. This is the maximum distance at which potential adverse effects due to air emissions would likely occur; the actual distance could be substantially less since the potential distance fluctuates with pipeline length, associated release volumes, and weather conditions. The ROI for potential worst-case releases associated with the operation of injection wells is estimated at approximately 0.02 miles (i.e., approximately 100 feet) from the perimeter of the proposed West Ranch oil field EOR area.

Potential accidental releases during the storage of hazardous materials were also considered. The ROI for these types of releases includes areas within 0.9 miles of the capture facility. This distance is based on the maximum predicted distance for potential adverse health effects that could result from the accidental release of MEA from the CO_2 capture facility. Most of the land within the ROI is controlled by NRG and is part of the W.A. Parish Plant. This compares with the W.A. Parish Plant Risk Management Plan (RMP) (NRG 2007) that defined a worst case release scenario of a leak from one of the existing aqueous ammonia tanks that could extend to 1.1 miles from the source of the leak. As discussed below, because no new ammonia tanks would be installed as part of the proposed project, this ammonia tank leak scenario is not evaluated in this EIS.

3.15.1.2 Method of Analysis

For chemical hazards, the DOE considered a full range of potential accident scenarios, including worst-case releases. Potential accident scenarios were considered for each aspect of the project, including the

CO_2 capture facility, the pipeline corridor, and EOR operations at the West Ranch oil field. The potential impacts from intentional destructive acts were evaluated based on the analysis of the worst-case release from these scenarios.

Accidents considered by DOE address concerns related to the potential release of hazardous chemicals and CO_2 and related health effects that could occur from exposure. Each release scenario was carefully reviewed to determine the predicted frequency at which such an event could occur. DOE considered engineering design and controls, as well as available industry safety statistics when determining the predicted frequency for each type of accident and release. The frequency of an accident is the chance that the accident might occur and is typically discussed in terms of the number of occurrences over a period of time that an accident may occur based on previous industry experience. For example, the frequency of occurrence for an accident that can be expected to happen once every 50 years, or one accident divided by the 50-year period, is $2x10^{-2}$ per year. Based on DOE's review, each accident was classified into one of the following frequency categories:

- **Possible:** Accidents estimated to occur one or more times in 100 years of facility operations (frequency $\geq 1x10^{-2}$ per year).
- **Unlikely:** Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from $1x10^{-2}$ to $1x10^{-4}$ per year).
- **Extremely Unlikely:** Accidents estimated to occur between once in 10,000 years and once in 1million years of facility operations (frequency from $1x10^{-4}$ to $1x10^{-6}$ per year).
- **Incredible:** Accidents estimated to occur less than one time in 1 million years of facility operations (frequency $<1x10^{-6}$ per year).

Potential health effects were considered for both workers and the general public based on modeling results. Comparisons were made between potential exposure concentrations and health criteria published by the EPA, OSHA, and other industry groups (e.g., American Industrial Hygiene Association [AIHA]) to determine potential health effects. DOE used the following categories to characterize the potential range of health effects that could occur for a particular exposure:

- Transient and reversible adverse effects – headache, dizziness, sweating, and/or vague feelings of discomfort;
- Irreversible adverse effects – breathing difficulties, increased heart rate, convulsions, and/or coma; and
- Life-threatening effects.

Potential exposure concentrations at locations with potential to affect workers and the general public were calculated by running industry standard or EPA-approved air quality computer models. Each accident (release) scenario was evaluated through computer modeling to determine potential exposure concentrations that could occur at various distances from the point of release.

The transport of the released gases from the CO_2 pipeline and EOR facilities at the West Ranch oil field was estimated through atmospheric dispersion modeling. The predicted concentrations were then used to estimate the potential for exposure and any resulting potential impacts on human receptors. The gas concentrations due to the releases to the atmosphere from the pipelines and injection wells during operation were simulated using the SLAB model (Ermak 1990). The pipeline-walk methodology, developed for and used in a previous DOE project (DOE 2007b), was used to evaluate the effects of gas phase releases along the entire length of a pipeline and to calculate the number of individuals hypothetically exposed to CO_2 from simulated pipeline ruptures and punctures. For active injection wells, the SLAB model was also used to estimate the CO_2 concentrations in air and the extent of a resulting plume due to a release from the well. The pipeline-walk routine was conducted at multiple locations to represent the potential impacts associated with different wells.

An advanced amine-based solvent would be used to extract the CO_2 from the flue gas. New storage tanks for this solvent would be installed at the plant. Due to the proprietary makeup of many commercial amine solvents, MEA, a common amine solvent component, was used for this analysis. For potential MEA releases from these storage tanks, air modeling was conducted using the SLAB model to determine the distances for different exposure levels and related potential for adverse health effects to plant workers and nearby off-site residents.

A small additional amount of aqueous ammonia would be needed for the operation of the HRSG, which is part of the new facilities for the proposed project. The existing RMP for the aqueous ammonia storage and handling system at the W.A. Parish Plant (NRG 2007) includes evaluations of accidental releases of ammonia. No accidental releases of ammonia have occurred from the plant's ammonia handling system since its installation. Because the amount proposed to be used is small compared to the existing aqueous ammonia use and the fact that no new ammonia storage tanks would be needed for the proposed project, no new evaluations of ammonia tank leaks or accidents involving transport of ammonia to the plant were conducted for this EIS.

Potential worker 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 numbers of employees anticipated during construction and operation of the proposed project. From these data, the projected numbers of total recordable cases (TRCs), lost work day cases (LWDs), and fatalities were calculated. Data from the 2010 U.S. census were used to approximate the number of people near project areas who could be affected by accidents or releases.

3.15.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to human health and safety, based on whether the proposed W.A. Parish Project would directly or indirectly increase any of the following:

- worker health risks due to industrial accidents, injuries, or illnesses during construction and normal operating conditions;
- public health risks due to accidental releases of amine solvent at the CO_2 capture facility;
- public health risks due to accidental releases associated with captured CO_2 transport and local geologic storage activities; or
- public health risks due to intentional destructive acts.

3.15.2 Affected Environment

This section presents health and safety data for populations that could be exposed to potential hazards resulting from the construction and operation of the proposed project.

3.15.2.1 ROI Description

As shown in Figure 3.15-1, the towns of Thompsons, Fairchilds, Needville, Damon, LaWard, Lolita and Vanderbilt are located within the ROI for analysis of potential health and safety impacts. Several other small towns are located in the vicinity of the surrounding areas; however, these towns are located outside the ROI. A total of 322 census tracts are located within the ROI. A summary of the population and sensitive receptor information from the 2010 U.S. Census for the census tracts located within the ROI is included in Table 3.15-1. Sensitive receptors include young children, the elderly, and those living in poverty (inadequate access to healthcare). There are no schools or licensed daycare providers located within the ROI. There is a high school located on the south side of Vanderbilt to the north of the West Ranch oil field. However, this high school is located more than 0.02 miles from the proposed EOR area and more than two miles from the proposed pipeline corridor.

The predominant winds are from the direction of the Gulf of Mexico (i.e., from the south and southeast), as shown in the wind rose diagrams (Figures 3.2-2 and 3.2-3) included in Section 3.2 of this EIS (Air Quality and Climate). Calm conditions occurred about 8.2% of the time in Houston and 2.2% of the time in Victoria. The predominant wind direction at Houston's George Bush Intercontinental Airport is from the south (11.4% of the time on an annual basis), with significant winds also from the north (10.3%). The predominant wind direction at the Victoria Airport is from the south (14% of the time), with significant winds also from the north (12.7% of the time).

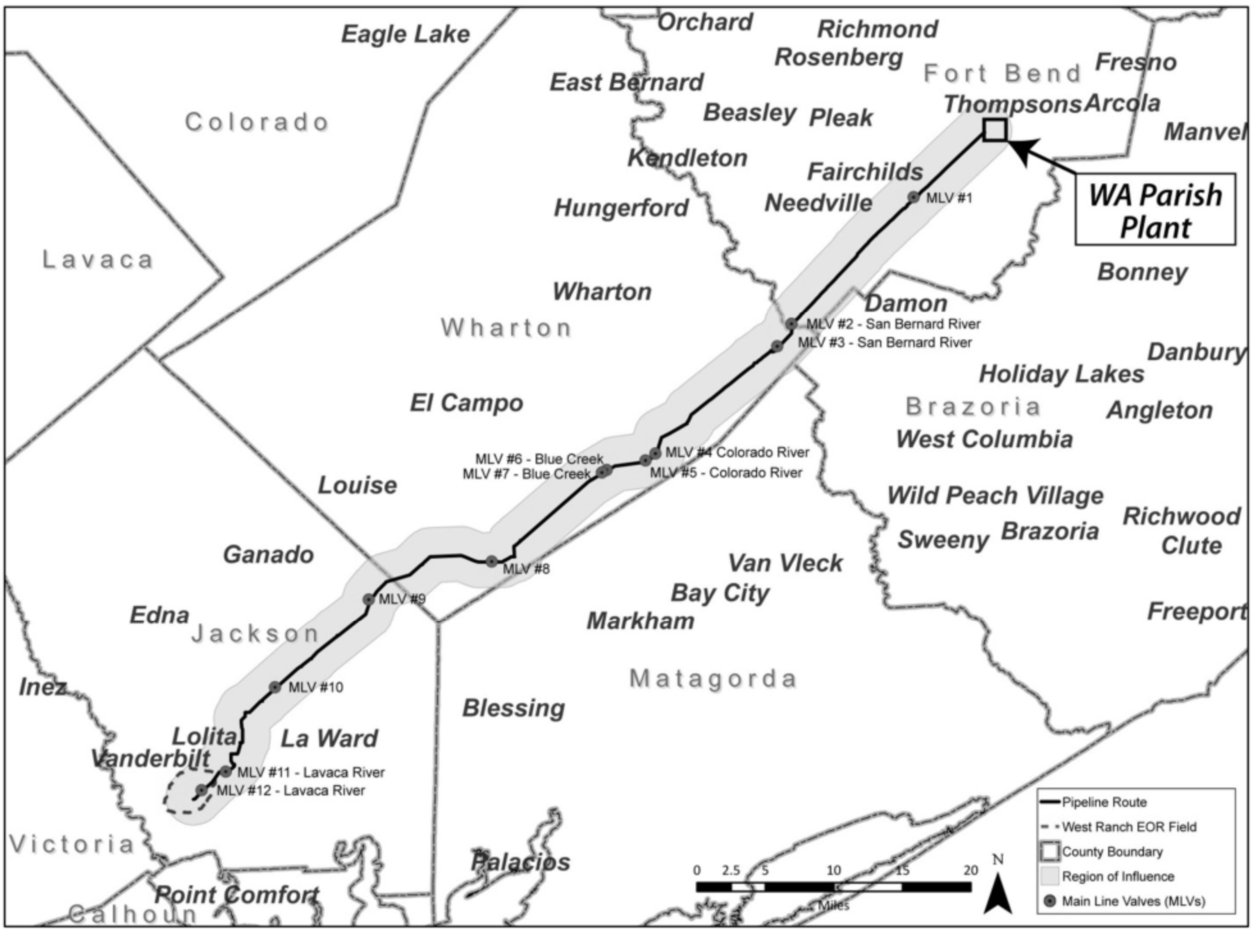

Figure 3.15-1. ROI for Analysis of Potential Health and Safety Impacts

Table 3.15-1. Summary of ROI Demographics

Full Tract and Block Group ID	2010 Population[a]	Sensitive Receptors		
		Persons in Poverty (percent)	Children Under 5 years old[a]	Adults 65 and older[a]
Fort Bend County		8.0		
480396620005	1099		82	145
480396627001	1992		126	256
481576755001	7080		621	395
481576756001	3709		248	325
481576756002	2099		114	207
481576757002	3490		257	377
Jackson County		11.7		
482399501001	1756		141	252
482399501002	1375		105	263
482399501003	1038		46	244
482399501004	1173		73	144
482399503002	984		64	189
482399503003	1012		58	140
Wharton County		17.2		
483217302013	1189		70	147
483217307002	1797		154	210
483217307003	516		24	79
484817406001	1334		84	180
484817406002	1273		92	158
484817406003	1181		83	174
484817407001	1875		170	231
484817410004	1331		121	140
484817411002	1535		98	248
Total			2,831	4,504

[a] U.S. Census Bureau, Census 2010 Summary File 1, Detailed Tables, Table P1 (Total Population), Texas; U.S. Census Bureau, Census 2010 Summary File 1, Detailed Tables, Table P12 (Population by Age and Sex), Texas

ROI = region of influence

Note: The numbers presented for children under 5 years old and adults 65 and older are an overstatement because the ROI includes only a part of each census block group.

Figure 3.15-2 illustrates the locations of project areas in relation to population densities in the surrounding area. The population densities are based on the 2010 U.S. Census. The W.A. Parish Plant is located in an area with a population density of 100 to 500 people per square mile, mostly located in a small area east of the plant and a larger area southwest of the plant. The population density west of the plant is 26 to 50 people per square mile. The areas north and south of the plant are mostly unpopulated. The majority of the pipeline traverses areas with population densities of five or less people per square mile, with certain segments that have a population density as high as 100 to 500 people per square mile. The population densities are higher within 15 miles of the plant than along the remainder of the pipeline. The areas surrounding the West Ranch oil field are primarily unoccupied with the following exceptions. The town of Vanderbilt and adjacent area, north of the oilfield has a population density of 25 to 50 people per square mile. Areas to the southwest and northeast of the oilfield have population densities of 5 to 25 people per square mile.

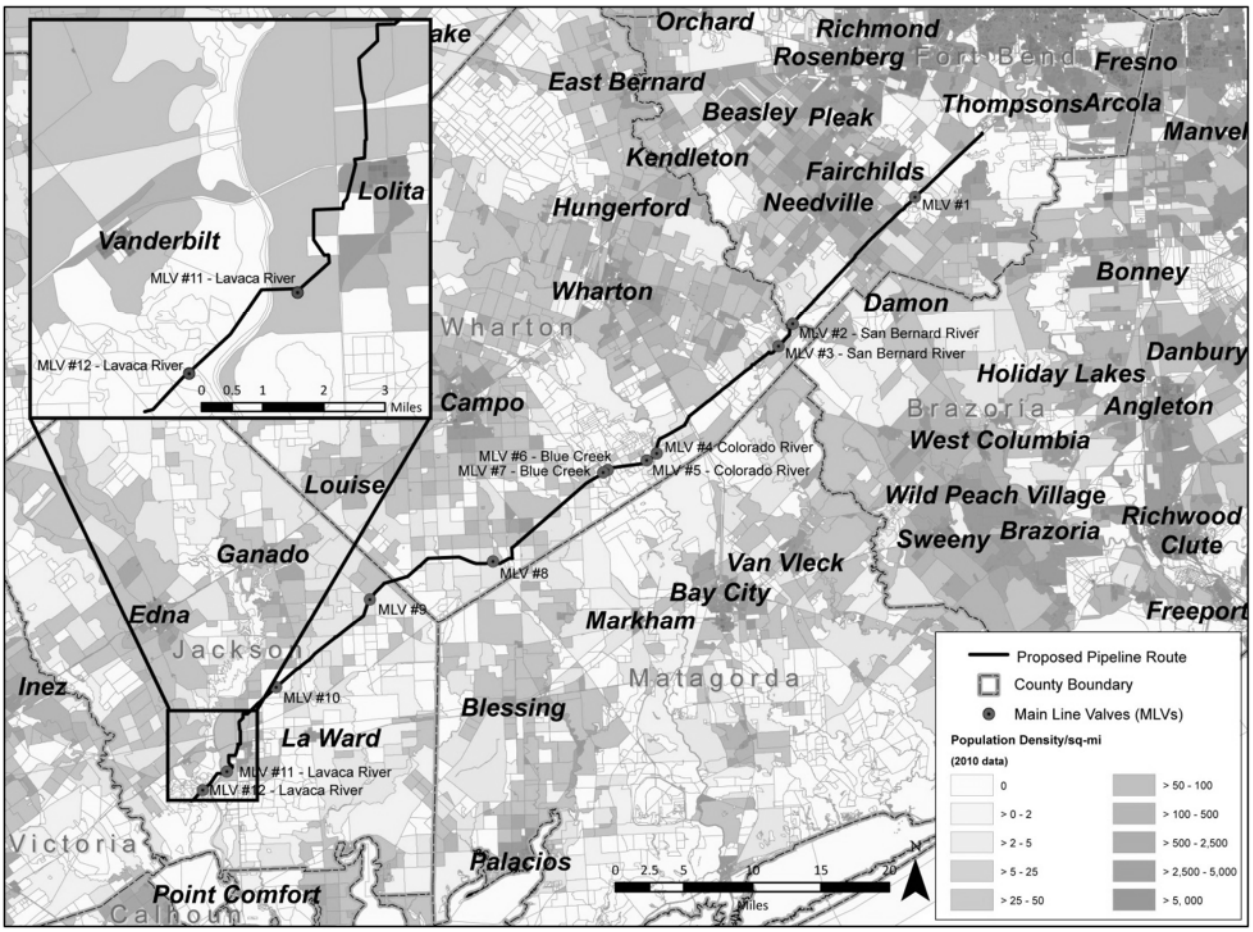

Figure 3.15-2. Population in Vicinity of the Capture Facility, Pipeline Route, and Injection Wells
Source: U.S. Department of Commerce, Bureau of the Census, Census 2010

3.15.2.2 Health Profiles

County health profiles were obtained from County Health Rankings and Roadmaps (CHRR 2012), an organization that aggregates health indicators from a range of public health information sources and from the Texas Department of State Health Services (TDSHS 2012a, TDSHS 2012b, TDSHS 2012c). The health profiles comprise an overview of the health status of residents in the three counties within the ROI compared with the State of Texas and the United States. Of the three counties in the ROI, Fort Bend County has the best overall health ranking. Health rankings for Wharton and Jackson Counties are generally not as good as Fort Bend County for most indicators but neither county is consistently better than the other. All three counties in the ROI have better overall health rankings than over half of the other counties in the state of Texas.

As indicated in Table 3.15-2, Wharton and Jackson Counties had higher incidences of cancer deaths when compared to the average cancer rate for Texas, while Fort Bend County had a lower incidence of cancer deaths. Texas had median age at 33.6 years in 2010 compared with 37.2 years for the median of all states in the U.S. in the year 2010. All other factors being equal, with a population younger than the median United States population, the incidence of certain cancers common to older populations would be expected to be lower.

The National Cancer Institute (NCI 2012) noted the following trends in cancer rates: Fort Bend County is below the national rate and is falling, Wharton County is similar to the national rate and falling, and Jackson County is stable and similar to the national rate of cancer deaths. Cancer incidences specific to Fort Bend, Wharton, and Jackson Counties are presented in Table 3.15-3.

3.15.2.3 Health Effects Criteria for CO_2 and MEA

Potential health effects from CO_2 and co-constituents, if present, would be dependent on the concentration and length of exposure to each gas. The evaluation considered gaseous releases that may occur rapidly for only a short time (e.g., rupture of a pipeline) or more slowly over a longer period of time (e.g., leakage from a pipeline puncture or subsurface reservoir). As discussed in Appendix F, the northern portion of the ROI (i.e., between the W.A. Parish Plant and main line valve [MLV] #**6**) was analyzed using wind data from George Bush Intercontinental Airport, while the southern portion of the ROI (i.e., between MLV #7 and the West Ranch oil field) was analyzed using wind data from the Victoria Airport.

Table 3.15-4 provides health risk criteria for workers and the public for exposure to CO_2. Potential 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. The current CO_2 Protective Action Criteria (PAC) at which mild, reversible effects and adverse effects such as breathing difficulties can occur (i.e., PAC-1 and PAC-2 levels, as indicated in Table 3.15-4) are assigned a concentration of 30,000 ppm (SCAPA 2012). No health effects to the general public, including susceptible individuals, are expected to occur at CO_2 concentrations of 5,000 ppm or less. The current CO_2 Protective Action Criteria (PAC) at which mild and reversible adverse effects such as breathing difficulties can occur (i.e., PAC-1 as indicated in Table 3.15-4) are assigned a concentration of 30,000 ppm (SCAPA 2012). Exposure at this level for longer than one hour constitutes PAC-2 exposure, resulting in irreversible adverse effects, and exposure at 50,000 ppm for one hour can be life threatening, as indicated in Table 3.15-4. These levels are based on Temporary Emergency Exposure Limits (TEEL) values set by the DOE's Subcommittee on Consequence Actions and Protective Assessments (SCAPA), since other criteria were not available for CO_2 including Acute Exposure Guideline Levels (AEGLs) set by the EPA or Emergency Response Planning Guidelines (ERPG) values set by the American Industrial Hygiene Association (AIHA).

Table 3.15-2. County Health Profiles Overview for 2009 (In Comparison to the State of Texas and the United States)

Category	U.S.	Texas	Fort Bend County	Wharton County	Jackson County
OVERALL HEALTH OUTCOME RANKING[a]	**N/A**	**N/A**	**9**	**57**	**61**
Mortality[a]	***N/A***	***N/A***	***6***	***58***	***78***
Premature death	5,466	7,186	4,871	7,478	7,854
Cancer death rate (2007)		167.6	138.9	192.1	170.8
Morbidity[a]	***N/A***	***N/A***	***60***	***81***	***49***
Poor or fair health	10%	19%	16%	NA	NA
Poor physical health days	2.6	3.6	3.3	4.3	6.3
Poor mental health days	2.3	3.3	3.0	1.9	2.9
Low birth weight	6.0%	8.2%	8.3%	8.5%	6.3%
HEALTH FACTORS[a]	**N/A**	**N/A**	**9**	**113**	**97**
Health Behaviors[a]	***N/A***	***N/A***	***4***	***120***	***112***
Adult smoking	14%	19%	11%	16%	NA
Adult obesity	26%	29%	26%	31%	30%
Physical inactivity	21%	25%	21%	29%	27%
Excessive drinking	13%	16%	13%	17%	NA
Motor vehicle crash death rate	11	17	11	30	22
Sexually transmitted infections	84	435	218	238	354
Teen birth rate	22	63	27	70	70
Clinical Care[a]	***N/A***	***N/A***	***10***	***49***	***107***
Uninsured	11%	26%	19%	28%	25%
Primary care physicians	631:1	1,050:1	891:1	1,238:1	2,821:1
Preventable hospital stays	49	73	59	67	103
Diabetic screening	89%	81%	82%	86%	85%
Mammography screening	74%	62%	63%	57%	60%
Social & Economic Factors[a]	***N/A***	***N/A***	***18***	***122***	***66***
High school graduation		84%	90%	92%	95%
Some college	68%	56%	70%	46%	53%
Children in poverty	13%	26%	13%	27%	25%
Inadequate social support	14%	23%	21%	16%	NA
Children in single-parent households	20%	32%	22%	39%	40%
Violent crime rate	73	503	363	442	252
Physical Environment[a]	***N/A***	***N/A***	***220***	***186***	***179***
Air pollution-particulate matter days	**0**	1	6	2	1
Air pollution-ozone days	0	18	2	0	0
Access to recreational facilities	16	7	6	5	0
Limited access to healthy foods	0%	12%	10%	1%	4%
Fast food restaurants	25%	53%	56%	52%	56%

Source: CHRR 2012.
[a] Rank compared to all 221 Texas counties. Lower is better.
N/A = Not applicable; NA = data not available

Table 3.15-3. Cancer Incidence by County in 2009

Category	Texas	Fort Bend County	Wharton County	Jackson County
All Cancer	167.6	139.9	192.1	170.8
Respiratory/Lung Cancer	45.7	36.1	66.2	NA
Female Breast Cancer	21.6	23.1	NA	NA
Colon, Rectum Cancer	15.9	15.7	NA	NA
Male Prostate Cancer	19.9	16.1	NA	NA

Note: Cancer cases per 100,000 population
NA = Not available
Sources: TDSHS 2012a, TDSHS 2012b, TDSHS 2012c

Table 3.15-4. Potential Health Effects from Exposure to CO_2

Gas	Potential Health Effects	Health Protective Action Criteria Concentrations – Public[1] (ppm)	Health Protective Action Criteria Concentrations – Workers[2] (ppm)
CO_2	No health effects	5,000 (1 hour or less)	PEL: 5,000 (8 hours)
	Reversible, adverse effects (e.g., headache, dizziness, sweating, vague feelings of discomfort)	PAC-1: 30,000 (1 hour or less) 20,000 (8 hours)	STEL: 30,000 (15 min, up to 4 times/day)
	Irreversible adverse effects (e.g., breathing difficulties, increased heart rate, convulsions, coma)	PAC-2: Above 30,000 (1 hour)	IDLH: 40,000 (30 minutes)
	Life threatening	PAC-3: Above 50,000 (1 hour)	

[1] Based on Protective Action Criteria (PAC) for exposure time of 1 hour or less established by DOE's Subcommittee on Consequence Actions and Protective Assessments (SCAPA 2012).

PAC-1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience discomfort, irritation, or certain asymptomatic, non-sensory effects; however, these effects are not disabling and are transient and reversible upon cessation of exposure (SCAPA, 2012)

PAC-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 (SCAPA, 2012)

PAC-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, if the concentration was sustained for 60 minutes. (SCAPA, 2012)

Longer term levels for 8 hours are from US EPA 2000, but are not AEGLs. The 8-hour OSHA TWA is 5,000 ppm.

The current CO_2 Protective Action Criteria (PAC-1) indicates when mild and reversible adverse effects such as breathing difficulties can occur if a concentration of 30,000 ppm lasts for only up to 1 hour (SCAPA 2012). Exposure above 30,000 ppm or equal to 30,000 ppm for longer than one hour constitutes PAC-2 exposure, resulting in irreversible adverse effects. These levels are based on Temporary Emergency Exposure Limits (TEEL) values set by the DOE's Subcommittee on Consequence Actions and Protective Assessments (SCAPA), since other criteria were not available for CO2 including Acute Exposure Guideline Levels (AEGLs) set by the EPA or Emergency Response Planning Guidelines (ERPG) values set by the American Industrial Hygiene Association (AIHA).

[2] PEL: Permissible Exposure Levels (PEL) are legally enforceable standards established by the U.S. Occupational Safety and Health Administration (OSHA, 2009a).

STEL: Short Term Exposure Limit (STEL) based on 3 percent in air, is a concentration it is believed workers can be exposed to for up to 15 minutes no more than 4 times per day, as defined by ACGIH (American Conference of Industrial Hygienists)

IDLH: Immediately Dangerous to Life and Health (IDLH) levels are recommended criteria established by the National Institute of Safety and Health (NIOSH, 2005), designed to allow a worker to escape within 30 minutes.

For the pipeline puncture releases, anticipated CO_2 concentrations from the modeling were compared to values of 5,000 ppm (i.e., the OSHA time-weighted average [TWA] value for eight hours); 20,000 ppm; and 40,000 ppm based on information from the EPA (2000). CO_2 can asphyxiate persons located close to a pipeline rupture, so this scenario would cause an acute health risk. Therefore, the potential for CO_2 as a dense gas to accumulate in low areas or confined spaces such as basements is discussed with respect to the releases evaluated and the setting of the plant, pipeline, and well field. Long-term exposure criteria (i.e., for exposure periods greater than eight hours) have not been developed for CO_2 because CO_2 does not pose an appreciable risk of deleterious effects to humans, including sensitive subgroups, for longer exposure periods.

For over 70 years, amine-based processes have been used to remove hydrogen sulfide (H_2S) and CO_2 for natural gas treatment. There are many different amines used in gas treating, but the most commonly used alkanolamines include monoethanolamine (MEA), diethanolamine (DEA), and methyldiethanolamine (MDEA). Among the amine solvents, MEA is the benchmark molecule because of its properties towards CO_2 capture (e.g., low price, high water solubility, high absorption capacity, and fast reaction). (Islam, et al. 2011) MEA is not classified as a carcinogen and is primarily an irritant to skin, eyes, and lungs. MEA inhalation exposure criteria for workers and the general public are summarized in Table 3.15-5.

New cases of cancer are not anticipated because the chemicals that would be used are not classified as carcinogens.

Table 3.15-5. MEA Criteria for Workers and General Public

Parameter[1]	MEA Concentration in Air (ppm)	Effect Level
PAC-1	6 (1 hour or less)	Mild, transient effects could occur – eye & skin irritant, a reversible effect
PAC-2	6 (Above 6 for 1 hour or more)	Above six serious health effects could occur to lungs, a reversible to irreversible effect
PAC-3	1,000	Life-threatening effects could occur to respiratory or nervous systems
IDLH for Workers	30	Immediately dangerous to life or health, when this level reached, workers should leave area or take other protective action to avoid effects if concentration lasts for 30 minutes
Odor Threshold	2.6	Level at which MEA can be detected in air by most people, a reversible effect

[1]PAC criteria for MEA (monoethanolamine) (SCAPA 2012); IDLH and Odor Threshold from MEA Material Safety Data Sheet (LyondellBasell 2010). The MEA Protective Action Criteria (PAC-1) indicates when mild and reversible adverse effects can occur if a concentration of 6 ppm lasts for only up to 1 hour (SCAPA 2012). Exposure above 6 ppm or equal to 6 ppm for longer than one hour constitutes PAC-2 exposure, resulting in irreversible adverse effects. These levels are based on Temporary Emergency Exposure Limits (TEEL) values set by the DOE's Subcommittee on Consequence Actions and Protective Assessments (SCAPA), since other criteria were not available for **MEA** including Acute Exposure Guideline Levels (AEGLs) set by the EPA or Emergency Response Planning Guidelines (ERPG) values set by the American Industrial Hygiene Association (AIHA).

3.15.2.4 Occupational Injury Data

Occupational injury and fatality data from the U.S. Bureau of Labor Statistics are presented in Table 3.15-6 and Table 3.15-7. These data provide the injury/illness and fatality rates for utility-related construction and natural gas distribution workers. These rates are expressed in terms of injuries/illnesses per 100 worker-years (or 200,000 hours) for total recordable cases; lost word day cases; days away, job transfer, or restriction; and fatalities, and are used for estimating potential impacts. However, the characteristics and associated pipeline risks are different for CO_2 and natural gas.

Table 3.15-6. Occupational Injury Data for Related Industries in 2008

Industry	2008 Average Annual Employment (thousands)	Total Recordable Case Rate (per 100 workers)	Lost Work Day Case Rate (per 100 workers)	Days away, job transfer, or restriction (per 100 workers)
Utility system construction	460.7	4.1	1.5	2.3
Non-residential construction	855.9	4.4	1.4	2.2
Oil and gas pipeline construction	107.7	2.2	0.5	0.9
Natural gas pipeline operation	25.5	2.3	0.7	1.2
Oil and gas extraction	153.8	1.4	0.4	0.7
Electric power generation	239.7	2.6	0.9	1.5

Source: USBLS, 2009 (Table 1. Incidence rates of nonfatal occupational injuries and illnesses by industry and case types, 2010; file name ostb2071,pdf)

Table 3.15-7. Fatality Data for Related Industries in 2008

Industry	Fatality Rate (per 100,000 FTE workers)
Utilities	3.9
Construction	9.7
Oil & gas extraction	23.9
Installation, repair, maintenance	6.7

Source: Fatality rates from USBLS, 2010 (Fatal occupational injuries, total hours worked, and rates of fatal occupational injuries by selected worker characteristics, occupations, and industries, civilian workers, 2008; File name cfoi_rates_2008hb.pdf)
FTE = full-time equivalent

3.15.2.5 Pipeline Safety Data

DOT's Office of Pipeline Safety administers and enforces the rules and regulations regarding the pipeline transport of hazardous materials, including CO_2. States also may regulate pipelines under partnership agreements with the Office of Pipeline Safety. Regulations are designed to protect the public and the environment by ensuring safety in pipeline design, construction, testing, operation, and maintenance. Table 3.15-8 shows the number of safety incidents between 1992 and 2011 involving natural gas, hazardous liquid, and CO_2 pipelines in the U.S. CO_2 pipeline incidents resulted in no fatalities through 2011 and injuries are rare. The annual incident frequency is 0.06 incidents per 100 miles of pipeline per year (OPS 2012b). The incident rate for natural gas pipelines is lower (i.e., 0.024 incidents per 100 miles of pipeline per year), but injuries and fatalities have occurred. The major cause of failure in serious incidents concerning all pipelines is damage (puncture or rupture) during excavation of existing pipelines for repair or for installation of new pipelines (OPS 2011c). For CO_2 pipelines, weld failures and equipment leaks, such as relief valves, were the cause of most incidents (OPS 2012b).

> "Within these data, the safety record for CO_2 pipelines is particularly good. Of the 3,695 serious accidents reported on hazardous liquid pipelines since 1994, only 36 involved CO_2 pipelines. Among the 36 incidents, only one injury, and no fatalities, was reported. In all other instances, the accidents were classified as serious based on the extent of property damage (including damage to the pipeline facility) or product loss."
>
> *- Krista L. Edwards, Deputy Administrator Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation before the Committee on Energy and Natural Resources U.S. Senate (PHMSA 2008)*

In 2011, there were 312,290 miles of pipeline in the U.S. transporting natural gas in onshore transmission and gathering lines and over 2.1 million miles of distribution lines for natural gas. Crude oil, other petroleum products, and other hazardous liquids were transported in 179,042 miles of pipeline. There were 4,560 miles of CO_2 pipeline in the United States in 2011 (OPS 2012a), with most used for EOR projects. The characteristics and pipeline transportation risks for CO_2 and natural gas or petroleum products are different. For example, CO_2 is expected to be transported by pipeline as a supercritical fluid with a density of approximately 70% to 90% of that of liquid water. If a leak develops along a pipeline, a portion of the escaping fluid would quickly expand to a gas, while the remainder would form a solid (i.e., dry-ice snow). Carbon dioxide gas is about 50% heavier than air and would disperse horizontally following the ground contours. In contrast, natural gas in a pipeline is lighter than supercritical CO_2 and is more likely to disperse upwards. Natural gas is also highly flammable, which poses different risks compared to CO_2, which is not flammable.

Additional information on pipeline safety and estimated frequency and probability of pipeline releases is included in Section 3.15.3.3.2.

Table 3.15-8. Pipeline Safety Record in United States (1992 through 2011)

Pipelines	Natural Gas	Hazardous Liquids*	CO_2
Length (miles)	312,290	179,042	4,560
All Incidents	1,702	5,379	57
Fatalities	43	41	0
Injuries	221	170	1
Property Damage	$1,505,472,966	$2,707,528,504	$1,910,197
Incidents/100 miles/year	0.027	0.15	0.062

Note: Based on Office of Pipeline Safety Data through 2011 Mileage data posted May 31, 2012 (OPS, 2012a; Incident Data (OPS, 2012b). Natural gas data included onshore transmission and gathering lines.
* CO_2 pipeline data have been separated from onshore Hazardous Liquid pipeline data. Mileage for types of HL pipelines listed separately only through 2010 used as 2011 mileage for incident calculation. HL pipeline mileage in 2010 for HVL was 64,870 and for non-HVL Petroleum – related pipelines was 120,102. CO_2 = carbon dioxide; HVL = hazardous volatile liquid;

3.15.3 Direct and Indirect Impacts of the Proposed Project

3.15.3.1 Construction Impacts

This section describes potential impacts to human health from physical and chemical hazards to workers and the general public that would be present during construction of the CO_2 capture facility, pipeline, and

EOR. In general, the impacts during normal operations of the project would be limited to workers directly involved in the various aspects of construction. Under accident conditions, the health and safety of both workers and members of the general public around the site could be affected.

Construction of the CO_2 capture facility would be accomplished using typical methods for an industrial construction site within an existing plant boundary. Construction would involve several types of heavy equipment and experienced personnel necessary to erect the structures for the CO_2 capture facility. Correspondingly, the occupational exposure risks would be typical for a construction project. Construction equipment would likely include cranes, powered industrial lifts, compressors, welding equipment, scaffolds, trucks, and trailers. Construction materials would consist of structural steel, concrete, piping, and earthen materials. Components would include ductwork, wiring, cables, insulation, fans, motors, and the components necessary to construct the facility. Construction would require laydown areas that would be within the property line of the plant site. Because of the conventional nature of the activities, no significant airborne hazards are expected to be present for the construction workers.

Construction of the CO_2 pipeline is expected to be similar to typical gas pipeline construction and would use comparable materials, equipment, and similar procedures to minimize potential worker exposures. Excavations would be constructed with proper shoring or benching to minimize the risk of cave-ins and excavated soil would be stockpiled to minimize slumping into the excavation. If applicable, two means of egress would be provided for each excavation.

Construction activities at the West Ranch oil field would include the installation of wells, if necessary, and connecting the wells to the EOR facilities. Installation of wells at the West Ranch oil field, if necessary, would involve the use of drilling rigs and associated support equipment and vehicles. Noise levels during drilling would likely exceed occupational standards for the site workers, therefore requiring hearing protection. According to 2008 data from the U.S. Bureau of Labor Statistics, the total nonfatal incident rate for utility system construction was 4.1 per 100 employees per year, with 1.5 lost work day incidents per 100 employees per year (including restricted duty cases). Construction is expected to take approximately 24 months to complete and the number of construction personnel would vary depending on the construction activity. An estimated nine to 12 OSHA recordable incidents would be anticipated during the construction of the CO_2 capture facility, pipeline, and EOR and CO_2 monitoring infrastructure based on national incidence rates. An OSHA recordable incident is defined as a work-related accident that results in lost time, work restriction, medical treatment or death. Based on fatality rates for construction and the number of construction personnel, the fatality rate would be well below one (i.e., less than 0.07) and no fatalities would be expected.

NRG would implement its existing Site Construction Safety Program for the project, which emphasizes risk identification and mitigation during pre-planning site activities to prevent accidents. Under this program, NRG would also develop and implement a hazardous communication program, monitoring procedures, a risk management program, site safety operating procedures, and process hazard analysis to maintain the safety of workers and the public during the construction phase.

3.15.3.2 Operational Impacts

This section describes potential impacts to human health from physical and chemical hazards to workers and the general public that would be present during facility operation. In general, the impacts during normal operations of the project would be limited to workers directly involved in facility operation and maintenance. Under accident conditions, the health and safety of both workers and members of the general public around the site could be affected.

Carbon Dioxide

The project would capture and store approximately 1.6 million tons of CO_2 per year. The CO_2 would be pressurized up to 2,115 psi, causing it to act as a supercritical fluid (i.e., exhibiting properties of both a liquid and a gas), and piped to the oil field ready for underground injection. If the CO_2 were released to the atmosphere, it would rapidly expand from a dense fluid to a gas, but could include both liquid and solid (i.e., dry ice) phases. This means that leaks or releases of the supercritical liquid would have the potential to result in high concentrations of CO_2 that can exceed CO_2 exposure limits and possibly reduce oxygen levels enough to cause asphyxiation in enclosed areas or in the immediate vicinity of the leak if there was no air movement at the time of the accident.

Health effects from CO_2 would depend on the concentration and length of exposure, as well as other environmental factors. Impacts of CO_2 releases on workers and the public would depend on the locations of the releases; the meteorological conditions, including atmospheric stability and wind speed and direction at the time of the release; and other factors such as topography and whether the release was to a confined space. Potential release locations during the operational period would include the CO_2 capture facility, along the pipeline corridor, or in the EOR area of the West Ranch oil field. The potential releases and related impacts are described in Section 3.15.3.3.

Amine-Based Solvent

The CO_2 capture system would use advanced amine-based solvent technology to extract CO_2 from the flue gas, with MEA as the primary basis for the solvent. The amine-based solvent would be stored in a new 15,000 gallon storage tank that would be installed adjacent to the CO_2 capture system at the W.A. Parish Plant. MEA is not classified as a carcinogen and is primarily an irritant to skin, eyes, and lungs. The compound degrades to nitrogen compounds (e.g., amides) mostly in three days or less in the atmosphere via photolysis and reaction with hydroxyl radicals (Shao and Stangeland, 2009). The most likely scenarios for accidental releases during the operational period would include leaks from storage tanks or process pipes, or spills during transport and handling.

Normal Operations

As with the operation of any industrial facility, the potential for workplace hazards and accidents exists. To promote the safe and healthful operation of the project, NRG would employ qualified personnel and implement written safety procedures. 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 would be 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. All employees working on or around the CO_2 capture system would be covered by a facility health and safety plan requiring training on the operating procedures and other requirements for safe operation of the project facilities. In addition, employees would receive annual refresher training, which would include the testing of their understanding of the procedures.

Approximately 15 employees would be required to operate the CO_2 capture facility with a projected three to four employees on site at any given time. All workers would be appropriately trained to minimize adverse exposure consequences from a potential release. Workers would be exposed to hazards typical of an industrial setting and for the utility sector, which would include physical hazards (e.g., slips, trips, and falls) as well as potential exposure to chemical or other industrial hazards. For the utility sector, the total incident rate per 100 employees in similar work situations is 2.6 with a day away/restricted or transfer rate of 1.5 and a rate for lost work days of 0.9. When these rates are applied to the anticipated 15 on-site employees over a 35 month period, the projected number of recordable incidents per year is estimated to be 1.16, with 0.40 being lost work days or 0.67 days away for restricted duty or job transfer.

