CHAPTER 9

ALTERNATIVES TO THE PROPOSED ACTION

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
μgm/m^3	micrograms per cubic meter
/Q	relative air concentration
AADT	annual average daily traffic
A/B	auxiliary building
ac	acre
AC	alternating current
ac-ft	acre-feet
ACFT	acre-feet
ACRS	advisory committee on reactor safeguards
ACSR	aluminum-clad steel reinforced
ADFGR	Alaska Department of Fish and Game Restoration
AEA	Atomic Energy Act
AEC	U.S. Atomic Energy Commission
AHD	American Heritage Dictionary
agl	above ground level
ALA	American Lifelines Alliance
ALARA	as low as reasonably achievable
AMUD	Acton Municipal Utility District
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
AOO	anticipated operational occurrences
APE	areas of potential effect
APWR	Advanced Pressurized Water Reactor

ACRONYMS AND ABBREVIATIONS

ARLIS	Alaska Resources Library and Information Services
ARRS	airborne radioactivity removal system
AS	ancillary services
ASCE	American Society of Civil Engineers
AVT	all volatile treatment
AWEA	American Wind Energy Association
AWG	American wire gauge
BAT	best available technology
bbl	barrel
BC	Business Commercial
BDTF	Blowdown Treatment Facility
BEA	U.S. Bureau of Economic Analysis
BEG	U.S. Bureau of Economic Geology
bgs	below ground surface
BLS	U.S. Bureau of Labor Statistics
BMP	best management practice
BOD	Biologic Oxygen Demand
BOP	Federal Bureau of Prisons
BRA	Brazos River Authority
bre	below reference elevation
BRM	Brazos River Mile
BSII	Big Stone II
BTI	Breakthrough Technologies Institute
BTS	U.S. Bureau of Transportation Statistics
BTU	British thermal units

ACRONYMS AND ABBREVIATIONS

BUL	Balancing Up Load
BW	Business Week
BWR	boiling water reactor
CAA	Clean Air Act
CBA	cost-benefit analysis
CBD	Central Business District
CCI	Chambers County Incinerator
CCTV	closed-circuit television
CCW	component cooling water
CCWS	component cooling water system
CDC	Centers for Disease Control and Prevention
CDF	Core Damage Frequency
CDR	Capacity, Demand, and Reserves
CEC	California Energy Commission
CEDE	committed effective dose equivalent
CEED	Center for Energy and Economic Development
CEQ	Council on Environmental Quality
CESQG	conditionally exempt small quantity generator
CFC	chlorofluorocarbon
CFE	Comisin Federal de Electricidad
CFR	Code of Federal Regulations
cfs	cubic feet per second
CFS	chemical treatment system
CG	cloud-to-ground
CGT	Cogeneration Technologies

ACRONYMS AND ABBREVIATIONS

CHL	Central Hockey League
CO	carbon monoxide
CO_2	carbon dioxide
COD	Chemical Oxygen Demand
COL	combined construction and operating license
COLA	combined construction and operating license application
CORMIX	Cornell Mixing Zone Expert System
CPI	Consumer Price Index
CPP	continuing planning process
CPS	condensate polishing system
CPNPP	Comanche Peak Nuclear Power Plant
CPSES	Comanche Peak Steam Electric Station
CRDM	control rod drive mechanism cooling system
CRP	Clean Rivers Program
CS	containment spray
Cs-134	cesium-134
Cs-137	cesium 137
CSA	County Supervisors Association of Arizona
CST	Central Standard Time
CST	condensate storage tank
CT	completion times
CT	cooling tower
cu ft	cubic feet
C/V	containment vessel
CVCS	chemical and volume control system

ACRONYMS AND ABBREVIATIONS

CVDT	containment vessel reactor coolant drain tank
CWA	Clean Water Act
CWS	circulating water system
DAW	dry active waste
dBA	decibels
DBA	design basis accident
DBH	diameter at breast height
DC	direct current
DCD	Design Control Document
DDT	dichlorodiphenyltrichloroethane
DF	decontamination factor
DFPS	Department of Family and Protective Services
DFW	Dallas/Fort Worth
DO	dissolved oxygen
DOE	U.S. Department of Energy
DOL	Department of Labor
DOT	U.S. Department of Transportation
DPS	Department of Public Safety
D/Q	deposition
DSHS	Department of State Health Services
DSM	Demand Side Management
DSN	discharge serial numbers
DSWD	Demand Side Working Group
DVSP	Dinosaur Valley State Park
DWS	demineralized water system

ACRONYMS AND ABBREVIATIONS

DWST	demineralized water storage tank
E	Federally Endangered
EA	Environmental Assessment
EAB	exclusion area boundary
E. coli	Escherichia coli
EDC	Economic Development Corp.
EDE	effective dose equivalent
EEI	Edison Electric Institute
EERE	Energy Efficiency and Renewable Energy
EFH	Energy Future Holdings Corporation
EFW	energy from waste
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EJ	environmental justice
ELCC	Effective Load-Carrying Capacity
EMFs	electromagnetic fields
EO	Executive Order
EOF	emergency operation facility
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
EPZ	emergency planning zone
ER	Environmental Report
ERA	Environmental Resource Associates
ERCOT	Electric Reliability Council of Texas
ESA	Endangered Species Act

ACRONYMS AND ABBREVIATIONS

ESC	Energy Storage Council
ESP	Early Site Permit
ESRP	Environmental Standard Review Plan
ESW	essential service cooling water
ESWS	essential service water system
F&N	Freese & Nicholas, Inc.
FAA	U.S. Federal Aviation Administration
FAC	flow-accelerated corrosion
FBC	fluidized bed combustion
FCT	Fuel Cell Today
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FFCA	Federal Facilities Compliance Act
FLMNH	Florida Museum of Natural History
FM	farm-to-market
FP	fire protection
FPL	Florida Power and Light
FPS	fire protection system
FPSC	Florida Public Service Commission
FR	Federal Register
FSAR	Final Safety Analysis Report
FSL	Forecast Systems Laboratory
ft	feet
FWAT	flow weighted average temperature
FWCOC	Fort Worth Chamber of Commerce

ACRONYMS AND ABBREVIATIONS

FWS	U.S. Fish and Wildlife Service
gal	gallon
GAM	General Area Monitoring
GAO	U.S. General Accountability Office
GDEM	Governor’s Division of Emergency Management
GEA	Geothermal Energy Association
GEIS	Generic Environmental Impact Statement
GEOL	overall geological
GFD	ground flash density
GIS	gas-insulated switchgear
GIS	Geographic Information System
GMT	Greenwich Mean Time
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
gps	gallons per second
GRCVB	Glen Rose, Texas Convention and Visitors Bureau
GST	gas surge tank
GTC	Gasification Technologies Conference
GTG	gas turbine generators
GWMS	gaseous waste management system
H-3	radioactive tritium
HC	Heavy Commercial
HCl	Hydrochloric Acid
HCP	Ham Creek Park

ACRONYMS AND ABBREVIATIONS

HEM	hexane extractable material
HEPA	high efficiency particulate air
HIC	high integrity container
HL	high-level
HNO_3	Nitric Acid
hr	hour(s)
HRCQ	highway route-controlled quantity
H_2SO_4	Sulfuric Acid
HT	holdup tank
HTC	Historic Texas Cemetery
HUC	hydrologic unit code
HUD	U.S. Department of Housing and Urban Development
HVAC	heating, ventilating, and air-conditioning
I	Industrial
I-131	iodine-131
IAEA	International Atomic Energy Agency
I&C	instrumentation and control
IEC	Iowa Energy Center
IGCC	Integrated Gasification Combined Cycle
IH	Interim Holding
in	inch
INEEL	Idaho National Engineering and Environmental Laboratory
IOUs	investor-owned electric utilities
IPE	individual plant examination
ISD	Independent School District

ACRONYMS AND ABBREVIATIONS

ISEP	Iowa Stored Energy Park
ISFSI	independent spent fuel storage installation
ISO	independent system operator
ISO rating	International Standards Organization rating
ISU	Idaho State University
JAMA	Journal of the American Medical Association
K-40	potassium-40
KC	Keystone Center
JRB	Joint Reserve Base
km	kilometer
kVA	kilovolt-ampere
kWh	kilowatt hour
L	LARGE
LaaR	Load Acting as a Resource
LANL	Los Alamos National Laboratory
lb	pounds
LC	Light Commercial
LG	Lake Granbury
LL	low-level
LLD	lower limits of detection
LLMW	low-level mixed waste
LNG	liquid natural gas
LOCA	loss of coolant accident
LPSD	low-power and shutdown
LPZ	low population zone

ACRONYMS AND ABBREVIATIONS

LQG	large-quantity hazardous waste generators
LRS	load research sampling
LTSA	long term system assessment
Luminant	Luminant Generation Company LLC
LVW	low volume waste
LWA	Limited Work Authorization
LWMS	liquid waste management system
LWPS	liquid waste processing system
LWR	light water reactor
M	MODERATE
ma	milliamperes
MACCS2	Melcor Accident Consequence Code System
MCES	Main Condenser Evacuation System
Mcf	thousand cubic feet
MCPE	Market Clearing Price for Energy
MCR	main control room
MD-1	Duplex
MDA	minimum detected activity
MDCT	mechanical draft cooling tower
MEIs	maximally exposed individuals
MF	Multi-Family
mG	milliGauss
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
MH	Manufactured Housing

ACRONYMS AND ABBREVIATIONS

MHI	Mitsubishi Heavy Industries
mi	mile
mi^2	square miles
MIT	Massachusetts Institute of Technology
MMbbl	million barrels
MMBtu	million Btu
MNES	Mitsubishi Nuclear Energy Systems Inc.
MOU	municipally-owned utility
MOV	motor operated valve
MOX	mixed oxide fuel
mph	miles per hour
MSDS	Materials Safety Data Sheets
msl	mean sea level
MSR	maximum steaming rate
MSW	municipal solid waste
MT	Main Transformer
MTU	metric tons of uranium
MW	megawatts
MW	monitoring wells
MWd	megawatt-days
MWd/MTU	megawatt–days per metric ton uranium
MWe	megawatts electrical
MWh	megawatt hour
MWS	makeup water system
MWt	megawatts thermal

ACRONYMS AND ABBREVIATIONS

NAAQS	National Ambient Air Quality Standards
NAPA	Natural Areas Preserve Association
NAP	National Academies Press
NAR	National Association of Realtors
NARM	accelerator-produced radioactive material
NAS	Naval Air Station
NASS	National Agricultural Statistics Service
NCA	Noise Control Act
NCDC	National Climatic Data Center
NCDENR	North Carolina Department of Environmental and Natural Resources
NCES	National Center for Educational Statistics
NCI	National Cancer Institute
NCTCOG	North Central Texas Council of Governments
ND	no discharge
NDCT	natural draft cooling towers
NEI	Nuclear Energy Institute
NELAC	National Environmental Laboratory Accreditation Conference
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation/Council
NESC	National Electrical Safety Code
NESDIS	National Environmental Satellite, Data, and Information Service
NESW	non-essential service water cooling system
NESWS	non-essential service water system
NETL	National Energy Technology Laboratory

ACRONYMS AND ABBREVIATIONS

NHPA	National Historic Preservation Act
NHS	National Hurricane Center
NINI	National Institute of Nuclear Investigations
NIOSH	National Institute for Occupational Safety and Health
NIST	U.S. National Institute of Standards and Technology
NJCEP	NJ Clean Energy Program
NLDN	National Lightning Detection Network
NOAA	National Oceanic and Atmospheric Administration
NOAEC	no observable adverse effects concentration
NOI	Notice of Intent
NOIE	non-opt-in entities
NO_x	oxides of nitrogen
NP	Nacogdoches Power
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NR	not required
NRC	U.S. Nuclear Regulatory Commission
NREL	U.S. National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NRRI	National Regulatory Research Institute
NSPS	New Source Performance Standards
NSSS	nuclear steam supply system
NTAD	National Transportation Atlas Database
NVLAP	National Voluntary Laboratory Accreditation Program
NWI	National Wetlands Inventory

ACRONYMS AND ABBREVIATIONS

NWS	National Weather Service
NWSRS	National Wild and Scenic Rivers System
O_2	Oxygen
O_3	Ozone
ODCM	Off-site Dose Calculation Manual
OECD	Organization for Economic Co-operation and Development
O&M	operations and maintenance
ORNL	Oak Ridge National Laboratory
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Act
OW	observation well
P&A	plugging and abandonment
PAM	primary amoebic meningoencephalitis
PD	Planned Development
PDL	Proposed for Delisting
PE	probability of exceedances
PEI	Princeton Environmental Institute
PEL	Potomac Economics, LTD.
percent g	percent of gravity
PET	Potential Evapotranspiration
PFBC	pressurized fluidized bed combustion
PFD	Process Flow Diagram
PGA	peak ground acceleration
PGC	power generation company
PH	Patio Home

ACRONYMS AND ABBREVIATIONS

P&ID	piping and instrumentation diagram
PM	particulate matter
PM_{10}	particulate matter less than 10 microns diameter
$PM_{2.5}$	particulate matter less than 2.5 microns diameter
PMF	probable maximum flood
PMH	probable maximum hurricane
PMP	probable maximum precipitation
PMWP	probable maximum winter precipitation
PMWS	probable maximum windstorm
PPE	plant parameter envelope
ppm	parts per million
PPS	preferred power supply
PRA	probabilistic risk assessment
PSD	Prevention of Significant Deterioration (permit)
PSWS	potable and sanitary water system
PUC	Public Utility Commission
PUCT	Public Utility Commission of Texas
PURA	Public Utilities Regulatory Act
PWR	pressurized water reactors
QA	quality assurance
QC	quality control
QSE	qualified scheduling entities
R10	Single-Family Residential
R12	Single-Family Residential
R7	Single-Family Residential