Potential health effects to the general public would not be expected during normal operations as it is not expected that the public would be exposed to chemical or industrial hazards, or contaminants that would exceed public health standards. As described in Section 3.2.3.2, emissions from the proposed facilities are not expected to exceed air quality standards. Potential effects that could occur from the accidental release of chemicals or gases are described in the following section.

3.15.3.3 Potential Accident Impacts

DOE reviewed the project for potential hazards and developed a range of accidents that could result in the release of hazardous chemicals and gases. The accidents considered include those that could occur during the handling, transfer, storage, and use of MEA. In addition, DOE considered accidents that could occur from the compression, transport, injection, and storage of CO_2. The full range of potential CO_2 release scenarios are discussed in detail in Appendix F and are summarized in the pipeline and injection well discussion included in this section.

DOE assessed each potential accident scenario to determine the potential frequency at which such an accident could occur. As described in Section 3.15.1.2, accidents were categorized as *possible*, *unlikely*, *extremely unlikely*, or *incredible* (see text box at right). When categorizing potential accidents, DOE considered engineering design and controls, as well as available industry safety statistics. DOE used this information to determine the potential frequency for each type of accident and release, as well as the potential for natural disasters or extreme events. For each accident considered, DOE evaluated the potential health effects to both workers and the public using three health effect categories: *transient and reversible adverse effects*, *irreversible adverse effects*, and *life-threatening effects* (see text box at right).

Accident Categories and Frequency Ranges

Possible: *Accidents estimated to occur one or more times in 100 years of facility operations (frequency ≥$1x10^{-2}$/year).*

Unlikely: *Accidents estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from $1x10^{-2}$/year to $1 x 10^{-4}$/year).*

Extremely Unlikely: *Accidents estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency from $1x10^{-4}$/year to $1x10^{-6}$/year).*

Incredible: *Accidents estimated to occur less than one time in 1 million years of facility operations (frequency <$1x10^{-6}$/year).*

Health Effect Categories

Transient and reversible adverse effects: *Headache, dizziness, sweating, vague feelings of discomfort.*

Irreversible adverse effects: *Breathing difficulties, increased heart rate, convulsions, and coma.*

Life-threatening effects

3.15.3.3.1 Accidents and Consequences Related to the CO_2 Capture Facility

An advanced amine-based absorption technology would be used to capture CO_2 from the flue gas. Using MEA, a common amine solvent component, DOE evaluated an accident scenario for potential releases from the solvent storage tank located in the CO_2 capture area on the W.A. Parish Plant property. The material potentially released was represented using physical and chemical properties of MEA, although a mixture of solvents with similar properties may be used in the proprietary system. The detailed analysis is included in Appendix F to this EIS (Health Risk Assessment). This accident is considered to be the worst case scenario and bounding accident based on a review of the W.A. Parish Plant RMP and the Health Risk Assessment for CO_2-Related Facilities in Appendix F. The results for this case are summarized below.

An accident involving the potential failure of the refill line valve to the 15,000-gallon solvent tank was evaluated for a scenario where a valve leak occurred. This event is considered to be unlikely, but could affect workers if a leak were to occur. The properties of MEA were used to estimate the evaporation rate of exposed MEA using the general methodology from the EPA's Risk Management Program for Offsite Consequence Analysis (EPA 2009) and the specific equation for liquid evaporation (D-1) in Appendix D.2 (EPA 1999). The liquid evaporation rate and computed duration if no response action was taken were then input to the SLAB air dispersion model to estimate the MEA concentrations in air under a range of wind conditions.

Under calm conditions, the SLAB results show that an MEA concentration in air of 6 ppm, the PAC-1 and PAC-2 level at which people may begin to experience mild irritation (see Table 3.15-5) could extend to about 0.9 miles within the area of the plume estimated by the model to be about 47 acres. The MEA plume would still be retained on the plant property, although it could extend into the southern part of Smithers Lake. Calm conditions occur about 8.2% of the time based on weather data from Houston's George Bush Intercontinental Airport (LES 2012). Thus, no nearby residents or general public in the vicinity of the plant would be affected if an MEA tank release occurred. Under other meteorological conditions (i.e., windier conditions), the plume dissipates more quickly, and an MEA concentration in air of 6 ppm over 60 minutes could extend to a distance of 0.08 miles or less and encompasses a smaller area of 0.6 to 3 acres. A tank release under calm conditions could possibly be detected based on the odor threshold of 2.6 ppm at a distance of about 1.6 miles from the tank. Under other meteorological conditions (i.e., windier conditions), MEA in the air from a release could possibly be detected within a distance of about 0.16 miles from the tank. The nearest residents to the plant are located approximately 0.5 miles east of the site and 1.5 miles southwest. The wind blows toward these directions less than 8% of the time and about 3% of the time, respectively. The odor threshold is below the concentration when even mild and transient effects could occur.

Plant workers near the tank at the time of a release under calm conditions would need to take appropriate response actions, since the IDLH criteria of 30 ppm (see Table 3.15-5) could occur at a distance of 0.3 miles of the release within a potential exposure zone area extending to about nine acres contained within the plant site. Under such circumstances, plant workers within 0.3 miles of the release could experience exposures that could cause an immediate threat to life or irreversible adverse health effects if appropriate corrective action were not taken

It should be noted that leaks containing MEA and other flue gas components from piping between the absorber, stripper, and compressor could occur, but the expected volumes would be far less than from a storage tank release. In such an event, smaller volumes of MEA would be released which means the exposure zones would be smaller and concentration levels would be lower.

3.15.3.3.2 Accidents and Consequences Related to the CO_2 Pipeline

Captured and pressurized CO_2 would be transported via pipeline to the EOR area at the West Ranch oil field. The pipeline would be designed to handle CO_2, and tested and operated in accordance with applicable federal and state regulations. NRG would comply with DOT standard pipeline protection and safety measures (49 CFR 195) to minimize pipeline CO_2 failures, including:

- internal pipeline inspection methods using smart pigs to detect corrosion, pitting, or other pipe imperfections;

- visual inspection and aerial surveys along pipeline ROWs to identify signs of damage or encroachment by vegetation or structures;
- a public awareness program to inform people how to identify the locations of pipelines and who to notify before conducting excavation work or digging, especially near the pipeline ROW; and
- training of pipeline operator staff on emergency and maintenance procedures.

Supercritical CO_2 Composition

After treatment by the carbon capture system, the supercritical fluid that would be transported in the proposed pipeline is expected to be 99.96% CO_2 with other constituents (i.e., oxygen, water, nitrogen, and argon) present in the concentrations shown in Table 3.15-9. Other trace gases such as SO_2 and NH_3 are not expected to be present in the compressed gas because upstream treatment processes would remove them.

Table 3.15-9. Estimated Captured Gas Composition for Parish Plant

Compound	Quantity[1]
Carbon dioxide	> 99.96 vol%
Oxygen	<10 ppmv
Water	100 ppmv
Nitrogen + Argon	231 ppmv

[1] Values for compounds were provided by NRG.
vol% = percentage by volume; ppmv = parts per million by volume

Simulation of Pipeline Accident Releases

Two accidental release scenarios, pipeline rupture and pipeline puncture, represent the most likely causes of pipeline releases at larger volumes. A pipeline rupture release would occur if the pipeline was completely severed, for example, by heavy equipment during excavation activities. A rupture could also result from a longitudinal running fracture of a pipe section or a seam-weld failure. In these cases, the entire contents of the pipeline between the two nearest control valves could be discharged from the severed pipeline within minutes, given the assumption that if a pressure drop occurred the nearest control valves on either side of the leak would shut down that section. Therefore, the maximum discharge would be the gas content between the two valves. A pipeline puncture release is defined here as a three-inch by one-inch hole that could be made by a tooth of an excavator. In such a case, all of the contents in the pipeline between the two nearest control valve stations would discharge into the atmosphere, but the release would occur over a period of several hours, as the opening would be small relative to the total volume and the pressure would decline as the fluid escapes. No credit is taken for the possible attenuating properties of the pipeline being buried at a depth of approximately three to four feet under compacted soil.

Captured CO_2 would be transported in the pipeline as a supercritical fluid, such that its density resembles a liquid but it expands to fill space like a gas. When mixed with water, CO_2 can form carbonic acid, which is highly corrosive. For this reason, the moisture content of the CO_2 would be maintained at a low level, approximately 100 parts per million by volume. If CO_2 is released from a pipe, it expands rapidly as a gas and can include both liquid and solid (i.e., dry ice) phases, depending on temperature and pressure. Supercritical CO_2 has a very low viscosity and is denser than air. A potential release of CO_2 through an open orifice in the pipeline as a gas moving at the speed of sound is referred to as choked or critical flow (Bird, et al. 2002). In the rupture scenario, the escaping fluid from the pipeline is assumed to escape as a horizontal jet at ground level, which is typically the worst-case event for heavier-than-air gases (Hanna and Drivas 1987), although the escaping fluid could move in another direction depending on the crater angle.

Potential releases to the atmosphere represent the primary exposure pathway considered in the exposure analysis. People likely to be exposed by releases from the CO_2 pipelines are on-site workers and nearby off-site populations. In addition to the potential health effects of a release, which would be dependent on the exposure concentrations and local meteorological conditions at the time of a release, workers near a ruptured or punctured pipeline or wellhead are likely to also be affected by the physical forces from the accident itself, including the release of gases at high flow rates and at very high speeds. Workers involved at the location of an accidental release would be potentially affected, possibly due to a combination of effects, such as physical trauma, asphyxiation (i.e., displacement of oxygen in a small confined place), or frostbite from the rapid expansion of CO_2 (e.g., 2,115 psi to 15 psi).

DOE used the SLAB air dispersion model to simulate hypothetical CO_2 releases caused by rupture and puncture of the pipeline. There are a total number of 12 MLVs planned along the approximately **81**-mile pipeline from the CO_2 compressor at the W.A. Parish Plant to the West Ranch oil field. The pipeline route with the MLVs is shown in Figure 3.15-1. Four pipeline sections for each release scenario were selected for simulation to represent the longest distances between the MLVs.

DOE used base case conditions for both large and small pipeline releases with a pressure of 2,115 psia at approximately 38.9°C (102°F), which means the CO_2 would be transported in a supercritical state. Under these conditions, if a pipeline release were to occur, part of the supercritical fluid would be converted to a dry-ice snow form and then would slowly sublimate (i.e., transform directly from a solid to a gas). The percent of CO_2 that would be released as a vapor is estimated to be 75% for the above temperature and pressure. The transport of the vapor phase in the atmosphere was simulated using the SLAB model and the results compared to appropriate health criteria. Seven meteorological stability classes, as defined in Tables F-7 and F-8 in Appendix F to this EIS (Health Risk Assessment), and all 16 different wind directions were used for the two simulations, based on local surface wind data from the George Bush Intercontinental Airport National Weather Service Station or the Victoria/WSO Airport (LES 2012).

Simulations were conducted to determine the impact zone where workers and the public could be exposed to concentrations from pipe ruptures equal to the pertinent short duration health criteria (i.e., PAC-0 through PAC-3) for CO_2 and the other criteria that pertain to workers (see Table 3.15-4). The exposure period if a pipe rupture occurred would be less than 15 minutes. However, the criteria sometimes were developed for longer durations (e.g., 30 to 60 minutes). The pipe puncture releases would be expected to occur for longer durations, with the longest exposure period estimated to be about four hours. There are no longer duration health criteria for CO_2, such as the EPA Acute Exposure Guideline Levels for eight hours (AEGL-1 to AEGL-3), since CO_2 is an acute hazard, rather than a chronic hazard. The same criteria were used for assessing the potential effects related to punctures.

<u>Pipeline Accident Simulation Results</u>

The estimated distances that a given exposure concentration plume could extend out from a hypothetical pipeline release due to a rupture or puncture for the four pipeline sections under base case conditions (i.e., pressure at 2,115 psia and temperature at 102^{o}F) were determined for the different PAC exposure criteria (see Table 3.15-4). In most of the simulated cases, the exposure zone extended farthest under calm conditions (F1 stability class). When the longest distance did not occur under calm conditions, the longest distance was determined based on other wind conditions. The worst-case "no effects level" potential exposure distances estimated for the two pipeline scenarios are summarized below. Additional details, including PAC-1, PAC-2, and PAC-3 potential exposure distances, are provided in Appendix F to this EIS (Health Risk Assessment).

Under the worst-case meteorological conditions (i.e., calm wind conditions), the farthest distance estimated along the pipeline route that a CO_2 concentration of 5,000 ppm (no effects level) could extend from a pipeline rupture accident scenario was estimated to be 3,324 meters (approximately 2.1 miles) within a 15-minute exposure averaging period. This distance is reduced to 631 meters (approximately 0.39 miles) over a 60-minute averaging period. The worst-case exposure under calm wind conditions from a puncture scenario was much shorter. There would be no effects to the general public (concentrations less than 5,000 ppm) beyond 444 meters (1,457 feet) over an eight-hour exposure period.

Table 3.15-10 presents the estimated number of people potentially affected by exposure to CO_2 at various PAC concentrations resulting from a hypothetical pipeline rupture and puncture. The estimated number of people is a calculated number based on the population density within each hypothetical plume given the full range of meteorological conditions that could occur multiplied by the percent of time that each of those conditions could occur. For both rupture and puncture accident scenarios, a CO_2 release would statistically affect less than one member of the general public in most cases. Workers would more likely be impacted by the physical effects of an accident or by a higher concentration exposure to CO_2 than by the predicted lower impact release event.

Table 3.15-10. Estimated Number of People Affected by CO_2 from the Hypothetical Pipeline Releases for Scenario A

Release Type	Exposure Duration	CO_2 Criteria, ppm [Exposure Level]	Number of People Potentially Affected	Furthest Plume Distance, meters
Rupture	15 minutes	50,000 [PAC-3]	0	**168**
	15 minutes	30,000 [PAC-2]	0	352
	15 minutes	5,000 [PAC-0]	0–12[a]	3,324
Puncture	8 hours	40,000 [EPA, 2000]	0	29
	8 hours	20,000 [EPA, 2000]	0	74
	8 hours	5,000 [PEL-TWA]	0	444

[a] Varies by pipeline segment: Plant to MLV #1 up to 4 people, MLV #1 to MLV #2 up to 12 people, MLV #10 to MLV #11 up to one person.

Estimated Frequencies and Probabilities of Pipeline Releases

Office of Pipeline Safety incident data from 1992 through 2011 (OPS 2012b), as summarized in Table 3.15-8, were used to calculate the frequency and probability of pipeline ruptures and punctures. The annual rupture failure frequency was calculated as the number of large releases (ruptures) per kilometer divided by the number of years with data, which is 2.96×10^{-5} (kilometer-year) $^{-1}$. The annual puncture failure frequency was calculated as the number of small releases (punctures) per kilometer divided by the number of years with data, which is $7.06\text{x}10^{-5}$ (kilometer-year)$^{-1}$. The probability of at least one failure over the estimated 20-year lifetime of a pipeline is calculated as the rupture or puncture failure rate listed above, which is equal to the product of the failure frequency and the pipeline length, assuming the probability of failure to be exponentially distributed.

The annual frequency of a rupture is estimated at **3.9**x10^{-3} for the **approximately 81**-mile (**130.8** km) pipeline. The probability of at least one rupture over a 20-year operating period is estimated to be **7.5**x10^{-2}. The annual frequency of a puncture on the proposed **81**-mile pipeline is estimated as **9.2**x10^{-3}. The probability of a puncture over a 20-year operating period is estimated to be $1.7\text{x}10^{-1}$. Based on the estimated frequencies of pipeline punctures or ruptures, both releases on the **81**-mile pipeline are considered unlikely (frequency from $1\text{x}10^{-2}$ to $1\text{x}10^{-4}$ per year).

In summary, in the unlikely event that a pipeline rupture occurred, the general public could experience minor, transient effects if they were located within about 2.1 miles of a rupture along the longer sections of the pipeline. The estimated upper bound number of people affected is up to 12 people, as shown in Table 3.15-10. If a pipeline puncture occurred, the general public would not be likely to experience transient effects, since the plume would be transported a shorter distance away from a release, less than about 250 feet for the longer pipe sections. Workers present near the pipeline at the time of a release could experience serious adverse effects from the CO_2 as well as physical effects. However, both pipeline ruptures and punctures are considered to be unlikely events.

3.15.3.3.3 Potential Releases from Subsurface Formations

This section addresses potential releases from the subsurface both during and after injection operations for EOR. A summary of the detailed analysis provided in Appendix F is included below.

Operations (CO_2 Injection) Phase

Potential failure of equipment in an example injection well was evaluated using the SLAB model for a well in each of the CO_2 injection units (i.e. the 98-A, 41-A, Glasscock, and Greta sand units). The SLAB model was used to determine the maximum distance at which the air concentration of CO_2 over a specified period of time exceeded the lowest PAC (i.e., 5,000 ppm). The pipeline-walk routine was then used to evaluate the maximum expected number of people that could be affected from a well release located in the West Ranch oil field. The maximum number of people that potentially could be affected was less than one for each of the four depths of wells, as shown in Table 3.15-11. As shown in Figure 3.15-3, the population density is low in the vicinity of the well field. There is a high school located on the south side of Vanderbilt to the north of the well field. If an injection well were located on this side of the well field, the model results indicate that the plume would not reach the school, which is 0.5 miles from the well field. Within the EOR area, there are no residents, so an injection well near the end of the pipeline would not affect any residents.

Table 3.15-11. Maximum Distances where CO_2 Concentrations Greater than 5,000 ppm Could Occur

Injection Unit	Well Depth (feet bgs)	Maximum Distance from Well (miles*)	Maximum Number of People Affected
98-A	6,300	0.016	<1
41-A	5,800	0.014	<1
Glasscock	5,500	0.014	<1
Greta	5,250	0.013	<1

*For calm conditions, which occur about 2.3% of the time in the vicinity of Victoria Airport.

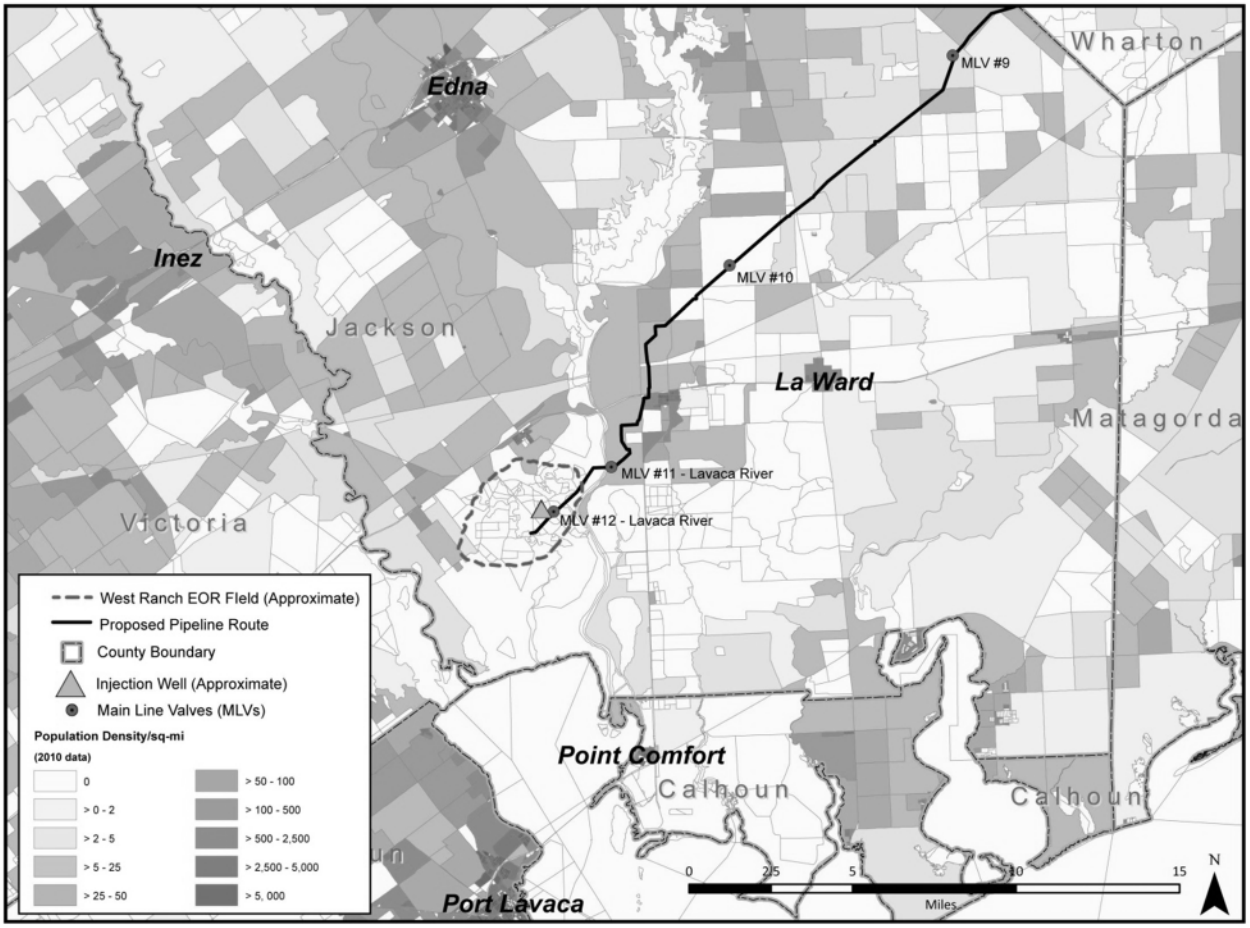

Figure 3.15-3. Population Density near West Ranch Oil Field

The probability of a failure of one well per year is estimated as $2.6x10^{-3}$ and the probability of at least one well over the 20 years of the project is estimated as $5.1x10^{-2}$. The likelihood of an injection well failure is considered extremely unlikely (defined as 10^{-4} to 10^{-6} per year) based on the above frequency and the previous experience with injection wells for water flood and brine disposal in this oil field.

Post-Operations (CO_2 Injection) Phase

Potential air releases of CO_2 that could result from post-operations leakage of CO_2 (i.e., leakage after CO_2 injection has ceased) were also evaluated for multiple release scenarios. Table 3.15-12 summarizes the types of potential post-injection releases considered in this analysis. The flux rates, or the amount of CO_2 that would flow through a unit area per unit time for these releases, were estimated based on the characteristics of the geologic formations, the planned EOR operations, and the different types of existing wells in the West Ranch oil field.

Table 3.15-12. Potential Types of Releases from EOR Area

Release Scenario	Exposure Duration	Potential Volume	Initial Release to
Upward leakage through the caprock due to catastrophic failure and quick release	Short-term	Variable, could be large	Air
Upward leakage through the caprock due to gradual failure and slow release	Long-term	Small	Air, Groundwater
Upward leakage through CO_2 injection well(s)	Short-term and long-term	Variable, could be large	Air, Groundwater
Upward leakage through deep oil and gas or saltwater reinjection or disposal wells	Short-term and long-term	Variable, could be large	Air, Groundwater
Upward leakage through undocumented, abandoned, or poorly constructed deep wells	Short-term and long-term	Variable, could be large	Air, Groundwater
Release through existing faults due to the effects of increased pressure	Long-term	Variable, could be large	Air, Groundwater
Release through induced faults due to the effects of increased pressure	Long-term	Variable, could be large	Air, Groundwater

The evaluation of the potential health effects due to air releases from the subsurface storage formations after EOR has ceased was conducted using the SCREEN3 and SLAB air dispersion models, and an analog database prepared for a previous DOE project that included results from studies performed at other CO_2 storage locations (DOE 2007b). The CO_2 concentrations from the **well** release scenarios estimated at distances of 100 feet and 300 feet from the release points were all less than 1 ppm. The risk ratios were all much less than one, so potential health effects from releases from the wells or subsurface to the general public after the EOR operations have been completed and the well and pipeline equipment removed are extremely unlikely. The release via this mechanism has a range, but even if it did occur there would be no consequence to human health because there would be no health effects at exposure of 1 ppm.

For each type of hypothetical well release scenario considered (see Table 3.15-12), the estimated frequency and probability of a release was also estimated. The estimated frequency of a release from a hypothetical deep abandoned well, deep oil and gas wells, and from CO_2 injection wells ranged from $2x10^{-5}$ per well per year to $1x10^{-3}$ per well per year, which is considered to be unlikely (i.e., $1x10^{-2}$ to $1x10^{-4}$) or extremely unlikely (i.e., $1x10^{-4}$ to $1x10^{-6}$). The probability of a release (i.e., the estimated frequency of a releaseover a period of 20 years) ranged from $4x10^{-4}$ per well per year to $2x10^{-2}$ per well per year. The probability of a release in one of the proposed 130 CO_2 injection wells over a 20-year period is estimated as $5x10^{-2}$.

In summary, the wellfield where the EOR is planned is located in an area with active oil operations and is largely unpopulated. If a release occurred from an active injection well, the general public is unlikely to experience even transient effects, unless they are close to the well at the time of a release. Workers within 50 feet of a well during the release could experience serious adverse effects. In the extremely unlikely occurrence of an injection well blowout (i.e., a sudden loss of CO_2 from failure of an injection well during operation), the main adverse outcome would be the potential for ejection of CO_2, possibly as dry ice particles, and formation fluids from the wellhead (Skinner 2003). Effects would be expected to be localized to the area around the affected wellhead and events of this type would be avoided or minimized by incorporating high pressure piping, overpressure protection (i.e., relief) valves, and blowout preventers into the design of the injection wells. However, such an event is considered extremely unlikely to occur, as shown in Table 3.15-13.

Post-injection releases from hypothetical deep abandoned wells, deep oil and gas wells, or the closed CO_2 injection wells would not be expected to result in ambient air concentrations at high enough concentrations to cause health effects to the general public, as shown in Table 3.15-13. Thus, these impacts are considered negligible.

3.15.3.3.4 Intentional Destructive Acts

As with any U.S. energy infrastructure, the proposed project could potentially be the target of terrorist attacks or sabotage. DOE examined the potential environmental impacts from acts of terrorism or sabotage against the project facilities.

Although the likelihood 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 of toxic substances from project facilities, which would likely be similar to what would occur under an accident or natural disaster. To evaluate the potential impacts of sabotage or terrorism, DOE considered failure scenarios without specifically identifying the cause of failure. For example, potentially harmful chemicals could be released as a result of component failure or human error (or a combination of both), or from such external events as aircraft crashes, seismic events, or other natural events as high winds, tornadoes, floods, ice storms, other severe weather, and fires (both natural and human-caused).

Potential release scenarios of toxic chemicals and related consequences presented for the CO_2 capture facility, pipeline corridor, and EOR facilities at the West Ranch oil field are considered to be representative of those that could be caused by intentional destructive acts. However, the frequency or likelihood of such events due to this cause cannot be quantified.

3.15.3.3.5 Summary of Potential Accident Impacts

Table 3.15-13 summarizes the types of accidental releases of chemicals that could occur, the probabilities, and the effects.

Table 3.15-13. Potential Lower and Upper Bound Effects from CO_2 Releases from Pipelines, Injection Wells, and Subsurface Formations

Events	Lower Bound	Upper Bound
Incredible: Events estimated to occur less than one time in 1 million years of facility operations (frequency < 1×10^{-6}/year).		
CO_2 release due to leakage from catastrophic failure of caprock or through lateral migration.	CO_2 concentrations in ambient air for this hypothetical would be less than established health criteria, and no effects to the public would be expected.	CO_2 concentrations in ambient air for this hypothetical would be less than established health criteria, and no effects to the public would be expected.
Extremely Unlikely: Events estimated to occur between once in 10,000 years and once in 1 million years of facility operations (frequency from 1×10^{-4}/year to 1×10^{-6}/year).		
CO_2 release from failure of an injection well during operation.	Release of gas containing high concentrations of CO_2 could expose individuals to potential health effects within 50 feet of wellhead. These effects are expected to be primarily limited to workers. Effects on non-involved workers would be transient effects from CO_2 if present within approximately 50 to 150 feet of wellhead at time of release. Potential effects to offsite receptors at the West Ranch oil field from CO_2 would be: **Type of Effect** — **No. Individuals** Transient and reversible 0 Irreversible adverse 0 Life-threatening 0	Release of gas containing high concentrations of CO_2 could expose populations to potential health effects within 50 feet of wellhead. These effects are expected to be primarily limited to workers. Effects on non-involved workers would be same as lower bound. Potential effects to offsite receptors from CO_2 would be: **Type of Effect** — **No. Individuals** Transient and reversible <1 Irreversible adverse <1 Life-threatening <1
Unlikely: Events estimated to occur between once in 100 years and once in 10,000 years of facility operations (frequency from 1×10^{-2}/year to 1×10^{-4}/year).		
CO_2 release from pipeline rupture during operation.	Rupture of pipeline could result in exposure of human populations to gas containing high concentrations of CO_2. **Type of Effect** — **No. Individuals** Transient and reversible 0 Irreversible adverse 0 Life-threatening 0	Rupture of pipeline could result in exposure of human populations to gas containing high concentrations of CO_2. **Type of Effect** — **No. Individuals** Transient and reversible 12 Irreversible adverse <1 Life-threatening <1

Table 3.15-13. Potential Lower and Upper Bound Effects from CO_2 Releases from Pipelines, Injection Wells, and Subsurface Formations

Events	Lower Bound	Upper Bound
CO_2 release pipeline puncture during operation.	The puncture of a pipeline would release gas containing high concentrations of CO_2 and could expose populations to potential health effects: **Type of Effect** — **No. Individuals** Transient and reversible — 0 Irreversible adverse — 0 Life-threatening — 0	The puncture of a pipeline would release gas containing high concentrations of CO_2 and could expose populations to potential health effects: **Type of Effect** — **No. Individuals** Transient and reversible — <1 Irreversible adverse — <1 Life-threatening — <1
Post injection CO_2 release due to leakage from abandoned or undocumented deep wells, existing faults, or unknown structural or stratigraphic connections.	Release of CO_2 through these mechanisms would not be expected to result in concentrations in ambient air in excess of established health criteria; no effects to the public would be expected. **Type of Effect** — **No. Individuals** Transient and reversible — 0 Irreversible adverse — 0 Life-threatening — 0	Release of CO_2 through these mechanisms would not be expected to result in concentrations in ambient air in excess of established health criteria; no effects to the public would be expected. **Type of Effect** — **No. Individuals** Transient and reversible — <1 Irreversible adverse — <1 Life-threatening — <1

3.15.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no increased risks to human health and safety.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. The operations of the cogeneration plant would be performed by existing W.A. Parish plant personnel. Specific operators from the W.A. Parish Unit 8 would be trained in the turbine operations as well as Unit 8 maintenance personnel. Additional personnel should not be required. Risks to human health and safety would be similar to current operation of the W.A. Parish plant. No increased risks to human health and safety are anticipated.

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3.16 UTILITIES

3.16.1 Introduction

This section identifies and describes public utility systems potentially affected by the construction and operation of the proposed Parish PCCS Project. This section also analyzes the potential effects of this project to these resources and the ability of existing utility infrastructure to meet the needs of the proposed project while continuing to meet the needs of other users.

3.16.1.1 Region of Influence

The ROI for utility systems includes the existing public utility infrastructure and facilities that would provide utility services to components of the proposed project or potentially be impacted by construction and operation of the proposed project. Utility services to the proposed project are limited to water, wastewater, natural gas, and electricity.

3.16.1.2 Method of Analysis

A comparative assessment was performed of the proposed utility needs of the project versus the existing infrastructure to determine whether the project would result in a demand on any of the existing utility systems that could not be met by existing capacity. Existing utility demand and available unused capacity from the entire service area were obtained from the local utility providers. NRG predicted the estimated utility consumption for the proposed project, which was compared to the existing utility demand. The analysis considered whether the predicted demand of the project would be greater than the available unused capacity.

3.16.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to utility systems based on whether the Parish PCCS Project would directly or indirectly:

- increase the demand on capacity of public water or wastewater utilities;
- require extension of water mains involving off-site construction for connection with a public water source;
- require extension of sewer mains involving off-site construction for connection with a public wastewater system;
- impact electricity service in the ROI;
- impact natural gas service in the ROI;
- impact coal supplies in the ROI;
- impact the effectiveness of existing utility infrastructure; or
- affect the capacity and distribution of local and regional utility suppliers to meet the existing or anticipated demand.

3.16.2 Affected Environment

3.16.2.1 CO_2 Capture Facility

Utility infrastructure located at the W.A. Parish Plant includes waterlines; wastewater treatment plant systems; plant sewer lines; storm water drainage systems; and public and private electrical, natural gas, and telecommunications lines. The natural gas supply needs of the plant are commercially supplied by a gas pipeline owned by Kinder Morgan. Storm water from the site runs into the 2,430-acre Smithers Lake or Dry Creek under a multi-sector general industrial storm water permit. The Brazos River, Smithers Lake and on-site wells provide the water supply for the W.A. Parish Plant, as discussed in Sections 3.6 and 3.7 of this EIS (Groundwater and Surface Water).

Potable Water

The W.A. Parish Plant uses seven existing groundwater wells located on the plant property to supply potable water as well as plant cooling water and wash down at the landfill. W.A. Parish has two public water systems registered with the TCEQ. Both are non-community, non-transient systems. One water system services the coal side and the other services the gas side of the power plant.

The W.A. Parish Plant use of potable water for consumption and sanitary waste needs is estimated to be approximately 12,000 gpd for the existing daily workforce of 385. Each employee uses an average of 30 gpd of potable water.

Plant Process Water Supply

The majority of the plant process water supply for the W.A. Parish Plant (i.e., approximately 34 to 50 mgd) is withdrawn from Smithers Lake, which is fed by tributaries of the Brazos River. Additionally, there are six groundwater wells located on plant property that supply 1.6 to 2.3 mgd of groundwater to the plant. These resources are located within the Brazos River Basin and are owned and operated by NRG (see Section 3.7 of this EIS, Surface Water for a description of the wells). Smithers Lake provides the cooling-water supply for the plant's generating units that use a once-through condenser cooling system. With once-through cooling, water is pumped into the plant where it is primarily used in a heat exchanger to condense exhaust steam from the steam turbines. The heated water is then returned to the lake, which serves as a cooling reservoir. The lake also receives storm water and wastewater discharges from the facility.

Smithers Lake has a capacity of 18,000 acre-feet of water and a surface area of 2,430 acres. The drainage area above the dam is 24.2 square miles. To maintain the required water level for plant operations, the lake is supplemented by water from the Brazos River, as discussed in Section 3.7 of this EIS (Surface Water).

Wastewater

The W.A Parish Plant generates wastewater from both sanitary facilities and industrial processes. The W.A. Parish Plant treats wastewater on site at two sanitary treatment facilities under its wastewater permit (i.e., outfalls 903 and 113). The guardhouse uses a separate septic system. The W.A. Parish Plant currently treats and discharges approximately 4,000 gpd of sanitary wastewater for the existing total workforce of 385 personnel and is permitted to treat and discharge up to 8,000 gpd (NRG 2012). The existing daily workforce of 275 personnel[1] generates an average of approximately 15 gpd of sanitary wastewater per person.

As discussed in Section 3.7 of this EIS (Surface Water), wastewater discharges are permitted by the TCEQ under TPDES Permit No. 01038, USEPA ID No. TX0006394. The permit covers 16 wastewater outfalls, six external outfalls which discharge to waters of the state and 10 internal outfalls that comingle

[1] The daily workforce is calculated as follows: (Total workforce of 385 personnel) x (five workdays per week/seven days per week) = 275 workers, on average, at the W.A. Parish Plant during each workday.

and then discharge with the external outfalls. Wastewater permit limits are determined by the TCEQ using USEPA's steam electric effluent guidelines and the Texas Water Quality Standards (TWQS). The limits are designed to be protective of state waters. The W.A. Parish Plant treats and discharges approximately 1,500 mgd of industrial wastewater and is permitted to treat and discharge 2,121 mgd of industrial wastewater (NRG 2012).

Storm water discharge is authorized by TPDES General Permit No. TXR050000 relating to storm water discharges associated with industrial activity. The permit number specific to the W.A. Parish Plant is TXR05V666. The W.A. Parish Plant identifies 21 outfalls that discharge storm water associated with industrial activities in the Storm Water Pollution Prevention Plan (SWPPP). Water quality is maintained by a combination of BMPs, routine inspections, and sampling.

Electricity

Most power needs at the W.A. Parish Plant are met with on-site electric generation resources, and supplemented by startup and standby generators, or electricity obtained from the grid as needed. The combined units at the W.A. Parish Plant are rated at 3,865 MW.

Natural Gas

The W.A. Parish Plant operates and maintains four natural gas-fired generating units and four coal-fired generating units. Natural gas is supplied to the plant site through a pipeline owned by Kinder Morgan, a private natural gas company. The combined units at the W.A. Parish Plant use a maximum of approximately 27,500 million cubic feet per hour (MMcf/hr).

3.16.2.2 Pipeline Corridor

Although the proposed pipeline corridor would be collocated with and/or would cross a number of existing HVTL and pipeline ROWs, NRG does not anticipate that construction of the CO_2 pipeline would disrupt any of these existing utilities. During pipeline construction, NRG would maintain appropriate setbacks from collocated utilities and would install the proposed pipeline deeper at utility crossings to provide appropriate separation distances. As discussed in Chapter 2 of this EIS (Proposed Action and Alternatives), segments of the proposed CO_2 pipeline would be collocated with HVTL corridors operated by CenterPoint and the South Texas Electric Cooperative (STEC). A portion of the ROW that would be shared with CenterPoint would also be collocated with the Energy Transfer Partners Spirit/Justice NGL pipeline. In the vicinity of the Lavaca River crossing, the proposed CO_2 pipeline would be collocated with the Kinder Morgan Tejas natural gas pipeline.

3.16.2.3 West Ranch Oil Field

At the West Ranch oil field, where the proposed EOR and CO_2 monitoring operations would occur, there is utility infrastructure in place to support oil field operations and well maintenance activities. This infrastructure includes potable water supplies, process or service water, and electricity. The West Ranch oil field currently uses approximately 0.5 mgd of potable water and 0.5 mgd of industrial water, all of which is obtained from existing groundwater supply wells located within the West Ranch oil field. Approximately 0.5 mgd of sanitary wastewater is treated by an on-site septic system and drainfield. Additionally, approximately 0.5 mgd of industrial wastewater generated by current oil field operations and well maintenance activities is captured and transported by truck within the West Ranch oil field for disposal in an existing Class II injection well operated by HEC. Produced water that is produced with oil and gas is primarily reinjected or disposed of by underground injection. As discussed in Section 3.4 of this EIS (Geology), this process is regulated by the RRC by means of UIC permits.

Crude oil produced at the West Ranch oil field is currently transported off site by truck. Existing pipelines are in place to receive crude oil shipments from the West Ranch oil field. The West Ranch oil field generates some natural gas as part of its existing oil production operations, but currently utilizes more natural gas for its gas-lift pumping systems than are generated by production. Therefore, HEC purchases approximately 440 million standard cubic feet per year (MMscf/year of natural gas to support its current West Ranch oil field operations. Natural gas is supplied to the West Ranch oil field by the existing Kinder Morgan Tejas Pipeline. Current average electrical use at the West Ranch oil field is approximately 3.6 MW, originating from the local electricity grid.

3.16.3 Direct and Indirect Impacts of the Proposed Project

DOE assessed the potential for impacts to utility systems in the ROI based on whether the Parish PCCS Project would result in any of the effects identified in Section 3.16.1.3.

3.16.3.1 Construction Impacts

Utility demands during construction would largely be temporary and would be driven by construction workforce activity.

3.16.3.1.1 CO_2 Capture Facility

Potable Water

NRG or its construction contractor would provide potable water, portable toilets, and hand-wash stations for construction workers during most of the two-year construction phase of the proposed project. In the later months of the construction phase and startup, potable water and wastewater needs may be incorporated into the proposed project infrastructure. During the construction period, there would be a negligible increase in the demand for a combination of potable water and process (service) water, which would be used for construction purposes like washdowns, washroom facilities, and hydrostatic testing. The estimated average **300** construction workers would generate a demand for **9,000** gpd of potable water, assuming 30 gpd per worker. This would approximately double the current demand from the existing 385 workers at the W.A. Parish Plant. NRG plans to meet this demand with existing water supplies. The demand would fluctuate depending on the level of construction activity and the number of construction personnel working on the site. Impacts to potable water utilities are expected to be short term and minor.

Other Construction-Related Water Use

Construction of the CO_2 capture facility would require approximately 0.02 mgd (combined potable and construction water), which would not significantly increase the demand for industrial water as compared to the current total demand of 36 to 52 mgd for W.A. Parish Plant operations. During construction and startup, the project would be expected to use water primarily for dust control and general washdown. As discussed in Sections 3.6 and 3.7 of this EIS (Groundwater and Surface Water), existing water supplies are sufficient to meet this increased water demand; therefore, the project would not affect local utility supplies. Impacts to water resources related to operation of the CO_2 capture facility would be negligible.