ACRONYMS AND ABBREVIATIONS

R8.4	Single-Family Residential
RAT	Reserve Auxiliary Transformer
RB	reactor building
R/B	reactor building
RCDS	reactor coolant drain system
RCDT	reactor coolant drain tank
RCRA	Resource Conservation and Recovery Act
RCS	reactor coolant system
RDA	Radiosonde Database Access
REC	renewable energy credit
REIRS	Radiation Exposure Information and Reporting System
RELFRC	release fractions
rem	roentgen equivalent man
REMP	radiological environmental monitoring program
REP	retail electric providers
REPP	Renewable Energy Policy Project
RES	Ridge Energy Storage and Grid Services, L.P.
RFI	Request for Information
RG	Regulatory Guide
RHR	residual heat removal
RIMS II	regional input-output modeling system
RMR	Reliability Must-Run
Rn_{222}	Radon-222
RO	reverse osmosis
ROI	region of interest

ACRONYMS AND ABBREVIATIONS

ROW	right of way
RPG	regional planning group
RRY	reactor reference year
RTHL	Recorded Texas Historic Landmarks
RTO	regional transmission organization
Ru-103	ruthenium-103
RW	test well
RWSAT	refueling waste storage auxiliary tank
RWST	refueling water storage tank
RY	reactor-year
S	SMALL
SACTI	Seasonal/Annual Cooling Tower Impact Prediction Code
SAL	State Archaeological Landmark
SAMA	severe accident mitigation alternative
SAMDA	severe accident mitigation design alternative
SB	Senate Bill
SCR	Squaw Creek Reservoir
SCDC	Somervell County Development Commission
scf	standard cubic feet
SCWD	Somervell County Water District
SDS	sanitary drainage system
SECO	State Energy Conservation Office
SER	Safety Evaluation Report
SERC	SERC Reliability Corporation
SERI	System Energy Resources, Inc.

ACRONYMS AND ABBREVIATIONS

SFPC	spent fuel pool cooling and cleanup system
SG	steam generator
SGBD	steam generator blow-down
SGBDS	steam generator blow-down system
SGs	steam generators
SGTR	steam generator tube rupture
SH	State Highway
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SMP	State Marketing Profiles
SMU	Southern Methodist University
SNL	Sandia National Laboratories
SOP	Standard Operations Permit
SO_2	sulfur dioxide
SO_x	sulfur
SPCCP	Spill Prevention Control and Countermeasures Plan
SPP	Southwest Power Pool
SQG	small-quantity generators
sq mi	square miles
SRCC	Southern Regional Climate Center
SRP	Standard Review Plan
SRST	spent resin storage tank
SSAR	Site Safety Analysis Report
SSC	structures, systems, and components
SSI	Safe Shutdown Impoundment

ACRONYMS AND ABBREVIATIONS

SSURGO	Soil Survey Geographic
SWATS	Surface Water and Treatment System
SWMS	solid waste management system
SWPC	spent fuel pool cooling and cleanup system
SWP3	Storm Water Pollution Prevention Plan
SWS	service water system
SWWTS	sanitary wastewater treatment system
T	Federally Threatened
t	ton
TAC	technical advisory committee
TAC	Texas Administrative Code
TB	turbine building
Tc_{99}	Technetium-99
TCEQ	Texas Commission on Environmental Quality
TCPS	Texas Center for Policy Studies
TCR	transmission congestion rights
TCS	turbine component cooling water system
TCWC	Texas Cooperative Wildlife Collection
T&D	transmission and distribution utility
TDCJ	Texas Department of Criminal Justice
TDOH	Texas Department of Health
TDOT	Texas Department of Transportation
TDPS	Texas Department of Public Safety
TDS	total dissolved solids
TDSHS	Texas Department of State Health Services

ACRONYMS AND ABBREVIATIONS

TDSP	transmission and distribution service provider
TDWR	Texas Department of Water Resources
TEDE	total effective dose equivalent
TGLO	Texas General Land Office
TGPC	Texas Groundwater Protection Committee
TH	Townhome
THC	Texas Historical Commission
THPOs	tribal historic preservation officers
TIS	Texas Interconnected System
TLD	Thermoluminescence Dosemeter
TMDLs	total maximum daily loads
TMM	Texas Memorial Museum
TOs	Transmission Owners
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
tpy	tons per year
TRAGIS	Transportation Routing Analysis Geographic Information System
TRB	Transportation Research Board
TRC	total recordable cases
TRE	Trinity Railway Express
TSC	technical support center
TSD	thunderstorm days per year
TSD	treatment, storage, and disposal
TSDC	Texas State Data Center
TSHA	Texas State Historical Association

ACRONYMS AND ABBREVIATIONS

TSP	transmission service provider
TSWQS	Texas Surface Water Quality Standards
TSS	total suspended sediment
TTS	The Transit System (Glen Rose)
TUGC	Texas Utilities Generating Company
TUSI	Texas Utilities Services Inc.
TWC	Texas Workforce Commission
TWDB	Texas Water Development Board
TWR	Texas Weather Records
TWRI	Texas Water Resources Institute
TxDOT	Texas Department of Transportation
TXU	Texas Utilities Corporation
TXU DevCo	TXU Generation Development Company LLC
UC	University of Chicago
UFC	uranium fuel cycle
UHS	Ultimate Heat Sink
UIC	Uranium Information Center
UO_2	uranium dioxide
USACE	U.S. Army Corps of Engineers
US-APWR	(MHI) United States-advanced pressurized water reactor
USC	U.S. Census
USCA	United States Court of Appeals
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	United States Environmental Protection Agency

ACRONYMS AND ABBREVIATIONS

USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
USHCN	United States Historical Climatology Network
USHR	U.S. House of Representatives
USNPS	U.S. National Park Service
UTC	Universal Time Coordinated
UV	ultra-violet
VCIS	Ventilation Climate Information System
VCT	volume control tank
VERA	Virtus Energy Research Associates
VFD	Volunteer Fire Department
VOC	volatile organic compound
VRB	variable
WB	Weather Bureau
WBR	Wheeler Branch Reservoir
WDA	work development area
WDFW	Washington Department of Fish and Wildlife
weight percent	wt. percent
WHT	waste holdup tank
WMT	waste monitor tank
WNA	World Nuclear Association
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plan
WRE	Water Resource Engineers, Inc.
WWS	wastewater system

ACRONYMS AND ABBREVIATIONS

WWTP	wastewater treatment plant
yr	year

CHAPTER 9

ALTERNATIVES TO THE PROPOSED ACTION

9.0 ALTERNATIVES TO THE PROPOSED ACTION

Chapter 9 describes the proposed action and reasonable alternatives for constructing and operating Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4 near Glen Rose, Texas. Specifically, the proposed action is the U.S. Nuclear Regulatory Commission (NRC) issuance of a Combined Operating License (COL) to Luminant Generation Company LLC (Luminant) for the two nuclear power plants, CPNPP Units 3 and 4, to produce baseload electricity at the CPNPP site.

Chapter 9 describes the alternatives to constructing and operating the two nuclear units at the CPNPP site, including alternative technologies, sites, and plant and transmission systems. Chapter 9 is divided into four sections:

- No-Action Alternative (Section 9.1).
- Energy Alternatives (Section 9.2).
- Alternative Sites (Section 9.3).
- Alternative Plant and Transmission Systems (Section 9.4).

The descriptions provided in these sections present sufficient detail for the reader to compare the effects of the alternatives relative to the proposed action. Two important terms are used in Chapter 9: “relevant service area” and “region of interest (ROI)” (Figure 8.1-1):

- Section 9.2 of the NRC’s regulatory review document, NUREG-1555, states, “The term ‘relevant service area’ is used here to indicate any region to be served by the proposed facility, whether or not it corresponds to a traditional utility service area. Relevant service area is a situation specific concept, and it must be defined on a case-by-case basis.” The Luminant relevant service area refers to the entire Electric Reliability Council of Texas (ERCOT) region where Luminant sells its wholesale baseload electric power.
- The term ROI is used to designate the geographic area that Luminant evaluated for locating alternative energy sources and sites. NUREG-1555 indicates that an ROI can be defined as the state (area) in which the proposed site is located or the relevant service area for the proposed plant. The ROI is defined as the area encompassed within ERCOT, as further discussed in Section 8.1.

9.1 NO-ACTION ALTERNATIVE

This section discusses the alternative to the proposed project that involves taking no action. The consideration of the no-action alternative is required to be performed under the National Environmental Policy Act (NEPA) and U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 4.2. The alternative of taking no action involves a decision not to proceed with construction and operation of Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. Such a decision may result from failure to acquire the necessary construction/operation permits, or failure to meet the economic criteria necessary for a merchant plant to construct and operate additional nuclear units. The implication of such an event is that Luminant Generation Company LLC (Luminant) would not construct or operate the proposed plant.

Because the proposed CPNPP Units 3 and 4 would not be constructed or operated under the no-action alternative, the need for additional electrical power by these units in the relevant service area, as described in Chapter 8, would not be met. Consequently, the environmental effects described and predicted in this report for the proposed nuclear reactors at the CPNPP site would not occur. However, some of these effects, or even greater effects, could still occur if another site or an alternative form of power generation is implemented to meet the documented need for power.

A description of the electrical supply and demand within the Electric Reliability Council of Texas (ERCOT) region is detailed in Chapter 8. Using assumptions and details from that description, an estimate of the energy consequences of this no-action alternative can be determined.

9.1.1 IMPLICATIONS AND EFFECTS OF TAKING NO ACTION

Demand for electricity in Texas is driven by increased population, higher per capita consumption of electricity, and retirement of aging generation plants. As described in Section 8.2, peak energy demand on the ERCOT system has grown approximately 2.4 percent each year from 1990 to 2006. Current forecasts indicate this peak demand trend continues at approximately 2.1 percent per year from 2006 – 2012. Lacking additional capacity, ERCOT would be unable to maintain an adequate reserve margin (12.5 percent) in the future and would fail its public service obligation to provide a stable electric grid (Chapter 8).

Another effect of the no-action alternative is that Luminant would be unable to support national goals to advance the use of nuclear energy and advance the goal of diversifying the electrical generation dispatch mix.

As stated above, if no action were taken, the ability of ERCOT to continue supplying reliable power to its customers would be impaired. Consequently, it is unreasonable for the effected region to take no action at all to meet growing demand for electricity. Therefore, alternatives to no action would likely take one of the following general paths:

- Path 1 - Demand Side Management (DSM) - These utility programs consist of planning, implementing, and monitoring activities that are designed to encourage consumers to modify their level and pattern of electricity usage. To avoid rolling blackouts or similar cutbacks, with the no-action alternative, significant reductions in customer electrical use would be necessary.

- Path 2 - Alternatives to Generating Capacity - Luminant may choose not to pursue construction of new generation capacity, with the no-action alternative, and attempt to meet the need for power with purchases from other electricity generators. This evaluation is discussed in detail in Subsection 9.2.1.

- Path 3 - Combination - It is possible that some combination of the above approaches would provide the equivalent of the generating capacity, with the no-action alternative. For example, the proposed capacity could be met by a certain amount of new coal-fired capacity combined with power purchased from outside the relevant service area. Combinations of alternative energy sources are considered in greater detail in Subsection 9.2.3.3.

9.2 ENERGY ALTERNATIVES

This section provides the analysis of the environmental impacts associated with energy alternatives to the proposed project for Comanche Peak Nuclear Power Plant (CPNPP) Units 3 and 4. The proposed project is a nuclear-powered electrical generation facility to be used as an independent merchant baseload plant. Mitsubishi Heavy Industries (MHI) US-Advanced Pressurized Water Reactor (US-APWR) units are proposed for CPNPP Units 3 and 4. The units are rated at approximately 1600 megawatts electrical (MWe) (gross) each, with a combined summertime expected baseload capability of 3200 MWe (Section 3.2). This baseload capability is the basis for the alternatives analyzed in this section.

Alternatives to the proposed project that do not require new generating capacity are discussed in Subsection 9.2.1, and those alternatives that do require development of additional generating capacity are discussed in Subsection 9.2.2. As discussed in Subsection 9.2.2, some of the alternatives that require additional generating capacity were eliminated from further consideration based upon their lack of availability in the region, overall feasibility, ability to supply baseload power, or environmental consequences. The remaining alternatives are discussed in further detail in Subsection 9.2.3.

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

This subsection discusses alternative options for meeting the consumer demand and future market requirements of Electric Reliability Council of Texas (ERCOT) that are identified in Sections 8.1, 8.2, 8.3, and 8.4 without constructing additional generating capacity. These options include purchased power, extended plant life, and initiating energy conservation measures that would avoid the need for the proposed baseload power that would be supplied by CPNPP Units 3 and 4. Several areas of pertinent information that set the context of discussion are provided below.