Wastewater

Wastewater generated from portable sanitary facilities during the first two years of construction of the CO_2 capture facility is estimated to be approximately **4,500** to **9,000** gpd based on an average number of **300** workers generating 15 to 30 gpd of wastewater each. This range of wastewater generation is based on the current rates of wastewater generation and potable water use at the W.A. Parish Plant. During construction, sanitary wastewater collected in the portable restrooms trailers would be disposed of at off-site sewage and wastewater facilities. As construction progresses and sanitary facilities would be incorporated into the site infrastructure, and wastewater would be accommodated with existing capacity of the W.A. Parish Plant wastewater treatment facilities. The volume of wastewater generated during construction would be expected to be well within the capacities of local wastewater treatment facilities and those at the W.A. Parish Plant. As a result, impacts to local or regional wastewater systems would be negligible.

Wastewater generated during general wash down activities would be properly contained and treated at existing W.A. Parish Plant wastewater treatment facilities in accordance with plant BMPs.

Electricity

Electricity for construction of the CO_2 capture facility would be provided by existing on-site electric generating units. In some cases, portable generators may be used in more remote construction locations. There should be no impact to off-site utility providers and regional users would not be affected.

Natural Gas

Construction of the new cogeneration train during testing and startup would require a short-term, negligible increase in natural gas supplies.

3.16.3.1.2 Pipeline Corridor

Although the proposed pipeline corridor would be collocated with and/or would cross a number of existing HVTL and pipeline ROWs, NRG does not anticipate that construction of the CO_2 pipeline would disrupt any of these existing utilities. NRG and its contractors would coordinate with potentially affected utility providers throughout the engineering, design, and construction phases of the project to ensure that no impacts to existing utilities occur. Prior to construction, NRG or its contractors would determine and demarcate the location of existing utilities to ensure that the pipelines could be installed safely and to reduce the probability of equipment making contact with or damaging existing utilities. During pipeline construction, NRG would maintain appropriate setbacks from collocated utilities and would install the proposed pipeline deeper at utility crossings to provide appropriate separation distances.

Potable Water

NRG or its construction contractor(s) would provide potable water for worker consumption from established local sources or commercial water suppliers. The estimated daily consumption of potable water for consumption and sanitary purposes at the construction site would be approximately **7,500** gpd based on the average of **250** workers using 30 gpd. Local sources for drinking water are readily available in the quantities that would be needed. Impacts to potable water availability would be expected to be short term and negligible.

Other Construction-Related Water Use

Construction, hydrostatic testing, and system startup of the proposed CO_2 pipeline is expected to use a total of approximately 1.75 million gallons of water for dust control, equipment washdown drilling mud makeup, hydrostatic tests, and other general use. This water which would be trucked in or obtained from surface water bodies adjacent to the pipeline after obtaining applicable permits (e.g., TCEQ water uptake permits). Water demands for construction would fluctuate based on vehicle and equipment activity, local weather conditions, and rainfall, and would be expected to use an average of approximately 10,000 gpd. Spent hydrostatic test water would be collected and reused for subsequent hydrostatic tests to the extent practicable, or would be discharged according to provisions of applicable RRC and/or EPA discharge permits.

Impacts to water utilities are expected to be negligible to minor, depending on the amount of rainfall in the area in the months preceding construction, and would represent a small temporary increase in demand for similar quality water in the region. Impacts to water availability would be expected to be short term and negligible to minor.

Wastewater

NRG or its contractor(s) would also provide portable toilets and hand-wash stations for construction workers for the duration of the construction phase of the pipeline portion of the project. These self-contained portable units would be serviced regularly. Wastewater generated from portable sanitary facilities during the pipeline construction and testing phase of the project would be collected and processed by permitted sewage treatment facilities. During pipeline construction, approximately **3,750** to **7,500** gpd of sanitary wastewater would be generated based on an average number of **250** workers generating 15 to 30 gpd of wastewater each. The demand from construction of the project would not affect local or regional wastewater treatment capability. These sanitary wastewater treatment and disposal needs would fluctuate depending on the actual number of construction personnel working along the pipeline corridor. Impacts to wastewater utilities are expected to be short term and negligible.

Spent hydrostatic testing water would be discharged at designated land or surface water locations along the pipeline corridor ROW in accordance with BMPs, as discussed in Section 3.5 of this EIS (Physiography and Soils); applicable RRC and/or EPA discharge permits; and landowner agreements. Prior to discharging any spent hydrostatic testing water, NRG or its contractor would characterize the water to verify that it meets the requirements of the applicable wastewater discharge permits. The discharge of spent hydrostatic testing water would not use any local utilities or limit the wastewater discharge of others. The impacts would be short term and negligible.

Electricity

During construction of the pipeline, portable generators would be used to provide electrical power at work locations along the ROW. There would be no demand on local or regional electricity supplies and any impact would be considered short term and negligible.

Overall utility demands for the potential pipeline corridor construction are expected to be short term and negligible.

Natural Gas

The construction of the pipeline would not require the use of additional natural gas resources.

3.16.3.1.3 West Ranch Oil Field

Potable Water

Potable water needed for equipment washdown, worker consumption, and sanitary use purposes during construction of EOR and CO_2 monitoring facilities and injection wells would be drawn from existing supplies and resources available and already in use for the same purposes at the West Ranch oil field.

There would be an adequate supply to support construction activities and the small short-term increase in construction workers at the site. Impacts to potable water utilities are expected to be short term and negligible.

Other Construction-Related Water Use

The drilling of new wells would occur during construction of the EOR and CO_2 monitoring facilities and would require the use of fresh and/or produced water depending on the type of drill rig used and the formation into which the well would be completed. Fresh water and produced water for well drilling would be drawn from existing supplies and resources available and already in use for the same purposes at the West Ranch oil field. The water would be pumped to and stored in large tractor-trailer-sized holding tanks until ready for use at the work location. Use of fresh water and produced water would not affect local utilities or water sources (see Section 3.7 of this EIS, Surface Water). Impacts to water availability would be short term and negligible.

Wastewater

During the construction of EOR and CO_2 monitoring facilities, sanitary wastewater would be disposed of in the existing on-site septic system for the HEC main office area. More remote locations would use portable restrooms and dispose of the collected wastewater at permitted sewage treatment facilities. The limited demand during construction would not affect local or regional wastewater treatment capability. These sanitary wastewater treatment and disposal needs would fluctuate depending on the actual number of construction personnel working. Impacts to any regional wastewater utilities are expected to be short term and negligible.

Drilling operations would generate waste streams including drill cuttings, drilling mud, and produced water during well construction. Any produced water removed would be contained in mud pits already used for that purpose in accordance with an existing TPDES permit held by HEC for the facility. Excess produced water would be collected, transported by truck within the West Ranch oil field to an existing injection well, and reinjected or disposed into existing permitted Class II injection wells currently operated by HEC at the West Ranch oil field. If required, approximately one to two new water reinjection wells would be installed to handle the additional volume of produced water expected to be generated from construction activities. In some cases, produced water may be pumped into portable storage tanks or tractor-trailer-sized brine tanker trucks and hauled off site for disposal by a licensed vendor within the region. Impacts related to treatment and disposal of produced water generated during well construction would be short term and negligible.

Electricity

Electrical power demands for construction of EOR and CO_2 monitoring facilities would be provided by the existing utility grid. Portable generators may be used at more remote work locations. There would be negligible increase in demands or impact to local electric utility providers.

Natural Gas

The construction related to EOR activities would not require the use of natural gas. There would be no increase in the use of natural gas resources.

3.16.3.2 Operational Impacts

3.16.3.2.1 CO_2 Capture Facility

Potable Water

Once the CO_2 capture facility becomes operational, the daily potable water demand from existing W.A. Parish Plant potable water resources would increase to meet the needs of approximately 15 additional employees. Based on an estimated usage rate of 30 gpd per person of potable water for consumption and sanitary needs, daily demand would increase by approximately 450 gpd or 3%. Existing on-site potable water sources would be used for this increased demand. Impacts to potable water utilities are expected to be negligible.

Plant Process Water

As discussed in Chapter 2 of this EIS, operation of the CO_2 capture facility would require an increased demand of approximately 4 to 5 mgd of plant process water, which is an approximate 10% increase over the 36 to 52 mgd of current water usage at the W.A Parish Plant. This additional volume would be supplied from Smithers Lake via a new water intake point and from the plant's existing groundwater extraction wells. As discussed in Sections 3.6 and 3.7 of this EIS (Groundwater and Surface Water), existing water supplies are sufficient to meet this increased water demand; therefore, the project would not affect local utility supplies. Impacts to water resources related to operation of the CO_2 capture facility would be minor.

Industrial Wastewater

CO_2 capture facilities that would be installed at the W.A. Parish Plant as part of the proposed project would generate approximately 40 to 80 gallons per hour (gph) of additional industrial wastewater as a result of operations and maintenance activities. NRG's existing WWTP capacity and permitted wastewater discharge limits have adequate capacity to treat and discharge the additional industrial wastewater that would be generated by the proposed project without modification as described in Section 3.7 of this EIS, (Surface Water). The proposed project would not affect local utilities and the abilities of others to generate and treat industrial wastewater.

Sanitary Wastewater

Based on an estimated generation rate of 15 to 30 gpd per person of sanitary wastewater, 15 additional workers would generate approximately 225 to 450 gpd of sanitary wastewater during operations and maintenance activities for the project. This represents a negligible increase in the demands for on-site sanitary wastewater treatment at the W.A. Parish Plant, as the WWTP currently treats 4,000 gpd of sanitary wastewater and is permitted to treat 8,000 gpd. NRG's existing WWTP capacity and permitted wastewater discharge limits provide adequate capacity to treat and discharge the sanitary wastewater that would be generated by the proposed project. No modifications or upgrades would be required. There would be no impact on public utilities or the abilities of others within the ROI to generate and treat sanitary wastewater.

Electricity

Power requirements for the carbon capture and compression equipment would be approximately 50 MW. The electricity would be supplied by a new 80-MW natural gas-fired cogeneration plant constructed on site, as described in Section 2.3.2.2 of this EIS (System Component Overview). As electricity for the proposed CO_2 capture facility would be supplied by the new cogeneration facility, there would be no additional demand on the existing grid and no impact to off-site electricity providers. Approximately 30 MW of electricity from the cogeneration facility would not be used by the CO_2 capture facility and would be available for commercial sale through the power grid. This would be a potential beneficial impact of the project.

Natural Gas

Natural gas demands for operation of the new natural-gas-fired cogeneration facility would be approximately 1.5 MMscf/hr (60,000 pounds per hour). This increase represents much less than 1% of the current maximum usage at the W.A. Parish Plant (i.e., 27,500 MMcf/hr). The gas would be provided by the privately-operated Kinder Morgan gas pipeline already located at the W.A. Parish Plant. The existing Kinder Morgan gas pipeline has enough reserve capacity to increase gas supply to the W.A. Parish Plant to meet project-related demand (Kush 2012). No new natural gas pipeline would be required, only a connection to the existing pipeline. Natural gas supplies are abundant in the region area so there should be no impact to public utility natural gas supplies.

Coal

The operation of the CO_2 capture facility would not require the use of coal. As mentioned above, natural gas is the fuel source for the facility operation. There would be no impact to coal resources.

3.16.3.2.2 Pipeline Corridor

Operation of the pipeline to transport compressed CO_2 is expected to have no independent operational utility demands aside from a negligible amount of electricity to operate the meter station and valves. Negligible impacts to utilities would occur from this component of the proposed project.

3.16.3.2.3 West Ranch Oil Field

Water and Wastewater

EOR and CO_2 monitoring activities at the West Ranch oil field would result in a negligible demand for additional potable water resources. These activities would also generate negligible additional amounts of produced water and wastewater, which would be managed by on-site processes as part of existing oil field operations.

Electricity

Electric compressors would be used to provide compression for the proposed EOR systems (i.e., CO_2 distribution and injection). Approximately 36 MW of additional electricity would be required to power the compressors for the CO_2 injection system and related EOR facilities. This additional electricity would be obtained from the West Ranch oil field's existing power provider and would result in minor impacts to existing utilities if additional electrical infrastructure is required to support the proposed project.

Natural Gas

TCV has not yet determined whether EOR operations would require additional natural gas to operate the West Ranch oil field's gas-lift pump systems or would result in development of surplus gas for commercial sale. TCV intends to have detailed design information available in the first quarter of 2013, including natural gas production estimates. If additional natural gas is required, there is sufficient capacity in the Kinder Morgan Tejas Pipeline to provide this additional supply to the West Ranch oil field. Similarly, if the West Ranch oil field becomes a net exporter of natural gas, there is sufficient capacity in Kinder Morgan's Tejas Pipeline or other nearby pipelines to transport the gas from the West Ranch oil field after processing at the oil field. As the infrastructure exists for transport of natural gas to and from the West Ranch oil field, impacts associated with changes in natural gas supply or demand are expected to be minor.

3.16.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The project would not be constructed and there would be no change to utilities.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. During the construction period, there would be a negligible increase in the demand for a combination of potable water and process (service) water, which would be used for construction purposes like washdowns, washroom facilities, and hydrostatic testing. The estimated maximum 100 construction workers would generate a demand for 3,000 gpd of potable water, assuming 30 gpd per worker. This would increase the current demand from the existing 385 workers at the W.A. Parish Plant. NRG plans to meet this demand with existing water supplies. The demand would fluctuate depending on the level of construction activity and the number of construction personnel working on the site. Impacts to potable water utilities are expected to be short term and minor. The volume of wastewater generated during construction would be expected to be well within the capacities of local wastewater treatment facilities and those at the W.A. Parish Plant. As a result, impacts to local or regional wastewater systems would be negligible. Electricity for construction of the cogeneration plant would be provided by existing on-site electric generating units. In some cases, portable generators may be used in more remote construction locations. There should be no impact to off-site utility providers and regional users would not be affected. Construction of the new cogeneration train during testing and startup would require a short-term, negligible increase in natural gas supplies.

No additional personnel are anticipated for operations of the cogeneration plant, and little to no water would be used by the plant; therefore impacts to water utilities are expected to be negligible. The natural gas-fired cogeneration plant would supply electricity that would be available for commercial sale through the power grid. This would be a potential beneficial impact. Natural gas demands for operation of the new natural-gas-fired cogeneration facility would be approximately 1.5 MMscf/hr (60,000 pounds per hour). This increase represents much less than 1% of the current maximum usage at the W.A. Parish Plant (i.e., 27,500 MMcf/hr). The gas would be provided by the privately-operated Kinder Morgan gas pipeline already located at the W.A. Parish Plant. The existing Kinder Morgan gas pipeline has enough reserve capacity to increase gas supply to the W.A. Parish Plant to meet project-related demand (Kush 2012). No new natural gas pipeline would be required, only a connection to the existing pipeline. Natural gas supplies are abundant in the region, so there should be no impact to public utility natural gas supplies.

3.17 COMMUNITY SERVICES

3.17.1 Introduction

This section identifies and describes the existing condition of community services potentially affected by the construction and operation of the proposed project. This section also analyzes the potential effects to these community services. Community services examined include: law enforcement, fire protection, emergency response, healthcare services, and schools.

3.17.1.1 Region of Influence

The ROI for community services includes:

- **CO_2 Capture Facility – Fort Bend County, Texas:** location of the W.A. Parish Plant and the proposed CO_2 capture facility and the originating segment of the proposed pipeline corridor;
- **Pipeline Corridor – Fort Bend County, Wharton County, and Jackson County, Texas:** location of the proposed pipeline corridor; and
- **West Ranch Oil Field – Jackson County, Texas:** location where the proposed pipeline corridor would terminate and location of the West Ranch oil field, within which the proposed EOR and CO_2 monitoring activities would be conducted.

3.17.1.2 Method of Analysis

Any influx of capital (spending) or employment to a region, such as from a large construction project, could affect the existing demographic conditions and, proportionately, the community services within that region. DOE evaluated the impacts of NRG's proposed project to community services based on anticipated changes in demand for law enforcement, fire protection, emergency response, healthcare services, and schools. In many cases, the change in demand is directly related to increased population. Therefore, DOE reviewed census data in conjunction with the socioeconomic analysis (see Section 3.18) to analyze how population trends could affect community services.

3.17.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for community service impacts based on whether the **proposed** project would directly or indirectly:

- impede effective access by law enforcement, fire protection, and/or emergency response services in the ROI;
- displace law enforcement or fire protection facilities, or increase the demand on service capacities of local and regional law enforcement, fire protection, and/or emergency response agencies;
- displace medical facilities or increase demand for hospital beds and/or medical facilities beyond available capacity; or
- displace school facilities or increase enrollment in local school systems beyond available capacity.

3.17.2 Affected Environment

3.17.2.1 CO_2 Capture Facility, Pipeline Corridor, and West Ranch Oil Field

Law Enforcement

CO_2 Capture Facility

The proposed CO_2 capture facility and a portion of the pipeline corridor would be located within the area served by the Fort Bend Sheriff's Office in Richmond, Texas. This office maintains a staff of approximately 28 law enforcement officers and provides the primary law enforcement services to the area, including and immediately surrounding the W.A. Parish Plant and a portion of the pipeline corridor. There are approximately 2.35 (City-Data 2010) law enforcement officers per 1,000 residents that serve the greater Houston area, including Fort Bend County, as compared to the Texas average of 2.2 police officers per 1,000 residents. The current crime rate in Fort Bend County is 1,752 crimes per year per 100,000 of population compared to the state of Texas crime rate of 4,236 crimes per year per 100,000 of population (City-Data 2010, TDPS 2010).

The W.A. Parish Plant is located within a fenced and secured industrial site with controlled ingress and egress. Site security personnel are present at all times and are trained to respond to incidents or emergencies.

Pipeline Corridor

The origination point of the pipeline corridor is within the area served by the Fort Bend Sheriff's Office and is described above. In Wharton County, where the center portion of the pipeline corridor would be constructed, the Wharton County Sheriff's office located in Wharton, Texas provides law enforcement services. This office has an average of 2.3 officers per 1,000 residents, as compared to the Texas average of 2.2 police officers per 1,000 residents. The current crime rate in Wharton County is 1,963 crimes per 100,000 of population compared to the state of Texas crime rate of 4,236 crimes per 100,000 of population (City-Data 2010, TDPS 2010). The termination point of the pipeline corridor is in Jackson County, Texas, which is served by the Jackson County Sheriff's Office, as described below.

West Ranch Oil Field

The proposed EOR demonstration facilities and CO_2 monitoring operations facilities and termination point of the pipeline corridor would be located at the West Ranch oil field in Jackson County, Texas near the city of Vanderbilt. The Jackson County Sheriff's office in Edna, Texas provides law enforcement services to the county areas adjacent to the West Ranch oil field. This office has approximately 1.6 officers per 1,000 residents in the area (TDPS 2010) as compared to the Texas average of 2.2 officers per 1,000 residents. The current crime rate in Jackson County is 1,325 crimes per 100,000 of population compared to the state of Texas crime rate of 4,236 crimes per 100,000 of population (City-Data 2010, TDPS 2010).

The combined number of officers per 1,000 residents in the three-county area within the ROI and the nearby greater Houston area is generally equivalent to the Texas average of 2.2 officers per 1,000 residents (City-Data 2010). The current average crime rate in the three-county area is 1,680 crimes per 100,000 of population as compared to the Texas average of 4,239 crimes per 100,000 of population **(TDPS 2010)**.

Fire Protection/Emergency Response

CO_2 Capture Facility

The CO_2 capture facility would be located within the W.A. Parish Plant. The W.A. Parish Plant has implemented a comprehensive emergency action plan as a part of the W.A. Parish Plant safety planning. The plant's Emergency Response Team and their staff of approximately 75 persons are trained and certified, and include Environmental Safety and Health (ES&H) professionals, firefighters, emergency medical technicians (EMTs), and hazardous material response personnel. The W.A. Parish Plant maintains an on-site fire station that houses Emergency Response Team personnel, rescue equipment, and firefighting equipment. The W.A. Parish Plant also maintains a First Aid Center to respond to minor incidents and accidents involving site workers. Emergency plans, trained staff, and equipment are in place to enable response to emergency situations such as fire, medical, bomb threats, severe weather, hazardous material releases, personnel evacuations, and terrorist attacks or threats.

Areas within the W.A. Parish Plant that pose potential fire or other safety hazards are provided with an appropriate amount of emergency protective and emergency response equipment, such as fire extinguishers, breathing apparatuses, wash stations, spill kits, first aid kits, and personnel protective equipment (PPE).

The W.A. Parish Plant safety plans apply to NRG personnel and contractors working within the plant site. All personnel are responsible for reporting emergency and unsafe conditions promptly following established guidelines and procedures. Wardens are assigned to each floor of the Coal Plant Administration Building and to other buildings and facilities throughout the W.A. Parish Plant. Wardens are trained and rehearsed in accounting for all personnel in the event of an emergency and for coordinating the implementation of emergency procedures and evacuation plans with the on-site W.A. Parish Plant Primary Communication Response Center using a site-wide, dedicated communication system. All NRG and contractor personnel working at the W.A. Parish Plant participate in required safety training appropriate to their work assignment and responsibilities. The W.A. Parish Plant holds routine safety and emergency drills and evacuation exercises. W.A. Parish Plant emergency responders also regularly train and conduct drills with members of the Fort Bend County's Regional Hazmat Response Team and Regional Rescue Response Team.

The W.A. Parish Plant is an active member of the Fort Bend County Office of Emergency Management, located in Richmond, Texas. Plant personnel and resources can be drawn upon from local and regional fire departments, paramedics, medical transport services, and hospitals in the region, such as the Memorial Hermann Sugar Land Hospital and the Oak Bend Medical Center. The W.A. Parish Plant site also maintains a heliport that can be used for quickly providing air medical services and life-flight evacuation assistance if needed.

The Richmond Fire Department would be one of the off-site first responders for emergencies at the W.A. Parish Plant. The Richmond Fire Department is located approximately 14 miles from the W.A. Parish Plant. The Richmond Fire Department is staffed by 18 full-time firefighters, 24 part-time firefighters, 15 volunteer firefighters, a Fire Chief, an Assistant Fire Chief, and a Fire Marshall. The Richmond Fire Department has three fire stations and is equipped with eight engines, a tanker, a hazmat command vehicle, a rescue trailer, and rescue watercraft. The average response time to a fire or medical emergency would range from five to ten minutes. The community of Thompson has a smaller volunteer fire department that could also respond based on availability of volunteers and the nature of the emergency. Other fire stations in the region can be quickly called upon to provide additional resources, when necessary, through activation of mutual aid agreements as part of the Fort Bend County Regional Emergency Response Program.

Pipeline Corridor

Fire protection and emergency response services within the proposed pipeline corridor are provided by multiple fire departments and emergency responder agencies and organizations within the ROI. The region is served by many fire protection and emergency response agencies and organizations that are principally located in Fort Bend County, Wharton County, and Jackson County, Texas. Each of these county agencies and organizations has an Emergency Management Office that coordinates fire protection and emergency response activities within its respective county and the region (Jackson 2012) and (Fort Bend County 2011). Within the ROI, there are Regional Hazmat Response Teams and Regional Rescue Response Teams that train and conduct drills with the operators of pipelines and oil production fields. The average response times for medical emergencies within the pipeline ROI are reported to average from 5 to 20 minutes after initial notification, depending on the location and nature of the emergency.

The Wharton County Volunteer Fire Department and Emergency Medical Service (EMS) Department located in Wharton, Texas serve an area through which a 36-mile segment of the proposed pipeline would pass. As such, its resources and services could potentially be called upon in the event of a fire or other emergency.

The Wharton County Volunteer Fire Department provides fire, rescue, and hazmat services for the city of Wharton and the surrounding 200-square-mile area via an established mutual aid agreement with all of Wharton County. The department's current staff of 36 firefighters and maintains fire and rescue equipment. The Wharton County EMT Department is staffed by a total of eight full-time paramedics, over 25 part-time EMTs–EMT Paramedics, and a full-time Supervisor and Director of Emergency Management Services. After initial notification, the average response times to a medical emergency ranges from 10.6 minutes in urban areas to 18.3 minutes in rural areas (NHTSA FARS 1997).

West Ranch Oil Field

The proposed EOR and CO_2 monitoring facilities and the termination point of the proposed pipeline corridor would be located at the West Ranch oil field in Jackson County near Vanderbilt, Texas. The Edna Volunteer Fire Department, located in Edna, Texas, provides fire protection and EMS services to a 315-square-mile area in Jackson County, including the oil field. First responders for a fire or emergency incident would likely be the Vanderbilt Volunteer Fire Department and EMS, located in the city of Vanderbilt approximately two miles north of the oil field's main entrance. The average response time would be in the range of five to ten minutes depending on availability and the nature of the emergency. The Vanderbilt Fire Department is a part of Jackson County Emergency Services District No. 1, which also includes the nearby communities of Lolita, Francitas, and LaWard, Texas. The District has 54 volunteer personnel who perform firefighting and EMS services, which could also be drawn upon in the event of an emergency. The District maintains 16 vehicles consisting of five brush fire trucks, three grass fire trucks, one pumper truck, two tankers, two engines, and two ambulances.

The Edna Fire and EMS Departments are located 15 miles from the West Ranch oil field and maintain three pumpers, one tanker, three grass fire trucks, one brush fire truck, one personnel vehicle, three EMS units, one supervisor vehicle, and miscellaneous support items. The departments also provide hazardous material response with command trailer and decontamination equipment. The two departments are staffed by 21 volunteer firefighters and a volunteer Fire Chief. There are seven permanent fire and EMS personnel, including an EMS Director/Fire Marshal.

Healthcare Services

Healthcare services within the three-county ROI are provided by 12 hospitals. Hospitals within each county and the approximate number of beds for each are listed in Table 3.17-1.

Table 3.17-1. Hospitals Serving the ROI

Hospital	Number of Beds
Fort Bend County	
Atrium Medical Center	68
Emerus Hospital	4
Healthsouth Sugar Land Rehabilitation Hospital	50
Memorial Hermann Sugarland (Level III Advanced Trauma Facility)	77
Methodist Sugarland Hospital	187
Oak Bend Medical Center Public (Level III Advanced Trauma Facility)	241
St. Luke Sugarland Hospital (Level IV Basic Trauma Facility)	100
Sugarland Surgical Hospital, LLP	6
Triumph Hospital Southwest	171
Subtotal	***904***
Wharton County	
El Campo Memorial Hospital	49
Gulf Coast Medical Center	161
Subtotal	***210***
Jackson County	
Jackson Healthcare Center (Level IV Basic Trauma Facility)	25
Subtotal	***25***
Total Three-County Area Number of Hospital Beds	**1,139**

Source: AHD 2012

Based on the 2010 population of the ROI **(U.S. Department of Commerce, Bureau of the Census 2010)**, there are **1.78** beds per 1,000 people. This is **below** the **Hospital Survey and Construction Act (or** Hill-Burton Act**) of 1946** threshold of 4.5 beds per 1,000 people. The Hill-Burton Act authorizes assistance to public and other nonprofit medical facilities such as acute care general hospitals, special hospitals, nursing homes, public health centers, and rehabilitation facilities and includes minimum standards of service.

Local School Systems

The three-county ROI includes many school districts that educate children living within their districts through numerous public high schools, middle schools, and elementary schools. Table 3.17-2 displays the school districts and the average student-teacher ratios for each in the three counties from which local workers living in the area would likely be drawn. Since the schools in the ROI have an average of **15.08** students per teacher, as compared to the maximum of 20 students per teacher specified in Section 25.111 of the Texas Education Code (TEC 2012), services from local school systems within the ROI appear to be adequate.

Table 3.17-2. School Statistics within the ROI

County	School District	Student Enrollment	Teachers	Ratio of Students to Teachers (%)
Fort Bend	Fort Bend	**68,948**	4,385	**15.7**
	Katy	59,078	4,120	14.3
	Lamar	23,684	1,456	**16.3**
	Needville	2,602	**166**	**15.7**
	Stafford	3,162	211	15.0
	Harmony	620	33	**18.8**
Fort Bend County Average				***15.24***
Wharton	Boling	985	69	**14.3**
	East Bernard	956	76	**12.6**
	El Campo	3,491	255	13.7
	Wharton	2,271	172	**13.2**
	Louise	508	45	**11.3**
Wharton County Average				***13.31***
Jackson	Edna	1470	112	13.1
	Ganado	651	53	**12.3**
	Industrial	**1,153**	**87**	**13.3**
Jackson County Average				***12.99***
ROI Average				**15.08**
Texas Average				**12.73**

Source: Edudemic 2012

3.17.3 Direct and Indirect Impacts of the Proposed Project

DOE assessed the potential for impacts to community services in the ROI based on whether the proposed project would result in any of the effects identified in Section 3.17.1.3.

3.17.3.1 Construction Impacts – CO_2 Capture Facility, Pipeline Corridor, and West Ranch Oil Field

Community services, such as law enforcement, fire protection, emergency response, healthcare services, and schools, can be affected during construction due to a temporary increase in construction personnel in the ROI, and the proposed construction activities themselves. The list below summarizes the needs for temporary personnel during project construction:

- The proposed CO_2 capture facility would require an average workforce of approximately **300** with a peak workforce of 600 workers during the two-year construction period and six-month startup period.
- The proposed pipeline would require an average workforce of approximately **250** with a peak workforce of approximately 500 workers during the six-month construction period and six-month startup period.
- The proposed EOR demonstration facilities and injection wells would require an approximate peak workforce of 12 and would require hiring approximately five additional workers.
- The proposed CO_2 monitoring facilities would require approximately five workers during the two-year construction period.

The proposed project would likely draw a large part of its construction workers from a large labor pool mostly within the ROI. As stated in Section 3.18 (Socioeconomics) of this EIS, approximately 40% of the construction workforce is expected to be local. The other 60% would come from outside the ROI, and would be personnel with specialized training. The local workers would be expected to commute to the construction site on a daily basis, while others might temporarily relocate to the area for the duration of their assignment. Temporary construction jobs created by the **proposed** project could cause a temporary increase in residents within the ROI. The exact number of construction workers and their families who would temporarily relocate to the area for the **proposed** project is unknown, but because of the short duration of the construction period, only a small number of workers and their families would be expected to relocate. Overall, the community services available in the ROI are expected to be adequate to accommodate the demands associated with approximately 1,100 construction workers during the two-year construction phase of the **proposed** project. Refer to Section 3.18 of this EIS (Socioeconomics) for more information regarding population distribution and the anticipated changes induced by the proposed project.

Construction projects of this nature require the use of a substantial number of workers to operate and maintain earth moving equipment, trucks, vehicles, material handling and fabrication equipment, and perform skilled and unskilled labor tasks. Some of these operations and work may increase the occurrences of vehicle or work site accidents or other emergencies that could place short-term demands on community services. Emergency services during construction would be coordinated with the local fire departments, police departments, paramedics, and hospitals. A first aid office would be provided on site for minor incidents. Trained EH&S personnel would be on site in areas of construction to respond to and coordinate response in the event of an emergency. Temporary facilities would have fire extinguishers, and fire protection would be provided in work areas where welding work would be performed. In addition, other existing EH&S plans and policies would be updated or prepared, as necessary, to accommodate the needs of the proposed project.

Law Enforcement

Construction jobs created by the proposed project could cause a temporary increase in residents within the ROI during the construction period. There are a sufficient number of law enforcement personnel within the ROI that would be available to support the projected needs.

Calls for law enforcement services could increase due to the temporary rise in personnel and families living in the area and calls for law enforcement services related to increases in personnel traveling to work locations and working in the area. However, this impact would be temporary in nature. As stated in Section 3.17.2.1, the number of law enforcement officers per 1,000 residents within the ROI is generally equivalent to the Texas average of 2.2 officers per 1,000 residents. The approximately 1,100 temporary construction workers for the proposed project (approximately 60% of whom would likely be hired from outside the ROI) would result in a negligible change in the local population and, therefore, a negligible change in the number of law enforcement officers per 1,000 residents. Existing law enforcement agencies within the ROI appear to be adequately staffed to handle the temporary increase in population and additional commuters.

Construction of the proposed project should not displace any law enforcement facilities, impact law enforcement access, or conflict with local and regional plans for law enforcement services. Therefore, potential impacts to law enforcement due to construction of the **proposed** project would be negligible.

Fire Protection/Emergency Response

Emergency services during construction of the CO_2 capture facility would be coordinated through the existing W.A. Parish Plant Emergency Response Team with the local fire departments, police departments, paramedics, and hospitals. An adequate number of trained and certified health, safety, and environmental personnel would be on site to respond to and coordinate emergency response. Temporary facilities would have fire extinguishers, and fire protection would be provided in work areas where welding work would be performed. In addition, NRG's plans, policies, and training regarding ES&H would be updated as necessary to accommodate the proposed project. NRG would procure equipment needed to deal with new hazards or potential events.

The on-site W.A. Parish First Aid Facility would provide services for minor construction accidents. Personnel would be on site to respond to and coordinate emergency response actions on the site and with local agencies and authorities as needed.

During pipeline construction, NRG would require the pipeline contractor to implement an ES&H plan. The plan, when executed, would provide for fire protection and emergency response actions that would be taken in designated locations and work areas along the pipeline corridor.

During construction of EOR demonstration facilities and CO_2 monitoring facilities, the responsible organization and its contractors would operate under the guidelines of the HEC Safety Program (HEC 2008) or a similar safety program. The HEC Safety Program identifies the responsibilities, actions to be taken, and resources that would be applied and could be drawn upon from local and regional fire departments, paramedics, medical transport services, and hospitals in Jackson County and the region in the event of a fire or medical emergency.

Any incidents that may occur during construction would not likely increase the demand for fire protection or emergency response services beyond the available capacity in the ROI. The construction of the **proposed** project would not displace any fire protection facilities, conflict with local and regional plans for fire protection services, or impede access to fire protection services. Thus, potential impacts to fire protection services due to construction of the **proposed** project would be negligible. Proactive and ongoing coordination of proposed construction activities with local fire protection and emergency service providers would ensure adequate resources are informed and available throughout the construction period.

Any emergencies that may occur during construction of the **proposed** project would not be expected to significantly increase the demand for emergency services such as ambulances, paramedics, or rescue services beyond the current available capacity in the ROI. The ROI is served by a number of emergency response staff and equipment that would be available for local response. The first responder to an event at the West Ranch oil field would likely arrive from the Vanderbilt Volunteer Fire Department and EMS located about two miles north of the main entrance to the oil field. After initial notification, the average response times to a medical emergency typically average from 5 to 10 minutes.

Healthcare Services

Temporary construction jobs created by the proposed project could cause a short-term increase in the number of residents living within the ROI. In the unlikely event that all of the temporary construction workers (i.e., up to a peak of approximately 1,100) relocated within the ROI, the **change in the** ratio of hospital beds per 1,000 residents would **be small, remaining at approximately 1.78, and would** continue to be **below the recommended ratio of beds to population**. Therefore, potential impacts on healthcare services due to construction of the **proposed** project would be negligible.

Local School Systems

Due to the temporary nature of the construction phase, it is unlikely that any significant number of construction workers would permanently relocate their families to the ROI. 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, potential impacts to local school systems due to construction would be negligible. In addition, the **proposed** project would not displace school facilities or conflict with local and regional plans for school system capacity or enrollment.

3.17.3.2 Operational Impacts - CO_2 Capture Facility, Pipeline Corridor, and West Ranch Oil Field

During the operations phase, it is estimated that 15 permanent employees would be hired at the CO_2 capture facility, two permanent employees for the pipeline, and three permanent employees would be hired for the CO_2 monitoring activities (see Table 3.18-5). The majority of the 20 employees would likely be hired from the local workforce, with the remaining workers transferred from existing facilities. The majority of permanent workers would be expected to commute to their work location on a daily basis.

Law Enforcement

The anticipated increase of less than 1% in population in the ROI due to operations of the proposed project would have a negligible long-term effect on the ratio of law enforcement officers per 1,000 residents. Therefore, potential impacts to law enforcement due to operations would be negligible.

Fire Protection

As described in Section 3.17.2.1, a substantial amount of fire protection personnel, apparatus, and resources within Fort Bend County, Wharton County, and Jackson County would be available to respond to fire or other emergencies if needed. These three counties also have mutual aid agreements with each other**,** and with adjacent counties**,** to coordinate and share resources in the event other support or resources are needed over the 20-year operational life of the proposed project.

Operation of the **proposed** project would involve the use of flammable and combustible materials that pose an increased risk of fire or explosion; however, the probability of a significant fire or explosion is very low, as described in Section 3.15 of this EIS (Human Health and Safety).

Prior to operation of the **proposed** project, copies of the **safety data sheets (SDSs)** for process materials and chemicals that would be stored and used during operations and maintenance activities would be provided by the responsible participant to local fire departments that would respond to any fires or other emergencies at **proposed** project facilities. **SDSs provide the information needed to allow the safe handling of hazardous substances.**

As described in Section 3.17.2.1, the fire departments within the ROI have the capacity, and are equipped to respond to a major fire emergency. Any incidents that might occur during operation of the **proposed** project would not increase the demand of fire protection services beyond the available capacity of currently existing services. Thus, the potential impact to fire protection services due to operations would be negligible.

Emergency and Disaster Response

The W.A. Parish Integrated Facility Contingency Plan would be updated to reflect any additional potential hazards, conditions, or emergency response needs required during operation of the CO_2 capture facility. The Railroad Commission of Texas would have regulatory jurisdiction over the proposed CO_2 pipeline, EOR demonstration facilities, and injection wells, and the CO_2 monitoring facilities. These pipelines, associated facilities, and wells would be designed, operated, and maintained in accordance with the Federal DOT Safety Standards specified in 49 CFR 195.

The safety standards specified in 49 CFR 195 require TCV as the pipeline operator to develop and implement an emergency plan, as described below. NRG and TCV would work with local fire departments and other agencies to identify personnel to be contacted, equipment to be mobilized, and procedures to be followed in responding to a hazardous condition caused by the pipeline or at associated facilities located at the W.A. Parish Plant, along the pipeline corridor, or at the West Ranch oil field. TCV would establish and maintain a liaison with the appropriate fire, police, and public officials to coordinate mutual assistance when responding to emergencies, and establish a continuing education program to enable customers, the public, government officials, and those engaged in responding to emergencies and excavation activities to recognize a pipeline or facility emergency and report it to appropriate public officials.

Before constructing the pipeline, and placing the associated EOR demonstration facilities and injection wells into service, TCV would prepare a procedure manual for operation and maintenance. TCV would monitor and maintain the pipelines in compliance with all regulatory requirements. In the event of a process malfunction, emergency action might be required. Emergency events would be addressed in a Hazards and Operability Study that NRG and TCV would prepare prior to operation of the **proposed** project. The study would identify potential problems and risks, raise employee awareness, plan for risk mitigation, and determine effective emergency procedures.

TCV would develop emergency response plans and implementing procedures and training to address any potential hazards, conditions, or emergency response needs at the West Ranch oil field resulting from the operation of **proposed** project facilities and systems.

Emergencies during operation of the **proposed** project would not be expected to increase the demand for emergency services beyond currently available capacity. As previously discussed, the three counties within the ROI are served by an adequate level of emergency staff that could be available for local response. The operation of the CO_2 capture facility, pipeline corridor, EOR demonstration, and CO_2 monitoring operations would not displace any emergency response facilities, conflict with local and regional plans for emergency response services, or impede access for emergency response services.

While it is not anticipated that emergency response conflicts would arise, the potential impacts to emergency services due to operations would be negligible. Section 3.15 of this EIS (Human Health and Safety) describes the risks from operation of the **proposed** project, including the potential for intentionally destructive acts. No hospitals or schools are located within 1,000 feet of the proposed pipeline route. The risks to the health and safety of the public are considered to be very low and the emergency response capabilities are expected to be adequate to address potential accidents and other risks.

Healthcare Services

Once operational, the proposed project would employ approximately 20 full-time equivalent workers. Approximately seven of the employees would be hired from the local workforce, with the remaining 11 moving into the ROI. The current healthcare capacity within the ROI is **below the recommended ratio of beds to population**, with **1.78** hospital beds per 1,000 residents. Although the proposed project could minimally increase the number of residents possibly requiring medical care, the ratio of hospital beds per 1,000 residents would remain at approximately **1.78** and, therefore, no impacts on healthcare services are expected. Operation of the proposed project would not displace any healthcare facilities or conflict with local and regional plans for healthcare or emergency services. Therefore, potential impacts on healthcare services due to operations would be negligible.

Local School System

Once operational, the proposed project would employ approximately 15 new full-time equivalent employees at the W.A. Parish Plant and three new full-time employees at the West Ranch oil field. Of these 20 employees, it is estimated that seven would be hired from the local workforce, with the remaining 11 moving into the ROI. Based on an estimated 1.75 children per family, it is estimated that a maximum of 32 new school-age children could potentially relocate to the ROI if all 20 new employees relocated to the ROI. An additional 32 new school-age children would not likely require the addition of teachers in order to maintain an acceptable average student-teacher ratio in Fort Bend County. However, based on the unemployment rate and number of available school districts within the ROI, it is unlikely that all new full-time employees would relocate to the ROI, and certainly not to the same school district. Therefore, potential impacts to local school systems due to operations would be negligible.

3.17.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for NRG's proposed project. Although NRG and TCV may still elect to construct and operate the **proposed** project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative would be equivalent to a No-Build Alternative. The **proposed** project would not be constructed and there would be no change to community services.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. The construction work force is

expected to peak at approximately 100 persons and should diminish as construction activities come to an end and the project moves into the startup / commissioning phase of the project. The operations of the cogeneration plant will be performed by existing W.A. Parish plant personnel; additional personnel should not be required. Community services are adequate to address the needs arising from the minor short-term population increase during construction, and no impacts are anticipated to community services during operations.

3.18 SOCIOECONOMICS

3.18.1 Introduction

This section identifies and describes the existing socioeconomic conditions within the ROI potentially affected by the construction and operation of the proposed Parish PCCS Project. This section also analyzes the potential effects to the socioeconomic conditions within the ROI. Socioeconomic conditions examined include: demographics, economy, sales and tax revenues, per capita and household incomes, sources of income, and housing availability.

3.18.1.1 Region of Influence

The ROI for this socioeconomic analysis includes Fort Bend, Wharton, and Jackson, Counties, the counties in which the W.A. Parish Plant, the proposed pipeline corridor, and the West Ranch oil field are located. The ROI also includes Brazoria and Matagorda Counties, which are adjacent counties where additional local workers who may be employed by the proposed project may reside or where construction labor may be temporarily housed. The entire ROI covers approximately 6,046 square miles in southeast Texas. DOE expects approximately 40% of temporary construction workers and the majority of permanent operations workers would live in these counties; and DOE expects goods, hospitality, and transportation services to originate here. The prominent cities in Brazoria County are Pearland, Lake Jackson, Alvin, and nine smaller cities. The prominent cities in Fort Bend County are Sugar Land, Missouri City, and Rosenberg, and six smaller cities. The prominent city in Jackson County is Edna and one other smaller city. The prominent city in Matagorda County is Bay City and one other smaller city. The prominent city in Wharton County is El Campo and two other smaller cities. With respect to the socioeconomic conditions, noticeable effects would not be expected to extend beyond these five counties. The five county ROI used in this analysis is larger than the three county community services ROI due to the proximity of the proposed project relative to goods, hospitality, and transportation services that would likely be consumed as a result of the **proposed** project's implementation.

3.18.1.2 Method of Analysis

The socioeconomic analysis used data from the following federal, state, and local sources: the U.S. Department of Commerce – Bureau of the Census, the Texas State Data Center, the Texas Comptroller of Public Accounts, and the counties and cities in the ROI.

Socioeconomic conditions were analyzed to assess type, magnitude, and severity of impacts to determine if the proposed project would result in the following: (1) demographic changes in population levels because additional temporary construction and permanent operations workers would be required; (2) housing availability changes for temporary construction and permanent operations workers; and (3) economic changes in employment, area taxes, and economic output of the region.

3.18.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for socioeconomic impacts, both beneficial and adverse, based on whether the proposed project or an alternative had the potential to cause any of the following changes within the ROI:

- Induce substantial population growth in the ROI, either directly (e.g., by encouraging new homes and businesses) or indirectly (e.g., through extension of roads or other infrastructure);

- Displace a substantial number of people or housing, necessitating the construction of replacement housing elsewhere;
- Change existing businesses or employment opportunities;
- Disrupt or divide the physical arrangement of an established community or alter an employment center; or
- Cause substantial effects to property values or the local tax base.

3.18.2 Affected Environment

3.18.2.1 CO_2 Capture Facility, Pipeline Corridor, and West Ranch Oil Field

3.18.2.1.1 Population and Housing

Population

The State of Texas had a population of 25,145,561 in 2010 and is expected to grow by approximately 78% over the next 30 years. Of the five counties within the ROI, Fort Bend County was the most populous at 585,375 persons and Jackson County was the least populous at 14,075 persons, according to the 2010 Census. Fort Bend County also had the highest population density (679.5 persons per square mile), while Jackson County had the lowest population density (17.0 persons per square mile). Table 3.18-1 summarizes the population data for the ROI.

Of the 28 cities within the ROI, Pearland had the highest population at 91,252 persons and Ganado had the lowest population at 2,003 persons, according to the 2010 Census. In the ROI, there were five cities with a population of 20,000 persons or higher. Meadows Place had the highest population density (4,946 persons per square mile), while Manvel had the lowest population density (220.3 persons per square mile).

According to the Texas State Data Center (2008), Fort Bend County is expected to more than triple its population to 1,917,470 persons by 2040, while Matagorda County is anticipated to shrink in population by 9% (i.e., a reduction of nearly 3,300 persons) by 2040. Brazoria County is expected to more than double its population to 664,503 persons by 2040. Jackson and Wharton Counties are anticipated to experience modest growth (6.9% and 3.7%, respectively). The Texas State Data Center does not provide city population projections.

Overall, the population within the five county ROI is expected to more than double by year 2040 according to the Texas State Data Center with the greatest increases expected in Fort Bend and Brazoria Counties.

Table 3.18-1. Population in the ROI

Location	2010 Current Population[1]	2010 Population Density (per Square Mile)[2]	2020 Projected Population[3]	2030 Projected Population[3]	2040 Projected Population[3]	Percent Increase 2010 to 2040
Texas	***25,145,561***	***96.3***	***30,858,449***	***37,285,486***	***44,872,038***	***78.4***
Brazoria County	***313,166***	***230.7***	***416,425***	***532,505***	***664,503***	***112.2***
Alvin	24,236	997.7	N/A	N/A	N/A	N/A
Angleton	18,862	1,673.3	N/A	N/A	N/A	N/A
Brazoria	3,019	1,155.6	N/A	N/A	N/A	N/A
Clute	11,211	2,090.2	N/A	N/A	N/A	N/A
Freeport	12,049	805.7	N/A	N/A	N/A	N/A

Table 3.18-1. Population in the ROI

Location	2010 Current Population[1]	2010 Population Density (per Square Mile)[2]	2020 Projected Population[3]	2030 Projected Population[3]	2040 Projected Population[3]	Percent Increase 2010 to 2040
Jones Creek	2,020	782.7	N/A	N/A	N/A	N/A
Lake Jackson	26,849	1,381.0	N/A	N/A	N/A	N/A
Manvel	5,179	220.3	N/A	N/A	N/A	N/A
Pearland	91,252	1,940.9	N/A	N/A	N/A	N/A
Richwood	3,510	1,141.4	N/A	N/A	N/A	N/A
Sweeny	3,684	1,851.3	N/A	N/A	N/A	N/A
West Columbia	3,905	1,525.3	N/A	N/A	N/A	N/A
Fort Bend County	***585,375***	***679.5***	***897,381***	***1,342,877***	***1,917,470***	***227.6***
Katy	14,102	1,253.0	N/A	N/A	N/A	N/A
Meadows Place	4,660	4,946.0	N/A	N/A	N/A	N/A
Missouri City	67,358	2370.4	N/A	N/A	N/A	N/A
Needville	2,823	1640.1	N/A	N/A	N/A	N/A
Richmond	11,679	2,973.2	N/A	N/A	N/A	N/A
Rosenberg	30,618	1,361.9	N/A	N/A	N/A	N/A
Stafford	17,693	2,529.9	N/A	N/A	N/A	N/A
Sugar Land	78,817	2,434.2	N/A	N/A	N/A	N/A
Weston Lakes	2,482	936.2	N/A	N/A	N/A	N/A
Jackson County	***14,075***	***17.0***	***15,978***	***15,801***	***15,043***	***6.9***
Edna	5,499	1,330.2	N/A	N/A	N/A	N/A
Ganado	2,003	1,719.6	N/A	N/A	N/A	N/A
Matagorda County	***36,702***	***33.4***	***38,566***	***36,589***	***33,403***	***-9.0***
Bay City	17,614	1,985.1	N/A	N/A	N/A	N/A
Palacios	4,718	955.2	N/A	N/A	N/A	N/A
Wharton County	***41,280***	***38.0***	***45,348***	***45,128***	***42,789***	***3.7***
East Bernard	2,272	600.2	N/A	N/A	N/A	N/A
El Campo	11,602	1,400.1	N/A	N/A	N/A	N/A
Wharton	8,832	1,180.0	N/A	N/A	N/A	N/A
Five-County ROI	***990,598***	***199.7***	***1,413,698***	***1,972,900***	***2,673,208***	***169.9***

Note: Texas State Data Center does not provide city population projections.
Projected population from Texas State Data Center uses the 2000-2007 Migration Rate.
N/A – Not Available

Source: [1] U.S. Department of Commerce, Bureau of the Census, Census 2010. Table DP-1
[2] U.S. Department of Commerce, Bureau of the Census, Census 2010. Summary File 1, Geographic Header Record G001
[3] Texas State Data Center 2008

Housing

There were 9,977,436 housing units in Texas in 2010, with approximately 10.6% vacant. Because Fort Bend County is so populous, it also had the largest amount of housing units in the ROI. Additionally, because Jackson County is the least populous, it had the least amount of housing units in the ROI, according to the 2010 Census. Housing data for the ROI is summarized in Table 3.18-2.

Brazoria and Wharton Counties experienced vacancy rates similar to the Texas average in 2010 (9.9% and 11.6%, respectively). While Fort Bend County's housing vacancy rate (4.9%) was nearly half of the Texas average vacancy rate, both Jackson and Matagorda Counties experienced significantly higher vacancy rates as compared to rest of Texas (19.8% and 26.1%, respectively).

A March 2012 internet-based search of the ROI determined that Brazoria County offered the highest number of rooms for temporary lodging with approximately 59 hotels/motels, while Jackson County had the least number of rooms with approximately seven hotels/motels. Of the 28 cities within the ROI, Bay City had the largest number of hotels/motels at 19, while Jones Creek, Richwood, Sweeny, Meadows Place, Needville, Richmond, Weston Lakes, and East Bernard did not have any hotels/motels that could be used for temporary lodging (i.e., by temporary construction workers).

Overall, there are approximately 29,600 vacant housing units within the five county ROI with a median home value of $111,700. Additionally, there are 150 hotel/motel facilities within the five county ROI. Of the 150 hotel/motels over half are within a reasonable commute distance to the proposed project area (i.e., within 20 miles).

Table 3.18-2. Housing and Occupancy in the ROI

Location	2010 Housing Units[1]	2010 Occupied Housing Units[1]	2010 Vacant Housing Units[1]	2010 Percent of Vacant Housing Units[1]	2010 Median Home Value[2]	2012 Hotels/ Motels[3]
Texas	***9,977,436***	***8,922,933***	***1,054,503***	***10.6***	***$123,500***	***N/A***
Brazoria County	***118,336***	***106,589***	***11,747***	***9.9***	***$140,300***	***59***
Alvin	9,645	8,742	903	9.4	$104,800	7
Angleton	7,621	6,923	698	9.2	$100,600	9
Brazoria	1,257	1,147	110	8.8	$84,200	2
Clute	4,549	3,896	653	14.4	$73,300	11
Freeport	4,668	3,827	841	18	$65,600	6
Jones Creek	812	726	86	10.6	$90,400	0
Lake Jackson	11,149	10,319	830	7.4	$134,600	5
Manvel	1,983	1,846	137	6.9	$168,400	4
Pearland	33,169	31,222	1,947	5.9	$173,700	10
Richwood	1,491	1,335	156	10.5	$119,500	0
Sweeny	1,558	1,381	177	11.4	$85,400	0
West Columbia	1,673	1,477	196	11.7	$88,300	5
Fort Bend County	***197,030***	***187,384***	***9,646***	***4.9***	***$171,500***	***47***
Katy	4,972	4,752	220	4.4	$140,700	15
Meadows Place	1,764	1,715	49	2.8	$144,900	0
Missouri City	23,374	22,376	998	4.3	$157,000	1
Needville	1,098	1,027	71	6.5	$92,400	0
Richmond	3,801	3,517	284	7.5	$100,500	0
Rosenberg	11,162	10,163	999	9	$98,100	16
Stafford	7,074	6,750	324	4.6	$149,200	9
Sugar Land	27,727	26,709	1,018	3.7	$230,800	6
Weston Lakes	985	930	55	5.6	$362,200	0
Jackson County	***6,590***	***5,284***	***1,306***	***19.8***	***$77,500***	***7***
Edna	2,509	2,054	455	18.1	$69,900	5
Ganado	765	672	93	12.2	$61,900	2
Matagorda County	***18,801***	***13,894***	***4,907***	***26.1***	***$83,400***	***23***
Bay City	7,856	6,648	1,208	15.4	$81,300	19
Palacios	1,987	1,611	376	18.9	$61,000	4
Wharton County	***17,127***	***15,132***	***1,995***	***11.6***	***$85,800***	***14***
East Bernard	909	838	71	7.8	$143,800	0
El Campo	4,491	4,140	351	7.8	$85,400	7
Wharton	3,928	3,468	460	11.7	$79,600	7
Five-County ROI	***357,884***	***328,283***	***29,601***	***14.5***	***$111,700***	***150***

Note: N/A – Not Available
Source: [1] U.S. Department of Commerce, Bureau of the Census, Census 2010. Table DP-1
[2] U.S. Department of Commerce, Bureau of the Census, Census 2010. Table DP04
[3] Google 2012

3.18.2.1.2 Economy and Employment

The average per capita income of persons in Texas was $23,863 according to the 2010 Census. Of the five counties within the ROI, the residents of Brazoria, Fort Bend, and Jackson Counties had higher average per capita incomes, while Matagorda and Wharton County residents had slightly lower average per capita income than the State of Texas. Of the 28 cities within the ROI, Weston Lakes had the highest average per capita income ($57,563), while Palacios and Wharton had the lowest average per capita incomes ($15,622 and $15,652, respectively). Income, labor force, and employment information is summarized in Table 3.18-3.

According to the 2010 Census, there were 12,363,612 civilian laborers in the State of Texas, with Fort Bend County having the highest number of civilian laborers at 273,604 and Jackson County having the lowest at 6,987. Of the 28 cities within the ROI, Pearland had the highest number of civilian laborers at 44,430 and Jones Creek had the lowest at 774.

According to the 2010 Census, the unemployment rate for Texas was 5.7%, with Brazoria County at 3.6% unemployed, Fort Bend County at 3.5% unemployed, Jackson County at 3.4% unemployed, Matagorda County at 6.4% unemployed, and Wharton County at 4.0% unemployed. Of the 28 cities within the ROI, Bay City had the highest unemployment rate at 8.8% and Weston Lakes had the lowest unemployment rate at 1.1% in 2010. The Texas Workforce Commission stated unemployment rate for Texas was up to 7.6% in 2012. Similarly, the unemployment rates for the five counties within the ROI were also higher in 2012, as shown in Table 3.18-3. 2012 unemployment rates for cities in Texas were not available, but are also expected to be higher due to current economic conditions experienced throughout Texas and the rest of the U.S.

Major employers in the ROI were the educational services, healthcare, and social assistance industries in 2010. Of the 28 cities within the ROI, only three cities had construction as the major employment by industry and another three cities had manufacturing as the major employment by industry.

Overall, the five county ROI had a higher per capita income as compared to the State of Texas in 2010. The five county ROI experienced a lower 2010 unemployment rate compared to the State of Texas. However, each county's unemployment rate was higher in 2012 than in 2010. Based on the recent unemployment data, there should be an ample supply of workers available to support the proposed project.

Table 3.18-3. Income, Labor, and Employment in the ROI

Location	2010 Average Per Capita Income (U.S. Dollars)[1]	2010 Civilian Labor Force (persons)[1]	2010 Un-employment Rate (%)[1]	January 2012 Un-employment Rate (%)[2]	2010 Major Employment by Industry (%)[1]
Texas	***$23,863***	***12,363,612***	***5.7***	***7.6***	***Educational services, healthcare, and social assistance (21.8)***
Brazoria County	***$27,529***	***147,009***	***3.6***	***8.5***	***Educational services, healthcare, and social assistance (21.8)***
Alvin	$18,789	10,180	4.0	N/A	Educational services, healthcare, and social assistance (19.7)

Table 3.18-3. Income, Labor, and Employment in the ROI

Location	2010 Average Per Capita Income (U.S. Dollars)[1]	2010 Civilian Labor Force (persons)[1]	2010 Un-employment Rate (%)[1]	January 2012 Un-employment Rate (%)[2]	2010 Major Employment by Industry (%)[1]
Angleton	$22,418	9,880	6.2	N/A	Educational services, healthcare, and social assistance (18.7)
Brazoria	$22,997	1,478	4.0	N/A	Construction (13.5)
Clute	$17,250	5,209	3.9	N/A	Construction (20.5)
Freeport	$16,866	5,629	4.1	N/A	Construction (24.0)
Jones Creek	$24,918	774	2.6	N/A	Educational services, healthcare, and social assistance (20.0)
Lake Jackson	$30,279	13,076	3.2	8.5	Manufacturing (24.5)
Manvel	$25,601	2,227	3.0	N/A	Educational services, and healthcare, and social assistance (18.8)
Pearland	$34,052	44,430	3.2	6.2	Educational services, healthcare, and social assistance (27.0)
Richwood	$24,382	1,914	8.1	N/A	Manufacturing (19.3)
Sweeny	$19,748	1,623	7.7	N/A	Manufacturing (24.2)
West Columbia	$17,556	1,687	3.3	N/A	Educational services, healthcare, and social assistance (19.9)
Fort Bend County	***$32,016***	***273,604***	***3.5***	***6.7***	***Educational services, healthcare, and social assistance (23.3)***
Katy	$25,436	6,961	2.7	N/A	Educational services, healthcare, and social assistance (16.3)
Meadows Place	$34,525	2,554	4.4	N/A	Educational services, healthcare, and social assistance (22.2)
Missouri City	$31,189	34,526	4.7	7.1	Educational services, healthcare, and social assistance (27.0)
Needville	$23,242	1,328	3.2	N/A	Educational services, healthcare, and social assistance (19.8)
Richmond	$17,911	5,471	2.9	N/A	Educational services, healthcare, and social assistance (23.1)
Rosenberg	$18,645	14,107	4.5	7.2	Educational services, healthcare, and social assistance (24.3)
Stafford	$27,082	9,982	3.7	N/A	Educational services, healthcare, and social assistance (23.2)

Table 3.18-3. Income, Labor, and Employment in the ROI

Location	2010 Average Per Capita Income (U.S. Dollars)[1]	2010 Civilian Labor Force (persons)[1]	2010 Un-employment Rate (%)[1]	January 2012 Un-employment Rate (%)[2]	2010 Major Employment by Industry (%)[1]
Sugar Land	$41,897	39,664	3.4	5.7	Educational services, healthcare, and social assistance (21.1)
Weston Lakes	$57,563	1,035	1.1	N/A	Educational services, healthcare, and social assistance (20.1)
Jackson County	***$24,337***	***6,987***	***3.4***	***6.1***	***Educational services, healthcare, and social assistance (22.7)***
Edna	$23,092	2,547	4.9	N/A	Educational services, healthcare, and social assistance (26.7)
Ganado	$19,838	918	2.6	N/A	Educational services, healthcare, and social assistance (17.6)
Matagorda County	***$22,623***	***17,282***	***6.4***	***11.6***	***Educational services, healthcare, and social assistance (21.2)***
Bay City	$21,430	8,155	8.8	N/A	Educational services, healthcare, and social assistance (22.9)
Palacios	$15,622	2,030	8.5	N/A	Educational services, healthcare, and social assistance (24.6)
Wharton County	***$21,049***	***20,542***	***4.0***	***8.1***	***Educational services, healthcare, and social assistance (22.7)***
East Bernard	$26,918	1,387	2.7	N/A	Educational services, healthcare, and social assistance (24.6)
El Campo	$21,841	5,809	5.4	N/A	Educational services, healthcare, and social assistance (18.1)
Wharton	$15,652	3,876	5.1	N/A	Educational services, healthcare, and social assistance (29.5)
Five-County ROI	***$25,511***	***465,424***	***4.2***	***8.2***	***Educational services, healthcare, and social assistance (22.5)***

Note: N/A – Not Available
Source: [1] U.S. Department of Commerce, Bureau of the Census, Census 2010. Table DP03
[2] Texas Workforce Commission 2012

3.18.2.1.3 Taxes and Revenue

The Texas Comptroller's Office serves the state by collecting more than 60 separate taxes, fees, and assessments, including local sales taxes collected on behalf of cities, counties, and other local governments around the state. Of the 28 cities within the ROI, nearly all had a sales tax rate of 8.25%, with two exceptions: Jones Creek in Brazoria County had a sales tax rate of 7.75%, while East Bernard in Wharton County had a sales tax rate of 8.0% (Texas Comptroller 2012a).

There is no individual income tax in Texas, but the state does levy sales, luxury, estate, and corporate income taxes. Only those revenues reported by the federal or state government (e.g., income and sales taxes) were considered in this analysis. Revenue information was gathered at the county level. Sales taxes apply to the retail sale of personal property or services in the state. Texas levies a 6.25% general sales tax (transaction privilege) on consumers, which is just above the national average of 5.4%.

Property taxes are levied by school districts, cities, counties, and special districts in Texas. Table 3.18-4 lists the total property tax rate for each county in the ROI, along with revenues received for 2010. Total revenue collected from property taxes in 2010 for the ROI was $493,508,263.

Table 3.18-4. Property Tax Rates and Revenues in the ROI

Location	2010 Total Property Tax Rate [1]	2010 Revenue
Brazoria County	0.463101	$146,643,380 [2]
Fort Bend County	0.480160	$295,823,687 [3]
Jackson County	0.557600	$8,427,394 [4]
Matagorda County	0.274780	$20,366,668 [5]
Wharton County	0.531830	$22,247,134 [6]
Five-County ROI	N/A	$493,508,263

Source: [1] Texas Comptroller of Public Accounts 2012b
[2] Brazoria County 2010
[3] Fort Bend County 2010a
[4] Jackson County 2010
[5] Matagorda County 2010
[6] Wharton County 2010

3.18.3 Direct and Indirect Impacts of the Proposed Project

DOE assessed the potential for impacts to the socioeconomic conditions in the five-county ROI based on whether the proposed project would result in any of the effects identified in Section 3.18.1.3.

3.18.3.1 Construction Impacts

3.18.3.1.1 Population and Housing

Population

Table 3.18-5 presents proposed schedule and workforce information for activities associated with construction and operations of the proposed project. NRG anticipates that construction would begin in **June 2013** and be complete in 24 months. The order in which each facility would be constructed may vary, depending on the capabilities of each contractor, available work force, and optimized logistics, but would generally follow the schedule outlined in Table 3.18-5.

Construction Spreads – A pipeline construction project looks much like a moving assembly line. A large project is typically broken into manageable lengths called "spreads." Each spread is composed of various crews, each with its own responsibilities. The tasks typically include: (1) clearing, grading, and trenching; (2) stringing and welding pipe segments together; (3) laying the pipeline, backfilling, and testing; and (4) restoration. As one crew completes its work, the next crew moves into position to complete its part of the construction process. Construction spreads may be 30 to 100 miles in length, with the front of the spread clearing the ROW and the back of the spread restoring the ROW.

The proposed CO_2 capture facility labor effort at the W.A. Parish Plant would ramp up to the peak workforce of 600 by **April 2014**, and maintain that peak for approximately five months until **August 2014**. The construction workforce would then gradually decrease over the next 10 months.

NRG anticipates that proposed CO_2 pipeline construction would be conducted simultaneously to the CO_2 capture facility using one construction spread. The pipeline labor effort would ramp up to the peak workforce of 500 by **October 2014**. The construction workforce would then gradually decrease over the next several months. During the last month, work crews would complete re-vegetation and restoration efforts and complete work around the end of **February 2015**.

Construction of the proposed EOR and CO_2 monitoring facilities at the West Ranch oil field would commence once the CO_2 pipeline is complete, and last for approximately **five** months, or from approximately **February 2015** through **June 2015**.Twelve construction workers would be needed for the EOR facilities, while five construction workers would be needed for the CO_2 monitoring infrastructure. The actual number of workers would vary depending on the pace of development.

NRG estimates the total construction labor force for the proposed project to require approximately 1,100 workers, as shown in Table 3.18-5. For the purposes of this analysis, and based on similar projects across the U.S., projects of this specialized nature typically result in a 60% non-local workforce and a 40% local workforce split. The resulting labor force split would be approximately 660 non-local workers and approximately 440 local workers.

The local workforce would likely be hired from within the five-county ROI, and consist of 65% skilled labor and 35% unskilled labor. The non-local workforce would likely include skilled labor from outside the ROI. In addition, a small increase in secondary local employment would be anticipated to provide goods, hospitality, and transportation services to the construction workforce. DOE anticipates that, based on the 8.2% unemployment rate in the ROI in 2012 shown in Table 3.18-3, the existing local workforce should be adequate to accommodate the anticipated construction employment requirements.

Table 3.18-5. Proposed Project Construction Schedule and Workforce

Facility/Spread	Current Workforce	Construction Start Date	Construction Completion Date	Estimated Construction Peak Workforce	Estimated Construction Peak Local Workforce	Estimated Permanent Workforce
W.A. Parish Plant	385	--	--	--	--	--
CO_2 Capture Facility	0	**June 2013**	**June 2015**	600 (Average **300**)	240 (Average **120**)	15
CO_2 Pipeline Spread	0	**July** 2014	**February 2015**	500 (Average **250**)	200 (Average **100**)	2
EOR at West Ranch Oil Field	6	**January** 2014	**June** 2015	12	5	0

Table 3.18-5. Proposed Project Construction Schedule and Workforce

Facility/Spread	Current Workforce	Construction Start Date	Construction Completion Date	Estimated Construction Peak Workforce	Estimated Construction Peak Local Workforce	Estimated Permanent Workforce
CO_2 Monitoring at West Ranch Oil Field	0	**January 2014**	**June** 2015	5	0	3
Total	**391**	**--**	**--**	**1,117 (Average 550)**	**447 (Average 220)**	**20**

Note: Dates presented are estimates. Actual construction start and completion dates would be dependent on the weather, date of receipt of the air permit, etc. 40% of labor is assumed to come from the local workforce.
EOR – enhanced oil recovery
Source: NRG 2012e

Because of the long history of oil and gas-related activities in the ROI, a substantial percentage of the workforce for the proposed project would be local. Overall, because of the short duration of the construction period, population effects of the proposed project are expected to be negligible. For the reasons described above, the proposed project would not induce substantial population growth, either directly or indirectly. In addition, a small increase in secondary local employment is anticipated in order to provide goods, hospitality, and transportation services to the workforce.

Housing

Approximately 60% of the construction workforce associated with the proposed project would be comprised of non-local contract workers. Because the work would be completed within 24 months, non-local workers would likely utilize existing housing facilities, such as vacant houses, hotels/motels, rental homes, mobile homes, and camping facilities. As indicated in Table 3.18-2, there are 29,601 vacant housing units and 150 hotel/motel facilities in the five-county ROI, with several options available for camping and mobile home facilities. Thus, the existing stock of vacant housing units and hotel/motel facilities in the ROI should be sufficient to accommodate both the peak construction demand related to the proposed project and other persons visiting the region (e.g., construction workers assigned to other projects). No new housing construction is likely to occur as a direct result of the proposed project because of the short duration of the construction phase.

DOE anticipates minimal population and housing effects since the **proposed** project avoids homes and population centers, thereby minimizing the risk of existing housing displacement. Additionally, the anticipated 60% non-local construction workforce (approximately 660 workers) would not result in a permanent population increase in the ROI because of the temporary nature of the construction activities. For the reasons described above, the proposed project would not displace a substantial number of people or housing, necessitating the construction of replacement housing elsewhere. Impacts related to construction workforce housing would be short-term and negligible.

3.18.3.1.2 Economy and Employment

NRG's proposed project would include construction within two existing industrial facilities (i.e., the W.A. Parish Plant and the West Ranch oil field) and along a proposed, approximately **81**-mile pipeline corridor. The pipeline ROW would be collocated along or within existing mowed/maintained utility ROWs for more than **75**% of its length. As such, the proposed project has been sited to avoid major land use conflicts. Therefore, implementation of the proposed project would not disrupt or divide an established community, change planned residential or commercial developments, or alter an employment center during construction.

The total construction labor effort for the proposed project is estimated to require approximately 1,100 workers. As shown in Table 3.18-5, approximately 440 workers are anticipated to be local labor and 660 workers would be non-local. It is assumed that because of the size of the available civilian labor force, coupled with an unemployment rate of 8.2% shown in Table 3.18-3, the ROI would be able to provide a sufficient amount of workers for construction-related activities. The anticipated 660 non-local workers would generate beneficial economic impacts regarding the consumption of goods, hospitality, and transportation services over the 24 month construction period. The impact of the short duration construction period would result in increased employment opportunities and expenditures in the local economy, but a minimal long-term decline in local unemployment.

As part of its DOE funding agreement, NRG would provide project-related payroll information to DOE to demonstrate compliance with the prevailing wage standards specified by the Davis-Bacon Act **of 1931**. Additionally, per NRG's agreement with the DOE, implementation of the Parish PCCS Project would not result in an increase in the cost of electricity.

3.18.3.1.3 Taxes and Revenue

Payroll and Wages

The local payroll expenditures during construction cannot be accurately estimated by NRG at this stage of proposed project planning. In order to provide a first approximation of payroll expenditures, an estimate was developed based on the schedule and staffing needs as shown in Table 3.18-5**. The estimated payroll is based on the following assumptions:**

- **All workers are paid for 240 hours per month (four weeks/month, 10 hours/day, six days/week).**
- **Forty percent of both skilled and unskilled workers would be hired locally, with the remainder of the workers being hired from outside of the ROI.**
- **Local hires are attributed to the counties in proportion to the pipeline mileage within the respective county.**
- **The hourly wage for skilled labor is $40 and for unskilled labor it is $20**.
- **The payroll rate is equal to 1.5 times the wage rate.**
- **Overtime pay, which was not included in this estimate, would increase the estimated payroll and wages above those shown in Table 3.18-6.**

Based on these assumptions, Table 3.18-6 shows the estimated local construction wage rate by county. The total estimated wages paid during construction is nearly $75 million, with local wages at nearly $30 million.

Table 3.18-6. Local Payroll and Sales Tax Revenues

County	Estimated Total Construction Payroll (dollars)	Estimated Total Construction Wages (dollars)[1]	Estimated Local Construction Wages (dollars)[1 2]	Estimated Sales Tax on Purchases Locally (dollars)
Brazoria County	--	--	--	--
Fort Bend County	**$67,535,000**	**$45,023,333**	**$18,009,333**	**$127,000**
Jackson County	**$18,102,000**	**$12,068,000**	**$4,827,200**	**$150,000**
Matagorda County	**--**	**--**	**--**	**--**
Wharton County	**$27,817,000**	**$18,554,667**	**$7,417,867**	**$235,000**
Five-County ROI	**$113,454,000**	**$75,636,000**	**$30,254,400**	**$512,000**

Note: The proposed project does not include facilities in Brazoria or Matagorda Counties. However, secondary local employment is anticipated in order to provide goods, hospitality, and transportation services to the workforce. **At this time, it is too speculative to estimate exact numbers of secondary local employment, payroll, wages, and sales taxes. No estimates are shown.**

Source: [1] NRG 2012e.
[2] Assumes local hires are 40% of both skilled and unskilled labor.

Sales Taxes

During proposed project construction, it is assumed that purchases would be made from local sources for vehicle fuel and a wide variety of construction materials. In addition, non-local workers would spend part of their income for short-duration lodging and food. These expenses cannot be accurately estimated at this stage of proposed project planning. In order to provide a first approximation of the local revenues associated with these expenditures several assumptions were necessary:

- **Fuel, concrete, paint, etc., costs were based on estimates obtained for a recent project, proportioned on a per-mile basis.**
- **Sales-taxable expenditures by county are proportional to the pipeline mileage in that county.**
- **All purchases are taxable at the general sales tax rate in each county.**
- **Motor fuel (diesel) was assumed to cost $3.50 per gallon.**

Based on these assumptions, Table 3.18-6 shows the estimated local sales tax revenues by county due to construction activities. The total estimated sales taxes would provide an estimated $512,000 in revenues.

Property Taxes

The property tax revenues generated would be based on the annual assessment multiplied by the local property tax rate. The annual assessment would be determined by the Comptroller of Public Accounts. The proposed project's facilities would be valued at their fair market value as of each January 1st. In order to approximate the annual property tax revenues accruing to the counties, it is assumed that, at least initially, construction cost would approximate fair market value. The other assumptions include:

- **A uniform millage rate would apply across all counties.**
- **The cost of the proposed project, excluding the cost of the CO_2 capture facility and other aboveground facilities, would be proportional to the percentage of the pipeline ROW located in that county.**

For the proposed project, the following specific assumptions were applied:

- **The total proposed project cost is estimated to be $775,000,000**.
- **The composite estimated statewide local property tax rate in Fort Bend, Jackson, and Wharton Counties is 52.32 mills (5.232%).**
- **The CO_2 capture facility construction in Fort Bend County is estimated to cost $684,800,000**
- **The CO_2 pipeline construction is estimated to cost $85,000,000 with the estimated land acquisition cost at 20% of the total, or $17,000,000.**
- **Two metering and regulation stations are assumed with the CO_2 pipeline, one in Fort Bend County and one in Jackson County. Each station is estimated to cost $600,000 for a total of $1,200,000.**
- **The EOR and MVA at West Ranch oil field is estimated to cost $4,000,000.**

Using the above assumptions, the estimated property tax revenues accruing to each county are presented in Table 3.18-7. It should be noted that these values are only general estimates of the actual revenues that would be received by the counties during the first year after the proposed project goes into full service. Property tax revenues are estimated to total approximately $24 million per year, once the proposed project is complete.

Table 3.18-7. Estimated Property Tax Revenues

County	Percentage of Route[1]	Estimated Value of ROW in County	Estimated Value of Aboveground Facilities in County [1]	Estimated CO_2 Capture Facility & EOR/CO_2 Monitoring Value in County[1]	Estimated Land Acquisition Cost[1]	Total Value In County	Total Annual Property Tax Revenue
Brazoria County	--	--	--	--	--	--	--
Fort Bend County	24.8%	$192,558,000	$600,000	$684,800,000	$4,223,800	$882,181,800	$14,079,622
Jackson County	29.3%	$226,876,000	$600,000	$4,000,000	$4,976,600	$236,365,600	$3,773,783
Matagorda County	--	--	--	--	--	--	--
Wharton County	45.9%	$355,556,000	$0	$0	$7,799,600	$363,365,600	$5,799,315
Five-County ROI	100.0%	$775,000,000	$1,200,000	$688,800,000	$17,000,000	$1,482,000,000	$23,652,720

Note: The proposed project does not include facilities in Brazoria or Matagorda Counties. No property tax benefits would occur.
Source: [1] NRG 2012e.

Synopsis

For the reasons described above, NRG's proposed project would likely result in a moderate, beneficial impact to taxes and revenue within the ROI. Construction of the proposed project would generate revenue through additional state and local taxes over the duration of the construction period. Local entities would benefit from temporarily increased sales tax revenues resulting from **proposed** project-related spending on payroll and construction materials. DOE anticipates that construction workers would spend their wages on short-term housing, food, and other personal items within the ROI. Additional sales tax revenues could result from taxes embedded in the price of consumer items such as gasoline. Therefore, an indirect and beneficial short-term impact could be expected for the local economy from increased spending and related sales tax revenue.

3.18.3.2 Operational Impacts

3.18.3.2.1 Population and Housing

During the operations phase, NRG estimated that 15 permanent employees would be hired at the CO_2 capture facility and three permanent employees would be hired for the CO_2 monitoring activities (see Table 3.18-3). Two new permanent employees would be hired for operation of the CO_2 pipeline. No new permanent employees are anticipated for EOR operations at the West Ranch oil field. The majority of these 20 employees would likely be hired from the local workforce. Because of the small number of permanent employees, DOE expects the long-term effects to population and housing due to implementation of the proposed project to be negligible. Whether the permanent employees are hired from the existing local workforce or from outside (including either within or outside of the ROI), the extent of immigration is expected to be minimal due the small number of workers to be hired as permanent employees. Therefore, the proposed project would not induce substantial population growth, either directly or indirectly, during operation and would also not cause substantial effects to property values or the local tax base. Because of the small number of permanent employees (i.e., 20), DOE anticipates no effects on housing stock or population due to the proposed project operations.

3.18.3.2.2 Economy and Employment

DOE does not anticipate the industrial development associated with the proposed project to negatively affect any of the communities within the ROI. Operation of the proposed project would not disrupt or divide an established community, change planned residential or commercial developments, or alter an employment center during operations.

During the operations phase, NRG estimated that approximately 20 permanent employees would be hired to support the proposed project (see Table 3.18-5). The majority of these 20 employees would likely be hired from the local workforce. Because of the small number of permanent employees, economic and employment impacts due to the proposed project are expected to be beneficial, but negligible. The impact of the operational period would result in minor employment opportunities and expenditures in the local economy.

As part of its DOE funding agreement, NRG would provide **proposed** project-related payroll information to DOE to demonstrate compliance with the prevailing wage standards specified by the Davis-Bacon Act **of 1931**. Additionally, per NRG's agreement with the DOE, implementation of the Parish PCCS Project would not result in an increase in the cost of electricity.

3.18.3.2.3 Taxes and Revenue

There would be a negligible, long-term, beneficial impact to taxes and revenue within the ROI from operation of the Parish PCCS Project. The estimated 20 employees who would fill new jobs created by the proposed project could generate sales and use tax revenues within the ROI. DOE anticipates this increase in revenue to be negligible.

The State of Texas offers many legislatively enacted production tax structures. Under the State's tax code, oil produced using methods involving the injection of CO_2 into an oil-bearing formation falls into two categories of tax rate - using CO_2 for EOR and using anthropogenic CO_2 for EOR. The Parish PCCS project would fall into both categories, which would result in an effective oil production tax rate of 1.15% (Texas Comptroller 2012c). The legislative record indicates the intent of these tax structures is to increase oil production in a manner that likewise increases tax revenue to the State. Consistent with the legislative intent, and as Section 2.3.4 of this EIS indicates, the Parish PCCS project is expected to substantially increase the rate of oil production from the West Ranch oil field and therefore increase tax revenue to the State. TCV's portion of the West Ranch oil field currently has approximately two million barrels of conventional proven oil reserves. TCV estimates that using CO_2 floods (i.e., EOR), the West Ranch oil field could produce an additional 55 to 75 million barrels of oil. This projected increase in oil production is expected to translate directly into additional revenues for the State of Texas, even after taking into account the tax exemptions related to use of CO_2 for EOR and use of CO_2 from anthropogenic sources.

3.18.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for the Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the **proposed** project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The **proposed** project would not be constructed and there would be no change to socioeconomic conditions in the ROI.

Under the No-Action Alternative, NRG plans to proceed with construction and operation of a natural gas-fired cogeneration plant without DOE funding for other purposes not related to the Parish PCCS project. This plant would begin operation in 2013. The construction work force is expected to peak at approximately 100 persons and should diminish as construction activities come to an end and the project moves into the startup / commissioning phase of the project. The operations of the cogeneration plant will be performed by existing W.A. Parish plant personnel; additional personnel should not be required. No socioeconomic impacts are anticipated due to operation of the cogeneration plant. Due to the short duration of the construction period, population effects of construction of the cogeneration plant are expected to be negligible. The ROI is expected to be able to provide a sufficient amount of workers for construction-related activities. The non-local workers would generate beneficial economic impacts regarding the consumption of goods, hospitality, and transportation services over the construction period. Construction of the cogeneration plant would likely result in a moderate, beneficial impact to taxes and revenue within the ROI.

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3.19 ENVIRONMENTAL JUSTICE

3.19.1 Introduction

This section identifies and describes the existing status and distribution of minority and low-income populations potentially affected by the construction and operation of the proposed project. This section also analyzes the potential environmental justice impacts of the proposed project on those populations.

The EPA defines environmental justice as "the fair treatment and meaningful involvement of all people, regardless of race, ethnicity, culture, income, or education level with respect to development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that racial, ethnic, or socioeconomic groups should not bear a disproportionate share of negative environmental consequences resulting from industrial, municipal, and commercial operations, or from the execution of federal, state, and local laws, regulations, and policies" (EPA 1998).

Executive Order (EO) 12898, Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations, (White House, 1994) requires that each federal agency address disproportionately high and adverse health or environmental effects of its programs, policies, and activities on minority and low-income populations. EO 12898 supplemented Title VI of the Civil Rights Act of 1964. In addition, EO 12898 is supplemented by more than 30 federal statutes, regulations, executive orders, and directives regarding non-discrimination.

3.19.1.1 Region of Influence

The ROI for this environmental justice analysis includes the area within nine census tracts in Fort Bend, Wharton, and Jackson Counties in southeast Texas as shown in Figure 3.19-1. Unlike the socioeconomic analysis (Section 3.18), the environmental justice analysis focuses on the approved U.S. Department of Commerce, Bureau of Census **(U.S. Census Bureau)** 2010 census tract information for minority and low-income populations located in the immediate vicinity of the W.A. Parish Plant, the proposed pipeline corridor, and the West Ranch oil field. As a part of this analysis, only those census tracts that contain components of the proposed project are considered and were evaluated for environmental justice impacts as they provide the best understanding of minority and low-income populations in the ROI.