Relevant Service Area - ERCOT

Key to the discussion of generation alternatives is the understanding of the Texas market specifically the ERCOT market environment. In 1968, the North American Electric Reliability Corporation (NERC) was formed with a mission to ensure that the bulk electric system in North America is reliable, adequate, and secure. The ERCOT, an independent, not-for-profit corporation is one of eight electric reliability regions in North America operating under the reliability and safety standards set by NERC. ERCOT is a deregulated market and is entirely within the boundaries of the state of Texas and under the authority of the Public Utilities Commission of Texas (PUC). As a result, many of the baseload electric generators, including those of Luminant, are wholesale merchant plants. ERCOT manages the flow of electric power to approximately 20 million Texas customers, representing 85 percent of the state’s electric load, and 75 percent of the state’s land area, approximately 200,000 square miles (sq mi) (Section 8.1). The combined construction and operating license (COL) applicant, Luminant, is a member of ERCOT and owns or leases 17,605 MWe of generation in ERCOT (Section 8.1). The proposed project at CPNPP would add 3200 MWe of generating capacity.

For a complete assessment of alternatives not requiring new generating capacity, the following data and information need to be addressed:

- Plants in ERCOT that are scheduled for retirement between the date of combined construction and operating license application (COLA) through the sixth year of commercial operation of the CPNPP Units 3 and 4. The relevant service area of Energy Futures Holding Company (EFH), the parent company of Luminant, is the entire ERCOT region, as described above. Power plants with the potential for reactivation or extended operation are considered. Since 1999, a total of 95 generating units have been decommissioned in the ERCOT region, and ERCOT expects more units to be decommissioned in the next few years. Within ERCOT, 112 units that are over 40 years old generate approximately 8700 megawatts (MW). Most of the generating capacity in ERCOT that is greater than 50 years old is in the Dallas-Fort Worth (DFW) area (Subsection 8.3.1).

- A description of the power system, factors associated with the power demand and supply, and an assessment of the need for power. A brief description of ERCOT is given above, and a more detailed description of the power system can be found in Section 8.1. Power demand and supply are discussed in detail in Section 8.2 and Section 8.3 respectively. Section 8.4 addresses the need for power.

- The potential for energy conservation within the relevant service area. Conservation technologies and measures have proven to be popular with retail marketers, public utility commissions, and members of the public. Energy conservation is a way of avoiding construction of more electric generating facilities; however in a deregulated market conservation is not a responsibility of a wholesale merchant baseload generator. Additional discussion is provided in Subsection 9.2.1.3.

9.2.1.1 Power Purchases

If available, purchased power from other sources could provide all or some of the baseload replacement power, and obviate the need to construct CPNPP Units 3 and 4. As described above and in Section 8.1, the ERCOT region operates wholly within the state of Texas, and it does not interconnect synchronously across state lines to import or export power with neighboring reliability regions. ERCOT can exchange about 820 MW with the Southwest Power Pool (SPP) and 286 MW with Mexico’s federal electricity commission through direct current (DC) links (Section 8.4). These relatively minor purchases have little impact on ERCOT’s ability to meet demand requirements (Subsection 8.4.1). Essentially, all power required to supply the ERCOT region loads must be generated within ERCOT region (Subsection 8.3.1). As demonstrated in Section 8.4, there is a need for power within ERCOT that can be partially offset by the proposed CPNPP Units 3 and 4. ERCOT’s limited interconnections with other reliability regions would preclude it from satisfying its future power needs through purchases of power from outside ERCOT.

9.2.1.2 Plant Reactivation or Extended Service Life

Electric utilities in general have given considerable attention to the issue of repowering nonnuclear generating facilities. Repowering is the process by which utilities update the technology of existing plants to realize gains in efficiency or output not possible at the time of the plant’s construction. Candidates for repowering would be fueled by coal or natural gas, and the environmental impacts are bounded by the coal- and natural gas-fired alternatives evaluated in Subsection 9.2.2.

The ERCOT region has approximately 6000 MW of mothballed generation capacity, which has been taken into account in determining that there is a need for additional power (Section 8.4). The continued operation of fossil fuel plants has environmental impacts on air quality that would exceed those of the proposed CPNPP Units 3 and 4. As explained in Subsection 9.2.3, operation of fossil fuel plants is not environmentally preferable to CPNPP Units 3 and 4 that are wholesale baseload units. Reactivating or extending the service life of existing plants is not a reasonable alternative as a means of satisfying ERCOT's need for additional power.

9.2.1.3 Conservation (Energy Efficiency)

Conservation technologies and measures, or demand-side management (DSM) programs, consist of planning, implementing, and monitoring activities by electric utilities to encourage consumers to modify their level and pattern of electricity usage. These programs, however, are not within the capability or responsibility of the wholesale baseload merchant generator. As identified in NUREG-1555, an analysis of the potential for conservation is not required if the applicant is proposing to build a merchant plant to sell electric power on the open market, which is the intent of CPNPP Units 3 and 4. Additionally, the U.S. Nuclear Regulatory Commission (NRC) has already determined that conservation is not a reasonable alternative to a merchant plant whose purpose is to sell wholesale power. Therefore, although DSM is an important alternative to the application of the overall energy management strategy, it is not an adequate alternative to the proposed CPNPP Units 3 and 4.

9.2.1.4 Combination of Alternatives

Even though individual alternatives might not be sufficient on their own to replace the CPNPP Units 3 and 4 generating capacity, a combination of individual alternatives could be a competitive alternative. Given the purpose of CPNPP Units 3 and 4 is to supply baseload power, a competitive alternative would also need to be capable of supplying baseload power. Combinations of power purchases, power plant life extension, and conservation could potentially be capable of supplying baseload power.

As identified above, in Subsection 9.2.1.1, power purchases are not a reasonable alternative in the ERCOT region because the ERCOT region operates wholly within the state of Texas, and it does not interconnect synchronously across state lines to import or export power with neighboring reliability regions. Also, for merchant plants, such as CPNPP Units 3 and 4, conservation, or DSM, is not a reasonable alternative, as explained in Subsection 9.2.1.3. Only the continued operation of fossil fuel plants could provide baseload power, and that alternative is not environmentally preferable to CPNPP Units 3 and 4, as discussed in Subsection 9.2.3. Therefore, reasonable combinations of power purchases, power plant extension, and conservation would not be able to provide baseload power, or would not be environmentally preferable to CPNPP Units 3 and 4.

9.2.2 ALTERNATIVES REQUIRING NEW GENERATING CAPACITY

This subsection discusses the use of reasonable energy alternatives requiring additional generating capacity that could substitute for the capacity expected from the proposed nuclear facility considered for the CPNPP site. For the future period considered that is covered by the life of the project, numerous uncertainties arise from the following:

- The expected available energy technologies.
- The operational performance and energy levels achievable through these technologies.
- The potential environmental impacts posed by these technologies.
- The capital costs and levelized cost of producing electricity utilizing these technologies.
- The availability and cost of fuels to produce energy from these technologies.

The energy alternatives are assessed in the subsequent subsections relative to the evaluation criteria listed in the Review Procedures for Subsection 9.2.2 in NUREG-1555. There are two basic criteria: (1) use of the energy source is consistent with national policy goals for energy use, and (2) federal, state, or local regulations do not prohibit or restrict the use of the energy source. Each of the alternative energy technologies considered in this analysis is consistent, with one or more of the national policy goals for energy use, and the technologies evaluated are either being utilized or are under development to some degree within Texas. Therefore, the technologies are not considered to be prohibited by federal, state, or local regulations throughout the entire state. Each alternative energy technology is considered to meet these two criteria; therefore, these two evaluation criteria are not discussed further in this subsection.

In addition to the two criteria discussed above, NUREG-1555 lists four additional evaluation criteria:

a. The alternative technology should be developed, proven, and available in the relevant region, the ERCOT service area (referred to as Criterion 1 in the following evaluations).

b. The alternative energy source should provide generating capacity equivalent to the capacity of the proposed project as established in Section 3.2 (referred to as Criterion 2 in the following evaluations).

c. The capacity should be available within the time frame determined for the proposed project (referred to as Criterion 3 in the following evaluations).

d. No unusual environmental impacts or exceptional costs are associated with the energy source that would make it impractical (referred to as Criterion 4 in the following evaluations).

Each of the alternative energy technologies is evaluated against these four criteria in the subsections below. Where applicable, the applicant has identified the significance of the potential environmental impacts associated with each alternative energy alternative as either SMALL, MODERATE, or LARGE. This characterization is consistent with the criteria that NRC established as follows in NRC Regulations 10 Code of Federal Regulations (CFR) 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, Appendix B, Table B-1, Footnote 3:

> SMALL - Environmental impacts are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the commission has concluded that those impacts that do not exceed permissible levels in the commission's regulations are considered small.
>
> MODERATE - Environmental impacts are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.
>
> LARGE - Environmental impacts are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

The range of alternative energy technologies considered was based upon the set of alternative energy technologies considered in NUREG-1437 and NUREG-1555. In NUREG-1437, the NRC assessed energy alternatives with commonly known generation technologies and researched energy plans of various states' to identify alternative generation sources that may be typically considered in energy planning. In satisfying National Environmental Policy Act (NEPA) requirements, the NRC considered these technologies as reasonable energy alternatives to nuclear power in NUREG-1437 and NUREG-1555:

- Wind (Subsection 9.2.2.1)
- Photovoltaic cells (Subsection 9.2.2.2)
- Solar thermal power (Subsection 9.2.2.2)
- Hydropower (Subsection 9.2.2.3)
- Geothermal (Subsection 9.2.2.4)
- Biomass (Subsection 9.2.2.5)
- Wood waste (Subsection 9.2.2.5)
- Energy crops (Subsection 9.2.2.5)
- Municipal solid wastes (Subsection 9.2.2.6)
- Synthetic fuels (Subsection 9.2.2.7)
- Petroleum liquids (Subsection 9.2.2.7)
- Fuel cells (Subsection 9.2.2.8)

- Coal (Subsection 9.2.2.9)
- Natural gas (Subsection 9.2.2.10)

Possible combinations of the alternative technologies listed above were evaluated in Subsection 9.2.3.3. All of these alternative technologies are considered to have achieved commercial acceptance, so demonstration or commercialization schedules projected by the DOE are not provided. Because the proposed project is a US-APWR, the proposed project satisfies the NUREG-1555 requirement to evaluate advanced nuclear technologies as alternatives. Other advanced nuclear technologies are not evaluated as alternatives in this subsection. Although NUREG-1437 is specific to license renewal, the applicant believes the following:

- The technologies analyzed in NUREG-1437 represent a reasonable set of alternative energies to the proposed project.
- The alternatives assessment protocol in NUREG-1437 can be applied to determine if the alternative technologies represent reasonable alternatives to the proposed project.
- The utilization of this approach satisfies the intent and requirements of NRC Regulations 10 CFR 52, Licenses, Certifications, and Approvals for Nuclear Power Plants, regarding a COLA.

Based upon one or more of the evaluation criteria listed above, several of the alternative energy sources were considered not to be a reasonable alternative after a preliminary review and were not considered further. These technologies that were not considered to be reasonable as energy alternatives to the proposed project include the following:

- Wind (Subsection 9.2.2.1)
- Photovoltaic cells (Subsection 9.2.2.2)
- Solar thermal power (Subsection 9.2.2.2)
- Hydropower (Subsection 9.2.2.3)
- Geothermal (Subsection 9.2.2.4)
- Biomass (Subsection 9.2.2.5)
- Wood waste (Subsection 9.2.2.5)
- Energy crops (Subsection 9.2.2.5)
- Municipal solid wastes (Subsection 9.2.2.6)
- Petroleum liquids (Subsection 9.2.2.7)
- Synthetic fuels (Subsection 9.2.2.7)

- Fuel cells (Subsection 9.2.2.8)

Alternatives that were considered to be reasonable are assessed in detail in Subsection 9.2.3. These potentially competitive technologies are coal (Subsection 9.2.3.1), natural gas (Subsection 9.2.3.2), and possible combinations of alternative energy technologies (Subsection 9.2.3.3).

9.2.2.1 Wind

Based upon the evaluation criteria listed above, wind power is not a reasonable alternative to the proposed project. Wind power can be considered a developed and proven technology that is available in the ERCOT service area. Wind power cannot provide baseload generating capacity and availability equal to the proposed project. Because of the large land requirements and other potential environmental issues such as bird mortality and impacts to aesthetics and recreation, wind power is considered to have potential environmental impacts in excess of the proposed project.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Wind power is currently used as an energy source within the ERCOT service area, accounting for approximately 0.4 percent of the electric capability available and approximately 2.1 percent of the energy utilized in the ERCOT system (ERCOT 2007). ERCOT projected that wind power would account for 298 MW (0.4 percent of the total) of the energy capacity in the summer of 2007 and 443 MW (0.6 percent of the total) during the winter of 2007 – 2008 (ERCOT 2007a). ERCOT reported that there was a total of approximately 4150 MW of wind power projects in service and under development in 2007 (ERCOT 2007b). An estimated total of 4850 MW of installed wind power energy would be available by the year 2009 (ERCOT 2006). However, at the capacity factors for wind (25 to 45 percent), there would have to be over 10,000 MWe to meet the baseload provided by CPNPP Units 3 and 4.

Criterion 2 - Capacity equivalent to the planned generation

Although wind power is a developed and available technology, wind power cannot be considered capable of generating a baseload equal to that of the proposed project. The total 4150 MW of wind capacity (ERCOT 2007b) is only about 900 MW larger than the proposed CPNPP Units 3 and 4. The total installed wind power capacity of 4850 MW by 2009 (ERCOT 2006) is only about 1600 MW larger than the proposed project. This total installed wind power capacity is, and would be, provided by a large number of wind power projects in multiple locations. The largest wind power facility in the world is Horse Hollow Wind Energy Center, in Texas. This facility has a total generating capacity of 735 MW, about one-fifth the power to be generated by the proposed project (FPL 2006).

Wind power is an intermittent form of energy that is not suitable for baseload power, because wind power generation is highly variable on an hourly, daily, weekly, seasonally, and annual basis. Wind power systems produce power that is dependent on the wind velocity and duration. For example, the highest energy demands in Texas occur during the months of May through September for a typical year (ERCOT 2006). However, these are the months that the wind power units' outputs (as a percentage of the nameplate energy output) are at the lowest levels.

Wind power capacity factors are at lows of 29 – 34 percent in August and September compared to 46 – 52 percent in April and 36 – 55 percent in December, for the different regions of Texas (ERCOT 2006).

Capacity factor means the amount of energy produced by a unit(s) during a year as a percentage of the unit(s) nameplate capacity multiplied by the number of hours in a year (ERCOT 2006). Despite advances in technology and reliability, the capacity factors for wind power systems remain relatively low at 25 – 45 percent nationwide (NJCEP 2005); compared to the 90 – 95 percent annual capacity factor recently achieved by a number of nuclear power plants. In Texas, the capacity factor varies by generation region with the capacity factor ranging from 29 – 47 percent in the Texas Coastal area, 29 – 48 percent in Abilene County, 34 – 46 percent in the McCarney Area, and 31 – 55 percent in Floyd County (ERCOT 2006). Therefore, wind power is not capable of producing baseload power and is not a reasonable alternative by itself to the proposed CPNPP Units 3 and 4.

Estimates of the wind resource are expressed in wind power classes ranging from class 1 (low) to class 7 (high), with each class representing a range of mean wind power density or equivalent mean speed at specified heights aboveground. Areas designated class 4 or greater are suitable for development of wind generation facilities with the advanced wind turbine technology under development today. Class 3 wind areas may be suitable for future technology, while class 2 areas are marginal, and class 1 areas are likely to be unsuitable for wind energy development under any circumstances. (EERE 2005)

Approximately one-third of the state of Texas contains areas with class 3 and higher winds and would, from the perspective of wind velocities, have the potential to develop wind generation facilities. Large open land areas are needed for major wind power operations. The Horse Hollow Wind Energy Center utilizes 47,000 acres (ac) of land in Taylor and Nolan counties to provide a generating capacity of 735 MW (FPL 2006). By simple extrapolation, a wind power facility with a capacity equal to the CPNPP Units 3 and 4 would be almost five times larger and could require over 204,000 ac of land. Allowing for the 25 – 45 percent capacity factor for wind, a wind generation facility that could produce an annual amount of energy equivalent to the proposed project would require 452,800 – 816,000 ac of land, effectively doubling the acreage of land that is developed in Texas for wind power. Some of this land could be used for other purposes, such as agriculture.

Most of the power generation capacity is available in the western portion of Texas. Only about 3200 MW of transmission transfer capacity is currently available to the eastern half of the state where the majority of the demand is located (ERCOT 2007b). This represents less capacity than the capacity that would be generated by the proposed CPNPP Units 3 and 4. ERCOT cites the significant congestion on the existing electric system in western Texas and the distance of the transmission to eastern Texas (from 150 mi to over 200 mi) as major obstacles to increased utilization of wind resources (ERCOT 2007b).

<u>Criterion 3 - Available during the same time frame</u>

Generating baseload capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed project. As discussed under Criterion 2 above, wind power is not considered capable of providing the baseload capacity equal to the proposed project. Even if suitable land with sufficient wind were available for development, energy produced by wind generators varies on an hourly, daily, weekly, seasonally, and annual basis. Because of this natural variability, wind generation cannot be effectively used for baseload power, and solutions to this variability are not expected within the project time frame.

Criterion 4 - No unusual environmental impacts or exceptional costs

A factor affecting the feasibility of this technology is that wind power, because of the large land requirements and other issues, is considered to have potential environmental impacts greater than those expected for the proposed CPNPP Units 3 and 4. The potential adverse impacts of wind power on water quality, air quality, human health, and waste management are expected to be SMALL. The potential adverse impacts on ecological resources, protected species, and cultural resources are expected to be MODERATE.

A potential MODERATE beneficial impact on socioeconomics would be expected. The leases for wind power may be on the order of $2000 – $5000 per turbine per year (GAO 2004), adding to the other salaries and economic activity associated with constructing and operating a wind farm.

The use of wind power would be expected to have a LARGE impact on land use, and by extension, on aesthetics. As discussed above, the Horse Hollow Wind Energy Center utilizes 47,000 ac of land to provide a generating capacity of 735 MW (FPL 2006). By extrapolation, and allowing for the wind power capacity factors, a wind power facility with a capacity equal to the proposed project could require on the order of 452,880 – 816,000 ac of land. Although some compatible land uses like agriculture could be practiced, a wind farm could preclude a number of land uses, particularly uses requiring aboveground structures that could interfere with, or disrupt, the windflow patterns driving the wind turbines.

Aesthetic concerns arise from the visibility of a large number of the tall aboveground towers and blades. The Horse Hollow Wind Energy Center has 421 turbines, each of which has towers that are approximately 262 feet (ft) tall with three blades (FPL 2007). A wind power project of capacity comparable to the proposed CPNPP Units 3 and 4 could have over 1830 of these types of towers. Aesthetic impacts would also exist from recreation and scenic value of ridge tops to the public that would be reduced by the presence of a very large wind farm.

Wind power production costs for conventionally sized facilities that are currently in operation generally range from $0.03 to $0.05 per kilowatt-hour (kWh) (BW 2005) based on equipment installation costs of $1000 to $2000 per kWh. Large-scale systems, greater than 100 MW, achieve the lowest cost when multiple units are installed at one location (IEC 2006).

Wind power is a contributor to the current total generation mix of energy in the ERCOT system, and Texas has more developed wind power energy than any other state. Based upon the evaluation criteria discussed above, wind power is not considered to be a reasonable energy alternative to the proposed project because wind power cannot provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4.

9.2.2.2 Solar Thermal Power and Photovoltaic Cells

Based upon the evaluation criteria listed above, solar power is not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Solar power can be considered a developed and proven technology that is available as small scale power generators in the ERCOT service area. Solar power cannot provide baseload generating capacity and availability equal to the proposed project. Solar power, because of the large land requirements, potential land use restrictions and aesthetics, has potential environmental impacts in excess of the proposed project. Because a solar power project of similar size to the proposed project has not been built, the cost implications of such an endeavor cannot be evaluated with the information available. The costs associated with solar power do not compare favorably to most other forms of baseload capacity. Generating capacity from this technology equivalent to the capacity of the proposed project is not considered achievable within the time frame of the proposed project.

<u>Criterion 1 - Developed, proven, and available in the relevant region ERCOT</u>

Thus far, solar power technologies have been developed as small scale generators of energy. Practical methods to produce electricity from solar energy include photovoltaic and solar thermal power. Photovoltaics, typically referred to as “solar cells,” convert sunlight directly into electricity using semiconducting materials. Solar thermal power (nonphotovoltaic) systems convert sunlight into electricity using heat as an intermediate step. These systems generate electricity from this heat with various methods. For this discussion, the different methodologies of nonphotovoltaic systems are grouped together. Some solar thermal systems can also be equipped with a thermal storage tank to store heated transfer fluid. These solar thermal plants could dispatch electric power on demand using this stored heat. The potential generation available in Texas from solar power is estimated to have the capacity to generate over 250 times the peak historical single year energy consumption (VERA 1995).

<u>Criterion 2 - Capacity equivalent to the planned generation</u>

Although Texas has a substantial potential for solar power generation, solar power cannot provide baseload generating capacity and availability equal to the proposed project. This technology has not been developed on a commercially large scale. No solar power generation plants are listed as providing capacity on the ERCOT system (ERCOT 2007c). Solar power may be included in the group of “other technologies” that account for 0.3 percent of the ERCOT capacity that equates to approximately 264 MW of summer capacity and 267 MW of winter capacity. Texas has partnered with the U.S. Department of Energy and the Western Governors Association with a statewide goal to have 1000 MW of solar power generation capacity in operation by 2010 (SECO 2007). This statewide capacity level, which would involve generation at a number of distributed locations, is significantly lower than the capacity to be provided by the proposed CPNPP Units 3 and 4.

Like wind power, solar power is an intermittent form of energy unsuitable to provide baseload power, because solar power generation is highly variable on an hourly, daily, weekly, seasonal, and annual basis. Solar power systems produce power on an intermittent basis dependent upon incident light intensity, insolation, and cloud cover. Also, capacity factors of solar power (typically 24 – 32 percent depending on technology) are too low to meet baseload requirements (NREL 2002).

Criterion 3 - Available during the same time frame

Generating baseload capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project. As discussed under Criterion 2 above, solar power is not capable of providing the baseload capacity equal to the proposed project. Even if suitable land with sufficient solar exposure were available for development, solar power varies on an hourly, daily, weekly, seasonally, and annual basis. Due to this natural variability, solar cannot be effectively used for baseload power, and solutions to this variability are not expected within the project time frame.

Criterion 4 - No unusual environmental impacts or exceptional costs

A factor affecting the feasibility of this technology is that solar power, because of the large land requirements, potential land use restrictions and aesthetics, has potential environmental impacts in excess of the proposed project. The potential adverse impacts of solar power on water quality, air quality, human health, and waste management are expected to be SMALL. The potential adverse impacts on ecological resources, protected species, and cultural resources are expected to be MODERATE. The size of solar power projects would increase the likelihood that sensitive resources could be impacted because of the extremely large amounts of land required; with the greater acreage, the chance of avoidance could be reduced. The potential impact on socioeconomics of a solar facility of the same capacity as the proposed CPNPP Units 3 and 4 is expected to be a MODERATE beneficial impact.

The use of solar power would be expected to have a LARGE impact on land use, and by extension, on aesthetics. The area of land required for a solar power plant depends on the available solar insolation and type of plant. Current solar power plants utilize from approximately 3.8 to 10 ac per MW and have capacity factors of between 23 and 32 percent (NREL). A solar plant requiring 3.8 ac per MW with a 24 percent capacity factor would utilize approximately 27,755 ac to generate energy equal to the proposed project.

In California, PG&E Corporation is planning a 553-MW solar power project in Mojave Solar Park. This solar power project is expected to cover 6000 ac of land (PG&E 2007). By extrapolation from the planned PG&E Mojave Solar Park project, the amount of land required by a solar power project of capacity equal to that of the proposed CPNPP Units 3 and 4 would be approximately 38,000 ac.

Unlike wind power, the development of a solar power project would limit the other uses that can be made of the land. The planned PG&E solar project would utilize 1.2 million mirrors with 317 mi of vacuum tubing effectively covering a large portion of the land in Mojave Solar Park. Besides restricting the land use, this facility would impact aesthetics by covering vistas with the mirrors and supporting structures.

In terms of cost, solar-powered technologies (photovoltaic cells and solar thermal power) are not competitive with conventional technologies in grid-connected applications because of higher capital costs per kilowatt of energy. Capital costs for photovoltaic installations range from $3000/kW to $4000/kW, and capital costs for solar thermal installations range from $2000/kW to $3000/kW (Solarbuzz 2007). Recent estimates indicate that in areas with good solar insolation, the levelized cost of electricity produced by photovoltaic cells would range from $0.18/kWh to $0.23/

kWh (EERE 2006), and electricity from solar thermal systems would range from $0.09/kWh to $0.12/kWh (CSP undated). Solar energy costs are not competitive with the cost of generation of baseload power from other sources, such as nuclear, fossil-fueled plants, and hydroelectric.

The potential for solar power as an energy resource is significant in Texas. Based upon the evaluation criteria, solar power is not a reasonable energy alternative to the proposed project. Solar power cannot provide baseload generating capacity and availability equal to the proposed project. Solar power, because of the large land requirements, potential land use restrictions and aesthetics, would have potential environmental impacts in excess of the proposed project. Because a solar power project of similar size to the proposed project has not been built, the cost implications of such an endeavor cannot be accurately determined with the information available. However the costs associated with solar power do not compare favorably to other forms of energy for baseload use. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project.

9.2.2.3 Hydropower

Based upon the evaluation criteria listed above, hydroelectric power is not a reasonable energy alternative to the proposed project. Hydropower is a developed and proven technology that is currently utilized for power in the ERCOT service area. No hydropower project is feasible in Texas that could provide baseload generating capacity and availability equal to the proposed project. Hydropower has potential environmental impacts in excess of the proposed project. There is not sufficient new hydropower capability available in Texas. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project.

<u>Criterion 1 - Developed, proven, and available in the relevant region ERCOT</u>

Hydroelectric power (hydropower) is a fully commercialized technology and is an integral part of the ERCOT energy generation capacity. For the purposes of this evaluation, hydroelectric power includes hydropower from dams; pumped storage projects; and ocean, tidal, and wave energy. In 2007, hydropower provided approximately 0.7 percent of the generating capacity in the ERCOT power grid, accounting for approximately 545 MW capacity in the summer and 520 MW capacity in the winter. Hydropower is expected to contribute a similar level of capacity through at least 2013.