3.19.1.2 Method of Analysis

For the purposes of this analysis, **U.S. Census Bureau** data for year 2010 was collected for the United States; State of Texas; Fort Bend, Wharton, and Jackson Counties; and the nine census tracts that contain components of the proposed project. The **U.S. Census Bureau** data are collected for total population, age, sex, ethnicity, and household information, among many other items. The environmental justice analysis is concerned with minority and low-income population data within a specific geographic area to determine the existence of such populations.

According to the **U.S. Census Bureau**, **ethnicity data is collected by two main population categories, race and Hispanic/Latino origin, following guidance of the U.S. Office of Management and Budget's 1997 *Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity*. This guidance mandates that race and Hispanic origin (ethnicity) are separate and distinct concepts. Racial groups include the following breakdown:** Black or African Americans, American Indians or Alaskan Natives, Asians, Native Hawaiian or Other Pacific Islanders, other races, and persons reporting two or more races. **Hispanic groups include the following breakdown: Cuban,**

Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race. DOE used these **two main** population categories to determine the percentage of the total population that self-reported as a minority for each census tract analyzed. People identify**ing** their origin as Hispanic may be of any race **(U.S. Department of Commerce 2011)**.

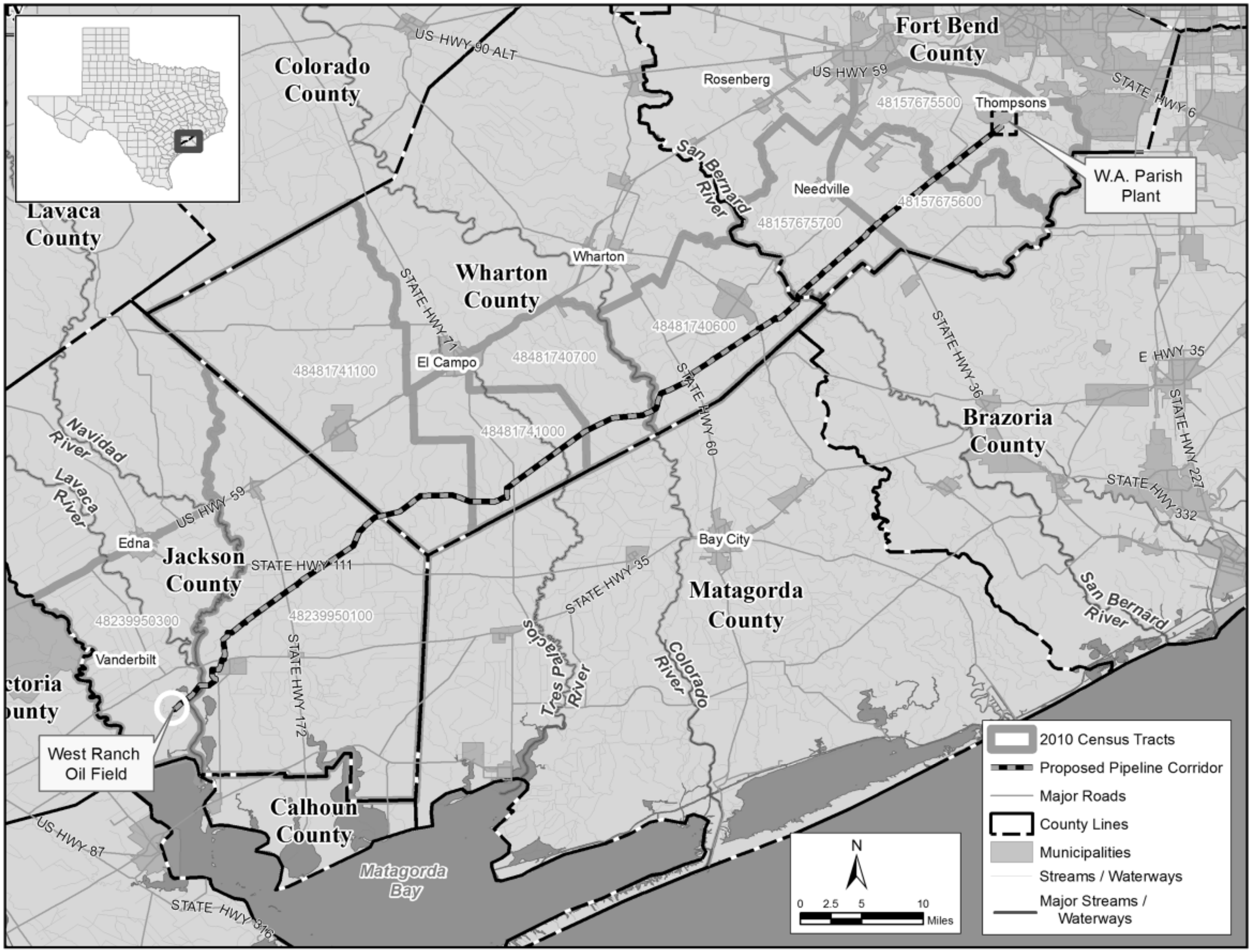

Figure 3.19-1. Environmental Justice Census Tracts

DOE used thresholds to **identify** minority environmental justice areas of concern, instead of an absolute number. These thresholds are based on percentages of minority populations and reflect the composition of minorities more appropriately than would the use of absolute numbers, as total population within census tracts vary. For a location to be considered a potential environmental justice area of concern, the minority population of that area must be "meaningfully greater" than that of the respective county. According to guidance set forth by the **EPA**, the affected area should be interpreted as the area in which the proposed project would or may have an effect on. The guidance also advises agencies not to "artificially dilute or inflate" the minority population when selecting the appropriate unit of geographic analysis. The selection of the appropriate unit of geographic analysis may be a "governing body's jurisdiction, a neighborhood census tract, or other similar unit" (EPA 1998). Therefore, absent a defined threshold by EPA or CEQ for the definition of a minority environmental justice area of concern in this EIS, DOE chose to define a county with a minority population that is greater than two times the state minority population percentage as having a meaningfully greater minority population than the state and, therefore, as an environmental justice area of concern. Likewise, DOE chose to define a census tract with a minority population that is greater than two times the corresponding county minority population percentage as having a meaningfully greater minority population than the corresponding county and, therefore, as an environmental justice area of concern.

Because people who identify their origin as Hispanic may be of any race, DOE conducted a secondary analysis based on additional EPA guidance, which specifies an environmental justice area of concern is determined if the population is more than 50 percent minority or if the percentage of minority population is 25 percent higher than the percentage of minority population in the corresponding county where the proposed project is located. An environmental justice area of concern could occur when one of these thresholds is reached.

There are two options for defining low-income populations: (1) a percentage of persons below the respective state/county poverty level (based on **U.S. Census Bureau** data) or (2) poverty status (based on the U.S. Department of Health and Human Services Poverty Guidelines). For the purposes of this EIS, DOE has defined a county with a population percentage below the poverty level that is greater than two times the state population percentage below the poverty level as having a meaningfully greater low-income population than the state and, therefore, as an environmental justice area of concern. Likewise, DOE has defined a census tract with a population percentage below the poverty level that is greater than two times the corresponding county population percentage below the poverty level as having a meaningfully greater low-income population than the corresponding county and, therefore, as an environmental justice area of concern. Additionally, DOE compared the median income of each census tract and county in the ROI to the 2010 Health and Human Services Poverty Guidelines for a family of four within the 48 contiguous states, which is $22,050 (HHS 2010). A census tract or county with a 2010 median household income less than $22,050 would also be considered a low-income population environmental justice area of concern.

The evaluation of potential impacts regarding environmental justice areas of concern considered whether the proposed project or an alternative would cause any of the following conditions within the ROI:

- whether the potential risk or rate of hazard exposure or health effects to a minority or low-income population from an environmental hazard is significant 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 would occur in a minority or low-income population affected by cumulative or multiple adverse exposures from environmental hazards; or

- whether there is or would be an impact to the natural or physical environment that significantly and adversely affects a minority or low-income population.

3.19.1.3 Factors Considered for Assessing Impacts

DOE assessed the potential for impacts to minority and low-income populations based on whether the **proposed** project would directly or indirectly:

- cause a significant and disproportionately high and adverse effect on a minority population; or
- cause a significant and disproportionately high and adverse effect on a low-income population.

3.19.2 Affected Environment

3.19.2.1 CO_2 Capture Facility, Pipeline Corridor, and West Ranch Oil Field

3.19.2.1.1 Minority Populations

The data analyzed in Table 3.19-1 uses the threshold of two times the state minority population percentage and two times the corresponding county minority population percentage as having a meaningfully greater minority population to determine an environmental justice area of concern. Members of **U.S. Census Bureau defined racial groups** accounted for approximately 29.6% of the population of Texas and 27.6% for the United States in 2010. **Members of the U.S. Census Bureau defined Hispanic groups accounted for 37.6% of Texas and 16.3% of the United States in 2010.** Within the three-county ROI, Fort Bend County had the largest percentage of **U.S. Census Bureau defined racial groups at** (49.5%), followed by Wharton County (27.9%) and Jackson County (18.8%) in 2010. **Members of the U.S. Census Bureau defined Hispanic groups accounted for 23.7% in Fort Bend County, 37.4% in Wharton County, and 29.0% in Jackson County in 2010.** Of the nine census tracts within the ROI, Fort Bend County – Census Tract 157675500 had the largest percentage of **U.S. Census Bureau defined racial groups** (42.9%), while Jackson County – Census Tract 239950100 and Wharton County – Census Tract 481741100 had the smallest percentage (15.0%) in 2010. **Of the nine census tracts within the ROI, Wharton County – Census Tract 481740700 had the largest percentage of U.S. Census Bureau defined Hispanic groups (59.1), while Wharton County – Census Tract 481741100 has the smallest percentage (26.8) in 2010.** None of the nine census tracts exhibited minority populations that were meaningfully greater than the corresponding county (i.e., no census tract had a minority population percentage that was greater than two times the minority population percentage of the corresponding county). Additionally, none of the three counties in the ROI exhibited minority populations that were meaningfully greater than the minority population of the state of Texas.

The data analyzed in Table 3.19-2 uses the following thresholds to determine an environmental justice area of concern: (1) if the population is more than 50 percent minority or (2) if the percentage of minority population is 25 percent higher than the percentage of minority population in the corresponding county. As noted above, this analysis was conducted because people who identify their origin as Hispanic may be of any race and may not be accounted for in the assessment presented above. Members of minority populations accounted for approximately 54.7% of the population of Texas and 36.3% for the United States in 2010. Within the three-county ROI, Fort Bend County had the largest percentage of minority populations (63.8%), followed by Wharton County (52.3%) and Jackson County (37.1%) in 2010. Of the nine census tracts within the ROI, Fort Bend County – Census Tract 157675500 and Wharton County – Census Tracts 481740700 and 481741000 experienced more than 50 percent minority populations. These same three census tracts, and Wharton County – Census Tract 481740600, also experienced a percentage

of minority populations that is 25 percent higher than the percentage of minority population in the corresponding county. Therefore, EO 12898 directs DOE to determine whether the proposed project could subject these populations to disproportionate adverse impacts.

3.19.2.1.2 Low-Income Populations

Table 3.19-1 summarizes the data collected on low-income populations in the ROI. The median household income for Texas was $48,615 and $51,914 for the United States in 2010. Of the three counties analyzed, Fort Bend County had the highest median household income ($79,845), while Wharton County had the lowest ($41,148) in 2010. Of the nine census tracts within the ROI, Fort Bend County – Census Tract 157675500 had the highest median household income ($70,321) while Wharton County – Census Tract 481740700 had the lowest ($26,818) in 2010. The mean income data for Texas was $66,756 and $70,833 for the United States in 2010. Of the three counties analyzed, Fort Bend County experienced the largest mean income at $101,146. Of the nine census tracts within the ROI, the census tracts in Fort Bend County also experienced the largest mean incomes in year 2010. The percentage of the census tract populations with annual incomes below the poverty level (the poverty threshold varies based on the size of the family) was determined from the 2010 census data as shown in Table 13.19-1. Poverty percentages ranged from a high of 23.3% in Census Tract 481741000 in Wharton County to a low of 6.0% in Census Tract 157675600 in Fort Bend County.

None of the nine census tracts exhibited low-income populations that were meaningfully greater than the corresponding county (i.e., no census tract had a low-income population percentage that was greater than two times the low-income population percentage of the corresponding county). Additionally, none of the three counties in the ROI exhibited low-income populations that were meaningfully greater than the low-income population of the state of Texas. Furthermore, none of the census tracts or counties in the ROI had a 2010 median household income that was less than $22,050.

Table 3.19-1. Race and Income Statistics in the ROI.

State/County/ Census Tract (CT)	Race As A Percentage Of Total Population[1]							Persons of Hispanic or Latino Origin (All Races) (percent) [1]	Median Household Income (dollars) [2]	Population Below Poverty Level (percent)[3]
	White	African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Persons Reporting Other Race(s)	Persons Reporting Two or More Races			
United States	**72.4**	**12.6**	**0.9**	**4.8**	**0.2**	**6.2**	**2.9**	**16.3**	**$51,914**	**13.8**
Texas	**70.4**	**11.8**	**0.7**	**3.8**	**0.1**	**10.5**	**2.7**	**37.6**	**$48,615**	**17.9**
2 Times Texas Minority/Poverty %	**--**	***23.6***	***1.4***	***7.6***	***0.2***	***21.0***	***5.4***	***75.2***	**--**	***35.8***
Fort Bend County	**50.6**	**21.5**	**0.4**	**17.0**	**0.1**	**7.6**	**2.9**	**23.7**	**$79,845**	**8.0**
CT 157675500	57.1	20.8	0.3	6.2	0.1	12.5	3.0	35.7	$70,321	10.9
CT 157675600	82.1	1.6	0.4	0.8	0.0	12.8	2.2	29.2	$57,021	6.0
CT 157675700	76.7	7.2	0.5	0.6	0.1	12.8	2.2	30.6	$57,529	7.0
2 Times Fort Bend County Minority/ Poverty %	**--**	***43.0***	***0.8***	***34.0***	***0.2***	***15.2***	***5.8***	***47.4***	**--**	***16.0***
Wharton County	**72.2**	**14.1**	**0.4**	**0.4**	**0.1**	**11.1**	**1.8**	**37.4**	**$41,148**	**17.2**
CT 481740600	78.6	6.4	0.6	0.3	0.0	13.0	1.2	41.9	$36,406	13.5
CT 481740700	68.6	9.1	0.5	0.1	0.0	19.7	2.1	59.1	$26,818	19.2

Table 3.19-1. Race and Income Statistics in the ROI.

State/County/ Census Tract (CT)	Race As A Percentage Of Total Population[1]							Persons of Hispanic or Latino Origin (All Races) (percent)[1]	Median Household Income (dollars)[2]	Population Below Poverty Level (percent)[3]
	White	African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Persons Reporting Other Race(s)	Persons Reporting Two or More Races			
CT 481741000	70.0	16.1	0.5	0.7	0.0	10.2	2.4	51.4	$35,087	23.3
CT 481741100	84.9	4.6	0.2	0.4	0.0	8.0	1.8	26.8	$50,028	8.8
2 Times Wharton County Minority/ Poverty %	***--***	***28.2***	***0.8***	***0.8***	***0.2***	***22.2***	***3.6***	***74.8***	***--***	***34.4***
Jackson County	**81.3**	**7.0**	**0.4**	**0.4**	**0.1**	**8.8**	**2.1**	**29.0**	**$47,483**	**11.7**
CT 239950100	84.9	1.3	0.5	0.3	0.0	11.3	1.6	30.1	$51,957	11.7
CT 239950300	84.0	5.8	0.4	0.4	0.0	7.4	2.1	27.0	$53,409	8.1
2 Times Jackson County Minority/ Poverty %	***--***	***14.0***	***0.8***	***0.8***	***0.2***	***17.6***	***4.2***	***58.0***	***--***	***23.4***

Note: (A) This table is based on U.S. Census Bureau figures that, due to rounding, may total slightly more or less than 100 percent.
(B) People who identify their origin as Hispanic or Latino may be of any race. Thus, the percent Hispanic or Latino should not be added to the race as percentage of population categories.
CT = Census Tract (as shown in Figure 3.19-1)

Source:
[1] U.S. Department of Commerce, Bureau of Census, Census 2010. Table DP-1
[2] U.S. Department of Commerce, Bureau of Census, Census 2010. Table DP03. 2006-2010 American Community Survey
[3] U.S. Department of Commerce, Bureau of Census, Census 2010 American FactFinder, S1701

Table 3.19-2. Minority Statistics in the ROI.

	Total Population	Total Population: Not Hispanic or Latino - White Alone	Total Population: Minority	Total Population: Minority (percent)	125% of Non-White Minority (percent)
United States	308,745,538	196,817,552	111,927,986	36.3	--
Texas	25,145,561	11,397,345	13,748,216	54.7	--
Fort Bend County	585,375	211,680	373,695	63.8	79.8
CT 157675500	11,151	4,027	7,124	63.9	79.9
CT 157675600	5,808	3,920	1,888	32.5	40.6
CT 157675700	6,808	4,134	2,674	39.3	49.1
Wharton County	41,280	19,681	21,599	52.3	65.4
CT 481740600	3,788	1,934	1,854	48.9	61.2
CT 481740700	1,875	582	1,293	69.0	86.2
CT 481741000	4,313	1,364	2,949	68.4	85.5
CT 481741100	2,500	1,688	812	32.5	40.6
Jackson County	14,075	8,855	5,220	37.1	46.4
CT 239950100	5,342	3,597	1,745	32.7	40.8
CT 239950300	4,829	3,193	1,636	33.9	42.3

Note: CT = Census Tract (as shown in Figure 3.19-1)
Source: U.S. Department of Commerce, Bureau of Census, Census 2010. Table DP-1

3.19.3 Direct and Indirect Impacts of the Proposed Project

3.19.3.1 Construction Impacts

According to the data presented in Table 3.19-1, none of the census tracts in the ROI qualify as a minority environmental justice area of concern based on reported minority population percentage **using the two times the state minority population percentage and two times the corresponding county minority population percentage threshold**. None of these census tracts have a minority population that is meaningfully greater than the corresponding county minority population percentage, and therefore do not qualify as having minority populations as defined by CEQ. Additionally, none of **the** three counties in the ROI have a minority population that is meaningfully greater than the minority population percentage for the state of Texas, and therefore do not qualify as having minority populations as defined by CEQ.

According to the data presented in Table 3.19-2, Fort Bend County, Wharton County, and four census tracts in the ROI qualify as a minority environmental justice areas of concern using the threshold of 50 percent minority or 25 percent higher than the percentage of minority population in the corresponding county. However, the proposed project is not expected to have disproportionately high and adverse human health or environmental impacts on minority populations. The impacts of the proposed project would not be directed at any one particular group, and are dispersed over the entire length of the proposed project. This means that significant and/or adverse impacts on potential environmental justice areas of concern do not exist. In addition, the proposed project is expected to create economic benefits for local communities,

regardless of race, by generating employment opportunities, local expenditures by workers, and compensation for proposed project-related easements to local landowners. In other portions of this EIS, environmental impact analyses have been conducted. Typically, the development of any large industrial activity, such as the proposed project, could result in impacts to the surrounding environment during construction activities at the W.A. Parish Plant, the proposed pipeline corridor, and the West Ranch oil field. Analyses included in this EIS indicate that the proposed project could result in:

- **potential beneficial impacts to regional socioeconomics;**
- **potential moderate adverse impacts to surface water and biological resources should a spill or leak occur, and**
- **potential negligible to minor adverse impacts to air quality, geology, physiography and soils, groundwater, wetlands and floodplains, cultural resources, traffic and transportation, human health and safety, utilities, and community services.**

In each case, no significant impacts were found to occur during construction of the proposed project. Mitigation measures have been identified to further reduce impact levels and adhere to local policies for the protection of the environment and local public. Therefore, the proposed project would not create a disproportionately high and adverse human health or environmental effect on minority populations during construction.

According to the data presented in Table 3.19-1, none of the census tracts in the ROI qualify as a low-income environmental justice area of concern based on the reported median household income and the percentage of the population with annual incomes below the poverty level. None of the census tracts or counties in the ROI have a median household income below $22,050. Additionally, none of the census tracts exhibited low-income populations that were meaningfully greater than the low-income population percentages of the corresponding counties and none of three counties in the ROI have a low-income population that is meaningfully greater than the low-income population percentage for the State of Texas. Because there is no low-income population, as defined by CEQ, in the ROI to be affected, the proposed project would not create significant and disproportionately high and adverse human health or environmental effects on environmental justice areas of concern regarding low-income populations during construction. Therefore, there would be no adverse **low-income** environmental justice impacts corresponding with the proposed project during construction.

The proposed project would not create an arbitrary or disproportionate impact to populations below the poverty level. As listed in Table 3.19-1, the **proposed** project would be constructed in census tracts with poverty rates ranging from 23.3% to 6.0%. All of the census tracts have populations with a lower incidence of poverty than the State of Texas poverty rate of 17.9% with the exception of two tracts in Wharton County.

3.19.3.2 Operational Impacts

Minority environmental justice areas of concern have been identified in the ROI and could be affected by the proposed project during operations. However, similar to the construction-related analysis above, the proposed project is not expected to have disproportionately high and adverse human health or environmental impacts on minority populations.

Because there is no low-income population in the ROI to be affected, there would be no adverse environmental justice impacts associated with the proposed project during operations. Similar to the construction-related analysis above, the proposed project is expected to create economic benefits for local communities during operations.

Similar to the construction-related analysis above, large industrial activities such as the proposed project could result in impacts to the surrounding environment during operational activities at the W.A. Parish Plant, the proposed pipeline corridor, and the West Ranch oil field. Analyses included in this EIS indicate that the proposed project could result in:

- **potential beneficial impacts with the reduction of greenhouse gas emissions;**
- **potential moderate adverse impacts to surface water and biological resources should a spill or leak occur, and**
- **potential negligible to minor adverse impacts to air quality, groundwater, wetlands and floodplains, human health and safety, utilities, and community services.**

In each case, no significant impacts were found to occur during operation of the proposed project. Mitigation measures have been identified to further reduce impact levels and adhere to local policies for the protection of the environment and local public. Therefore, the proposed project would not create a disproportionately high and adverse human health or environmental effect on minority populations during operations.

3.19.4 Direct and Indirect Impacts of the No-Action Alternative

Under the No-Action Alternative, DOE would not provide cost-shared funding for NRG's proposed Parish PCCS Project. Although NRG and TCV may still elect to construct and operate the **proposed** project in the absence of DOE cost-shared funding, for the purposes of the analysis in this EIS, DOE assumed that the No-Action Alternative is equivalent to a No-Build Alternative. The **proposed** project would not be constructed and there would be no associated environmental justice impacts.

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4 MITIGATION MEASURES

For all environmental resources, the minimization and mitigation of potential adverse impacts from project activities would be achieved through the implementation of BMPs and compliance requirements contained in facility permits and other applicable federal, state, or municipal regulations and ordinances. This section provides a consolidated summary of the minimization and mitigation measures that would be implemented for each resource area. Per established protocols, procedures, and requirements, NRG and TCV would implement BMPs and would satisfy all applicable regulatory requirements in association with the design, construction, and operation of the project. These minimization and mitigation measures, which are included as components of the proposed project, are described by resource area in Chapter 3 of this EIS (Affected Environment and Impacts) and summarized in Table 4-1 below. This EIS analyzes the impacts of the proposed Parish PCCS Project with these mitigation measures in place. DOE will determine whether specific additional mitigation measures would be required for implementation of the Proposed Action, and will document these requirements and this decision-making in the ROD.

Table 4-1. Summary of Mitigation Measures

Resource	Mitigation Measure
Air Quality and GHG Emissions	Construction During construction, NRG would implement the following practices: • Using dust-abatement techniques such as wetting soils • Surfacing unpaved access roads with stone when reasonable • Covering construction materials and stockpiled soils to reduce fugitive dust • Minimizing the size of disturbed areas • Watering land prior to disturbance (excavation, grading, backfilling, or compacting) • Revegetating disturbed areas as soon as practicable after disturbance • Moistening soil before loading into dump trucks • Covering material in dump trucks before traveling on public roads • Minimizing the use of diesel or gasoline generators for operating construction equipment • **Using motorized construction equipment that is late model, has appropriate emissions control systems, and is properly maintained to ensure maximum efficiency and minimized emissions** Operation The following process enhancements and improved work practices would be implemented to mitigate emissions: • To reduce NO_x: Equipping the HRSG with an SCR catalyst bed and an ammonia injection grid • To reduce CO and volatile organic compounds: Implementing good combustion practices in the combustion turbine by equipping with duct burners and an oxidation catalyst • To reduce SO_2: 98% removal in the DCC with the remainder of SO_2 removed by reaction with the amine-based solvent in the CO_2 scrubber (Emissions of HCl, HF, and NH_3 would also be substantially reduced) • To reduce PM: Implementing good combustion practices in the combustion turbine; incorporating high-efficiency drift eliminators in the cooling tower • To reduce CO_2: Capturing 90% of the CO_2 entering the CO_2 capture facility for

Table 4-1. Summary of Mitigation Measures

Resource	**Mitigation Measure**
	use in EOR
Air Quality and GHG Emissions	• NRG would obtain and retire **NO_x** ERCs**, DERCs,** and NO_x MECT allowances to offset project emissions by reducing other emissions of NO_x in the HGB MSA. Due to these emission reduction credits, the proposed project would result in no net adverse impact on air quality in the HGB MSA with regard to ozone.
Geology and Soils	Construction • NRG's CO_2 pipeline would be collocated along or within existing mowed and maintained utility ROWs for approximately **75**% of the route. • Existing wells would be used (i.e., refurbished or deepened as needed) at the West Ranch oil field to the extent practicable to minimize the number of new wells that would be needed. New injection wells would be drilled if the existing wells cannot be reworked for injection. All new injection wells would require UIC permits and TCV would install the new injection wells in accordance with the design standards specified by the RRC UIC Program. New wells would be installed on existing well pads to the extent practicable. • Existing roads would be used to the extent practicable at the West Ranch oil field to access EOR and CO_2 monitoring areas within the West Ranch oil field. No new road construction is anticipated. • New piping for CO_2 distribution at the West Ranch oil field would be installed, to the extent practicable, along existing piping corridors. • NRG would segregate and stockpile excavated topsoil in agricultural areas until reuse and reseed disturbed areas, as applicable. • Except in cultivated fields, unless requested by the landowner, areas of disturbed soil along the pipeline construction ROW would be planted following construction with an appropriate mix of seeds for perennial grasses and forbs native to the area or with a seed mixture requested by the landowner to reduce the potential for soil erosion and establishment of invasive plant species. Depending on the season in which construction is completed, NRG may also seed with a cold-weather annual grass species, such as Gulf Coast ryegrass (*Lolium multiflorum*), to establish a temporary vegetative cover until conditions become favorable for growth of perennial grasses and forbs. • NRG and TCV would develop and implement a project-specific SWPPP to reduce erosion, control sediment runoff, reduce storm water runoff, and promote ground water recharge. This SWPPP would incorporate SPCC Plan elements, as applicable, to provide guidance to construction personnel regarding potential spills. The following BMPs would be employed to avoid, minimize, and/or mitigate impacts from construction activities to soils, groundwater, surface water, wetlands, floodplains, and biological resources: o Grading, berming, or terracing would be used to reduce runoff of sediment and to divert storm water run-off to drainage ditches or vegetated areas off-ROW. o Discharge structures and erosion control devices (e.g., silt fencing and/or hay bales) would be used to minimize erosion and sediment discharge to downgradient surface water or wetland areas. o Materials, equipment, and activities would be located in such a way that leaks are contained in existing containment and diversion systems or would have portable spill kits to contain leaks and spills.

Table 4-1. Summary of Mitigation Measures

Resource	Mitigation Measure
Geology and Soils	o Secondary containment (i.e., sufficiently impervious dikes, berms, or retaining walls) with sufficient capacity to retain spilled materials (i.e., 110% of the volume of the largest tank or larger) would be provided for tanks and chemical storage containers greater than 55 gallons. Drainage from within dikes in permanent storage areas would be restrained by valves to prevent unintended discharge. Drainage from within dikes in temporary storage areas would use portable pumps once the water collected within the dike has been determined to meet discharge requirements. Inspections would be conducted to verify adequacy of secondary containment and prompt removal of any accumulated fluids (e.g., storm water or spilled materials). o Construction areas would be revegetated as soon as practicable following construction. Areas with high erosion potential (e.g., steep slopes, particularly adjacent to surface water bodies) may require additional erosion control (e.g., mulch, erosion control blankets, turf reinforcement mats). o Security measures would be put in place in bulk storage areas. Sites where storage tanks and/or hazardous chemicals are located would be accessible by authorized personnel only. After regular working hours, valves would be locked closed where possible. o Personnel would be trained in spill prevention and spill control procedures, as well as hazard recognition. o Spill/overflow protection equipment would be used where applicable. Pumps used for loading/unloading or refueling would have automatic shutoff switches and/or high level alarms to prevent overfilling of tanks. o An operator or driver would be present and observant of any loading/unloading or refueling operations so they can manually stop fluid transfer (e.g., stop pump and/or close valves) in case of overfilling. Loading/unloading operations would be conducted in well-lit areas so as to easily identify spills. o Drip pans and absorbents would be used under or around leaky vehicles and equipment or store indoors where feasible. o Dust generation and off-site tracking of waste or potentially hazardous materials would be minimized by washing vehicles and equipment, as applicable, before they leave the work site and by employing dust suppression measures (e.g., covering loads, watering dusty areas during dry weather). o Cleaning operations would be performed indoors, within storm resistant shelters, or within bermed areas that prevent runoff and run-on and that also that capture overspray. o Wastes, garbage, and/or floatable debris would be prevented from entering surface waters by keeping exposed areas free of such materials or by intercepting them before they are discharged. o Trench dewatering and storm water runoff would be diverted, contained, reused, or otherwise reduced to minimize the potential for pollutant discharges. o Sorbent booms or diversion devices would be placed around any sumps or drains that may act as preferential pathways for groundwater or surface water contamination. o Emergency contacts for large spills (e.g., company, local, state, federal) would be readily available in areas with higher probability for spills (e.g., oil or chemical storage areas, loading and unloading areas).

Table 4-1. Summary of Mitigation Measures

Resource	Mitigation Measure
Geology and Soils	o Spills and leaks would be cleaned up promptly using dry methods (e.g., absorbents) to prevent the discharge of pollutants. Spill control kits (e.g., sorbent pads, socks, and/or booms) would be staged in areas with higher probability for spills (e.g., oil or chemical storage areas, loading and unloading areas). o Permanent trench plugs would be installed at stream crossings and in areas where subsurface flow of water may occur along the pipeline. Operation • NRG and TCV would continue to implement relevant parts of their SWPPP and SPCC Plans, as updated to include project-related facilities.
Groundwater and Surface Water Resources	Construction • NRG would develop and implement a SWPPP for construction activities, which would incorporate SPCC Plan elements, as applicable. As discussed above for Geology and Soils, NRG and TCV would develop and implement BMPs as part of this plan to reduce storm water runoff and erosion, control sediment runoff, promote ground water recharge, and avoid or mitigate potential spills. • NRG would implement additional BMPs (i.e., double silt fencing; avoiding clearing of stream bank and in-stream native vegetation; phasing work during dry periods; minimizing any stream bed disturbance; and siting equipment storage areas, valves, and pump stations beyond the floodplain) for Ecologically Sensitive Stream Segments (ESSSs) that are not crossed using HDD construction techniques. • Reuse of hydrotest water, to the extent practicable, to reduce water required for testing and reduce the volume of hydrotest water discharges required after testing. Operation • NRG and TCV would continue to implement relevant parts of their SWPPP and SPCC Plans, as updated to include project-related facilities.
Wetlands and Floodplains	Construction • NRG has designed the proposed pipeline ROW to avoid wetlands to the extent practicable by collocating the proposed ROW along or within existing mowed and maintained utility ROWs for approximately **75**% of the route. • ROW width may be reduced to from 100 feet to 75 feet in some areas to minimize impacts to wetlands. In other wetland areas, NRG may lay timber mats or use low ground pressure equipment to protect the root structures of wetland vegetation in lieu of reducing ROW width. • NRG would segregate and stockpile excavated topsoil in wetland areas until reused, install silt fences, and reseed disturbed areas, as applicable. • Except in cultivated fields, unless requested by the landowner, areas of disturbed soil along the pipeline construction ROW would be planted following construction with an appropriate mix of seeds for perennial grasses and forbs native to the area or with a seed mixture requested by the landowner to reduce the potential for soil erosion and establishment of invasive plant species. Depending on the season in which construction is completed, NRG may also seed with a cold-weather annual grass species, such as Gulf Coast ryegrass (*Lolium multiflorum*), to establish a temporary vegetative cover until conditions become favorable for growth of perennial grasses and forbs.

Table 4-1. Summary of Mitigation Measures

Resource	**Mitigation Measure**
Wetlands and Floodplains	• With the exception of aboveground facilities, the construction ROW would be restored to preconstruction contours. • NRG would develop and implement a SWPPP for construction activities, which would incorporate SPCC Plan elements, as applicable. As discussed above for Geology and Soils, NRG and TCV would develop and implement BMPs as part of this plan to reduce storm water runoff and erosion, control sediment runoff, promote ground water recharge, and avoid or mitigate potential spills. • NRG would revise the pipeline construction ROW design in selected areas to avoid forested wetlands to the extent practicable. NRG would mitigate impacts to scrub-shrub wetlands during construction by leaving roots intact during clearing to the extent practicable. As applicable, NRG may also lay timber mats or use low ground pressure equipment in these areas to protect the root structures of wetland vegetation. • **Based on the current project design and field survey data collected to date, DOE does not anticipate that any compensatory mitigation would be required for NRG's proposed project. However, if unavoidable permanent impacts were to exceed 0.1 acres in any single and complete project, NRG would use a functional assessment to determine the magnitude of the impacts and create a mitigation plan to fully compensate for the loss of wetland function. Mitigation options include purchasing credits from a wetland mitigation bank or working with the USACE to fund a project (or projects) to create or improve the function of wetlands in the same watershed as the impacted wetland area.** <u>Operation</u> • NRG and TCV would continue to implement relevant parts of their SWPPP and SPCC Plans, as updated to include project-related facilities.
Biological Resources	<u>Construction</u> • NRG would develop and implement an approved SWPPP that would minimize potential impacts on wildlife using downstream water resources, wetlands, and floodplains. • NRG would use dust suppression and sedimentation control measures. • NRG would comply with the provisions of the federal Migratory Bird Treaty Act, which could include limiting land-clearing activities to periods outside of the nesting season. • NRG would avoid construction in the vicinity of a bald eagle's nest that has been identified in the area per the provisions of the U.S. Bald and Golden Eagle Protection Act.

Table 4-1. Summary of Mitigation Measures

Resource	Mitigation Measure
Biological Resources	• NRG would coordinate with the Texas Parks and Wildlife Department (TPWD) with regard to state-listed species and sensitive habitats listed in the TPWD Natural Diversity Database. Mitigation of impacts to state-listed species could incorporate a variety of options ranging from passive measures (e.g., construction timing outside critical breeding periods and permanent protection of known habitats elsewhere that contain the resource to be affected) to more aggressive measures (e.g., complete avoidance of impact). • **NRG would cross the Colorado River using HDD to avoid impacts to state-listed mussel species (Smooth pimpleback) identified at the proposed crossing location. Impacts to rare mussel species would be avoided, or mussels would be relocated under a permit from TPWD to the extent practicable.** • Bird surveys would be conducted prior to construction to determine the presence of migratory bird nests, bald eagles, **whooping cranes**, or other protected species. Operation • NRG and TCV would continue to implement relevant parts of their SWPPP and SPCC Plans, as updated to include project-related facilities.
Cultural Resources	Construction • In accordance with Section 106 of the National Historic Preservation Act (Public Law 89- 665), NRG has performed Phase I surveys and provided cultural resource assessments for the proposed pipeline construction ROW and preliminary assessment recommendations to the THC for review and comment.
Land Use and Aesthetics	Construction • NRG would segregate and stockpile excavated topsoil in agricultural areas until reuse and reseed disturbed areas, as applicable. • Except in cultivated fields, unless requested by the landowner, areas of disturbed soil along the pipeline construction ROW would be planted following construction with an appropriate mix of seeds for perennial grasses and forbs native to the area or with a seed mixture requested by the landowner to reduce the potential for soil erosion and establishment of invasive plant species. Depending on the season in which construction is completed, NRG may also seed with a cold-weather annual grass species, such as Gulf Coast ryegrass (*Lolium multiflorum*), to establish a temporary vegetative cover until conditions become favorable for growth of perennial grasses and forbs. Operation • In areas that are not currently in industrial use, NRG and TCV would plan and install outdoor lighting in a manner that would minimize nighttime, off-site illumination and glare. Lighting installed at the meter station would be down shielded to avoid interference with wildlife.

Table 4-1. Summary of Mitigation Measures

Resource	Mitigation Measure
Traffic and Transportation	Construction • NRG would cross the majority of roads using conventional boring techniques to avoid trenching across roadways. • To prevent unnecessary traffic congestion and road hazards, NRG would coordinate with local authorities and employ safety measures, especially during the movement of oversized loads, construction equipment, and materials. • Where traffic disruptions would be necessary, NRG would coordinate with local authorities and implement detour plans, warning signs, and traffic-diversion equipment to improve traffic flow and road safety. Operation • NRG would make road improvements, where necessary, to minimize traffic congestion and road hazards. Improvements may include widening and/or resurfacing roads.
Noise	Construction and Operation • The CO_2 capture facility is located within an existing industrial area (i.e., the W.A. Parish Plant) over 0.5 miles from the nearest residential landowner. • The proposed EOR area and CO_2 recycle facility are located within an existing industrial area (i.e., the West Ranch oil field) over 0.5 miles from the nearest residential landowner.
Health and Safety	Construction and Operation • NRG would comply with OSHA requirements as they apply to the project during construction and operation activities.

BMP = best management practice; CO = carbon monoxide; CO_2 = carbon dioxide; DCC = direct contact cooler; EOR = enhanced oil recovery; ERC = emission reduction credit; HCl = hydrochloric acid; HDD = horizontal directional drilling; HF = hydrofluoric acid; HGB = Houston Galveston Brazoria; HRSG = heat recovery steam generator; MECT = Mass Emission Cap & Trade; MSA = Metropolitan Statistical Area; NH_3 = ammonia; NOx = nitrogen oxides; NRG = NRG Energy, Inc.; OSHA = U.S. Occupational Safety and Health Administration; PM = particulate matter; ROW = right-of-way; SCR = selective catalytic reduction (system); SO_2 = sulfur dioxide; SPCC = Spill Prevention, Control, and Countermeasure; SWPPP = Storm Water Pollution Prevention Plan; TCV = Texas Coastal Ventures LLC; THC = Texas Historical Commission; TPWD = Texas Parks and Wildlife Department; VOC = volatile organic compounds

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5 CUMULATIVE IMPACTS

5.1 ASSESSMENT APPROACH

5.1.1 Background

Compliance with NEPA requires an analysis of cumulative effects for each alternative (40 CFR 1508.25(c)(3)). Cumulative effects are the collective result of the incremental effects of a proposed project that, when added to the impacts of other past, present, and reasonably foreseeable future actions, would affect the same resources, regardless of what agency or person undertakes those actions (40 CFR 1508.7). Cumulative effects can result from actions that individually cause minor impacts but that collectively impose significant impacts over a period of time. DOE considers reasonably foreseeable actions to be future actions with a realistic expectation of occurring. These include, but are not limited to, actions under analysis by a regulatory agency, proposals being considered by state or local planners, plans that have begun implementation, or future actions that have been funded.

Humans have been altering the area where the proposed Parish PCCS Project would be constructed and operated since people began settling the region. In combination with natural processes, past and present human actions and activities have produced the affected environment, which is described in detail in Chapter 3 of this EIS. Chapter 3 also describes the impacts of the proposed project on the existing environment. In this chapter, DOE describes the potential for the proposed project and identified reasonably foreseeable future actions to cause cumulative effects. The following sections describe the process DOE used to identify the reasonably foreseeable future development actions occurring in the areas of analysis and determine potential cumulative effects issues.

5.1.2 Analysis Methodology

DOE analyzed cumulative effects based on particular environmental resources and ROIs. Depending on the specific resource area, the ROIs may be defined by: a human community or political boundary (e.g., a county, city, or neighborhood); an area based on typical natural resource boundaries (e.g., a watershed or defined ecological region); a resource as described on a regional, national, or global level (e.g., air quality within an Air Quality Control Region); or an area of effects dependent on locations of project disturbances (e.g., the footprint of disturbance for the CO_2 pipeline construction ROW). The ROIs for particular resource areas in this cumulative effects analysis are the same as the defined ROIs described for each resource area described in Chapter 3. Instances where the ROI was defined as an area of project disturbance in Chapter 3 also generally includes areas of disturbance anticipated for the foreseeable future actions.

For the purposes of conducting a meaningful cumulative effects analysis, the DOE included and analyzed reasonably foreseeable future actions in the ROI based on location (i.e., proximity to the project), potential to result in environmental effects on the project's ROI for each resource area, and the timeframe in which they are planned. DOE identified these future actions through scoping; conversations with regulatory agencies, local municipalities, and county governments; and reviewing published and online resources, including local policies, land use plans, and other information available from reliable internet sources.

DOE developed a list of indicators to determine the level of importance and potential for cumulative impacts for each resource area (see Table 5-1 and Table 5-2). DOE considered each resource area based on these criteria, and then provided more detailed evaluation of those issues determined to be of intermediate to high importance. Areas of low importance or where negligible impacts could be expected were not considered in as much detail. For each issue, DOE searched for relevant information on past and current activities and associated environmental impacts in the area of concern to establish a basis upon which to consider the project's potential impacts. Trends in past and current activities and associated environmental impacts were projected into the future for at least the expected life of the project, to the extent that the projection was considered to be reasonable.

Table 5-1. Indicators of Importance for Cumulative Impacts Issues

High Importance	• The incremental impact alone would generally be considered a significant impact, as this phrase is used in context of NEPA review and analysis. • An analysis of cumulative impacts for this issue would be required to support a reasoned decision among the alternatives. • Society, in general, has a history or record of being concerned about this type of cumulative impact and two or more of the factors of intermediate importance are present.
Intermediate Importance	• There is a regulatory/resource threshold or physical limit (e.g., utility capacity) that might be exceeded or that is approaching an exceedance in the cumulative effect, and this potential exceedance of the threshold or physical limit is of significance from the viewpoint of NEPA review, federal decision making, and public disclosure. • There is a governmental organization or nationally recognized nongovernmental organization that has a history or record of being concerned about the cumulative effect. • The cumulative effect issue was raised during the scoping process by either a governmental organization or by more than one nongovernmental entity or person, and the particular issue is not irrelevant or inconsequential in federal decision making. • Issue is indicated to be important judging by the fact that one or more governmental or nongovernmental organizations have published statistics or trends on the issue.
Low Importance	• Issues not having any of the indicators listed in the two categories above. • Issues in which the project would contribute no, negligible, or beneficial impacts.

NEPA = National Environmental Policy Act

Table 5-2. Cumulative Effects Issues Considered for Each Resource Area

Resource Area	Issues Considered	Level of Importance
Air Quality	• Increased emissions of criteria pollutants and hazardous air pollutants (HAPs) • Adverse changes in regional air quality as compared to the NAAQS	Intermediate
Greenhouse Gases	• Increased GHG emissions	High (see Section 4.2.2)
Geology	• Potential for locally induced increase in seismic activity or other geologic hazards • Potential for reducing the value of, or access to, mineral or petroleum resources • Potential for permanent alteration of unique geologic features or landforms • Potential for migration of injected CO_2 significantly outside of the intended containment zone with consequent changes to mineralogical properties of geologic formation(s)	Intermediate
Physiography and Soils	• Permanently disturb soils during the construction and/or operations phase of the project • Conversion of soils classified as Prime Farmland (or other important classifications) • Increase soil erosion and soil loss	Intermediate
Groundwater	• Potential to affect the water quality or availability of regional USDWs • Increase in groundwater consumption rates; • Reduce groundwater recharge due to increase in amount of impervious ground cover components or facilities relative to distribution of existing soil cover • Potential for groundwater contamination from CO_2 injection and/or from increased brine water injection/disposal rates as a result of EOR or waste disposal activities	Intermediate
Surface Water	• Reduction in surface water flows due to increases in water consumption rates • Affects to regional surface water quality	Intermediate
Wetlands and Floodplains	• Wetland loss and/or modification • Alteration of floodplains resulting in a higher potential for flooding	Intermediate

Table 5-2. Cumulative Effects Issues Considered for Each Resource Area

Resource Area	Issues Considered	Level of Importance
Biological Resources	• Habitat loss, habitat fragmentation, and wildlife displacement associated with land development • Loss or change in vegetation in disturbed areas from native to non-native (potentially invasive) species • Fish and wildlife mortality • Affects to protected species	Intermediate
Cultural Resources	• Potential for disturbance of undiscovered cultural or historic resources	Intermediate
Land Use and Aesthetics	• Land use conversions • Effects on views from public viewing locations • Increased night lighting and night glow impacts in the sky	Intermediate
Traffic and Transportation	• Increased vehicle traffic • Increased rail traffic	Low
Noise and Vibration	• Increased noise and vibrations associated with increasing vehicle and rail traffic • Increased construction and operational noise	Intermediate
Materials and Waste Management	• Reduction in construction material availability • Reduction in process material availability • Reduction in waste disposal capacity	Intermediate
Human Health and Safety	• Operational worker health risks • Public health risks due to accidental releases of CO_2 or other hazardous substances	Intermediate
Utilities	• Increase demand on utility providers	Intermediate
Community Services	• Effects on community services based on the need for construction and operations workers • Effects on community services due to project operations	Intermediate
Socioeconomics	• Increased demand for housing supply and worker availability • Regional economic impacts from expansion of CO_2 use for EOR	Low Intermediate
Environmental Justice	• Potential for disproportionate and adverse impacts on minority or low-income populations	Low

CO_2 = carbon dioxide; EOR = enhanced oil recovery; GHG = greenhouse gas; HAPs = hazardous air pollutants; NAAQS = National Ambient Air Quality Standards; USDW = underground source of drinking water

5.1.3 Foreseeable Future Actions Considered

DOE established an approximately 30-mile radius from each project component as the geographic basis by which foreseeable future actions would be considered in this cumulative effects analysis, with the exception of Air Quality and Climate and Greenhouse Gases, where DOE considered foreseeable future energy-related projects beyond the 30-mile radius that were applicable. This distance would encompass the ROIs for each resource area as identified in Chapter 3. Potential foreseeable future actions considered in this analysis are described in Table 5-3.

Table 5-3. Reasonably Foreseeable Future Actions Considered in the Cumulative Impacts Analysis

Action	Location	Distance to Project Feature (miles)	Description
Proposed Road Improvements	Greatwood	3 (from W.A. Parish Plant)	TXDOT has funded a project to repair FM 762 for 7.3 miles. Construction is projected to start in 2015.
Greatwood Subdivision	Greatwood	5 (from W.A. Parish Plant)	A new affordable housing subdivision is planned for the Greatwood subdivision. 200 apartments are planned to be built on 12 acres within the neighborhood.
Colorado Bend Energy Center	Wharton, Wharton County	30 (from W.A. Parish Plant)	Phases I and II (550 MW) of this natural gas combined-cycle facility currently in full operation. An additional 275 MW would be added with Phase III construction.
Deer Park Energy Center Expansion	Deer Park, Harris County	34 (from W.A. Parish Plant)	A planned expansion would add 400-MW capacity to an existing natural gas-fired combined-cycle energy plant. (Analysis of air impacts only)
King Power Station	Houston, Harris County	40 (from W.A. Parish Plant)	New natural gas power plant projected to have a 1,380-MW capacity.
White Stallion Energy Center	Bay City, Matagorda County	40 (from W.A. Parish Plant)	New 1,320-MW, base load, coal-fired power plant.
ETP Spirit/Justice NGL Transport	Jackson County	0 (from Pipeline Corridor)	ETP is currently constructing a 129-mile, 20-inch natural gas liquid (NGL) pipeline from a Jackson County natural gas processing plant to Mont Belvieu, Texas. Construction is expected to be completed in 2012. NRG's proposed pipeline would be collocated with ETP's ROW for a distance of approximately 42 miles.
Bridge Replacement	Fairchilds	0.5 (from Pipeline Corridor)	TXDOT has funded a project to replace the bridge on FM 361 over Deer Creek and Fairchilds Creek. Construction is projected to start in 2015.
Bridge Replacement	El Campo	3 (from Pipeline Corridor)	TXDOT has funded a project to replace the bridge on CR 421 over Blue Creek. Construction is projected to start in 2013-2014.

Table 5-3. Reasonably Foreseeable Future Actions Considered in the Cumulative Impacts Analysis

Action	Location	Distance to Project Feature (miles)	Description
Flag City Natural Gas Processing Plant	Edna	~10 (from Pipeline Corridor)	Boardwalk Field Services is planning to build a cryogenic natural gas processing plant outside of Edna. A pipeline would also be built to connect the plant to the existing Gulf South Pipeline. Once operating (2013), the plant would have a capacity to process up to 150 million cubic feet per day of natural gas from the Eagle Ford Shale.
Bridge Replacement	La Salle	3 (from West Ranch Oil Field)	TXDOT has funded a project to replace the bridge on CR 313 over Venado Creek. Construction is projected to start in 2014.
Bennett Park Boat Ramp	La Salle	5 (from West Ranch Oil Field)	Jackson County is planning to build a concrete boat ramp, walkways, and parking as part of the Coastal Impact Assistance Program. The ramp would be built to access Garcitas Creek.
Jackson County Hospital Expansion	Edna	11 (from West Ranch Oil Field)	Jackson County Hospital board members approved the Phase III expansion of the Jackson County Hospital, which would include renovating 19,486 square feet of the hospital, and adding 5,253 square feet to the existing space.
New RV park	Edna	12 (from West Ranch Oil Field)	The City of Edna granted a Specific Use Permit for a planned RV park off West Main Street.
Caterpillar Manufacturing Plant	Victoria	~23 (from West Ranch Oil Field)	Caterpillar announced that it would expand a hydraulic excavator manufacturing plant that is currently under construction. The expansion would add 200,000 square feet to the 850,000-square-foot facility. Excavator production at the original proposed plant site is expected to begin in 2012.
Hurricane Safe Shelter	Bloomington	~20 (from West Ranch Oil Field)	FEMA has granted 1.8-million dollars to the Bloomington Independent School District to construct a 15,000 to 20,000 square-foot shelter and school gymnasium. The project is initiated through the Texas Safe Shelter Initiative.

CR = county road; ETP = Energy Transfer Partners; FEMA = Federal Emergency Management Agency; FM = Farm-to-Market Road; MW = megawatt; NGL = natural gas liquid; ROI = region of influence; RV = recreational vehicle; TXDOT = Texas Department of Transportation

5.2 CUMULATIVE IMPACTS

5.2.1 Summary of Cumulative Impacts

DOE determined potential impacts on individual resource areas by combining the anticipated impacts of NRG's proposed project with the likely impacts of other foreseeable future projects, as listed in Table 5-4, using the available information on those projects. The effects of past actions are generally considered as being captured in the affected environment described in Chapter 3 of this EIS; however, a general description of the history of development in the region follows.

The general area of the proposed project (i.e., Fort Bend, Wharton, and Jackson Counties) is a relatively flat coastal plain. Historically, the area consisted primarily of tallgrass prairie and surface waters/wetlands were an important part of the landscape, including coastal marshes and the Colorado, San Bernard, and Tres Palacios Rivers (CEC 2011). European settlement of the area began in the early 1820s, primarily around waterways, and agricultural practices (e.g., cattle grazing) began changing the landscape. Typically, agricultural activities involve the conversion of naturally vegetated areas to stands of monolithic crops (e.g., sugarcane and rice). In the case of cattle grazing, the activities of the animals generally make areas unsuitable for typical native vegetation through directly eating plants and trampling on and compacting soils. In addition, agricultural activities occurring near surface waters can have substantial negative effects on surface waters through nonpoint source pollution caused by use of fertilizers, herbicides, and pesticides as well as the generation of animal wastes. The area continued to be mostly wilderness with scattered farm settlements into the mid-1800s. The extension of rail access to the area in 1860 brought economic benefits and overall population and land development increases. The population began to expand considerably in the 1880s due to continued railroad extension and an influx of Europeans and new towns developed. Mineral development began in the area in the early 1900s with the first drilled oil wells. Extraction of oil, gas, and sulfur has been a major influence on the area causing land disturbances and landscape changes. Increased urbanization began during the World War II era and since the 1960s home developments, industry, business, and commerce, increased considerably in the area. This urbanization and trend of land development resulted in further landscape changes generally from native vegetated land to impervious surfaces, such as roads, and structures. Industrialization has increased as well. Land development has continued in the area since that time, to the characteristics seen today. Land development trends typically correlate with population growth. In the last decades in the 20th Century, Fort Bend County was one of the fastest growing counties in the U.S (Hudgins, undated; and Ott, undated).

Table 5-4 describes impacts on resource areas for the project could potentially contribute to cumulative impacts. Since the DOE has determined that a high level of importance should be placed on the area of GHGs due to the project's anticipated effect on this resource area, Table 5-4 is followed by a more detailed discussion of GHGs in Section 4.2.2.

Table 5-4. Cumulative Effects of the Proposed Project and Other Reasonably Foreseeable Future Actions

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
Level of Importance – High				
Green-house Gases	Greenhouse gases (GHGs) in the atmosphere absorb solar energy that would be emitted back into space if they were not present, which results in the planet being warmer than it would otherwise be (known as the "greenhouse effect"). During the past century, humans have substantially added to the amount of GHGs in the atmosphere by burning fossil fuels. The added gases, primarily CO_2 and methane, increase the natural greenhouse effect and likely contribute to an increase in global average temperature and related climate changes (EPA 2012d).	The capture and geological storage of existing GHG emissions by the project would produce a minor beneficial cumulative effect on a national and global scale. The proposed project would result in a net CO_2 emissions decrease of approximately 815,000 tons per year (0.74 million metric tons per annum). This reduction would incrementally reduce the rate of GHG accumulation in the atmosphere and help to incrementally mitigate climate change related to atmospheric concentrations of GHGs.	Analyses of GHG emissions and related climate changes need to be considered on a global scale, thus the reasonably foreseeable future actions are too numerous to discuss specifically. Overall, it is likely that GHG emissions globally will continue to increase for some time, thus exacerbating the potential for adverse climate change-related impacts. Any strategies to curtail global climate change will require a global approach to controlling GHG emissions and is the subject of the United Nations Framework on Climate Change (UNFCC).	Overall, it is thought that climate change will affect economic activities, people's behavior, environmental conditions, and infrastructure. Impacts may include: rising sea levels, increases in heat waves, increases in precipitation events and intensities of hurricanes, increases in drought conditions, increases in wildfires, etc. Potential climate change impacts on the proposed Parish PCCS Project and other reasonably foreseeable future actions may include water supply disruptions due to more severe and frequent drought and hazardous conditions or disruptions of construction of operational activities due to more frequent or severe weather. The proposed project would be expected to contribute minor beneficial impacts, though it is currently impossible to determine the exact magnitude of effect on the global environment (see Section 4.2.2 for more information). Other projects in the ROI that would include combustion of additional fossil fuels or other GHG emissions (e.g., Colorado Bend Energy Center, Deer Park Energy Center Expansion, King Power Station, White Stallion Energy Center, and the Flag City Natural Gas Processing Plant) would be expected to cumulatively emit additional amounts of GHGs within the ROI.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
Level of Importance – Intermediate				
Air Quality and Climate	Currently, the ROI is an attainment area for CO, NO_2, SO_2, $PM_{10}/PM_{2.5}$, and lead. Fort Bend County (one of the counties in the ROI) is in a nonattainment area for ozone called the Houston Galveston Brazoria (HGB) Metropolitan Statistical Area (MSA). Air monitoring data indicates that ozone levels are decreasing in the HGB MSA (HRM 2011).	This project would result in increased emissions of CO, NO_2, VOC, $PM_{10}/PM_{2.5}$, and H_2SO_4. Emissions increases resulting from construction would be temporary and expected to be minimal. The project would also result in beneficial impacts in the form of elimination of SO_2 emissions from the Unit 8 flue gas slipstream, as well as reduced emissions of HCl, HF, and NH_3. Operational emissions of VOC and NO_x from the CO_2 capture facility exceed major source thresholds; therefore, NRG must obtain and retire **NO_x** emission reduction credits (ERCs **and/or DERCs**) and NO_x Mass Emission Cap & Trade (MECT) allowances to reduce the total net project increases of these ozone precursors (i.e., NO_x and VOC) within the HGB MSA. Due to the 1.3 to 1 retirement ratio of emission reduction credits and allowances, the Parish PCCS Project would result in no net adverse impact on air quality in the HGB MSA with regard to ozone. Dispersion modeling results for the CO_2 capture facility and related infrastructure show that operational emissions from the proposed project would not result in concentrations exceeding applicable Significant Impact Levels (SILs) for criteria pollutants. Therefore, adverse impacts to air quality in the ROI due to operational emissions from the proposed project would be considered minor. **The TCEQ issued a NNSR permit**	The Texas State Implementation Plan (SIP) is the state's comprehensive plan to meet the NAAQS. The SIP anticipates emissions from development in Texas and how those emissions would affect air quality. As long as projects conform to the SIP, based on a conformity determination and/or Texas air permitting programs, criteria pollutant concentrations should remain below the NAAQS in attainment areas or should make progress toward meeting the NAAQS in nonattainment areas. The Colorado Bend Energy Center, Deer Park Energy Center Expansion, King Power Station, White Stallion Energy Center, and the Flag City Natural Gas Processing Plant may have emissions that impact the same airsheds as the proposed project. Due to emission limits imposed by the TCEQ as part of the Texas air permitting process, in conformity with the SIP, cumulative effects from project emissions would not be expected to increase concentrations of air pollutants above the NAAQS. In the case of ozone in Fort Bend County, the proposed project may contribute to reductions in concentrations of air pollutants	Due to emission limits imposed by the TCEQ as part of the Texas air permitting process, in conformity with the Texas SIP, significant adverse cumulative effects on air quality are not expected.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
		which addressed and mitigated potential air quality impacts of the proposed CO_2 capture facility on December 21, 2012.	through the acquisition of credits and allowances.	
Geology	Subsurface hydrocarbon extraction generally began in the area in the early 1900s. The West Ranch oil field has been a productive oil field since 1938; however, oil production rates have been steadily declining since the early 1970s.	Impacts to geologic resources from construction and operation of the CO_2 capture facility and the CO_2 pipeline would be negligible to very minor and limited to near-surface geology. Injection of CO_2 into the Frio Formation sand units would likely have a beneficial impact to continued production of oil and gas from these units within the West Ranch oil field. The injection process and subsequent movement of the CO_2 is expected to force the migration of hydrocarbon fluids to the proposed EOR oil production wells, boosting oil production rates by approximately 25% to 50%, or maintaining oil production rates at current levels as opposed to continued decline. Due to the properties of the geologic units comprising and overlying the Frio Formation at the West Ranch oil field and because there are no known major faults present within the ROI for the EOR field, the possibility of creating any increase in seismicity in the region is considered to be very low. Additional site characterization and modeling work would be performed prior to operation to confirm this. Any issues identified would be monitored as part of CO_2 monitoring activities.	None of the foreseeable future actions would be expected to have a noticeable impact on subsurface geology.	The project would be expected to cause beneficial impacts on oil and gas production with only negligible to minor adverse impacts on subsurface geology. The other foreseeable future projects would not be expected to adversely impact subsurface geology. The potential for adverse seismic impacts to occur is considered very low, though further site characterization work and the CO_2 Monitoring Program would be in place to identify any issues that may arise.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
Physio-graphy and Soils	Overall soil loss and disturbance in the area has generally followed the historic trend of land development.	In general, potential minor impacts to physiography and soils would include disturbance of soils from grading, excavation activities, earthwork compaction, installation of impermeable surfaces over soils at some locations (soil loss), and increased soil erosion. All of the areas classified as Prime Farmland at the W.A. Parish Plant lands were converted to industrial use years ago, so construction and operation of the CO_2 capture facility would not impact Prime Farmland. Up to **1,197** acres of soils would be disturbed for the proposed pipeline **and access roads**, including up to **819** acres classified as Prime Farmland and **up to 18** acres classified as severely or very severely erodible. Approximately **75%** of the pipeline corridor is collocated along or within existing mowed and maintained utility ROWs. Areas of currently maintained ROW may be expanded, as necessary, to provide access for routine inspection and maintenance of the proposed pipeline. Disturbed land areas would be restored following construction. For the EOR area, soil classified as Prime Farmland and soil classified as highly erodible would be disturbed or lost; however these are within an existing oil field and would not be utilized for agricultural purposes.	Each of the reasonably foreseeable future actions would cause some degree of soil disturbance, loss, and/or erosion. It is unlikely that large areas classified as Prime Farmland that could be used for agricultural production would be lost as many of the projects would be located within industrial landscapes, within a ROW, and/or within established municipalities.	Minor cumulative impacts would be expected overall and the contribution by the project would also be considered minor. Although Prime Farmland soils would be disturbed or lost as a result of the project, these land areas would otherwise likely not be available for agricultural production due to the locations.

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Ground-water	The existing W.A. Parish Plant draws about 1.6 to 2.3 mgd of water from a series of on-site water supply wells. Extensive use of groundwater in Fort Bend County for municipal and agricultural use has resulted in a decline in groundwater levels in wells across the county since the 1980s. Subsidence problems resulted in the formation of the Fort Bend Subsidence District in 1989 by the Texas Legislature to control land subsidence and manage groundwater resources. **One groundwater well is located within the construction corridor of the proposed pipeline.** Existing water supply wells located within a 2-mile search distance along both sides of the centerline have total depths ranging between **29** and **1,258** feet bgs, with some existing oil or gas wells in this search area extending to 8,100 feet bgs. Major groundwater uses include municipal and agricultural use, including irrigation. Groundwater aquifers comprising USDWs used for public consumption are present between approximately 200 to 1,350 feet bgs near the West Ranch oil field. **One** existing public water supply well **is** located within a search distance of 2 miles outside the boundary of the West Ranch oil field**, it has a** depth **of 1,235** feet bgs.	Operation of the CO_2 capture facility would require an additional 0.2 to 0.3 mgd of groundwater from existing onsite wells (an approximately 13% increase). The existing wells have capacity to supply this additional water and the proposed project area is located to the southwest of the area that is most significantly impacted by aquifer drawdown and associated subsidence. Therefore, potential impacts to on-site groundwater supplies, such as aquifer drawdown and subsidence, would be minor. There are currently no plans to withdraw groundwater or to discharge directly to groundwater during construction of the proposed pipeline. **The groundwater well located within the construction corridor would be avoided during construction and maintenance, and NRG would test flow rates in the well before and after construction to ensure no impacts have occurred.** In the proposed EOR area, water supply wells are not anticipated to be affected by injected fluids (CO_2 or produced water) or displaced fluids due to: • the relatively shallow depths of existing groundwater supply wells within 2 miles compared to the depths of proposed injection wells (about 4,250 to 6,300 feet bgs). • the presence of an approximately 400-foot-thick, low-permeability confining caprock formation (Anahuac Formation), and • the absence of known faults and fracture systems in the area.	Each of the reasonably foreseeable future projects may require some amount of water for construction and/or operation. The primary water consumer would likely be the new subdivision planned for Greatwood, though it is assumed that any substantial water supply concerns would be addressed during the public approval process and only minor impacts on supplies would result. The Colorado Bend Energy Center, Deer Park Energy Center Expansion, King Power Station, and White Stallion Energy Center projects may result in increased demands on groundwater supplies; however, these facilities are approximately 30 to 40 miles from the W.A. Parish Plant, thus, they would not be expected to interact with the proposed Parish PCCS Project. Development of the Flag City Natural Gas Processing Plant would likely increase water demand in the Edna area; however, it would not affect the deep subsurface and interact with the injection activities associated with the project.	Minor cumulative impacts in terms of increases on groundwater demand may occur in the ROI. The contribution of the project would be minor as the groundwater demand would be minor (13%) over the existing demand. There are no planned projects in the region that would be expected to affect the deep subsurface or cause any increased groundwater contamination potential cumulatively with the project's CO_2 injection activities.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
Surface Water	Past surface water alterations and human-induced water quality degradation in the region generally follows the historic pattern of land development. The prevalence of development and agricultural activities in the area has likely been a main contributor to any historic water quality degradation, as evidenced by depressed dissolved oxygen and elevated bacteria concentrations in some waterbodies (as listed on Texas 303(d) list), which can be associated with agricultural runoff and/or wastewater discharges. Approximately 95% of the total water supply for current W.A. Parish Plant operations (i.e., approximately 34 to 50 mgd) is obtained from Smithers Lake, including water conveyed to Smithers Lake from the Brazos River. The lake is used as a cooling reservoir for generating units and receives storm water and wastewater discharges from the facility. The discharge water quality is maintained through permits issued by the TCEQ. The Brazos River water supply to the W.A. Parish Plant was not adversely affected during the 2011 drought, which was the most severe one-year drought in Texas on record. However, the flow of the Brazos River was threatened during 2011 in north Texas due to very low flow rates.	The CO_2 capture facility would require an increase of approximately 3.5 to 4.9 mgd of surface water, approximately 10% over the existing surface water demand for the plant, which would account for 0.5% of the average Brazos River flow and 1% of the Brazos River's critical low-flow. Therefore, the proposed project would result in a minor impact to surface water supply sources even during typical drought (i.e., low-flow) conditions. The total annual demand of the W.A. Parish Plant on surface water sources (i.e., 38 to 55 mgd) would be 3% to 6% of the average Brazos River flow and 8% to 13% of the Brazos River's critical low-flow, which would remain well below NRG's surface water right allocations of 99 mgd. Water required for hydrostatic testing of the pipeline and other construction activities may be trucked in or obtained from surface water bodies adjacent to the pipeline. Pipeline construction impacts are expected to be negligible (i.e., for HDDs) to moderate (i.e., for open cuts) and temporary and minimized by implementing BMPs. The potential exists, although extremely unlikely, for a CO_2 well blowout to occur, with some formation fluids being released into nearby surface waters. If that were to occur, such effects would be highly localized and readily avoided or minimized by proper injection well design. Accidents during operations could result in spills of toxic materials into surface waters; however,	Each reasonably foreseeable future project may require water for construction and/or operation. The primary water consumer would likely be the planned Greatwood subdivision, although it is assumed that any substantial water supply concerns would be addressed during the public approval process and only minor impacts on supplies would result. Several other proposed projects may result in increased demands on surface water supplies, but would not be expected to interact with the Parish PCCS Project because these facilities are not located in the Brazos River watershed, as discussed below. The Colorado Bend Energy Center project in Wharton and the White Stallion Energy Center project in Bay City are approx. 30 to 40 miles from the W.A. Parish Plant in the Colorado River Basin. The Deer Park Energy Center Expansion and King Power Station projects are located to the east of the project area in Harris County, approx. 34 to 40 miles from the W.A. Parish Plant. The Flag City Natural Gas Processing Plant is located near Edna between the Lavaca and Navidad Rivers. The Caterpillar Manufacturing Plant is located in Victoria, which is in the Guadalupe River Basin.	Minor cumulative impacts on surface water supplies and contamination potential would be expected. The surface water rights allocation processes would ensure no significant impacts on supplies would occur. There are no planned industrial activities in close proximity to the project that would be expected to incrementally contribute to surface water degradation. Any discharges from the Flag City Natural Gas Processing Plant could affect the same waterbodies (i.e., Lavaca River and Lavaca Bay) as the nearby West Ranch oil field, which is located 10 miles downstream. Therefore, if concurrent pollutant discharges were to occur from these facilities, cumulative water quality impacts may result in the Lavaca River or Lavaca Bay. Any discharges from the Caterpillar Manufacturing Plant (in Victoria, Texas, which is located in the Guadalupe River Basin) would discharge to Lavaca Bay downstream of the West Ranch oil field. Therefore, if concurrent pollutant discharges were to occur from these facilities, cumulative water quality impacts may result in Lavaca Bay.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
		implementation of standard BMPs and prompt remediation of any spills would likely result in no long-term impacts.	Discharges from these facilities would likely be regulated through permits issued by the TCEQ.	
Wetlands and Floodplains	Land cover in the region is primarily pasture/hay and cultivated crops. Historic conversion of the native plant communities to agricultural use and developed land has substantially modified natural wetlands (including removing much of the historic wetlands from existence) and modified the floodplains. Past channelization of rivers and establishment of drainage ditches have greatly impacted floodplains in the region. Current wetland and floodplain regulations are designed to provide mitigation for significant impacts.	There are no wetlands located within the area proposed for the CO_2 capture facility and its supporting infrastructure, which would be built on a previously developed site. Approximately **96** acres of wetlands would be within the pipeline construction ROW **and access roads** of the proposed project. Of these wetlands, **79** acres are palustrine emergent wetlands, which would have only temporary impacts during construction as vegetation would re-establish quickly. Within palustrine forested and scrub-shrub wetlands (**less than** 3 acres), long-term impacts would consist of conversion to emergent systems due to continued ROW maintenance. Permanent impacts to wetlands would be minor as construction would be performed in accordance with USACE permit requirements. Impacts to large riverine features and adjacent wetlands would be avoided using HDDs. Approximately **248** acres of the pipeline construction corridor would be within the FEMA 100-year floodplain. Negligible impacts to floodplains are anticipated as the pipeline is mostly underground and the **five** valves (MLVs) that would be installed in floodplain areas would likely cause very small losses of flood storage capacity.	Many of the reasonably foreseeable future projects would be expected to have some impact on wetlands and floodplains; however, any projects that would have impacts on wetlands or floodplains would require permits for construction. The permitting process is designed to ensure that there is no net loss of wetland acreage or function, and that no flood hazards occur. Thus, none of the reasonably foreseeable future projects are expected to result in a net significant negative impact to wetlands or floodplains in the region. The ETP NGL pipeline would have impacted a portion of the proposed pipeline construction ROW for approximately 42 miles of the proposed pipeline route. Restoration of wetlands would be in progress during the proposed construction period for the propose CO_2 pipeline.	Impacts to wetlands and floodplains from the proposed project are expected to be negligible to minor. The only foreseeable future project that may directly interact with the proposed project would be the construction of the ETP NGL pipeline, which could interact with construction of the CO_2 pipeline and cumulatively reduce wetland acreage by expanding the width of the mowed and maintained ROW in the existing utility corridor and/or increase the duration of temporary impacts (i.e., since NRG's proposed pipeline would be constructed during the wetland restoration period for ETP's NGL pipeline). Cumulative impacts associated with these project would be minor, however, as both projects would be required to avoid, minimize, and mitigate wetland impacts according to USACE permit requirements. No significant negative impacts are anticipated from other reasonably foreseeable future actions aside from potential cumulative reductions in wetland acreage. These cumulative effects are expected to be minor since the ROI is under the jurisdiction of the USACE Galveston District, which would review all projects that would impact wetlands in the area.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
		The 5,500-acre EOR area includes approximately 1,556 acres of wetlands identified by the NWI as well as FEMA floodplains adjacent to Venado Creek, the Lavaca River, Menefee Lake, and Menefee Bayou. There are no wetlands or floodplains within the approximately 16-acre area where the CO_2 recycle facility would be located.		
Biological Resources	Land cover in the region is primarily pasture/hay and cultivated crops. Historic conversion of the native plant communities to agricultural use and developed land, as well as habitat loss/degradation resulting from oil and gas development, has caused a significant loss of wildlife habitat. Remaining areas of favorable natural habitat have been fragmented by development and conversion to agricultural use, thus, limiting overall habitat quality for wildlife. Historic surface water quality degradation due to agricultural activities and land development has reduced the habitat quality for native aquatic species. The State of Texas has identified five previously used nesting areas within the ROI that are no longer in use, including a previously used colonial waterbird rookery and four previously used bald eagle nests. An active bald eagle nest was observed adjacent to the proposed pipeline corridor in Wharton County near Jones Creek. **A state-listed mussel**	The CO_2 capture facility and CO_2 recycle facility would be expected to have negligible impacts to biological resources as affected habitats have been previously disturbed for industrial and oil production uses. Impacts to wildlife from construction of the pipeline corridor would be negligible to minor because approximately **112** acres of natural systems would be temporarily impacted and **26** acres would be permanently impacted and comparable habitat is available throughout the region. Approximately **75**% of the proposed pipeline corridor would be constructed within or immediately adjacent to existing mowed/maintained utility corridors. Also, approximately 60% of the pipeline corridor is currently in agricultural use, which is of limited use to wildlife. These existing uses would minimize the overall effect to wildlife and fragmentation of wildlife habitat. Construction activities, including land clearing, would cause a negligible loss of wildlife habitat. **The proposed pipeline route would cross the Colorado River and Jones Creek by HDD approximately**	Each of the reasonably foreseeable future projects may result in some degree of wildlife habitat losses. The total area of these impacts would not be expected to significantly reduce the remaining wildlife habitat, and would be consistent with much of the existing land use in the region.	The impacts to wildlife habitat resulting from the proposed project combined with other reasonably foreseeable future projects would be minor because comparable habitat is available throughout the region.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
	species was identified at the proposed Colorado River crossing. There are no documented sightings of federally listed protected species within the ROI and none were observed during field surveys. **The pipeline corridor crosses the migratory pathway of the whooping crane. Whooping crane critical habitat is located approximately 30 miles south of the ROI.**	**1 mile from the identified** active bald eagle nest**. No impacts to state-listed mussels or bald eagles are anticipated. No other** state-listed or federally-listed species were identified during field surveys in the ROI. **Additional bird surveys will be conducted prior to construction to determine the presence of migratory bird nests, bald eagles, whooping cranes, or other protected species. If present, these species would be avoided during construction.**		
Cultural Resources	Historically, the quality and quantity of cultural resources in the ROI has been diminished by land development, primarily associated with residential and commercial construction, agriculture, and oil and gas development.	Based on desktop cultural resources surveys, DOE determined, and the THC has concurred, that no impacts to historic properties listed, or eligible for listing, in the NRHP would be expected from construction or operational activities in the CO_2 capture facility or EOR/CO_2 monitoring areas. Additionally, based on cultural resources survey data collected to date, the DOE has determined that no historic properties listed, or eligible for listing, in the NRHP would be impacted by the construction and operation of the proposed pipeline. DOE has submitted its findings regarding pipeline corridor surveys to the THC for review and consultation with the THC is ongoing.	Each of the reasonably foreseeable future actions may cause some degree of cultural resource disturbance. Thus, minor cumulative impacts would be expected on cultural resources.	A low likelihood of significant adverse effects to cultural resources would be expected.
Land Use and Aesthetics	Past land use at the W.A. Parish Plant has been industrial since the first electric generating unit was constructed in 1958. Construction of the W.A. Parish Plant converted some Prime	The proposed construction and operation of the CO_2 capture facility, EOR, and CO_2 monitoring activities is entirely consistent with existing land use. Construction of the proposed CO_2 pipeline would result in minor	There are no foreseeable future projects anticipated to create incompatibilities with current land use that would interact with the project. Should construction of the CO_2	Overall, minor impacts on land use would be expected due to relatively small amounts of long-term land cover alterations. The only foreseeable future project that may interact with the proposed project

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	Farmland to industrial use. Within the approximately 610-acre operational area of the W.A. Parish Plant, approximately 440 acres have been categorized as Prime Farmland (NRCS 2011). Approximately **75%** of the proposed pipeline ROW is adjacent to existing utility ROWs that have been in use for many years. Some of the existing ROWs are more recent and some segments of the pipeline would cross lands that have been used for other purposes. The West Ranch oil field where the EOR activities would occur has been actively producing oil since its discovery in 1938. There are no designated scenic vistas in any part of the proposed project.	temporary loss of agricultural land and natural land cover (forests, grasslands, etc.), but only negligible permanent loss of agricultural land and natural land cover. Construction of the pipeline would cause temporary minor to moderate aesthetic impacts to adjacent property owners, depending on their proximity to the construction easement. A total of 123 residences are located within 1,000 feet of the proposed, approximately **81**-mile-long pipeline route. These impacts would be short-term and related to construction noise; truck traffic; emissions, mainly fugitive dust (i.e. particulate matter); and vegetation clearing. Impacts to aesthetic values would be negligible at the CO_2 capture facility and EOR field as the existing aesthetic character would generally remain unchanged. Along the CO_2 pipeline route, minor aesthetic impacts would occur in some locations due to woody vegetation losses resulting from ROW maintenance and placement of a meter station, **12** aboveground MLVs, and signs.	pipeline coincide with construction of the ETP NGL pipeline, construction-related, temporary cumulative impacts may occur, (e.g., relatively small land areas being unavailable for other uses during construction). However, current information suggests that the construction timeframes would be unlikely to overlap. Due to the lack of designated scenic vistas in the area there would be no contribution to reasonably foreseeable future impacts on such resources.	would be the construction of the ETP NGL pipeline, which could interact with construction of the CO_2 pipeline and cumulatively make land unavailable for other uses temporarily. This is possible, but unlikely. No greater than negligible impacts on aesthetic resources would be expected as there are no designated scenic vistas that would be impaired by the cumulative effects of the proposed project and other foreseeable projects in the area.
Noise and Vibration	The historical noise environment around the W.A. Parish Plant has been composed of industrial noises from boilers, turbines, generators, fans, and heavy truck, vehicle, and railroad traffic. Overall, the historic noise environment of the region through which the pipeline would travel has generally followed the historic	Construction of the CO_2 capture facility and at the EOR field would have negligible to minor short-term impacts of increased sound levels on sensitive receptors due to construction activities and negligible impacts from the operations of the project components. Construction of the CO_2 pipeline would have minor to moderate	There are no foreseeable future projects anticipated to generate noise that would interact with the project (i.e., projects that would generate noise and exist within one mile of project components). Should construction of the CO_2 pipeline coincide with construction of the ETP NGL	Overall, minor to moderate, short-term cumulative effects of increased sound levels and perceptible vibrations may occur during project construction, which would most likely be entirely attributable to the project. Should CO_2 pipeline construction occur simultaneously with construction of either the ETP NGL pipeline or the bridge

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
	trend of land development, particularly with respect to the increased presence and use of motor vehicles and railways. The areas potentially affected by the project generally consist of rural land uses, including agricultural activities and oil production with some rural residential. The historical noise environment around the West Ranch oil field has been composed of noises from drilling activities, pumps, compressors, and some vehicle traffic noises.	impacts on sensitive receptors of increased sound levels as well as potentially perceptible vibrations due to HDD construction techniques in some areas, in which case sensitive receptors near HDD activities would likely experience elevated noise and vibration levels temporarily. Operation of the CO_2 capture plant, pipeline, and EOR facilities would likely result in no perceptible increase in sound levels for sensitive receptors. Noise levels should not exceed ambient levels for these project components.	pipeline and/or the bridge replacement in Fairchilds, construction-related, temporary cumulative impacts of increased sound levels may occur. However, current information suggests that the construction timeframes would be unlikely to overlap.	replacement in Fairchilds, cumulative short-term high impacts may result to sensitive receptors. Impacts would not be considered significant due to their very short-term nature and it is highly unlikely that these cumulative effects would occur.
Materials and Waste Manage-ment	In general, process materials used in oil and gas exploration and energy generation have been common and relatively easy to acquire for years. Landfills and other waste disposal facilities in the area of the project have had ample past disposal capacities to meet increasing waste disposal needs that generally coincide with historic land development trends.	Due to the generation of approximately 2,712 pounds per day of reclaimer effluent, a hazardous material, the W.A. Parish Plant would become a large quantity generator of hazardous waste instead of a conditionally exempt small quantity generator. Because the plant currently conforms to the requirements of a large quantity generator, impacts related to hazardous waste generation and management would be moderate. Approximately 24 shipments of reclaimer effluent would be sent to a permitted TSDF per year. The amounts sent for disposal would not substantially affect the capacities of the TSDF. Construction and operation of the pipeline or at the West Ranch oil field is not expected to generate appreciable quantities of hazardous waste, if any. Adequate suppliers exist for	Each of the foreseeable future actions would require construction materials and/or operational materials, which are readily available in the ROI due to existing and historical oil and gas development in the area. The demands on waste disposal facilities in the ROI would be slightly increased; however, adequate waste treatment, storage, and disposal capacity exists in the ROI to meet the increased demand.	Minor cumulative adverse impacts on availability of materials and waste disposal facilities' capacities would be expected; however, commercial landfills, disposal facilities, and recycling facilities in the ROI would have adequate capacities to accept generated wastes. The proposed project's contribution to availability of materials and the reduction in waste disposal capacity would be negligible.