<u>Criterion 2 - Capacity equivalent to the planned generation</u>

Although hydropower is currently a developed and available technology, available hydropower in Texas is not capable of generating a baseload equal to that of the proposed project. The total 545 MW of hydropower capacity reported for the ERCOT service area could provide only 16 percent of the energy planned for production by the proposed project. Hydropower generating capacity for the entire state of Texas is estimated at approximately 643 MW (VERA 1995), which represents about 18 percent of the generating capacity of the proposed CPNPP Units 3 and 4. The largest hydropower project in Texas is the approximately 93-MW Mansfield Dam facility on the Colorado River. Total undeveloped capacity for hydropower projects in Texas is estimated to be 1019 MW (VERA 1995), which represents less than 30 percent of the capacity planned for the proposed project. There are no major pumped storage projects in Texas. The potential energy that could be developed through pumped storage projects in the state is estimated to be 1300 MW (VERA 1995), which represents approximately 37 percent of the power planned for the proposed project. The resources for producing power using wave or tidal power from the Gulf of Mexico are considered modest because of the relatively low waves and tides common to the Texas coast. Potential ocean, wave, and tidal energy projects, where feasible, are expected to produce power on the kW level (VERA 1995), and do not approach the energy production capacity of the proposed project.

In addition to the limited potential in Texas, hydropower has water use restrictions that, at times, could affect the ability of hydropower to meet baseload demands. Hydropower units are typically dispatched to meet peak and intermediate load needs. Their availability is dependent upon the availability of water and the necessity to control water flow to meet broad multi-purpose goals. Hydropower generation may be restricted to allow for competing water demands, such as downstream fisheries, recreation and aesthetics, and potable water supplies. These restrictions may vary on a daily, weekly, and seasonal basis. Hydroelectric output is vulnerable to extreme weather conditions such as droughts. Hydropower capacity factors are too low to meet baseload requirements. Average annual capacity factors for hydropower generation in the United States range from 40 to 50 percent (DOE 2001), compared to the 90 – 95 percent annual capacity factor recently achieved by a number of nuclear power plants.

Criterion 3 - Available during the same time frame

Generating baseload capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed project. As discussed under Criterion 2, the potential for new hydropower is limited because of the availability of the locations in Texas that can be developed by hydropower. Because this physical limitation of the resource cannot be changed, hydropower is not a reasonable alternative to provide the same amount of project baseload capacity within the time frame of the proposed project.

Criterion 4 - No unusual environmental impacts or exceptional costs

There would be environmental impacts associated with hydropower. Hydropower, because of its large land and water requirements and other issues, has potential environmental impacts in excess of the proposed CPNPP Units 3 and 4. The land use was estimated in NUREG-1437 to be on the order of 1 million ac per 1000 MW of hydropower capacity. Based on this estimate, a hydropower project equal to the proposed CPNPP Units 3 and 4 would require flooding more than 3.2 million ac of land, significantly more than the acreage to be impacted by the proposed CPNPP Units 3 and 4. Given such a large amount of land, and the potential impacts of such a project on ecological resources, protected species, aesthetics, and cultural resources, the impact of such a hydropower project would be considered LARGE. The impacts on socioeconomics would be considered MODERATE beneficial impacts including recreational benefits. SMALL potential impacts on human health and air quality would be expected with a large hydropower project.

In terms of cost, determining the average capital cost is difficult to estimate because of the many various types of hydropower sites (high-low heads and/or high-low flows) and the myriad of possible environmental requirements. Recent estimates indicate that capital costs for a hydropower facility range from $1700/kW to $2300/kW capacity. The levelized cost of electricity produced from new hydropower facilities is estimated at a total cost of $0.04/kWh (DOE 2001). Because Texas lacks sufficient water resources to develop a hydropower project that is equal to the proposed CPNPP Units 3 and 4, it is unlikely that such cost estimates would be applicable to a large hydropower project in Texas, where the potential for additional hydropower development is very limited.

Although hydropower is a contributor to the current total generation capacity in the ERCOT system, it is not a feasible energy alternative to the proposed project based on the criteria discussed above. Because of the limited water resources available for hydropower development in Texas, no new hydropower project is feasible that could provide baseload generating capacity and availability equal to the proposed project. Hydropower, because of the large land and water requirements and other issues, would have potential environmental impacts in excess of the proposed project. Furthermore, there is not sufficient hydropower capability existing in Texas that can be used to realistically evaluate the cost implications of a new large hydropower facility. Generating capacity from this technology equivalent to the capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project.

9.2.2.4 Geothermal

Based upon the evaluation criteria listed above, geothermal power is not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Geothermal power is a developed and proven technology that is available for small-scale power generation in the ERCOT service area. Geothermal power cannot provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. Geothermal power, because of the geotechnical development requirements and other issues, would have potential environmental impacts in excess of the proposed project. Because a geothermal power project of similar size to the proposed CPNPP Units 3 and 4 has not been built, the cost implications of such an endeavor cannot be evaluated with the information available. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Geothermal energy is a developed technology for power generation. To produce electric power with geothermal energy, underground reservoirs of high-temperature steam or hot water are tapped by wells and the escaping steam rotates turbines to generate electricity. Typically, water is then returned to the ground to recharge the reservoir. Geothermal generating technology can achieve average capacity factors of 89 – 97 percent (GEA undated).

No commercial geothermal power plants exist in Texas. Geothermal resources are located in both eastern and western Texas, so the potential for geothermal power does exist, if only on a small scale. In February 2007, the first leases for geothermal production were awarded for six coastal tracts of properties that covered more than 11,000 ac (TGLO 2007).

Criterion 2 - Capacity equivalent to the planned generation

Geothermal power in Texas cannot generate a baseload equal to that of the proposed CPNPP Units 3 and 4. As indicated above, there are no commercial geothermal plants in Texas, and the first leases for geothermal development were issued in 2007. No geothermal power generation plants are listed as providing capacity on the ERCOT system (ERCOT 2007c).

The installed geothermal generating capacity in the entire United States is currently only 2700 MW. Of this total, approximately 500 MW is realized from direct-use geothermal applications, such as greenhouses, fish farms, resorts and spas, and space and direct heating systems (CGT 2007). Even with the direct-use applications, the generating capacity from geothermal power in the entire nation is less than the planned capacity of the proposed CPNPP Units 3 and 4. Power plant development is limited to those locations where the quantity, quality, and reliability have been proven from intensive geological exploration, drilling, testing, and production. Given the lack of resource development and the technological limitations, geothermal power is not a reasonable alternative to the proposed CPNPP Units 3 and 4.

Criterion 3 - Available during the same time frame

Generating baseload capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project. As discussed in Criterion 2, geothermal power does not have the potential to generate the baseload capacity in Texas because of resource and technological limitations. The resource limitations cannot be altered, and the technological advances are still in development. Geothermal power does not have the potential to generate the baseload capacity within the project timeline.

Criterion 4 - No unusual environmental impacts or exceptional costs

A factor affecting the feasibility of this technology is that geothermal power has potential environmental impacts in excess of the proposed CPNPP Units 3 and 4. Because no geothermal power project has been developed equal to the proposed CPNPP Units 3 and 4, the potential environmental impacts of a large geothermal power facility are difficult to evaluate. Depending on the land area required, SMALL to MODERATE impacts can be expected on ecological resources, protected species, human health, cultural resources, aesthetics, and socioeconomics.

MODERATE impacts can be expected on land uses, water quality, waste management, and possibly air quality. Geothermal power plants require an estimated 1 – 8 ac of land per MW of power generated (REPP 2003). For a project equal to the proposed CPNPP Units 3 and 4, the geothermal plant would utilize from approximately 3500 – 28,000 ac. The size could vary considerably depending on the acreage of the well fields and the groundwater handling facilities.

The generation of geothermal power involves the extraction of large amounts of groundwater that would need to be reinjected or handled as wastewater. From September 1989 to May 1990, the DOE operated a hybrid binary geothermal power plant in Brazoria County, Texas. This plant generated 905 kW of power from the combination of a geothermal power turbine and a natural gas powered engine. The plant operated on 10,000 barrels (bbl) of pumped water per day, a pumping rate of 292 gallons per minute (gpm) (CEED 2006). These numbers would translate to approximately 31.5 million barrels (MMbbl) of groundwater to be extracted per day at a pumping rate of approximately 920,000 gpm. After use in the plant, this volume of water would need to be reinjected or managed daily for a geothermal plant equal to the proposed capacity provided by the proposed CPNPP Units 3 and 4.

Given these volumes of groundwater utilization, a very large number of high capacity, deep extraction and reinjection wells would be needed to operate a large capacity geothermal plant. The drilling, installation, and development of these wells would create large volumes of drill spoils and muds, adding to the waste management scenario. The groundwater can be expected to contain gasses that would need to be sparged or managed and could create air quality issues. In the DOE Brazoria County geothermal plant, 22 standard cu ft (scf) of gas was produced with every barrel of groundwater extracted (CEED 2006). The extraction of the required volume of water on a daily basis could cause subsidence at the ground surface, increasing the land-use impacts beyond that of just the footprint of the power generation facility and well fields.

In terms of cost, because no geothermal energy project has been developed or planned that is comparable to the proposed CPNPP Units 3 and 4, sufficient information is not available on the costs of constructing or operating a large geothermal power project. For the current sized geothermal plants, the estimated capital cost of construction is approximately $2300/kW (NRRI 2007). The levelized cost of electricity from geothermal power plants is estimated to be between $0.04/kWh to $0.08/kWh (CGT 2007). Because these costs are based upon smaller geothermal plants, whether these costs can be extrapolated to a project on the scale of the proposed CPNPP Units 3 and 4 is uncertain.

Based upon the evaluation criteria, geothermal power is not considered to be a feasible energy alternative to the proposed CPNPP Units 3 and 4. In Texas, geothermal power cannot provide baseload generating capacity and availability equal to the proposed project. Geothermal power would have potential environmental impacts in excess of the proposed CPNPP Units 3 and 4. Because a geothermal power project of similar size to the proposed CPNPP Units 3 and 4 has not been built, the cost implications of such an endeavor cannot be evaluated with the information available. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project.

9.2.2.5 Biomass, including Wood Waste and Energy Crops

Biomass related fuels are considered to be fuels derived from agricultural and forestry products and wastes, excluding domestic and municipal solid wastes. As such, biofuels can include switchgrass, corn, rice, soybean, cotton and cotton seed, wheat, sugarcane, other potential energy crops, wood, wood pulp, wood wastes, peat, manure, and other sources of combustible organic material. Fuels derived from solid wastes, though technically a biomass fuel, are discussed as municipal solid wastes fuel in Subsection 9.2.2.6.

Based upon the evaluation criteria listed above, biomass-related fuels are not a feasible energy alternative to the proposed CPNPP Units 3 and 4. Biomass related fuels can be considered a developed and proven technology that is available as small scale power generators in the ERCOT service area. Biomass related fuels cannot provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. Biomass related fuels are not considered to have potential environmental impacts that would affect the feasibility of this technology. The use of biomass fuels would not offer an environmental advantage over the proposed CPNPP Units 3 and 4. Although a biomass related fuels project of similar size to the proposed project has not been built and the costs are difficult to assess, the costs of generating power equal to that of the proposed CPNPP Units 3 and 4 are considered to make biomass fuels an uneconomic alternative.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Biomass energy is considered to be a developed technology for power generation. Biomass fired facilities generate electricity using commercially available equipment and well-established technology. On a national basis, biomass combustion is a current significant energy source for electrical generation. Nationwide, biomass energy plants, including municipal solid waste, have surpassed hydropower as the largest domestic source of renewable energy (SECO 2007a). The utilization of all potential biomass fuels, including municipal solid wastes, available in Texas is estimated to have the potential of supplying two-thirds of the electricity demand in the state (TCPS 1995). The competing uses of agriculture and forestry products make the realistic potential for using biomass materials as an energy resource much smaller.

Texas, because of the large agricultural and forest sectors, has a large potential for biomass energy production. These potential resources cover cropland, rangeland, forests, and wetlands that can be harvested to yield organic material for fuels. Most of the biomass fueled generation facilities in the United States use steam turbine conversion technology, and can accept a wide variety of biomass fuels. Biomass fuels in Texas may be more valuable as liquid fuels for use in transportation, such as ethanol, rather than as a source of electricity (VERA 1995).

Criterion 2 - Capacity equivalent to the planned generation

Biomass-derived power cannot be considered capable of generating a baseload equal to that of the proposed CPNPP Units 3 and 4. Biomass power is not a significant contributor of energy to the ERCOT system and is not listed as a current energy source by ERCOT. No biomass power generation plants are listed as providing capacity on the ERCOT system (ERCOT 2007a). Biomass may be included in the category of “other” fuels that combine for about 0.3 percent of the ERCOT capacity, translating to approximately 264 MW in summer and 267 MW during the winter (ERCOT 2007a).

In June 2007, plans for the proposed Nacogdoches Power Plant, a 100-MW biomass fueled plant to be built in Nacogdoches County were announced. According to the press release, this plant would be the major biomass power generating facility in Texas. The plant would also be the largest biomass fuel power plant in the United States (NP 2007). This biomass plant, although the largest in the entire country, would provide about 3 percent of the energy to be generated by the proposed CPNPP Units 3 and 4. Biomass fuels may be a dependable supplier of power at a smaller magnitude, but are not reasonable alternatives in the range of that power to be generated by the proposed CPNPP Units 3 and 4.

In NUREG-1437, the NRC evaluated other biomass-derived fuels for the purposes of alternative energy source analysis. These included burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). The NRC concluded that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant. This conclusion applies to this analysis. The other biomass-derived fuels do not represent a reasonable alternative to the proposed CPNPP Units 3 and 4.

Criterion 3 - Available during the same time frame

Generating baseload capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed CPNPP Units 3 and 4. As discussed in Criterion 2, biomass-derived power does not have the realistic potential to generate the baseload capacity equivalent to CPNPP Units 3 and 4 because of resource and technological limitations.

Criterion 4 - No unusual environmental impacts or exceptional costs

A biomass energy plant would not offer an environmental advantage over the proposed CPNPP Units 3 and 4. SMALL to MODERATE impacts would be expected from a biomass energy plant on land use, ecological resources, protected species, human health, aesthetics, cultural resources and socioeconomics. SMALL impacts could be expected if the feedstock is obtained without dedicating new land to growing fuel crops. MODERATE to LARGE impacts could occur if additional land is required to produce the fuel, converting large tracts of land to the production of energy crops. These impacts could include changes to wildlife habitat and biodiversity, reduced soil fertility, increased erosion, and reduced water quality.

Construction of a biomass-fired plant would have an environmental impact that would be similar to that for a coal-fired plant. Like coal-fired plants, biomass-fired plants require areas for fuel storage, processing, and waste; i.e., ash disposal. Biomass is less dense than coal, requiring a greater volume of fuel to be handled per MW of power generated. The proposed 100-MW Nacogdoches power plant is designed to use approximately one million tons of wood as fuel per year (NP 2007).

Operation of biomass-fired plants has the potential for MODERATE impacts on the aquatic environment because of water consumption and air quality due to emissions. The combustion of biomass fuels could generate air emissions similar to those generated by coal-fired plants, including greenhouse gases and ash.

In terms of cost, because no biomass energy project has been developed or planned that is comparable to the proposed CPNPP Units 3 and 4, sufficient information is not available on the costs of constructing or operating a large biomass power project. The costs of generating power equal to that of the proposed project make biomass fuels an uneconomic alternative. Based upon existing plants that are considerably smaller than the proposed CPNPP Units 3 and 4, the estimated capital cost of a biomass fuel plant is on the order of $1800/kW to $2100/kW (NRRI 2007). The proposed 100-MW Nacogdoches power plant is expected to cost approximately $300 million, resulting in a capital cost of approximately $3000/kW. The levelized cost of electricity from a biomass power plant is estimated to be in the range of $0.052/kWh to $0.067/kWh (SORR undated).

Based upon the evaluation criteria, biomass related fuels are not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Biomass related fuels cannot provide baseload generating capacity and availability equal to the proposed project. The use of biomass fuels have greater environmental impacts than the proposed CPNPP Units 3 and 4. Biomass energy is not a reasonable alternative to the proposed CPNPP Units 3 and 4 for baseload power. Generating capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed CPNPP Units 3 and 4.

9.2.2.6 Municipal Solid Wastes

Based upon the evaluation criteria listed above, municipal solid waste (MSW) fuels are not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. MSW fuels are a developed and proven technology that is available as small scale power generators in the ERCOT service area. Fuels derived from MSW cannot provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. The use of fuels derived from MSW would have greater environmental impacts than the proposed CPNPP Units 3 and 4. Because an MSW fuels project of similar size to the proposed project has not been built, the cost implications of such an endeavor cannot be evaluated with the information available. The costs of producing energy from MSW even on smaller scales indicate that the costs would render this energy source not a reasonable alternative to the proposed CPNPP Units 3 and 4. Generating capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed CPNPP Units 3 and 4.

<u>Criterion 1 - Developed, proven, and available in the relevant region ERCOT</u>

MSW-derived energy is a developed technology for power generation. MSW fired facilities, often referred to as energy from waste (EFW) plants, generate electricity using commercially available equipment and well-established technology. On a national basis, MSW and biomass combustion are energy sources for electrical generation. Nationwide, MSW and biomass energy plants have surpassed hydropower as the largest domestic source of renewable energy (SECO 2007a). The large municipal areas in Texas make MSW a potential energy resource in the state.

MSW can be used to fuel electrical generation similar to biomass or coal and usually involves the incineration of MSW. MSW would be delivered to the EFW plant by collection trucks and shredded or processed to ease handling. After removal of recyclable material, the remaining waste would be fed into a combustion chamber to be burned. The resulting heat of combustion is used to produce steam, which is either used for heating or is used in a steam turbine to generate electricity.

<u>Criterion 2 - Capacity equivalent to the planned generation</u>

MSW power is not a significant contributor of energy to the ERCOT system and is not listed as a current energy source by ERCOT. MSW, like solar power and biomass energy, may be included in the category of “other” fuels that combine for about 0.3 percent of the ERCOT capacity, translating to approximately 264 MW in summer and 267 MW during the winter (ERCOT 2007a). There are 26 power plants listed in the ERCOT system that generate power from landfill gasses. The two largest landfill gas plants are the approximately 7-MW Coastal Plains plant in Galveston County and the approximately 10-MW Atascocita plant in Harris County (ERCOT 2007c).

EFW plants exist as small energy generators in Texas but none are on the scale of the proposed CPNPP Units 3 and 4. The largest EFW facility in Texas and the southwestern United States is the Chambers County Resource Recovery and Recycling Facility in Anahuac. Three other communities operate EFW plants in Texas: (1) Center, (2) Cleburne, and (3) Carthage (TCPS 1995). No MSW power facility on the scale of the proposed CPNPP Units 3 and 4 exists (CCI 2007). The cost of EFW is greater than other forms of waste disposal and the need to collect the MSW from widely scattered municipal areas also affects the feasibility of a large MSW power plant.

The decision to burn MSW to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. EFW power plants reduce the need for landfill capacity because disposal of ash created by MSW combustion requires less volume and land area as compared to unprocessed MSW. Many landfills are unlikely to begin converting waste to energy because of costs and obstacles to MSW power generation, primarily environmental regulations and public opposition to siting MSW facilities near feedstock supplies; i.e., in populated areas. As long as less expensive and more easily approved methods of disposal are available, MSW energy production would be less appealing than the other waste disposal options to the waste management industry.

<u>Criterion 3 - Available during the same time frame</u>

Generating baseload capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed CPNPP Units 3 and 4. As discussed in Criterion 2, MSW-derived power is not considered to have the potential to generate the baseload capacity because of resource and technological limitations. The resource limitations cannot be altered, and the technological advances are still in development. MSW-derived power is not considered to have the potential to generate the baseload capacity within the project timeline.

<u>Criterion 4 - No unusual environmental impacts or exceptional costs</u>

An MSW energy plant would have greater environmental impacts than the proposed CPNPP Units 3 and 4. SMALL to MODERATE impacts would be expected from an MSW energy plant on land use, ecological resources, protected species, human health, aesthetics, cultural resources, and socioeconomics.

Construction of an MSW energy plant would have an environmental impact that would be similar to that of a coal-fired plant. MSW energy plants are expected to be similar in size to coal-fired plants, and like coal-fired plants, would require areas for fuel storage, processing, and waste; i.e., ash handling and disposal. Solid waste is less dense than coal, requiring a greater volume of fuel to be handled per MW of power generated.

Operation of MSW energy plants has the potential for MODERATE impacts on the aquatic environment because of water consumption and air quality because of emissions. MSW power plants can concentrate the toxins from the feedstock within the smaller ash volume. Regulations require MSW ash sampling on a regular basis to determine its hazardous status. Hazardous ash must be managed and disposed of as hazardous waste. Depending on state and local restrictions, nonhazardous ash may be disposed of in an MSW landfill or recycled for use in roads, parking lots, or daily covering for sanitary landfills. The combustion of MSW for energy could generate air emissions similar to those generated by coal-fired plants, including greenhouse gases and ash. Depending on the type of solid waste, priority air pollutants, as designated by the U.S. Environmental Protection Agency (EPA) could also be emitted.

In terms of cost, because no biomass energy project has been developed or planned that is equal to the proposed CPNPP Units 3 and 4, sufficient information is not available on the costs of constructing or operating a large biomass power project. The costs of generating power equal to that of the proposed CPNPP Units 3 and 4 make biomass fuels an uneconomic alternative. Specialized waste separation and handling equipment increases initial capital costs over other technologies. Recent estimates indicate that capital costs for MSW plants range from \$2500/kW to \$4600/kW. The levelized cost of electricity produced from MSW plants is \$0.035/kWh to \$0.153/kWh (FPSC 2003).

Based upon the evaluation criteria, MSW fuels are not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Fuels derived from MSW cannot provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. MSW fuels have greater environmental impacts than the proposed CPNPP Units 3 and 4. The costs of producing energy from MSW even on a smaller scale indicate that the costs would render this energy source an infeasible alternative to the proposed CPNPP Units 3 and 4. Generating capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed CPNPP Units 3 and 4.

9.2.2.7 Petroleum Liquids and Synthetic Fuels

Based upon the evaluation criteria listed above, fuels derived from petroleum liquids and synthetic fuels are not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Fuels derived from petroleum liquids and synthetic fuels are a developed and proven technology that may be available as small-scale power generators in the ERCOT service area. Fuels derived from petroleum liquids and synthetic fuels are not available to provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. The use of fuels derived from petroleum liquids and synthetic fuels would have greater environmental impacts than the proposed CPNPP Units 3 and 4. The cost implications of a fuels project cannot be evaluated with the information available because fuels derived from petroleum liquids and synthetic fuels for projects of similar size to the proposed CPNPP Units 3 and 4 have not been built. The costs of producing energy, from petroleum liquids and synthetic fuels, even on smaller scales, indicate that the costs would render this energy source an infeasible alternative to the proposed CPNPP Units 3 and 4.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Energy derived from petroleum liquids is considered to be a developed technology for power generation. Petroleum liquids fired facilities generate electricity using commercially available equipment and well-established technology. Most plants are thermal generation plants that burn oil and other petroleum liquids to generate electricity. In many plants, oil and petroleum liquids can be burned as an alternative to natural gas or coal. Petroleum liquids in this discussion include distillate fuel oil, diesel, residual fuel oil, jet fuel, kerosene, petroleum coke converted to liquid petroleum, and waste oil. Synthetic fuels are included in this subsection because many of the environmental issues related to the use of this fuel are similar to those associated with petroleum liquids. Liquid natural gas (LNG) is considered in the subsection on natural gas, below, and not as a liquid petroleum fuel in this subsection.

Criterion 2 - Capacity equivalent to the planned generation

Petroleum liquids and synthetic fuels power is not a significant contributor of energy to the ERCOT system. Petroleum liquids and synthetic fuels, like solar power, MSW, and biomass energy, may be included in the category of “other” fuels that combine for about 0.3 percent of the ERCOT capacity, translating to approximately 264 MW in summer and 267 MW during the winter (ERCOT 2007a). There are seven diesel power plants listed in the ERCOT service area with the largest being the approximately 11-MW Stryker Creek D1 in Cherokee County (ERCOT 2007c). Petroleum liquid power plants on the scale of the proposed CPNPP Units 3 and 4 do not currently exist.

Similar to the MSW and biomass alternatives, obtaining, transporting, storing and handling a sufficient fuel stock to generate power on the scale of the proposed CPNPP Units 3 and 4 is difficult. This difficulty in maintaining suitable fuel stockpiles contributes to the infeasibility of petroleum liquids and synthetic fuels as a baseload fuel source. No new petroleum-liquids-fired units have been constructed in the United States since 1981 (RTII 2003). Petroleum liquids accounted for 122,522 thousand MWh or about 3 percent of net electricity generated in 2005 (EIA 2006). With the combination of the decline of domestic petroleum production since 1970, rising import quantities, increasing global prices, plus competition for petroleum from the transportation sector and petrochemical industry, the downward trend for using petroleum to generate electricity is likely to continue.

Criterion 3 - Available during the same time frame

Generating baseload capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed project. As discussed in Criterion 2, petroleum liquid fuel power is not considered to have the potential to generate the baseload capacity because of resource and technological limitations. The resource limitations cannot be altered, and the technological advances are still in development. Petroleum liquid fuel power is not considered to have the potential to generate the baseload capacity within the project timeline.

Criterion 4 - No unusual environmental impacts or exceptional costs

A petroleum liquids and synthetic fuels energy plant would have environmental impacts that would have greater environmental impacts than the proposed CPNPP Units 3 and 4. SMALL to MODERATE impacts would be expected from a petroleum liquids and synthetic fuels energy plant on land use, ecological resources, protected species, human health, aesthetics, cultural resources and socioeconomics.

Construction of a petroleum liquids and synthetic fuels power plant would have an environmental impact that would be similar to that for a coal-fired plant. Like coal-fired plants, petroleum liquid power plants require areas for fuel storage, in this case, a petroleum liquid tank farm, in addition to the footprint of the plant and buffer areas.

Operation of a petroleum liquids and synthetic fuels power plant has the potential for MODERATE impacts on the aquatic environment and air quality because of water consumption and emissions, respectively. The combustion of petroleum liquids and synthetic fuels could generate air emissions similar to those generated by coal-fired plants, including greenhouse gases and priority air pollutants.