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		construction and operational materials. Adequate disposal capacity exists along the Texas Gulf Coast for solid waste disposal. The proposed project would result in negligible impacts to materials and waste management service providers.		
Human Health and Safety	The population density near the W.A. Parish Plant varies from unpopulated areas to areas with up to 100 to 500 people per square mile. The majority of the pipeline traverses areas with population densities of 5 or less people per square mile, with certain segments that have a population density as high as 100 to 500 people per square mile. The areas surrounding the West Ranch oil field are primarily unpopulated, except for the town of Vanderbilt, north of the oil field, which has a population density of 25 to 50 people per square mile. The winds in the ROI are predominately from the direction of the Gulf of Mexico (i.e., from the south and southeast). Occupational injury data for related industries (i.e., utility system construction, non-residential construction, and oil and gas pipeline construction) have total recordable case rate between 2.2 and 4.4 cases per 100 workers and lost work day case rates between 0.5 and 1.5 cases per 100 workers. Fatality rates per 10,000 workers are 3.9	An estimated 9 to 12 recordable incidents would be anticipated during project construction based on national incident rates. No fatalities would be expected during project construction. During operations, the projected number of recordable incidents per year is estimated to be 1.16, with 0.40 being lost work days or 0.67 days away for restricted duty or job transfer. Potential accidents related to project operations may include CO_2 releases from the pipeline, injection wells, or from the subsurface. In the unlikely event of a pipeline release (i.e., puncture or rupture), transient and reversible effects may affect up to 12 people. More severe impacts would affect less than one person. Physical effects to workers near a release could experience physical trauma, asphyxiation, frostbite, or exposure to higher CO_2 concentrations than the surrounding population. In the unlikely event of a CO_2 release from a well, the impacts would be localized (i.e., less than 0.02 miles) and would not affect nearby communities. The probability of a CO_2 release from the subsurface in the EOR area ranges from unlikely to incredible and would affect less than	There could be a potential increase in risks to human health and safety from construction and operation of the ETP NGL pipeline. Part of the CO_2 pipeline would occupy a ROW adjacent to the ETP ROW for part of the CO_2 ROW length; therefore, construction of the proposed CO_2 pipeline must be conducted in proximity to an existing pipeline. Although the construction hazards of both pipelines are similar, the operation hazards are different due to the different products that would be conveyed in the pipelines. There would be no contribution to the potential for a CO_2 release related to cumulative impacts for reasonably foreseeable projects because none of the identified proposed projects involve the management of CO_2.	There would be no cumulative effect from the potential release of CO_2 because none of the existing or reasonably foreseeable future actions involve the management of CO_2. Overall risks to workers due to industrial accidents would be similar for all of the cumulative projects within their particular industrial classification.

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	for utilities, 6.7 for installation, repair, and maintenance, 9.7 for construction, and 23.9 for oil and gas extraction.CO2 pipelines have a safety record that is better than for other hazardous liquid and natural gas pipelines. Current safety programs and OSHA requirements have contributed to the decreasing impacts to human health and safety.	one person. A potential, unlikely leak of amine-based solvent from a storage tank would be confined to the W.A. Parish Plant property and no nearby residents or the general public would be affected beyond mild irritation or odors. However, plant workers would need to take appropriate response actions, since life-threatening concentrations of the solvent in air could occur within the plant site to a distance of 0.3 miles from the release.		
Utilities	Negative impacts on local utility services have generally not occurred due to historic land development trends as providers have been able to adequately extend/develop these services. Utility services currently are not strained and are maintaining adequate service levels in the ROI.	Beneficial impacts to utility gas, oil, and electric supplies would be provided in the long term as a result of increased production of oil and natural gas supplies in the ROI as a result of EOR operations. Minor adverse impacts of increased demand would occur for natural gas and potable water utility providers.	Oil supplies in the region would be increased as a result of increased oil production from EOR operations causing beneficial impacts. The planned Greatwood subdivision, Colorado Bend Energy Center, Deer Park Energy Center Expansion, King Power Station, White Stallion Energy Center Flag City Natural Gas Processing Plant, Jackson County Hospital Expansion, and new RV park in Edna would each likely require local utilities and would have minor impacts on demand and supply in the ROI. The King Power Station and the White Stallion Energy Center would likely require additional natural gas supplies.	Minor beneficial cumulative impacts would be expected in terms of oil and electric supplies. Minor cumulative adverse impacts on utility providers' supply capacities would be expected; however, the existing utility capacities within the ROI would be adequate to support the increased demand. Utility service needs are anticipated to increase as the population of the ROI continues to grow. Utility services would be expected to take measures to expand supply and distribution capacities appropriately; thus, additional utility services or capacity may be required, depending upon the long-term growth of the ROI. Development of the project would contribute minor adverse impacts.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
Community Services	The workforce and infrastructure needed to supply community services to a geographic area generally parallels the population of that area. Thus, within the ROI, the amount of services provided has generally followed historic population growth. The demand of the population for law enforcement, fire protection, emergency response, healthcare services, and schools currently is adequately provided by the applicable service providers.	A temporary workforce of up to 1,100 would be required for construction of the project. Long-term operation of the project would require up to 20 new employees. It is likely that these workers would be drawn from the existing workforce of the area; however, an undeterminable number of workers and associated families may relocate to the area, temporarily for the construction workforce. Negligible impacts on community services would be expected due to a relatively small population increase as well as the actual construction and operation of the project. Existing emergency response capabilities are expected to be adequate to address potential accidents and other risks, while the potential risks to the health and safety of the general public are considered to be very low.	The only reasonably foreseeable future action that would be expected to add substantially to the local population would be the planned new subdivision in Greatwood. No other projects would be expected to add much in terms of population growth. The Flag City Natural Gas Processing Plant may add slightly to service needs in the Edna area.	The Greatwood subdivision would likely add to community service demands in the in the general W.A. Parish Plant area, though it is anticipated that the local zoning, planning, and approval processes would account for these needs and plan for them appropriately if current service levels are not adequate. The project may interact with the Flag City Natural Gas Processing Plant in terms of the Edna area's community services; however, it is anticipated that existing services would be adequate to support them both and the project's contribution would be negligible. Overall, minor impacts on community services in the Greatwood area may occur, though the contribution of the project would be negligible.
Socio-economics	Negative impacts to population and housing numbers; local economy and employment figures; and taxes and revenue generation have typically not occurred as a result of oil and gas exploration and production. Beneficial short-term impacts result from increased employment opportunities, local spending, and related sales/ property tax revenue.	Beneficial impacts to populations, employment, and sales tax revenue in the short-term during construction phase of the proposed project. **The total estimated wages paid during construction is nearly $75 million, with local wages at nearly $30 million.** Beneficial impacts to sales/property tax revenue during the operations phase of the proposed project. **The total estimated sales taxes would provide an estimated $512,000 in revenues. Property tax revenues are estimated to total approximately $24 million per year, once the proposed project is complete.**	Construction projects could compete for skilled and unskilled labor, as well as facilities for lodging in the short-term. However, beneficial short-term and long-term impacts result from increased employment opportunities, local spending, and related sales/property tax revenue.	Multiple concurrent projects may result in competition for short-term skilled and unskilled labor, as well as facilities for lodging. Beneficial short-term and long-term impacts result from increased employment opportunities, local spending, and related sales/property tax revenue. NRG's new CO_2 supply could impact the regional CO_2 market and other proposed near-term suppliers of CO_2 in the region. The incremental increase in central Texas Gulf Coast oil production (and reserves) is not likely to be enough to cause local oil prices to decline. Introduction of infrastructure for CO_2-based EOR in the Texas Gulf Coast could

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
				increase the region's projected oil reserves and increase the value of existing oil fields. Additional oil production resulting from investments in EOR infrastructure would generate jobs and additional tax revenue (e.g., sales/ property tax revenue and oil production tax revenue).
Level of Importance – Low				
Trans-portation and Traffic	Overall, transportation resources generally followed the historic trend of land development, particularly with respect to the increased use of motor vehicles and railways. The areas potentially affected by the project generally consist of rural land uses, including agricultural activities and oil production with some rural residential.	Traffic would increase at the W.A. Parish Plant, along the pipeline, and at the West Ranch oil field due to additional construction vehicles and traffic delays near the proposed sites. These effects would be temporary in nature and would end with completion of the construction phase. W.A. Parish Plant. NRG's proposed project would increase the total number of trips to and from the plant 2.7%, from 349 trips per day to 358 trips per day. All roadways in the area have the capacity for all operational traffic at the plant combined. The pipeline and changes at the West Ranch oil field would not generate substantial traffic during operation. Transportation-related effects associated with these maintenance activities would be negligible. These incremental changes would have no appreciable effect on overall traffic in the area when compared to existing conditions.	There are no foreseeable future projects anticipated to generate traffic that would interact with the project (i.e., projects that would generate traffic and exist within the vicinity of project components). Should construction of the CO_2 pipeline coincide with construction of the ETP NGL pipeline and/or the bridge replacement in Fairchilds, construction-related, temporary cumulative impacts of increased traffic may occur. However, current information suggests that the construction timeframes would be unlikely to overlap.	Cumulative impacts associated with transportation and traffic would be negligible. The introduction of a temporary increase in traffic during construction (up to 1,100 workers) would be easily accommodated by the existing road systems with only minor temporary disruptions. Continuing operation of the W.A. Parish Plant, the pipeline, and the West Ranch oil field would have negligible effects as a relatively small number of commuting employees would be added (20) as well as a relatively small amount of additional material deliveries. No large-scale projects or proposals have been identified that when combined with the project would have significant cumulative impacts.
Environ-mental Justice	Fort Bend, Wharton, and Jackson Counties do not have minority populations greater than two times the state or U.S. minority	**Three census tracts in the ROI qualify as a minority environmental justice areas of concern using the threshold of 50 percent minority in**	**While large minority populations exist within Fort Bend and Jackson Counties, the contribution of**	**While there are existing minority populations in the ROI, none would be impacted by the proposed project and other**

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
	population percentage. None of the nine census tracts in the proposed project area have minority populations greater than two times the corresponding county minority population percentage. **However, Fort Bend and Wharton Counties, and three census tracts in the ROI have large minority populations based on the 50 percent minority or 25 percent higher than the percentage of minority population in the corresponding county threshold.** **Also, the ROI does not have low-income populations greater than two times the state or U.S. low-income population percentages. Additionally, none of the nine census tracts exhibited low-income populations that were greater than two times the corresponding county low-income population percentage.** **The effects of past actions were generally not directed at any one particular group, and were typically dispersed over the entire ROI. This means that significant and/or adverse impacts on potential minority environmental justice areas of concern do not exist.** Therefore, disproportionately negative impacts to minority or low-income communities have not	**the corresponding county. However, the proposed project is not expected to have disproportionately high and adverse human health or environmental impacts on minority populations. The impacts of the proposed project would not be directed at any one particular group, and are dispersed over the entire length of the proposed project. This means that significant and/or adverse impacts on potential environmental justice areas of concern do not exist. Typically, the development of any large industrial activity, such as the proposed project, could result in impacts to the surrounding environment during construction or operational activities at the W.A. Parish Plant, the proposed pipeline corridor, and the West Ranch oil field. Analyses included in this EIS indicate that the proposed project could result in:** • **potential beneficial impacts to regional socioeconomics and reduction of greenhouse gas emissions;** • **potential moderate adverse impacts to surface water and biological resources should a spill or leak occur, and** • **potential negligible to minor adverse impacts to air quality, geology, physiography and soils,**	**reasonably foreseeable future actions are not expected to be directed at any one particular group, and are anticipated to be dispersed over the entire ROI of the proposed project. This means that significant and/or adverse impacts on potential minority environmental justice areas of concern would not exist.** Since Fort Bend, Wharton, and Jackson Counties do not have low-income populations in the ROI, based on comparisons of county census data to state and U.S. census data, foreseeable future projects would also not be expected to impact low-income populations.	**foreseeable future projects.** There are no existing minority or low-income populations in the ROI **that would** be impacted by the proposed project and other foreseeable future projects. Ongoing development within the ROI would continue to provide increased economic opportunities to local populations, thus providing a beneficial cumulative environmental justice effect. No disproportionately adverse cumulative effects would occur to minority or low-income populations.

Resource Area	Pertinent Historical Information and Effects of Past Actions	Contribution from Proposed Project	Contribution of Reasonably Foreseeable Future Actions	Cumulative Effects
	occurred as a result of **past actions.**	**groundwater, wetlands and floodplains, cultural resources, traffic and transportation, human health and safety, utilities, and community services.** **In each case, no significant impacts were found to occur during construction or operation of the proposed project. Mitigation measures have been identified to further reduce impact levels and adhere to local policies for the protection of the environment and local public. Therefore, the proposed project would not create a disproportionately high and adverse human health or environmental effect on minority populations during construction or operation.** **Because there is no low-income population in the ROI to be affected, there would be no adverse environmental justice impacts associated with the proposed project during operations. The proposed project is expected to create economic benefits for local communities during construction and operation.**		

bgs = below ground surface; CO = carbon monoxide; CO_2 = carbon dioxide; DOE = U.S. Department of Energy; EOR = enhanced oil recovery; EPA = U.S. Environmental Protection Agency; ERC = emission reduction credit; ETP = Energy Transfer Partners; FEMA = Federal Emergency Management Agency; H_2SO_4 = sulfuric acid; HDD = horizontal directional drilling; HGB = Houston Galveston Brazoria; HRM = Houston Regional Monitoring Corporation; MECT = Mass Emission Cap & Trade; mgd = million gallons per day; MSA = Metropolitan Statistical Area; NAAQS = National Ambient Air Quality Standards; NGL = natural gas liquid; NO_2 = nitrogen dioxide; NOx = nitrogen oxides; NRG = NRG Energy, Inc.; NRHP = National Register of Historic Places; OSHA = U.S. Occupational Safety and Health Administration; $PM_{2.5}$ = particulate matter with a diameter of 2.5 microns or less; PM_{10} = particulate matter with a diameter of 10 microns or less; ROI = region of influence; ROW = right-of-way; RV = recreational vehicle; SIP = State Implementation Plan; SO_2 = sulfur dioxide; TCEQ = Texas Commission on Environmental Quality; THC = Texas Historical Commission; TSDF = treatment, storage, and disposal facility; UNFCC = United Nations Framework on Climate Change; USACE = U.S. Army Corps of Engineers; VOC = volatile organic compounds

5.2.2 Cumulative Impacts on Greenhouse Gases

DOE determined that a high level of importance should be placed on the area of GHGs due to the project's anticipated effect on this resource area. DOE considers GHG emissions to be an area of relatively high interest to the public based on a considerable amount of media reporting on the subject of GHG emissions, which are widely associated with global climate change. This section addresses potential impacts from the construction and operation of the proposed Parish PCCS Project in the context of global climate change.

5.2.2.1 Impacts of Greenhouse Gases on Climate

Climate is usually defined as the "average weather" of a region, or more scientifically as the statistical description of a region's weather in terms of the means and variability of relevant parameters over periods ranging from months to thousands of years. The relevant parameters include temperature, precipitation, wind speed and direction, and dates of meteorological events such as first and last frosts, beginning and end of rainy seasons, and appearance and disappearance of pack ice. Greenhouse gases in the atmosphere absorb energy that would otherwise radiate into space, increasing the possibility that anthropogenic (human-caused) releases of these gases could result in warming that might eventually alter climate (IPCC 2007). Potential impacts of GHGs on climate are essentially cumulative impacts, because no single source of GHG emissions is substantial enough to affect climate independently.

Changes in climate are difficult to detect because of the complex variability in natural meteorological patterns over long periods of time and across broad geographical regions. There is much uncertainty regarding the extent of global warming caused by anthropogenic GHGs, the climate changes this warming will produce, and the appropriate strategies for stabilizing the concentrations of GHGs in the atmosphere. The World Meteorological Organization and United Nations Environment Programme established the IPCC to provide an objective source of information about global warming and climate change. The IPCC's reports are generally considered an authoritative source of information on these issues.

According to the IPCC Fourth Assessment Report, "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level" (IPCC 2007). The IPCC report found that the global average surface temperature has increased by about 1.3°F in the last 100 years; global average sea level has risen about 6 inches over the same period; and cold days, cold nights, and frosts over most land areas have become less frequent during the past 50 years. The report concluded that most of the temperature increase since the middle of the 20th century "is very likely due to the observed increase in anthropogenic [GHG] concentrations."

The 2007 report estimated that, at present, CO_2 accounts for about 77% of the global warming potential attributable to anthropogenic releases of GHGs, with the vast majority (74%) of this CO_2 coming from the combustion of fossil fuels. Although the report considers a wide range of future scenarios regarding GHG emissions, CO_2 would continue to contribute more than 70% of the total warming potential under all of the scenarios. The IPCC therefore believes that further warming is inevitable, but that this warming and its effects on climate could be mitigated by stabilizing the atmosphere's concentration of CO_2 through the use of (1) "low-carbon technologies" for power production and industrial processes; (2) more efficient use of energy; and (3) management of terrestrial ecosystems to capture atmospheric CO_2 (IPCC, 2007).

5.2.2.2 Environmental Impacts of Climate Change

The IPCC and the U.S. Global Change Research Program (USGCRP), formerly the U.S. Climate Change Science Program, have examined the potential environmental impacts of climate change at global, national, and regional scales. The IPCC report states that, in addition to increases in global surface temperatures, the impacts of climate change on the global environment may include:

- more frequent heat waves, droughts, and fires;
- rising sea levels and coastal flooding;
- melting glaciers, ice caps, and polar ice sheets;
- more severe hurricane activity and increases in frequency and intensity of severe precipitation;
- spread of infectious diseases to new regions;
- loss of wildlife habitats; and
- heart and respiratory ailments from higher concentrations of ground-level ozone (IPCC 2007).

On a national scale, average surface temperatures in the U.S. have increased, with the last decade being the warmest in more than a century of direct observations (CCSP 2008). Potential impacts on the environment attributed to climate change observed in North America include

- extended periods of high fire risk and large increases in burned area;
- increased intensity, duration, and frequency of heat waves;
- decreased snow pack, increased winter and early spring flooding potentials, and reduced summer stream flows in the western mountains; and
- increased stress on biological communities and habitat in coastal areas (IPCC 2007).

The USGCRP recently reported the following impacts and trends in the southeast region of the U.S., including the Texas Gulf Coast, associated with climate change (USGCRP 2009):

- Projected increases in air and water temperatures will cause heat-related stresses for people, plants, and animals.
- Decreased water availability is very likely to affect the region's economy as well as its natural systems.
- Sea-level rise and the likely increase in hurricane intensity and associated storm surge will be among the most serious consequences of climate change.
- Ecological thresholds are likely to be crossed throughout the region, causing major disruptions to ecosystems and to the benefits they provide to people.
- Quality of life will be affected by increasing heat stress, water scarcity, severe weather events, and reduced availability of insurance for at-risk properties.

5.2.2.3 Addressing Climate Change

Concern regarding the relationship between GHG emissions from anthropogenic sources and changes to climate has led to a variety of federal, state, and regional initiatives and programs aimed at reducing or controlling GHG emissions from human activities as discussed in Section 3.3 of this EIS (Greenhouse Gases). It is generally accepted that any successful strategy to address GHG reductions would require a global approach to controlling these emissions.

Because climate change is considered a cumulative global phenomenon, it is generally accepted that any successful strategy to address climate change must rest on a global approach to controlling these emissions. In other words, imposing controls on one industry or in one country is unlikely to be an effective strategy. In addition, because GHGs remain in the atmosphere for a long time, and industrial societies will continue to use fossil fuels for at least the next 25 to 50 years, climate change cannot be avoided. As the IPCC report states: “Societies can respond to climate change by adapting to its impacts and by reducing [GHG] emissions (mitigation), thereby reducing the rate and magnitude of change” (IPCC 2007).

According to the IPCC, there is a wide array of adaptation options. While adaptation will be an important aspect of reducing societies’ vulnerability to the impacts of climate change over the next two to three decades, “adaptation alone is not expected to cope with all the projected effects of climate change, especially not over the long term as most impacts increase in magnitude” (IPCC 2007). Therefore, it will also be necessary to mitigate climate change by stabilizing the concentrations of GHGs in the atmosphere. Because these gases remain in the atmosphere for long periods of time, stabilizing their atmospheric concentrations will require societies to reduce their annual emissions. The stabilization concentration of a particular GHG is determined by the date that annual emissions of the gas start to decrease, the rate of decrease, and the persistence of the gas in the atmosphere. The IPCC report predicts the magnitude of climate change impacts for a range of scenarios based on different stabilization levels of GHGs. “Responding to climate change involves an iterative risk management process that includes both mitigation and adaptation, taking into account actual and avoided climate change damages, co-benefits, sustainability, equity, and attitudes to risk” (IPCC 2007).

5.2.2.4 Climate Change, Greenhouse Gases, and the Proposed Parish PCCS Project

The capture and geologic storage of existing GHG emissions by the proposed project would produce a beneficial cumulative effect on a national and global scale. The Parish PCCS Project would remove approximately 1.6 million tons of CO_2 annually from the W.A. Parish Plant Unit 8 flue gas for use in EOR and ultimate sequestration at the West Ranch oil field. Taking into account the approximately 785,000 tons of CO_2 that would be emitted each year from operation of the proposed CO_2 capture facility, including associated project facilities at the W.A. Parish Plant (e.g., the CT/HRSG), and operation of the proposed CO_2 recycle facility to support EOR activities at the West Ranch oil field, NRG’s proposed project would result in a net reduction of approximately 815,000 tons of CO_2 emissions annually. Over the 20-year span of the proposed project, the project would result in a total net reduction of approximately 16.3 million tons in CO_2 emissions that would otherwise be emitted. Additional details regarding CO_2 emissions that would result from the proposed Parish PCCS Project are provided in Sections 3.2 (Air Quality and Climate) and 3.3 (Greenhouse Gases) of this EIS.

These reductions in emissions alone, however, would not appreciably reduce global concentrations of GHG emissions. However, these emissions changes would incrementally affect (reduce) the atmosphere’s concentration of GHGs, and, in combination with past and future emissions from all other sources, contribute incrementally to future change in atmospheric concentrations of GHGs. At present there is no methodology that would allow DOE to estimate the specific effects (if any) this increment of change would produce near the project area or elsewhere.

5.2.2.5 Climate Change, Greenhouse Gases, and the DOE CCPI Financial Assistance

As described in more detail in Section 1.2, the DOE selected the proposed project for further, more detailed consideration for financial assistance. The project would serve the DOE's CCPI Round 3 objective to demonstrate advanced coal-based technologies that capture and sequester CO_2 emissions. DOE believes that accelerated commercial use of new or improved technologies will help sustain economic growth, yield environmental benefits, and produce a more stable and secure energy supply.

Demonstration and advancement of technologies that increase efficiency, facilitate carbon capture, beneficially use CO_2, and ultimately sequester CO_2 are important steps in developing strategies for controlling GHG emissions. The 2007 IPCC report states that there is "high agreement" that atmospheric concentrations can be stabilized by "deployment of a portfolio of technologies that are either currently available or expected to be commercialized in coming decades assuming that appropriate and effective incentives are in place for their development." The IPCC identifies CCS for coal-fired power plants as one of the "key mitigation technologies" for development before 2030 (IPCC 2007). The IPCC notes that energy efficiency will also play a key role in stabilizing atmospheric concentrations of GHGs.

The DOE believes that the objectives of the CCPI cost-shared effort between the U.S. Government and industry fulfill, in part, the recommendations of the IPCC. The DOE further believes that by providing financial assistance for this proposed project, the DOE would be providing appropriate incentives for developing technologies that can help reduce GHG emissions and climate change concerns. Therefore, successful demonstration of the proposed project, in combination with its broader scale application of its technology, and other similar DOE-sponsored GHG-reducing initiatives in the region and across the U.S., would be expected to result in a significant long-term cumulative (beneficial) effect by reducing GHG emissions and addressing climate change concerns.

DOE does acknowledge that the oil produced by EOR (i.e., CO_2 floods) would ultimately lead to the emissions of CO_2 to the atmosphere when the oil-derived products are produced and consumed. However, DOE does not expect that this project would result in increased GHG emissions from consumption of oil-derived fuels domestically or globally. Domestic production of crude oil in 2011 was 5.7 million barrels per day (bpd). The estimated CO_2 capture rate for this project is 1.6 million tons per year (1.5 MMTA). Assuming a typical CO_2 EOR efficiency of 3.1 barrels of crude oil produced per metric ton of CO_2 sequestered, this project would result in an average crude oil production rate of approximately 12,000 bpd (0.012 million bpd) over the life of the project. DOE believes that the resulting 0.22% increase in domestic supply of crude oil would not be enough to change the market price. With no price signal, the project would not affect the crude oil consumption rate, and therefore there would be no change in CO_2 emissions from the combustion of oil-derived fuels.

DOE predicts that the increased domestic crude oil production from this project would offset imports of crude oil as a source of supply. Imported crude oil is more expensive and would be the first source to be offset with an increase in domestic supply. This assertion is supported by crude oil supply data from the Energy Information Administration. During the economic downturn in 2007, demand for crude oil decreased. However, domestic supply remained level, and all of the reduction in supply came from imports. Based on the estimated crude oil production rate of 0.012 million barrels per day and using a five-year rolling average price for crude oil of $78.00 per barrel, the project would reduce the outflow of cash for imported crude oil by roughly $350 million per year and enhance the nation's energy security.

6 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes the amounts and types of resources that would be irreversibly and irretrievably committed for the proposed project. A resource commitment is considered *irreversible* when primary or secondary impacts from its use by the project would limit future use options. Irreversible commitment applies primarily to nonrenewable resources, such as minerals or cultural resources, and to those resources that are renewable only over long spans of time (i.e., generally greater than 100 years), such as soil productivity. A resource commitment is considered *irretrievable* when the use or consumption of the resource by the project would only be renewable or recoverable for use by future generations. Irretrievable commitment applies to the loss of production, harvest, or renewable natural resources that would be lost for a period of time (i.e., generally less than 100 years), but would recover or be available for use by future generations over time.

The principal resources that would be committed are the lands required for the construction of the proposed CO_2 capture facility at the existing W.A. Parish Plant, the proposed pipeline ROW (i.e., construction and permanent ROWs), and the locations of EOR and CO_2 monitoring facilities (i.e., well pads, CO_2 capture facility, etc.) at the existing West Ranch oil field, as well as the target formations proposed for permanent CO_2 storage. Existing wells would be used (i.e., refurbished or deepened as needed) to the extent practicable to minimize the number of new wells that would be needed. New injection wells would be drilled if the existing wells cannot be reworked for injection. New wells would be installed on existing well pads to the extent practicable. Considerable amounts of water used to operate the Parish PCCS Project would also be lost (i.e., evaporated rather than discharged back to surface or groundwater). Other resources that would be committed to the proposed project include construction materials (e.g., steel, concrete) and energy sources (e.g., coal, natural gas) used for construction and operation.

The amount of land that would be committed during construction of the project would include construction staging and laydown areas, pipeline construction ROWs, injection and monitoring well construction sites at the existing West Ranch oil field, and to a lesser extent, access road construction sites. The CO_2 capture facility would occupy 29 acres, the construction ROW for the CO_2 pipeline would occupy up to 100 feet in width for a distance of approximately **81** miles (approximately **1,040** acres total), **43 miles of access roads would occupy approximately 157 acres,** the CO_2 recycle facility would occupy and area of approximately 1.5 acres, and each injection/monitoring well construction site would require up to 2 acres.

The amount of land that would be committed during operation of the project would include the CO_2 capture facility site, permanent pipeline ROW (i.e., 30 feet in width for **approximately 81** miles, or approximately **296** acres), injection/monitoring well sites, and new access roads. This land would be irretrievably committed during the operation phase of the project, which has a potential to last 20 years. These commitments are not viewed as irreversible, as lands would be allowed to return to prior uses after the potential 20-year operational life of the project is over, and the project is decommissioned. For this analysis, it is presumed that decommissioning would involve the removal or the proper closure and abandonment in place of project components.

All of the land proposed for the CO_2 capture facility is owned by NRG and the injection/monitoring well sites are currently owned by TCV; therefore, there would be no loss of these lands as they would be used for their intended purpose by NRG and TCV. The pipeline would be constructed and operated by TCV.

As proposed, the pipeline would be co-located along or within existing mowed and maintained utility ROWs for approximately **75** percent of the route. For the remainder of the pipeline, temporary easements would be required during pipeline construction, and permanent easements would be maintained for the pipeline ROWs. The pipeline corridor would preclude farming only during construction, as any land currently being used for agricultural use would be returned to agricultural use after construction. Temporary and permanent easement lands would not be considered as an irreversible commitment of resources because lands in the ROWs would be returned to agricultural production with few restrictions. However, the loss of agricultural use of these lands during the proposed construction period would be an irretrievable commitment.

Natural habitat would be lost primarily where pipeline ROWs would cross wooded areas (i.e., forest and scrub-shrub) mainly along streams and adjacent wetlands areas. Construction of the pipeline corridor would result in the conversion of approximately **54** acres of forest and **99** acres of scrub-shrub to grassland, primarily where the proposed pipeline corridor is not collocated with existing utility ROW. However, except for the approximately 30-foot-wide permanent ROW, which would be mowed and maintained as grassland during the operational life of the pipeline, the remainder of the previously wooded areas would be allowed to revert back to forest or scrub-shrub. After the pipeline is removed from service, the permanent ROW could revert back to forest or scrub-shrub as well. This loss of wooded area is, therefore, considered an irretrievable commitment.

Injection of CO_2 into the subsurface would irreversibly commit portions of the 98-A, 41-A, Glasscock, and Greta sand units of the Frio Formation to CO_2 storage. The Frio Formation is a well-characterized oil-producing geological formation which is found between approximately 5,000 and 7,200 feet bgs. At 5,000 to 6,300 feet below the ground surface, the 98-A, 41-A, Glasscock, and Greta sand units are oil bearing units. Successful recovery of oil at this stage in the West Ranch oil fields history requires the injection of large volumes of CO_2, which in this case would be obtained from the W.A. Parish Plant CO_2 capture facility and delivered to the West Ranch oil field in the proposed pipeline. Hence, a portion of the remaining oil in these reservoirs would be recovered during CO_2 injection operations. TCV's portion of the West Ranch oil field currently has approximately two million barrels of conventional proven oil reserves. TCV estimates that using CO_2 floods (i.e., EOR), the West Ranch oil field could produce an additional 55 to 75 million barrels of oil. Once CO_2 injection is completed, some wells and equipment at the injection well site could still be used for long-term monitoring purposes, but after removal of surface facilities, the land could return to other uses.

Approximately 10,800 gpd of potable water and 12,000 gpd of industrial water would be used during construction of the CO_2 capture facility, along with approximately 3.5 million gallons for hydrotesting and system startup. Potable water would be obtained from existing W.A. Parish Plant groundwater wells and the majority of the industrial water would be taken from Smithers Lake. Approximately 12,750 gpd of potable water would be used during construction of the pipeline, along with approximately 1.75 million gallons for hydrotesting and other construction use. This water trucked in from nearby suppliers or obtained from a municipal water source. Hydrotest and construction water may also be obtained from nearby surface waterbodies (i.e., after appropriation permits are obtained, as applicable).

During operation, the CO_2 capture facility would use up to 5 mgd of plant process water that would be committed for the potential 20-year operational lifespan of the project. The majority of this water would be taken from Smithers Lake via a new surface water intake point and the remaining from existing groundwater wells. Most of the water would be cycled through the cooling towers, where some of the water would evaporate, and the balance would be treated and returned to Smithers Lake.

Because the project would not discharge water directly back to groundwater, this groundwater would not be available to the local area. Therefore, the water evaporated during operation and the potable water that would not be discharged directly back to groundwater are considered irretrievable commitments of water resources.

Material and energy resources committed for the project would include construction materials (e.g., steel, concrete), electricity, and fuel (e.g., diesel, gasoline). All energy used during construction and operation would be irreversible. Power requirements for operation of the carbon capture and compression equipment would be approximately 50 MW, which would be supplied by a new 80-MW natural gas-fired cogeneration plant constructed at the W.A. Parish Plant. Approximately 36 MW of additional electricity would be required to power the compressors for the CO_2 injection system and related EOR facilities at the West Ranch oil field. Natural gas demands for operation of the new natural-gas-fired cogeneration plant at the W.A. Parish Plant would be approximately 1.5 MMscf/hr (60,000 pounds per hour). TCV has not yet determined whether EOR operations would require additional natural gas to operate the West Ranch oil field's gas-lift pump systems or would result in development of surplus gas for commercial sale. During operation, the CO_2 capture facility would use amine-based solvent, ammonia, and other process chemicals, which would be irreversibly committed.

The construction and operation of the project would require the obligation of human resources that would not be available for other activities during the commitment period. This would be an irretrievable commitment of resources.

Finally, the construction and operation of the project would require the commitment of fiscal resources by NRG, TCV, HEC, their investors and lenders, and DOE for the construction and operation of the project. This fiscal investment would be an irreversible commitment.

As described above, the project would result in irretrievable (i.e., lost for a period of time) commitments of primarily renewable natural and human resources. The project would also result in irreversible (i.e., permanently lost) commitment of portions of geologic storage formations, fiscal resources, energy, material resources, and fuel. However, DOE believes these commitments would reduce the overall, long-term environmental effects (i.e., GHG emissions) of using fossil energy resources and would fulfill national objectives as identified by the CCPI Program.

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7 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

During the planned 20-year operational life of the proposed Parish PCCS Project, a total of approximately **1,476** acres of land (i.e., including 29 acres for the CO_2 capture facility; **1,197** acres for the pipeline construction ROW **and access roads**; and approximately 250 acres for construction of EOR and CO_2 monitoring facilities at the West Ranch oil field) would be used for project construction and operation. Easements would be required for the pipeline ROW. Additionally, the CO_2 capture facility would consume resources, including amine based solvent, ammonia, water, and small quantities of other process chemicals, paints, degreasers, and lubricants.

A long-term benefit of the project from the perspective of DOE would be to achieve lower emissions of GHGs by capturing and storing approximately 1.6 million tpy of CO_2. The widespread acceptance and employment of this technology could foster the overall long-term reduction in the rate of CO_2 emissions from power plants across the U.S., thereby reducing national GHG emissions. If the project is successful, the short-term use of land, materials, water, energy, and labor to construct and operate the project would have long-term positive impacts on reducing GHG emissions both in the U.S. and abroad.

The project would reduce emissions of $CO_{2,}$ as well as SO_2, HCl, HF, and NH_3, from the existing W.A. Parish Plant Unit 8 flue gas slipstream. The project would result in a net reduction of approximately 815,000 tpy (0.74 MMTA) of CO_2 emissions from the W.A. Parish Plant (see Section 3.2, Air Quality and Climate). The project would support the objectives of the CCPI Program to demonstrate an advanced coal-based technology that would capture, put to beneficial use, and geologically sequester CO_2 emissions from a coal-fired power plant.

The project would enhance short-term productivity in the ROI through the direct, indirect, and induced creation of approximately 1,100 jobs during the 24-month construction period. The project would also result in a beneficial impact to the economy, employment, and tax base within the ROI over its operational life as a result of the 20 permanent jobs that would be created, as well as, the indirect and induced jobs created as a result of these permanent jobs (see Section 3.18, Socioeconomics). Introduction of infrastructure for CO_2-based EOR in the Texas Gulf Coast could increase the region's projected oil reserves and increase the value of existing oil fields. Additional oil production resulting from investments in EOR infrastructure would generate jobs and additional tax revenue (e.g., sales/property tax revenue and oil production tax revenue).

Short-term uses of the environment would include the activities and associated impacts during the proposed construction and the 20-year operational lifespan of the project. Potential short-term impacts to various resources have been described throughout Chapter 3. Potential resources impacts evaluated include the following:

- Air quality impacts, as described in Section 3.2 of this EIS (Air Quality and Climate), including construction emissions due to material handling (e.g. dirt moving) and combustion of fuel;
- Erosion and sedimentation impacts on surface waters during construction, which generally would be mitigated through the use of appropriate BMPs, as described in Section 3.5 (Physiography and Soils) and 3.7 (Surface Water) of this EIS;
- Vegetation and wildlife habitat impacts caused by land-clearing activities, as described in Sections 3.8 (Wetlands and Floodplains) and 3.9 (Biological Resources) of this EIS;

- Aesthetic impacts from construction and operations affecting nearby residents, as described in Section 3.11 of this EIS (Land Use and Aesthetics);
- Traffic impacts during construction attributable to temporary detours and the movement of heavy equipment, plus increased traffic on local roadways during construction and operation, as described in Section 3.12 of this EIS (Traffic and Transportation); and
- Noise impacts from construction activities and operations, as described in Section 3.13 of this EIS (Noise).

8 REGULATORY AND PERMIT REQUIREMENTS

Council on Environmental Quality (CEQ) regulations for the National Environmental Policy Act (NEPA) Part 1502 Section 1502.25 states that, to the fullest extent possible, agencies shall prepare Draft EISs concurrently with and integrated with environmental impact analyses and related surveys and studies required by environmental review laws and Executive Orders (EOs). It also requires a Draft EIS list all federal permits, licenses, and other entitlements which must be obtained in implementing the proposed project. The following table contains relevant regulatory and permit requirements for the construction and operation of the Parish PCCS Project to comply with CEQ regulations. The table identifies relevant federal regulatory requirements considered within the EIS including federal regulations and EOs, state regulations and permitting requirements, and local regulations and permitting requirements.

Statute, Regulation, Order	Description
Federal Regulations and Permitting	
American Indian Religious Freedom Act of 1978 (42 U.S. Code [USC] 1996)	This act ensures the protection of sacred locations and access of Native Americans to those sacred locations and traditional resources that are integral to the practice of their religions.
Bald and Golden Eagle Protection Act 16 USC 668-668d	Prohibits "taking" bald or golden eagles, including their parts, nests, or eggs. The Act defines "take" as pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb. Prohibits the disturbance of a bald or golden eagle to a degree that causes, or is likely to cause, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.
Clean Air Act, Title I, IV, and V 40 CFR 50 through 95	Establishes NAAQS set by the EPA for certain air pollutants. Applicable Titles: • Title I—Air Pollution Prevention and Control. Basis for air quality and emission limitations, PSD permitting program, SIPs, New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAPs). • Title IV—Acid Deposition Control. Establishes limitations on SO_2 and NO_x emissions, permitting requirements, monitoring programs, reporting and record keeping requirements, and compliance plans for emission sources. This Title requires that emissions of SO_2 from utility sources be limited to the amounts of allowances held by the sources. (40 CFR 72 through 75) • Title V—Permitting. Required if the plant falls within 40 CFR 70.3 designations. This Title provides the basis for the Operating Permit Program and establishes permit conditions, including monitoring and analysis, inspections, certification, and reporting. Authority for implementation of the permitting program is delegated to the State of Texas.
Clean Air Act, continued	State-administered programs for Clean Air Act compliance: • Clean Air Interstate Rule (30 TAC 101, Subchapter H, Division 7) applies to any stationary, fossil fuel-fired combustion turbine meeting the applicability requirements under 40 CFR Part 96, Subpart AA or Subpart AAA. Clean Air Interstate Rule remains in effect, although it is under litigation. • Clean Air Mercury Rule (30 TAC 101, Subchapter H, Division 8) requires new and existing coal-fired electric generating units to participate in an EPA-administered nationwide cap-and-trade system to reduce mercury emissions.

Statute, Regulation, Order	Description
Chemical Accident Prevention/Accidental Release Prevention Program/Risk Management Plans **40 CFR 68 and Section 112(r) of the Clean Air Act Amendments**	This Act requires stationary sources having more than a threshold quantity of the specific regulated toxic and flammable chemicals to develop a Risk Management Plan for submittal to the EPA, which then makes the information publicly available, including: • Hazard assessment that details the potential effects of an accidental release, an accident history of the last 5 years, and an evaluation of the worst-case and alternative accidental releases. • Prevention program that includes safety precautions and maintenance, monitoring, and employee training. • Emergency response program that spells out emergency health care, employee training measures and procedures for informing the public and response agencies (e.g., the fire department) should an accident occur. • The plan must be updated and resubmitted to the agency every 5 years.
Clean Water Act, Title IV **40 CFR 104 through 140**	Focuses on improving the quality of water resources by providing a comprehensive framework of standards, technical tools, and financial assistance to address the many causes of pollution and poor water quality, including municipal and industrial wastewater discharges, polluted runoff from urban and rural areas, and habitat destruction. Applicable Sections: • Section 311—Oil and Hazardous Substances Liability. Requires certain facilities that store oil or oil products to prepare and implement a Spill Prevention, Control, and Countermeasure (SPCC) Plan. • Section 401—Certification. Provides states with the opportunity to review and approve, condition, or deny all federal permits or licenses that might result in a discharge to state or tribal waters, including wetlands. The major federal permit subject to Section 401 review is a Section 404 permit. Every applicant for a Section 404 permit must request state certification that the proposed activity would not violate state or federal water quality standards. Section 402—National Pollutant Discharge Elimination System (NPDES) Permit. Requires sources to obtain permits to discharge effluents and stormwater to surface waters. The CWA authorizes EPA to delegate permitting, administrative, and enforcement duties to stage governments, while EPA retains oversight responsibilities. The State of Texas has been delegated NPDES authority under the jurisdiction of the TCEQ's TPDES Program. Construction activities associated with oil and gas exploration and production activities, including pipelines to convey CO_2 for EOR use, are exempted by the provisions of 40 CFR 122 from CWA Section 402 requirements for NPDES stormwater permitting. This exemption does not apply to point source discharges, such as discharges of hydrostatic test water. Any hydrostatic test water discharged into a water of the U.S. (i.e., ponds, streams, bayous, rivers, wetland areas, etc.) requires an EPA-issued NPDES (i.e., Federal storm water and wastewater permitting program) hydrostatic test water discharge permit. All other hydrostatic test water discharges are under the jurisdiction of the RRC due to an existing memorandum of understanding (MOU) between the TCEQ and the RRC.