In terms of cost, no petroleum liquids or synthetic fuels energy project has been developed or planned that is equal to the proposed CPNPP Units 3 and 4, and no new petroleum liquids-fired units have been constructed in the United States since 1981. Sufficient information is not available on the costs of constructing or operating a large petroleum liquids or synthetic fuels power project. The costs of generating capacity from petroleum liquids and synthetic fuels equal to the costs of the expected capacity from the proposed CPNPP Units 3 and 4 make the consideration of a large petroleum liquids and synthetic fuels energy project an uneconomical alternative.

The high cost of petroleum liquids as a fuel has prompted a steady decline in its use for electricity generation in recent decades. Comparing costs in dollars per million Btu ($/MBtu) coal was $1.77/MBtu, natural gas was $6.82/MBtu, and petroleum liquids were $11.98/MBtu (EIA 2007a). While capital costs for new petroleum-fired plants could be expected to be similar to those of new natural-gas-fired plants, operation is more expensive because of the high cost of petroleum. Future increases in petroleum prices are expected to make petroleum-fired generation increasingly more expensive.

Based upon the evaluation criteria, fuels derived from petroleum liquids and synthetic fuels are not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Petroleum liquids and synthetic fuels would have greater environmental impacts than the proposed CPNPP Units 3 and 4. The costs of producing energy, from petroleum liquids and synthetic fuels, even on smaller scales, indicate that the costs would render this energy source not a reasonable alternative to the proposed CPNPP Units 3 and 4.

9.2.2.8 Fuel Cells

Based upon the evaluation criteria listed above, fuel cells are not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Fuel cells are a developing technology that may be considered for small-scale power generators in the ERCOT service area. Fuel cells cannot provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. The use of fuels derived from fuel cells would not offer an environmental advantage over the proposed CPNPP Units 3 and 4. Because a fuel cells project of similar size to the proposed CPNPP Units 3 and 4 has not been built, the cost implications of such an endeavor cannot be evaluated with the information available. The costs of producing energy from fuel cells even on a smaller scale would render this technology not a reasonable alternative to the proposed CPNPP Units 3 and 4. Generating capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed CPNPP Units 3 and 4.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Energy derived from fuel cells is a developing technology for power generation. Fuel cell powered facilities generate electricity on a small scale, using commercially available equipment and established technology. Fuel cell power plants are approaching utility scale, with over 800 stationary fuel cell systems built and operated worldwide (BTI 2000), but the total global stationary fuel cell electricity generating capacity is small compared to conventional generation. Fuel cells have an electrical efficiency of up to 55 percent (EPRI 2005).

Fuel cells operate similar to batteries but rely on a supply of hydrogen, which is broken into free protons and electrons within the fuel cell. There are several types of fuel cells, using different materials and operating at different temperatures. Stationary fuel cells can hypothetically be connected to the electricity grid, and smaller cells are envisioned for use in the transportation sector.

Phosphoric acid fuel cells, which operate at relatively low temperatures, are currently being used in several applications with efficiency rates of 37 – 42 percent. An advantage of this cell type is that relatively impure hydrogen is tolerated, broadening the source of potential fuels. The major disadvantage, other than the small scale of energy generated, is the high cost of the platinum catalyst.

Molten carbonate fuel cells, which use nickel in place of more costly metals, can achieve a 50 percent efficiency rate and are operating experimentally as power plants. Solid oxide fuel cells, also currently being developed, use ceramic materials, operate at relatively high temperatures, and can achieve similar efficiencies of around 50 percent. Fuel cells have applications in the electric power sector, such as driving gas turbines, saving fuel in the energy production phase.

Criterion 2 - Capacity equivalent to the planned generation

Power generated from fuel cells is not a significant contributor of energy to the ERCOT system and is not listed as a current energy source by ERCOT (ERCOT 2007c). No fuel cell power generation plants are listed as providing capacity on the ERCOT system (ERCOT 2007c). There are no fuel cell power plants in existence or proposed that generate electricity on the scale of the proposed CPNPP Units 3 and 4.

The technology has not advanced to the level that energy on the scale of the proposed CPNPP Units 3 and 4 could be generated from fuel cells. Power generated by fuel cell units are still in the kW range, a small percentage of the capacity of the proposed CPNPP Units 3 and 4, and does not approach the MW power range. Rather, fuel cells are being used more as batteries to help small-scale electric generating units than as commercial electricity generators. The ability to obtain sufficient hydrogen for use in the fuel cells also affects the feasibility of this technology for the large-scale generation of electricity.

Criterion 3 - Available during the same time frame

Generating baseload capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is not considered achievable within the time frame of the proposed CPNPP

Units 3 and 4. As discussed in Criterion 2, fuel cell power is not considered to have the potential to generate the baseload capacity equivalent to CPNPP Units 3 and 4 because of technological limitations. The technological advances are still in development. Fuel cell power is not considered to have the potential to generate the baseload capacity within the project timeline.

Criterion 4 - No unusual environmental impacts or exceptional costs

A fuel cell energy plant could be expected to have environmental impacts that would not significantly affect the feasibility of this technology but do not offer an environmental advantage over the proposed CPNPP Units 3 and 4. SMALL to MODERATE impacts would be expected from a fuel cells energy plant on human health, aesthetics, waste management, water quality, air quality and socioeconomics. MODERATE TO LARGE impacts on land use, ecological resources, protected species, and cultural resources could be expected because, if a fuel cell plant on the scale of the proposed CPNPP Units 3 and 4 could be feasibly built, the land requirement for the fuel cells plants would be substantial.

In terms of cost, because no fuel cells energy project has been developed or planned that is equal to the proposed CPNPP Units 3 and 4, sufficient information is not available on the costs of constructing or operating a fuel cells power project. The costs of generating power equal to that of the proposed CPNPP Units 3 and 4 make fuel cells an uneconomic alternative.

Fuel cells are still not cost effective when compared with other energy generation technologies. The cost per kilowatt-hour is not yet competitive with current utility delivered prices. The levelized cost of electricity produced by commercial fuel cells is in the range of approximately $0.12/kWh to $1.50/kWh (EPRI 2005). Based upon the costs of the small scale units in operation, the capital cost is in the range of $2000/kW to $4000/kW (EPRI 2005). It is unknown if the costs derived from significantly smaller fuel cells projects can be applied to a power plant on the order of the proposed CPNPP Units 3 and 4.

Based upon the evaluation criteria, fuels cells are not a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Fuel cells cannot provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. Fuel cells are not considered to have potential environmental impacts that would affect the feasibility of this technology but would not offer an environmental advantage over the proposed CPNPP Units 3 and 4. The costs of producing energy from fuel cells even on a smaller scale indicate that the costs would render this energy source not a reasonable alternative to the proposed CPNPP Units 3 and 4. Generating capacity from this technology equivalent to that capacity of the proposed project is not considered achievable within the time frame of the proposed CPNPP Units 3 and 4.

9.2.2.9 Coal

Coal fuel power systems include a number of technologies, including pulverized coal and Integrated Gasification Combined Cycle (IGCC). Primary technologies for generating electrical energy from pulverized coal include conventional pulverized coal boiler and fluidized bed combustion. The evaluation in this subsection is intended to cover the range of coal technologies for generating electric power.

Based upon the evaluation criteria listed above, coal fuel is a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Coal fuel power is a developed and proven technology that is utilized for energy generation in the ERCOT service area. There is the potential that coal fuel power plants could provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. The use of coal fuels would have greater environmental impacts than the proposed CPNPP Units 3 and 4. The costs of coal fuel plants are well-known and would not make the use of this technology economically impractical. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is considered achievable within the time frame of the proposed project. Given this potential feasibility as an energy alternative, a more detailed evaluation of coal fuel is presented in Subsection 9.2.3.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Energy derived from coal is a developed technology for power generation. Coal powered facilities generate electricity using commercially available equipment and well-established technology. Coal is the second largest source of energy production in the ERCOT service area, with natural gas being the largest energy source and nuclear power being the third largest. Coal accounts for approximately 20 percent of the energy capacity in the ERCOT system. Approximately 15,709 MW are generated from coal-fired plants in the summer and 15,737 MW in the winter (ERCOT 2007a).

In conventional pulverized-coal-fired plants, like the ones commonly used in the ERCOT system, pulverized coal is blown into a combustion chamber of a boiler and ignited. The released heat converts water in the boiler into steam. This high-pressure steam is applied in a steam turbine to produce electricity. Fluidized bed combustion (FBC) is an advanced electric power generation process. The FBC method is similar overall to conventional pulverized-coal-fired boilers, but differs in the combustion process and content. IGCC is an emerging, advanced technology that combines modern coal gasification technology with both gas turbine and steam turbine power generation.

Criterion 2 - Capacity equivalent to the planned generation

Power generated from coal is a significant contributor of energy to the ERCOT system. There are seven operating or planned coal-fired power plants in the ERCOT system that generate over 1000 MW of energy or more. There are two additional coal-fired plants that generate between 600 and 1000 MW of energy. The largest of these coal-fired plants are the 2394-MW Martin Lake Units 1, 2, and 3 in Rusk County and the 1881-MW Monticello Units 1, 2, and 3 in Titus County (ERCOT 2007c). Although these plants are between 26 percent and 42 percent smaller than the proposed CPNPP Units 3 and 4, these facilities suggest that pulverized-coal-fired plants on the scale of the proposed project are potentially feasible.

To improve the thermal efficiency of the FBC technology, a new type of FBC boiler is being proposed that encases the entire boiler inside a large pressure vessel. This technology is referred to as pressurized fluidized bed combustion (PFBC). Burning coal in a PFBC boiler results in a high-pressure stream of combustion gases that can spin a gas turbine to make electricity, then boil water for a steam turbine. The PFBC technology is currently in the demonstration phase and is not a reasonable alternative for the proposed CPNPP Units 3 and 4. Barriers in commercial deployment opportunities of second-generation PFBC systems arise because of slow progress in hot gas filter development, high turbine costs, and complex plant integration.

IGCC technology still needs operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But the joining of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new. This technology has been demonstrated at only a small number of facilities around the world, including five in the United States. Experience has been gained with the chemical processes of gasification and the impact of coal properties on the IGCC areas of design, efficiency, economics, etc. System reliability is still relatively low, as compared to conventional pulverized-coal-fired power plants. There are problems with the process integration between gasification and power production as well.

Criterion 3 - Available during the same time frame

The energy capacity from the alternative technology is available within the time determined for the proposed CPNPP Units 3 and 4. As discussed under Criterion 2 above, coal fired power plants have the potential to generate the needed baseload capacity. Because the technology and resources are available, sufficient baseload capacity from a coal-fired plant is available within the project time frame.

Criterion 4 - No unusual environmental impacts or exceptional costs

A coal energy plant would have greater environmental impacts than the proposed CPNPP Units 3 and 4. SMALL to MODERATE impacts would be expected from a coal energy plant on land use, ecological resources, protected species, human health, aesthetics, cultural resources, and socioeconomics. Waste management impacts, including the handling of the combustion ashes and air emission control wastes, are considered to be SMALL to MODERATE. Water quality impacts, including the discharge of thermal effluents, are expected to be SMALL to MODERATE.

Depending on the size of the plant and the emissions control technology, air impacts could be SMALL to MODERATE. To reduce emissions in pulverized-coal-fired plants, flue gas is cleaned of significant fractions of major pollutants such as oxides of nitrogen (NO_X), oxides of sulfur SO_X, and particulates. FBC reduces gaseous pollutants by better controlling coal combustion parameters and by injecting a sorbent, such as crushed limestone, into the combustion chamber along with the fuel. Crushed fuel mixed with the sorbent is fluidized on jets of air in the combustion chamber. Sulfur released from the fuel as sulfur dioxide (SO_2) is captured by the sorbent in the bed to form a solid compound that is removed with the ash. The resultant by-product is a dry, benign solid that is potentially a marketable by-product for agricultural and construction applications.

Compared to conventional pulverized coal plants, the IGCC technology is potentially lower emitting because major pollutants can be removed from the gas stream prior to combustion. The IGCC process generates much less solid waste than the pulverized-coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a sand-like marketable by-product. Slag production is a function of the fuel ash content. The other large-volume by-product produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. The IGCC units do not produce ash or scrubber wastes.

In terms of cost, because large-scale coal-fired energy projects approaching the size of the proposed CPNPP Units 3 and 4 exist, there is sufficient information available on the costs of constructing or operating a large coal-fired power project. From the available information, the costs of generating power equal to that of the proposed CPNPP Units 3 and 4 make pulverized-coal-fired power plants an economical alternative.

Capital costs for conventional pulverized-coal-fired power plants are estimated to range from \$1562/kW – \$2883/kW (NETL 2007). Because of limitations on unit sizes and lower fuel efficiencies, FBC is not a cost-effective alternative for the proposed CPNPP Units 3 and 4. Experience with IGCC indicates generation costs are more expensive than comparably sized pulverized coal plants because of the coal gasifier and other specialized equipment. The capital costs for coal-fired IGCC power plants are \$1841/kW – \$2496/kW and have levelized costs of electricity of \$0.078/ kWh (NETL 2007).

The United States has abundant low-cost coal reserves, and the price of coal for electric generation should increase at a relatively slow rate. Even with recent environmental regulation, coal capacity is expected to be an affordable technology for reliable, near-term development.