Statute, Regulation, Order	Description
Clean Water Act, continued	• Section 404 o Permits for Dredged or Fill Material. Regulates the discharge of dredged or fill material in the jurisdictional wetlands and waters of the United States. The USACE has been delegated the responsibility for authorizing these actions. o Nationwide Permit 12 Utility Line Activities. Authorizes the construction, maintenance, and repair of utility lines and the associated excavation, backfill, or bedding for the utility lines in all waters of the United States. The USACE has been delegated the responsibility for authorizing these actions. o Permitting related to CWA Section 404 is overseen by the USACE in coordination with permitting. Section 10 of the Rivers and Harbors Act. The proposed Parish PCCS Project is located within the Galveston District of the USACE, which manages Section 10/404 permitting for coastal Texas and a portion of western Louisiana. • State-administered programs for Clean Water Act compliance: o Hydrostatic Test Water Discharge Permit (Texas Water Code, Chapter 26) if hydrostatic test water is discharged. A TPDES General Permit No. TXG670000 would be required, as described above. o TPDES General Construction Storm Water Permit (Texas Water Code, Chapter 26) requires a TPDES permit if a storm water discharge occurs from construction sites disturbing 1 ac (0.5 ha) or more of land. TPDES General Industrial Storm Water Permit (Texas Water Code, Chapter 26) is required for storm water discharges associated with industrial activity.
Compliance Assurance Monitoring Program **40 CFR 64**	The federal regulations implementing this program apply to major sources that must obtain a Title V operating permit pursuant to 40 C.F.R. Part 70. The compliance assurance modeling rules are primarily aimed at emission units that are individually above major source thresholds and that utilize control devices to comply with an emission limitation (40 CFR 64.2).
Emergency Planning and Community Right-to-Know Act of 1986 **42 USC 1101 et seq.**	Requires that inventories of specific chemicals used or stored on site be reported on a periodic basis. The project would process or otherwise use substances subject to the Act's reporting requirements, such as ammonia and sulfuric acid.
Endangered Species Act **16 USC 1536 et seq.**	Enacted by Public Law 93-205, Endangered Species Act of 1973 (16 USC 1531 et seq.). Section 7, "Interagency Cooperation," requires any federal agency authorizing, funding, or carrying out any action to ensure that the action is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat of such species. Under Section 7 of the Act, DOE has consulted with the USFWS and the TPWD.
Farmland Protection Policy Act **7 USC 4201 et seq.**	Directs federal agencies to identify and quantify adverse impacts of federal programs on farmlands. The Act's purpose is to minimize the number of federal programs that contribute to the unnecessary and irreversible conversion of agricultural land to non-agricultural uses.
Federal New Source Review/PSD Permit **40 CFR 51 and 52.21**	A component of the Clean Air Act, the PSD program was developed to prevent significant deterioration in the air quality of those areas that meet the NAAQS. In general, the New Source Review/PSD rules define a "major source" as any source with the potential to emit 250 tpy or more of a criteria pollutant. A more stringent threshold is defined for a limited number of "categorical sources," source categories for which the PSD applicability threshold is 100 tpy of any criteria pollutant.
Fish and Wildlife Conservation Act **16 USC 2901 et seq.**	Encourages federal agencies to conserve and promote conservation of non-game fish and wildlife species and their habitats.

Statute, Regulation, Order	Description
Fish and Wildlife Coordination Act **16 USC 661 et seq.**	Requires federal agencies undertaking projects affecting water resources to consult with the USFWS and the state agency responsible for fish and wildlife resources. These agencies are to be sent copies of this EIS and their comments will be considered.
General Conformity Rule **40 CFR 6, 51, and 93**	Pursuant to this rule, an area that does not meet (or contributes to ambient air quality in a nearby area that does not meet) the primary or secondary NAAQS for a criteria pollutant (CO, lead, NO_2, PM_{10}, $PM_{2.5}$, ozone, SO_2) is referred to as a nonattainment area. The CAA requires states to submit to the EPA a SIP for attainment of the NAAQS in nonattainment areas. The 1977 and 1990 amendments to the CAA require comprehensive SIP revisions for areas where one or more of the NAAQS have yet to be attained. The Clean Air Act Amendments required federal actions to show conformance with the SIP. Federal actions include, but are not limited to, those projects that are funded by federal agencies and the review and approval of a proposed action through a federal agency's NEPA process. Conformance with the SIP means that the federal action will not interfere with the approved SIP's purposes of eliminating or reducing the severity and number of violations of the NAAQS and achieving expeditious attainment of such standards. The need to demonstrate conformity is applicable only to federal actions that occur in nonattainment areas or areas that were previously nonattainment and are currently designated as maintenance areas.
Greenhouse Gas Reporting Program **40 CFR 98**	Suppliers of fossil fuel or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 tpy or more of GHG emissions are required to submit annual reports to EPA in accordance with this CAA requirement.
Migratory Bird Treaty Act **16 USC 703 et seq.**	Protects birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. The Act regulates the take and harvest of migratory birds, their nests, and eggs. The USFWS will review this EIS to determine whether the activities analyzed would comply with the requirements of the MBTA.
National Emissions Standards for Hazardous Air Pollutants **40 CFR 61 and 63**	A component of the Clean Air Act, NESHAPs rules address health concerns that are considered too localized to be included under the scope of NAAQS. In general, the NESHAPs rules apply to affected sources that are located at (or are themselves) major sources of HAP emissions, as defined in 40 CFR 63.2, that is, any stationary source that emits or has the potential to emit (considering controls in the aggregate) 10 tpy or more of any single HAP or 25 tpy or more of any combination of HAPs.
National Environmental Policy Act **42 USC 4371 et seq.**	This EIS is being prepared to comply with NEPA, the federal law that requires agencies of the federal government to study the possible environmental impacts of major federal actions significantly affecting the quality of the human environment.
National Historic Preservation Act **16 USC 470 et seq. and 36 CFR 60.4 and 36 CFR 800**	Under Section 106 of the NHPA, the head of any federal agency having direct or indirect jurisdiction over a proposed federal or federally assisted undertaking in any state and the head of any federal department or independent agency having authority to license any undertaking shall, prior to the approval of the expenditure of any federal funds on the undertaking or prior to the issuance of any license, as the case may be, take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. The head of any such federal agency shall afford the Advisory Council on Historic Preservation established under Title II of the Act a reasonable opportunity to comment with regard to such undertaking. NRHP criteria for evaluation are specified in 36 CFR 60.4. 36 CFR 800 specifies that certain parties must be consulted during the Section 106 process. The Texas Historical Commission serves as the State Historic Preservation Officer (SHPO) for the State of Texas. As such, the THC is the lead agency in Texas for reviewing cultural resource surveys conducted under Section 106 of the NHPA and determining eligibility for listing properties on the NRHP, as defined in the NHPA and other related laws.

Statute, Regulation, Order	Description
Native American Graves Protection and Repatriation Act **25 USC 3001**	Directs the Secretary of the Interior to guide the repatriation of federal archaeological collections and collections that are culturally affiliated with Native American tribes and held by museums that receive federal funding. Major actions to be taken under this law include: • The establishment of a review committee with monitoring and policymaking responsibilities. • The development of regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims. • The oversight of museum programs designed to meet the inventory requirements and deadlines of this law. • The development of procedures to handle unexpected discoveries of graves or grave goods during activities on federal or tribal land.
New Source Performance Standards **40 CFR 60**	The NSPS are technology-based standards applicable to new and modified stationary sources of regulated air emissions. Where the NAAQS emphasize air quality in general, the NSPS focus on particular sources of approximately 70 industrial source categories or sub-categories of sources (e.g., fossil fuel-fired generators, grain elevators, steam generating units) that are designated by size as well as type of process.
Noise Control Act **42 USC 4901 et seq.**	Directs federal agencies to carry out programs in their jurisdictions "to the fullest extent within their authority" and in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare.
Notice to the Federal Aviation Administration **14 CFR 77**	The FAA must be notified if any structures more than 200 feet high would be constructed at the proposed site pursuant to 14 CFR 77. The FAA would then determine if the structures would or would not be an obstruction to air navigation.
Occupational Safety and Health Act **29 USC 651 et seq.**	Compliance with the OSHA would be required according to OSHA standards. Applicable Rules: • The development of regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims. • OSHA General Industry Standards (29 CFR 1910) • OSHA Construction Industry Standards (29 CFR 1926)
Pollution Prevention Act **42 USC 13101 et seq.**	This act establishes a national policy for waste management and pollution control that focuses first on source reduction, and then on environmentally safe waste recycling, treatment, and disposal.
Resource Conservation and Recovery Act **42 USC 6901 et seq. and 40 CFR 239 through 299**	This act regulates the treatment, storage, and disposal of solid and hazardous wastes. Resource Conservation and Recovery Act (RCRA) Title II, Solid Waste Disposal (known as the Solid Waste Disposal Act), regulates the disposal of solid wastes. Title II, Subtitle C-Hazardous Waste Management, provides for a regulatory system to ensure the environmentally sound management of hazardous wastes from the point of origin to the point of final disposal. Title II, Subtitle D—State or Regional Solid Waste Plans, requires all states to implement 'Solid Waste Plans' that maximize waste reduction and recycling. EPA has delegated authority for implementing RCRA to the State of Texas through 40 CFR 272.2201, RCRA Standard Permits for Storage and Treatment Units (30 TAC 305).
Rivers and Harbors Appropriation Act of 1899 **33 U.S.C. 401, 403, 407**	The Rivers and Harbors Act (RHA) addresses projects and activities in navigable waters and harbor and river improvements. Permitting related to Section 10 of the RHA is overseen by the USACE in coordination with CWA Section 404 permitting.
Safe Drinking Water Act **42 USC 300 et seq. and 40 CFR 144**	This act gives EPA the authority to regulate public drinking water supplies by establishing drinking water standards, delegating authority for enforcement of drinking water standards to the states, and protecting aquifers from hazards such as injection of wastes and other materials into wells. The State of Texas implements the Safe Drinking Water Act in Texas (30 TAC 290).

Statute, Regulation, Order	Description
Underground Injection Control Permit **40 CFR 144 through 146**	A CO_2 injection well for geologic storage would require the issuance of an underground injection control (UIC) permit in accordance with 40 CFR 144 through 146 of the Safe Drinking Water Act. The State of Texas has been granted authority to issue and administer Class I-V wells permits. On December 10, 2010, EPA published a final rule, "Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration (GS) Wells" (Federal Register Vol. 75, No. 237). Under this rule, EPA created a new category of injection wells (Class VI wells) with new federal requirements to allow for injection of CO_2 for geologic sequestration to ensure the protection of underground sources of drinking water.
Executive Orders	
Executive Order 11514 Protection and Enhancement of Environmental Quality	This EO directs federal agencies to continuously monitor and control activities to protect and enhance the quality of the environment. The Order also requires agencies to develop procedures to ensure the fullest practical provision of timely public information and the understanding of federal plans and programs with potential environmental impacts, and to obtain the views of interested parties. DOE promulgated regulations (10 CFR 1027) and issued DOE Order 451.1b, National Environmental Policy Act Compliance Program to ensure compliance with this EO Because the Proposed Action is a Federal Action that requires NEPA analysis, DOE must comply with Order 451.1b.
Executive Order 11988 Floodplain Management; Executive Order 11990 Protection of Wetlands	Executive Order 11988, Floodplain Management, directs federal agencies to establish procedures to ensure that they consider potential effects of flood hazards and floodplain management for any action undertaken. Agencies are to avoid impacts to floodplains to the extent practical. Executive Order 11990, Protection of Wetlands, requires federal agencies to avoid short- and long-term impacts to wetlands if a practical alternative exists. DOE regulation 10 CFR 1022 establishes procedures for compliance with these Executive Orders. Where no practical alternatives exist to development in floodplain and wetlands, DOE is required to prepare a floodplain and wetlands assessment discussing the effects on the floodplain and wetlands, and consideration of alternatives. In addition, these regulations require DOE to design or modify its actions to minimize potential damage in floodplains or harm to wetlands. DOE is also required to provide opportunity for public review of any plans or proposals for actions in floodplains and new construction in wetlands. A statement of findings from the assessment will be incorporated into the Final EIS.
Executive Order 12856 Right-to-Know Laws and Pollution Prevention Requirements	Directs federal agencies to reduce and report toxic chemicals entering any waste stream, improve emergency planning, response, and accident notification, and encourage the use of clean technologies and testing of innovative prevention technologies. In addition, this Order states that federal agencies are persons for purposes of the Emergency Planning and Community Right-to-Know Act, which requires agencies to meet the requirements of the Act.
Executive Order 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Requires federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.
Executive Order 13007 Indian Sacred Sites	Directs federal agencies, to the extent permitted by law and not inconsistent with agency missions, to avoid adverse effects to sacred sites and to provide access to those sites to Native Americans for religious practices. This Order directs agencies to plan projects to provide protection of and access to sacred sites to the extent compatible with the project.

Statute, Regulation, Order	Description
Executive Order 13101 Greening the Government through Waste Prevention, Recycling, and Federal Acquisition	Directs federal agencies to incorporate waste prevention and recycling in each agency's daily operations and work to increase and expand markets for recovered materials through preference and demand for environmentally preferable products and services.
Executive Order 13112 Invasive Species	Directs federal agencies to prevent the introduction of or to monitor and control invasive (non-native) species, to provide for restoration of native species, to conduct research, to promote educational activities, and to exercise care in taking actions that could promote the introduction or spread of invasive species.
Executive Order 13148 Greening the Government through Leadership in Environmental Management	Makes the head of each federal agency responsible for ensuring that all necessary actions are taken to integrate environmental accountability into agency day-to-day decision-making and long-term planning across all agency missions, activities, and functions.
Executive Order 13175 Consultation and Coordination with Indian Tribal Governments	Directs federal agencies to establish regular and meaningful consultation and collaboration with tribal governments in the development of federal policies that have tribal implications, to strengthen United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates on tribal governments.
Executive Order 13186 Responsibilities of Federal Agencies to Protect Migratory Birds	Requires federal agencies to avoid or minimize the negative impacts of their actions on migratory birds, and to take active steps to protect birds and their habitats. • Directs each federal agency taking actions having or likely to have a negative impact on migratory bird populations to work with the USFWS to develop an agreement to conserve those birds. • Directs agencies to avoid or minimize impacts to migratory bird populations, take reasonable steps that include restoring and enhancing habitat, prevent or abate pollution affecting birds, and incorporate migratory bird conservation into agency planning processes whenever possible. • Requires environmental analyses of federal actions to evaluate effects of those actions on migratory birds, to control the spread and establishment in the wild of exotic animals and plants that could harm migratory birds and their habitats, and either to provide advance notice of actions that could result in the take of migratory birds or to report annually to the USFWS on the numbers of each species taken during the conduct of agency actions.
Executive Order 13423 Strengthening Federal Environmental, Energy, and Transportation Management	Executive Order No. 13423 directs federal agencies to conduct their environmental, transportation, and energy-related activities in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner.

Statute, Regulation, Order	Description
Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance	Executive Order No. 13514 sets sustainability goals for federal agencies and focuses on making improvements in their environmental, energy, and economic performance. This order establishes an integrated strategy promoting sustainability in the federal government, makes reduction of GHG emissions a priority for federal agencies, and sets goals in the areas of energy efficiency, acquisition, renewable energy, toxics reductions recycling, renewable energy, sustainable buildings, electronics stewardship, fleets, and water conservation.
Texas State Regulations and Permitting	
Railroad Commission of Texas, Oil And Gas Division Rules for Water Protection **16 TAC 3.8**	A RRC minor permit, as defined in 16 TAC 3.8(d)(6)(G), is required for the disposal of hydrostatic test water in the state of Texas unless certain exemption criteria are met. RRC permits may include conditions requiring discharge sampling and analysis, limitations on discharge rates, and other conditions regarding how discharges may be conducted. A separate RRC minor permit is required for the landfarming of drilling muds (e.g., mud generated by HDDs). Landfarming sites must comply with RRC siting and design criteria. RRC permits may include conditions requiring landfarm soil sampling and analysis, limitations on application rates, and other conditions regarding how landfarming operations may be conducted. Neither type of RRC minor permit authorizes discharges into waters of the U.S. For discharges into waters of the U.S.,
Railroad Commission of Texas Rules for Carbon Dioxide (CO_2) **16 TAC 5**	In 2010, the RRC adopted the provisions of 16 TAC 5 to govern the geologic storage and injection of anthropogenic CO_2, with additional rules added for EOR in 2011 (16 TAC 5, Subchapter C). These regulations specify permitting, monitoring, reporting, and recordkeeping requirements for the geologic storage of anthropogenic CO_2.
Fluid Injection into Productive Reservoirs **16 TAC 3.46**	Under 16 TAC 3.30, the RRC has jurisdiction over wells into which fluids are injected for enhanced recovery of oil or natural gas as well as jurisdiction over injection wells for geologic storage of CO_2. A permit from the RRC is required for fluid injection operations in reservoirs productive of oil, gas, or geothermal resources. The RRC regulates the injection of water, steam, gas, oil and gas wastes, or other fluids into porous formations producing oil, gas, or geothermal resources in the state of Texas using Class II injection well permits.
Underground Storage of Gas in Productive or Depleted Reservoirs **16 TAC 3.96**	Under 16 TAC 3.30, the RRC has jurisdiction over wells into which fluids are injected for enhanced recovery of oil or natural gas as well as jurisdiction over injection wells for geologic storage of CO_2. A permit from the RRC is required for operation of a gas storage project.
Registration of Power Generation Companies and Self-Generators **Public Utility Commission Substantive Rule 25.109**	Power-generation plants operating in the state of Texas must register with the Public Utility Commission of Texas.

Statute, Regulation, Order	Description
Texas Threatened and Endangered Species Regulations **31 TAC 65, Subchapter G and Texas Parks and Wildlife Code Chapters 67 and 68**	These laws and regulations protect threatened and endangered species in Texas by prohibiting the taking, possession, transportation, or sale of protected species without the issuance of a permit.
Ecologically Significant Stream Segments **Section 16.051(f) of the Texas Water Code and 31 TAC 357.8**	Based on recommendations from regional planning groups, the Texas legislature has designated certain river and stream segments in the state of Texas as ecologically unique (aka, Ecologically Significant Stream Segments or ESSSs). This designation solely means that the State may not finance the construction of a reservoir in a designated ESSS.
Marl, Sand, Gravel, Shell or Mudshell Permits **31 TAC 69, Subchapter H and Texas Parks & Wildlife Code Chapter 86**	Pursuant to chapter 86, subtitle F, of the Texas Parks and Wildlife Code, The TPWD manages, controls, and protects marl and sand of commercial value and all gravel, shell, and mudshell located within tidewater limits of the state, and on islands within those limits, and within the freshwater areas of the state not embraced by a survey of private land, and on islands within those areas. If a stream is perennial (flows most of the time) or is more than 30 feet wide between the banks (even if it is dry most of the time), the State claims the bed and the sand and gravel in it as State-owned and under the jurisdiction of the TPWD. According to TPWD regulations, a Marl, Sand, Gravel, Shell or Mudshell Permit is required to disturb or take marl, sand, gravel, shell, or mudshell under the TPWD's jurisdiction or operate in or disturb any oyster bed or fishing water for any purpose other than that necessary or incidental to navigation or dredging under state or federal authority.

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9 AGENCIES AND TRIBES CONTACTED

9.1 FEDERAL AGENCIES

U.S. Army Corps of Engineers, Galveston District
U.S. Environmental Protection Agency, Region 6, Office of Planning and Coordination
U.S. Fish and Wildlife Service, Clear Lake Ecological Services Field Office

9.2 NATIVE AMERICAN TRIBES

Alabama-Coushatta Tribe of Texas
Apache Tribe of Oklahoma
Comanche Nation of Oklahoma
Coushatta Tribe of Louisiana
Kiowa Indian Tribe of Oklahoma
Mescalero Apache Tribe of the Mescalero Reservation
Tonkawa Tribe of Indians of Oklahoma
Tunica-Biloxi Indian Tribe of Louisiana

9.3 STATE AGENCIES

Texas Historical Commission
Texas Parks and Wildlife Department, Wildlife Division, Wildlife Habitat Assessment Program

9.4 LOCAL AGENCIES

Fort Bend County Engineering Department, Floodplain Administrator
Jackson County Permit and Inspection Department, Floodplain Administrator
Wharton County Permit & Inspection Department, Floodplain Administrator

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10 DISTRIBUTION LIST

10.1 U.S. SENATE AND HOUSE OF REPRESENTATIVES COMMITTEES

The Honorable **Barbara Mikulski**, Chairman Committee on Appropriations U.S. Senate	The Honorable Lisa Murkowski, Ranking Member Committee on Energy and Natural Resources U.S. Senate
The Honorable **Richard Shelby**, Ranking Member Committee on Appropriations U.S. Senate	The Honorable Fred Upton, Chairman Committee on Energy and Commerce U.S. House of Representatives
The Honorable Dianne Feinstein, Chairman Committee on Appropriations, Subcommittee on Energy and Water Development U.S. Senate	The Honorable Henry A. Waxman, Ranking Member Committee on Energy and Commerce U.S. House of Representatives
The Honorable Lamar Alexander, Ranking Member Committee on Appropriations, Subcommittee on Energy and Water Development U.S. Senate	The Honorable **Hal** Rogers, Chairman Committee on Appropriations U.S. House of Representatives
The Honorable Barbara Boxer, Chairman Committee on Environment and Public Works U.S. Senate	The Honorable **Nita Lowey**, Ranking Member Committee on Appropriations U.S. House of Representatives
The Honorable **David Vitter**, Ranking Member Committee on Environment and Public Works U.S. Senate	Honorable Rodney P. Frelinghuysen, Chairman Committee on Appropriations, Subcommittee on Energy and Water Development U.S. House of Representatives
The Honorable **Ron Wyden**, Chairman Committee on Energy and Natural Resources U.S. Senate	The Honorable **Marcy Kaptur**, Ranking Member Committee on Appropriations, Subcommittee on Energy and Water Development U.S. House of Representatives

10.2 UNITED STATES SENATE

The Honorable John Cornyn, Texas	The Honorable Frank Lautenberg, New Jersey
The Honorable **Ted Cruz**, Texas	The Honorable Robert Menendez, New Jersey

10.3 UNITED STATES HOUSE OF REPRESENTATIVES

The Honorable Pete Olson Congressional District 22 of Texas	The Honorable Rush Holt Congressional District 12 of New Jersey
The Honorable Ron Paul Congressional District 14 of Texas	The Honorable Blake Farenthold Congressional District 27 of Texas

10.4 NATIVE AMERICAN TRIBAL LEADERS

Mr. **Carlos Bullock**, Chairman Alabama-Coushatta Tribe of Texas	Ms. Amber C. Toppah, Chair Kiowa Indian Tribe of Oklahoma
Mr. Louis Maynahonah, Chairman Apache Tribe of Oklahoma	Mr. Mark Chino, President Mescalero Apache Tribe of the Mescalero Reservation
Mr. Johnny Wauqua, Chairman Comanche Nation of Oklahoma	Mr. Donald Patterson, President Tonkawa Tribe of Indians of Oklahoma
Mr. Kevin Sickey, Chairman Coushatta Tribe of Louisiana	Mr. Earl J. Barbry, Sr., Chairman Tunica-Biloxi Indian Tribe of Louisiana

10.5 FEDERAL AGENCIES

Mr. Reid Nelson Director, Office of Federal Agency Programs Advisory Council on Historic Preservation	Mr. Ed Pfister Environmental Program Manager U.S. Department of Health and Human Services
Mr. Jeff C. Wright Director, Office of Energy Projects Federal Energy Regulatory Commission	Mr. David Reese Federal Preservation Officer Office of the Chief Administrative Officer Occupational Safety and Environmental Programs U.S. Department of Homeland Security
Mr. David Ingersoll Environmental Specialist International Trade Commission	Ms. Terry Lukes Deputy Regional Environmental Officer U.S. Department of Homeland Security, Federal Emergency Management Agency Region VI
Mr. Fred Anthamatten Regulatory Chief U.S. Army Corps of Engineers, Galveston District	Mr. Willie R. Taylor Director, Office of Environmental Policy and Compliance U.S. Department of the Interior
Mr. Kenny Jaynes Chief, Compliance Section U.S. Army Corps of Engineers, Galveston District	Ms. Camille Mittelholtz Deputy Director, Office of Safety, Energy and Environment U.S. Department of Transportation
Mr. Mark Matusiak Civil Works Policy and Policy Compliance Division Office of Water Project Review U. S. Army Corps of Engineers	Ms. Victoria Rutson Surface Transportation Board U.S. Department of Transportation
Mr. Mark Plank Rural Utilities Service U.S. Department of Agriculture	Mr. Thomas Cuddy Office of Environment and Energy FAA 9AEE e00) U.S. Department of Transportation
Ms. Genevieve Walker NEPA Coordinator U.S. Department of Commerce	Mr. Michael P. Jansky Regional Environmental Review Coordinator EPA Region 6
Mr. Steve Kokkinakis National Oceanic and Atmospheric Administration Program Planning and Integration U.S. Department of Commerce	Ms. Edith Erfling Field Supervisor, Houston Ecological Services Field Office U. S. Fish and Wildlife Service

10.6 NATIONAL AND REGIONAL NONGOVERNMENTAL ORGANIZATIONS AND GOVERNMENTAL ORGANIZATIONS

Ms. Arnetta McCrae President American Association of Blacks in Energy	Ms. **Lorraine Sciarra** Vice President and General Counsel National Audubon Society
Mr. Thomas H. Adams Executive Director American Coal Ash Association	Mr. Robert A. Beck Executive Vice President National Coal Council
Mr. Harry Ng General Counsel American Petroleum Institute	Ms. Meg Power Senior Advisor National Community Action Foundation
Ms. Joy Ditto Director, Legislative Affairs American Public Power Association	Mr. Jim Lyon Senior Vice President, Conservation National Wildlife Federation
Mr. Richard Liebert Chairman Citizens for Clean Energy, Inc.	Mr. David Hawkins Director, Climate Center Natural Resources Defense Council
Mr. Paul Schwartz National Policy Coordinator Clean Water Action	Dr. Allen Hershkowitz Senior Scientist Natural Resources Defense Council
Dr. Scott C. Yaich Director, Conservation Operations Ducks Unlimited, Inc.	Mr. David Goldstein Director, Energy Program Natural Resources Defense Council
Ms. Barbara Bauman Tyran Director, Washington Relations Electric Power Research Institute	Mr. Ed Hopkins Director, Environmental Quality Sierra Club
Ms. Anna Aurilio Director, Washington, D.C. Office Environment America	Mr. Jimmie Powell Director, Federal Programs The Nature Conservancy
Ms. Vickie Patton General Counsel Environmental Defense Fund	Mr. Barry K. Worthington Executive Director U.S. Energy Association
Mr. Erich Pica President Friends of the Earth	Mr. John W. Fainter, Jr. President & CEO Association of Electric Companies of Texas, Inc.
Mr. **Brian Trusty** Executive Director Audubon Texas	Dr. James Bergan Director, Science and Stewardship The Nature Conservancy of Texas
Mr. David Foster State Program Coordinator Clean Water Action	Mr. Kenneth Nemeth Executive Director Southern States Energy Board
Ms. Scheleen Walker Director Sierra Club, Lone Star Chapter	

10.7 STATE ELECTED OFFICIALS

The Honorable Rick Perry Governor of Texas	The Honorable Ron Reynolds House District 27 The Texas State House of Representatives
The Honorable Chris Christie Governor of New Jersey	The Honorable John Zerwas House District 28 The Texas State House of Representatives
The Honorable Joan Huffman Senate District 17 Texas State Senate	The Honorable Geanie Morrison House District 30 The Texas State House of Representatives
The Honorable Glenn Hegar Senate District 18 Texas State Senate	

10.8 STATE AGENCIES

Ms. Donna L. Nelson Chairwoman Public Utility Commission of Texas	Mr. Lonnie Gregorcyk, P.E. District Engineer TxDOT Yoakum District
The Honorable Barry T. Smitherman Commissioner Railroad Commission of Texas	The Honorable Jerry Patterson Commissioner of the Texas General Land Office Texas General Land Office
Ms. Ashley K. Wadick Director, Region 12 – Houston Texas Commission on Environmental Quality	Mr. Terry Zrubek Governor's Advisor, Water Texas Governor's Office
Ms. Susan Clewis Director, Region 14 – Corpus Christi Texas Commission on Environmental Quality	Ms. Denise Stines Francis State Single Point of Contact Office of Budget, Planning, and Policy and State Grants Team Texas Governor's Office
Dr. Bryan W. Shaw Chairman Texas Commission on Environmental Quality	Mr. Toby Baker Governor's Advisor, Natural Resources and Agriculture Texas Governor's Office
The Honorable Todd Staples Agriculture Commissioner Texas Department of Agriculture	Mr. Mark Wolfe Executive Director/SHPO Texas Historical Commission
The Honorable Dr. David L. Lakey Commissioner of State Health Services Texas Department of State Health Services	Mr. Carter P. Smith Executive Director Texas Parks & Wildlife Department
Mr. Ted Houghton Chair Texas Department of Transportation	Ms. Julie Wicker Habitat Assessment Program, Wildlife Division Texas Parks & Wildlife Department
Mr. Michael Alford, P.E. District Engineer TxDOT Houston District	Mr. John Grant Chairman, Colorado River Municipal Water District TPWD

10.9 REGIONAL AND LOCAL OFFICIALS

Mr. Joe D. (Joe) Hermes City of Edna - Mayor	Mr. Freddie Newsome Town of Thompsons - Mayor
Mr. Richard Young City of El Campo Mayor, At Large	Mr. Andres Garza, Jr. City of Wharton - City Manager
Ms. Mindi Snyder City of El Campo City Manager	Mr. Domingo Montalvo, Jr. City of Wharton - Mayor
Mr. Clinton Tegeler The City of Ganado - Mayor	Mr. Donald Mueller City of Wharton - Mayor Pro-Tem
Mr. Mike Konarik The City of Ganado - Mayor Pro Tem	Mr. Robert E. Hebert Fort Bend County Judge
Mr. Delbert Wendt City of Needville - Mayor	Mr. Richard Morrison Fort Bend County Commissioner Precinct 1
Mr. Kermit Blezinger City of Needville - Mayor Pro-Tem	Mr. Johnny Ortega Fort Bend County Floodplain Administrator
Mr. Hilmar G. Moore City of Richmond - Mayor	Mr. Harrison Stafford II Jackson County Judge
Mr. Jack Hamlett The City of Rosenberg - City Manager	Floodplain Administration Jackson County Permit & Inspection Department
Mr. Vincent Morales The City of Rosenberg - Mayor	Mr. Phillip Spenrath Wharton County Judge
Mr. James A Thompson City of Sugar Land - Mayor	Ms. Monica Martin Wharton County Floodplain Administrator

10.10 INTERESTED PARTIES

No interested parties have requested a copy of the **Final** EIS for the Parish PCCS Project as of the date of this printing.

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12 LIST OF PREPARERS

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12.4 TETRA TECH, INC.

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12.5 BUREAU OF ECONOMIC GEOLOGY

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Khandaker Zahid, Co-author (Appendix I)
Ph.D. Geosciences
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B.S. Geophysics
2 years of experience in static geologic modeling.

12.6 CONFLICT OF INTEREST AND DISCLOSURE FORMS

DOE contractors who prepared this Draft EIS were required to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. Signed disclosure statements from URS Group, Inc.; Potomac-Hudson Engineering, Inc.; and Tetra Tech, Inc. are shown in Figures 12-1, 12-2, and 12-3, respectively.

DISCLOSURE STATEMENT
URS GROUP, INC.
ENVIRONMENTAL IMPACT STATEMENT
NRG ENERGY: W.A. PARISH POST-COMBUSTION CO2 CAPTURE
AND SEQUESTRATION PROJECT

Regulatory Requirement

Council on Environmental Quality (CEQ) Regulations at 40 CFR 1506.5(c), which have been adopted by the Department of Energy (DOE) at 10 CFR 1021, require contractors who will prepare an Environmental Impact Statement (EIS) to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for the purposes of this disclosure is discussed in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at question 17a and b.

"Financial interest or other interest in the outcome of the project" includes "any financial benefits such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g. if the project would aid proposals sponsored by the firm's other clients)." 46 FR 18026-18031.

Disclosure Statement

In accordance with the requirements set forth above, URS Group, Inc. (URS) hereby makes this disclosure statement and certifies that URS and its affiliates have no past, present, or currently planned financial, or other interest in the outcome of the NRG Energy: W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project (the Project). URS agrees that should it become aware of any facts giving rise to a potential future conflict of interest, it will promptly notify the DOE National Environmental Policy Act (NEPA) Document Manager and take any steps necessary to mitigate the conflict.

For the purposes of complete disclosure, URS makes the following representations:

1. URS has no interest in the Project other than the NEPA-related work and related environmental permitting/planning services on which URS is proposing. The majority of these environmental permitting/planning services (including environmental field surveys) would be conducted concurrently with preparation of the Environmental Impact Statement (EIS) for the Project and are anticipated to be substantially complete before the issuance of a Record of Decision (ROD). Some relatively minor permitting/planning services may be performed closer to the date of Project construction. To promote consistency between the EIS and application materials for associated permits and authorization materials, certain URS personnel may be involved in both the EIS preparation and environmental permitting scopes of work. URS' NEPA and environmental permitting/planning services will be conducted on a time and materials basis and will not involve a contingent fee arrangement.

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Figure 12-1. Disclosure Statement from URS Group, Inc. (Page 1 of 3)

2. URS provides other services to NRG related to the W.A. Parish Power Station and other NRG facilities. URS' NEPA-related work and environmental permitting will be conducted under the management of URS' Infrastructure & Environment (IE) business. Other than the proposed Project, current URS IE projects related to the W.A. Parish Power Station include an upcoming VOC emissions credit study (contract value $25,000) and ongoing routine groundwater and surface water monitoring and reporting associated with coal combustion products disposal operations (annual contract value of approximately $80,000). Additionally, personnel from URS' Energy & Construction (EC) business provide ongoing general engineering support to the W.A. Parish Power Station. None of these URS EC personnel will be involved in the NEPA-related work or related environmental permitting/planning for the Project. The total contract value for current URS projects related to the W.A. Parish Power Station represents less than 0.01% of URS' total annual revenue. The total contract value for all current URS projects for NRG represents less than 0.1% of URS' total annual revenue. URS anticipates that future work for NRG will be similar in nature to the work that URS has performed for NRG in the past. No work has been promised to URS pending the successful outcome of the NEPA review for the Project.

3. To ensure that the EIS is prepared independently of other services for NRG and in an unbiased manner, URS' Lead EIS Author, Mr. Robert Peel, will not participate in the environmental permitting scope of work for the Project or any other projects for NRG for the duration of the EIS preparation. As Mr. Peel reports to URS' Salt Lake City, Utah office, he is operationally independent of personnel who would be providing environmental permitting services, who primarily report to URS' Houston, Texas office. Additionally, URS is in the process of arranging a subcontract with Potomac-Hudson Engineering (PHE) of Bethesda, Maryland to prepare portions of the EIS. As part of their scope of work, PHE personnel will also perform an independent technical review of the EIS and will deliver review comments to URS, NRG, and DOE.

4. URS also provides other services to the DOE. To prevent a potential organizational conflict of interest, no personnel employed by URS or its affiliates will participate in the DOE review of the EIS for the Project or other documents related to the Project. Upon selection to perform NEPA-related work for the Project and prior to each round of DOE review, the URS Project Manager for the Project will notify URS personnel who perform contract work for DOE so they will be aware of the potential conflict of interest and recuse themselves from the review of documents related to the Project.

5. URS has existing roles in the NEPA process for two other DOE Clean Coal Power Initiative (CCPI) Round III projects, the Hydrogen Energy project in Kern County, CA and the Southern Company/Mississippi Power project in Kemper County, Mississippi. Since the DOE has already selected NRG's Project as one of the CCPI Round III projects, URS' involvement in these projects should not represent an organizational conflict of interest. URS is also currently supporting other projects (e.g., the DKRW Medicine Bow project in Wyoming and the FutureGen project in Illinois) that are at least partially funded by the DOE. However, URS understands

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Figure 12-1. Disclosure Statement from URS Group, Inc. (Page 2 of 3)

that these projects should also not represent an organizational conflict of interest with regards to NRG's proposed project.

Certified by:

SIGNATURE

August 22, 2011
DATE

Ernest Beadle – Vice President, Houston Office
NAME & TITLE (PRINTED)

URS Group, Inc.
COMPANY

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Figure 12-1. Disclosure Statement from URS Group, Inc. (Page 3 of 3)

Disclosure Statement

Potomac-Hudson Engineering, Inc.

Environmental Impact Statement
NRG Energy: W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project
DOE / EIS-0473D

CEQ Regulations at 40CFR 1506.5(c), which have been adopted by the DOE (10CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for the purposes of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at question 17a and b.

"Financial interest or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." See 46 FR 18026-18031.

In accordance with these requirements, the entity signing below hereby certifies as follows: (check either (a) or (b) and list items being disclosed if (b) is checked).

Financial Interest:

(a)	X	Has no past, present, or currently planned financial interest in the outcome of the project.
(b)		Has the following financial interest in the outcome of the project and hereby agrees to mitigate to the extent necessary to preclude a conflict prior to award of this contract:

1.
2.
3.

Contractual Interest:

(a)	X	Has no past, present, or currently planned financial interest in the outcome of the project.
(b)		Has the following financial interest in the outcome of the project and hereby agrees to mitigate to the extent necessary to preclude a conflict prior to award of this contract:

1.
2.
3.

1

Figure 12-2. Disclosure Statement from Potomac-Hudson Engineering, Inc. (Page 1 of 2)

Organizational Interest:

(a)	X	Has no past, present, or currently planned financial interest in the outcome of the project.
(b)		Has the following financial interest in the outcome of the project and hereby agrees to mitigate to the extent necessary to preclude a conflict prior to award of this contract:

1.
2.
3.

Other Interest:

(a)	X	Has no past, present, or currently planned financial interest in the outcome of the project.
(b)		Has the following financial interest in the outcome of the project and hereby agrees to mitigate to the extent necessary to preclude a conflict prior to award of this contract:

1.
2.
3.

Certified by:

8/30/12

Signature Date

Frederick J. Carey, President
Name & Title (Printed)

Potomac-Hudson Engineering, Inc.
Company

2

Figure 12-2. Disclosure Statement from Potomac-Hudson Engineering, Inc. (Page 2 of 2)

DISCLOSURE STATEMENT
Tetra Tech, INC.
ENVIRONMENTAL IMPACT STATEMENT
NRG ENERGY: W.A. PARISH POST-COMBUSTION CO2 CAPTURE
AND SEQUESTRATION PROJECT

Regulatory Requirement

Council on Environmental Quality (CEQ) Regulations at 40 CFR 1506.5(c), which have been adopted by the Department of Energy (DOE) at 10 CFR 1021, require contractors who will prepare an Environmental Impact Statement (EIS) to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for the purposes of this disclosure is discussed in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at question 17a and b.

"Financial interest or other interest in the outcome of the project" includes "any financial benefits such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g. if the project would aid proposals sponsored by the firm's other clients)." 46 FR 18026-18031.

Disclosure Statement

In accordance with the requirements set forth above, Tetra Tech, Inc. (Tetra Tech) hereby makes this disclosure statement and certifies that Tetra Tech and its affiliates have no past, present, or currently planned financial, or other interest in the outcome of the NRG Energy: W.A. Parish Post-Combustion CO_2 Capture and Sequestration Project (the Project). Tetra Tech agrees that should it become aware of any facts giving rise to a potential future conflict of interest, it will promptly notify the DOE National Environmental Policy Act (NEPA) Document Manager and take any steps necessary to mitigate the conflict.

For the purposes of complete disclosure, Tetra Tech makes the following representations:

1. Tetra Tech has no interest in the Project other than the NEPA-related work being conducted for the Project.

2. Tetra Tech NUS of Newark Delaware is currently conducting work for an NRG subsidiary, NRG Energy Repowering LLC in Dover, Delaware. This work involves land surveying and subsurface investigations in Delaware. Similar projects may be conducted for this NRG subsidiary in the future by Tetra Tech NUS. Tt NUS staff working on these projects belong to a separate subsidiary of Tetra Tech. The Tt NUS staff has no involvement with the staff working on the EIS for the Project in a Tetra Tech Division office in Lafayette, California.

Page 1 of 2

Figure 12-3. Disclosure Statement from Tetra Tech, Inc. (Page 1 of 2)

3. Tetra Tech is working on the NEPA EIS for the FutureGen 2.0 project in Illinois as a subcontractor to Potomac Hudson Engineering, which is partially funded by the DOE. Since the DOE has already selected NRG's Project as one of the CCPI Round III projects, Tetra Tech's involvement in this project should not represent an organizational conflict of interest. Tetra Tech understands that this project should not represent an organizational conflict of interest with regards to NRG's proposed project.

Certified by:

[signature]
SIGNATURE

August 22, 2011
DATE

THOMAS M. GRIEB, VICE PRESIDENT
NAME & TITLE (PRINTED)

Tetra Tech, Inc.
COMPANY

Page 2 of 2

Figure 12-3. Disclosure Statement from Tetra Tech, Inc. (Page 2 of 2)

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