Based upon the evaluation criteria, pulverized-coal-fired power plants are considered to be a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Pulverized-coal-fired power is a developed and proven technology that is utilized for energy generation in the ERCOT service area. There is the potential that pulverized-coal-fired power plants could provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. Coal fuels would have greater environmental impacts that the proposed CPNPP Units 3 and 4. The costs of pulverized-coal-fired power plants are well-known and would make the use of this technology economically practical. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is achievable within the time frame of the proposed project. An IGCC facility is not a reasonable alternative, because IGCC technology currently is not cost-effective and requires further research to achieve an acceptable level of reliability.

Given this potential feasibility as a competitive energy alternative, a more detailed evaluation of pulverized-coal-fired power is presented in Subsection 9.2.3.1. The discussion in Subsection 9.2.3.1 includes the plant size and land requirements, fuel quality and consumption estimates, waste management issues, emissions evaluation, economic costs evaluation, and potential environmental and health restrictions or impacts. As stated in the introductory paragraphs in Subsection 9.2.2, the use of this energy technology is considered to be consistent with U.S. national policy, which includes maintaining a diverse energy supply and the continued use of coal but with more efficient combustion and air emission controls.

9.2.2.10 Natural Gas

Based upon the evaluation criteria listed above, natural gas is a reasonable energy alternative to the proposed CPNPP Units 3 and 4. Electrical power derived from natural gas is a developed and proven technology that is utilized for energy generation in the ERCOT service area. There is the potential that natural gas power plants could provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. Natural gas would have greater environmental impacts than the proposed CPNPP Units 3 and 4. The costs of natural gas fuel plants are well-known and would not make the use of this technology economically impractical. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is considered achievable within the time frame of the proposed project. Given this potential feasibility as an energy alternative, a more detailed evaluation of natural gas is presented in Subsection 9.2.3.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Energy derived from natural gas is a developed technology for power generation. Natural gas powered facilities generate electricity using commercially available equipment and well-established technology. Natural gas-fired generation using combined-cycle turbines is a technology that is available and economical in the ERCOT service area.

Natural gas is by far, the largest single technology of energy production in the ERCOT service area. Natural gas provides approximately 71.7 percent of the energy generating capacity for the ERCOT power grid. Natural gas provides approximately 55,093 MW of capacity in the summer and 57,874 MW of capacity in the winter (ERCOT 2007a).

Criterion 2 - Capacity equivalent to the planned generation

Power generated from natural gas is a significant contributor of energy to the ERCOT system, and natural gas can be delivered in large volumes to power plants on a reliable basis. There are 18 natural gas power plants in the ERCOT system that have a capacity over 1000 MW and an additional 33 natural gas plants with a capacity between 500 and 1000 MW. The largest of these are the 2241-MW Cedar Bayou Units 1, 2, and 3 in Chambers County, the 2234-MW PH Robinson Units 1, 2, 3, and 4 in Galveston County, and the 1804-MW Forney Energy Center in Kaufman County (ERCOT 2007c). Although these plants are between 31 percent and 44 percent smaller than the proposed CPNPP Units 3 and 4, these facilities suggest that natural gas power plants on the scale of the proposed project are potentially feasible alternative energy technologies.

Criterion 3 - Available during the same time frame

The energy capacity from the alternative technology is available within the time determined for the proposed CPNPP Units 3 and 4. As discussed under Criterion 2 above, natural gas power plants have the potential to generate the needed baseload capacity. The technology and resources are considered available; sufficient baseload capacity from a natural gas power plant is available within the project time frame.

Criterion 4 - No unusual environmental impacts or exceptional costs

A natural gas energy plant would have greater environmental impacts than the proposed CPNPP Units 3 and 4. SMALL to MODERATE impacts would be expected from a natural gas energy plant on land use, ecological resources, protected species, human health, aesthetics, cultural resources, water quality, waste management, air quality, and socioeconomics.

In terms of cost, because there are large-scale natural gas energy projects approaching the size of the proposed CPNPP Units 3 and 4, there is sufficient information available on the costs of constructing or operating a large natural gas power project. From the available information, the costs of generating power equal to that of the proposed CPNPP Units 3 and 4 make natural gas power plants an economic alternative. The capital costs for natural-gas-fired power plants are estimated at approximately $544/kW. Electrical generation costs utilizing natural gas as fuel are in the range of $35/MWh to $48/MWh or $0.035/kWh to $0.048/kWh.

Based upon the evaluation criteria, natural gas is reasonable energy alternative to the proposed CPNPP Units 3 and 4. Electrical power derived from natural gas is a developed and proven technology that is utilized for energy generation in the ERCOT service area. There is the potential that natural gas power plants could provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. Natural gas would have greater environmental impacts than the proposed CPNPP Units 3 and 4. The costs of natural gas fuel plants are well-known and would make the use of this technology economically practical. Generating capacity from this technology equivalent to that capacity of the proposed CPNPP Units 3 and 4 is achievable within the time frame of the proposed project.

Given this potential feasibility as a competitive energy alternative, a more detailed evaluation of natural gas-fired power is presented in Subsection 9.2.3.2. The discussion in Subsection 9.2.3.2 includes the plant size and land requirements, fuel quality and consumption estimates, emissions evaluations, economic costs evaluation, and potential environmental and health restrictions or impacts. As stated in the introductory paragraphs in Subsection 9.2.2, the use of this energy technology is consistent with U.S. national policy, which includes maintaining a diverse energy supply and the use of domestic energy sources with lower greenhouse gas emissions than fuels like petroleum liquids.

9.2.2.11 Alternatives Requiring New Generation in Combination with Energy Storage

Due to the unpredictable and intermittent nature of renewable energy sources such as solar or wind power, these technologies are considered to be peaking and not a baseload power supply, as discussed in Subsections 9.2.2.1 and 9.2.2.2. There have been no technological advances in energy storage technology that would enhance the feasibility of wind or solar products to function as a baseload power supply comparable to CPNPP Units 3 and 4. There have been no technological advances that would change the conclusion in Subsections 9.2.2.1 and 9.2.2.2 that solar and wind power are not feasible alternatives for baseload energy supply comparable to CPNPP Units 3 and 4.

As part of the alternatives analysis in the following subsections, the concept of combining either wind or solar power generation with an energy storage technology to produce baseload power generation comparable to CPNPP Units 3 and 4 is evaluated in the context of the evaluation criteria presented in NUREG-1555. The basic concept evaluated is that the primary baseload power could be produced by solar or wind units with some of the excess energy placed into storage. The stored energy would then be utilized to produce power when the renewable power resources are either not available or not available at sufficient strength to produce the required baseload power.

As part of this evaluation, the concept of using a natural gas facility to supplement the wind and solar power generation with the storage capacity is also evaluated. In this conceptual scenario, a natural gas power plant could be activated when the baseload power requirements could not be met, such as when the wind and solar power is interrupted and the stored energy supply exhausted. In actuality, due to the intermittent and unpredictable availability of solar and wind power and the finite capacity of the energy storage units, the baseload power would have to be generated by the natural gas plant and the use of the natural gas plant could be temporarily suspended or reduced when solar and wind power or stored energy is available.

The alternative of using natural gas to provide baseload power comparable to CPNPP Units 3 and 4 was fully evaluated in Subsections 9.2.2.10 and 9.2.3.2. The alternative of combining technologies, including using a baseload power (such as natural gas or coal) with an intermittent renewable power (such as wind or solar power) was evaluated in Subsection 9.2.3.3, including Subsections 9.2.3.3.1 through 9.2.3.3.5.

As discussed in these subsections, combining a renewable power source with a baseload power technology is not an environmentally preferable alternative to CPNPP Units 3 and 4. The alternatives evaluation presented in the following subsections does not change the conclusions in Subsections 9.2.2.1, 9.2.2.2, 9.2.2.10, 9.2.3.2 and 9.2.3.3 that natural gas, wind, and solar, either individually or in combination with each other and energy storage, are not viable alternatives to CPNPP Units 3 and 4 that could both produce baseload power comparable to that generated by CPNPP Units 3 and 4 and be environmentally preferable to CPNPP Units 3 and 4.

9.2.2.11.1 Available Alternatives Requiring New Generation in Combination with Energy Storage

Luminant does not view nuclear, solar, wind, natural gas, or other energy sources as alternative competing energy production technologies. Rather, Luminant believes that baseload energy technologies (like nuclear, coal, and natural gas), technologies that provide peaking or intermittent power generation (like wind and solar power), along with energy storage, are all essential components needed to create and maintain an integrated, diverse, flexible, and dependable energy system reliably serving the public needs. The energy demands of society are so great and the logistics to reliably satisfy these demands are so complicated and interdependent that the entire range of baseload, peak load, and intermittent energy sources and storage options must be fully utilized to maintain a functioning power grid.

With this philosophy, Luminant is committed to exploring and attempting to utilize the feasible options for generating power. As of 2008, Luminant was the largest purchaser of wind-generated electricity in Texas and the fifth largest purchaser of wind-generated power in the United States. Mitsubishi, the reactor supplier for CPNPP Units 3 and 4, was the seventh largest producer of wind turbines with over 516 MW of turbine capacity installed in 2008 (AWEA, 2009). Luminant, in conjunction with Shell Wind Energy, is developing plans for potential wind power projects in Briscoe County, Texas that could collectively generate a total of 3000 MW of power. As part of these wind power projects, the potential for developing energy storage capabilities is also being evaluated (EFH, 2007). As the power industry continues to evolve, Luminant intends to maintain a critical role in pursuing, developing, and implementing feasible power options in appropriate applications.

Based on the discussions in Subsection 9.2.2, the utilization of renewable power generation options includes challenges because the generation source is intermittent, unpredictable, and not always available at a sufficient strength to provide reliable baseload power. The potential for using renewable power sources might be enhanced if the generation source is combined with an energy storage technology that could increase the availability, reliability and predictability of the power deliverability. The two primary renewable power generation sources in this category are wind and solar power.

The theory behind the combination of renewable power generation with energy storage is that, when the generation capacity is available, the amount of power produced could, at times, exceed the demand for power at that time. Excess energy could be stored and returned later to the electrical grid when the renewable power generation resource is either not available or is available at a diminished level that is insufficient to satisfy the demand for power.

Therefore, in order for this combination of technologies to function, the renewable energy source would have to be sized to be larger than the baseload power level, in this case 3200 MW. This need to have a generation capacity greater than the baseload requirements in order to place energy into storage would cause environmental impacts to a level greater than the impacts of a generation source rated at the baseload value alone. For example, if a solar or wind generation source was conservatively assumed to be available for 12 hours every day and if the energy storage technology was conservatively assumed to be 100 percent efficient, a solar or wind power generator rated at 6400 MW would be needed for 12 hours to provide 3200 MW of baseload generation for 12 hours and 3200 MW of power generation from the storage units for 12 hours. In reality, the solar or wind generation would have to be much greater because neither solar nor wind generation is available at full load for 12 hours per day and energy storage technologies do not approach 100 percent efficiency in energy transfer capability.

To assess the generation combined with storage option, the potential storage options are discussed first in the following subsection. The combinations of renewable power generation with the options that are considered the most advanced at this time, along with supplemental natural gas, are then evaluated in the subsequent subsections.

9.2.2.11.2 Energy Storage Options

There are a number of potential energy storage options that might be considered for the technology combination of power generation with energy storage. These storage technologies include (DOE 2009; ESC 2002; PEI 2008):

- Pumped hydropower storage
- Compressed air energy storage (CAES)
- Batteries
- Hydrogen

- Molten salt
- Flywheels
- Supercapacitors

The feasibility of utilizing these storage options to generate baseload power comparable to that of CPNPP Units 3 and 4 in the relevant ERCOT service area is discussed below.

9.2.2.11.2.1 Pumped Hydropower Storage

Pumped hydropower (hydro) storage is a proven technology with power facilities in existence that can generate up to 1000 MW of peaking power. Pumped hydropower facilities consist of a storage reservoir located in an elevated location over a lower receiving reservoir or body of water. During non-peak power demand hours, when the energy costs are lower, water is pumped from the lower receiving reservoir or water body into the topographically higher storage reservoir. During peak power demand hours, when the energy prices are higher, water is released from the upper reservoir through turbines to generate power and returned to the lower receiving reservoir or water body (DOE 2009; ESC 2002).

Pumped hydro storage as an energy storage methodology in the relevant ERCOT service area has the same challenges as new or expanded hydropower projects that could generate baseload power comparable to CPNPP Units 3 and 4. The need for both an upper and lower reservoir would double the land requirements and environmental impacts of a new or expanded hydropower project discussed in Subsection 9.2.2.3. For the same reasons that hydropower is not a viable baseload alternative in Texas, as discussed in Subsection 9.2.2.3, pumped hydro storage is not a viable energy storage option to be used in combination with renewable power generation methods for producing baseload power in Texas.

9.2.2.11.2.2 Compressed Air Energy Storage (CAES)

Like pumped hydro storage, CAES are generally operated as a peaking plant with energy being placed into storage during the less expensive, non-peak demand hours and being generated from the storage units during the higher priced, peak demand hours. CAES involves using compressors powered by the generation source to pump air into a storage facility, such as an underground cavern. The compressed air is then used in combination with a heat source, such as natural gas, to drive turbines and generate electricity. To generate the electricity from the CAES, the natural gas usage is between one third and one half the amounts needed to generate the same amount of electricity at a natural gas generating plant (DOE 2009; ESC 2002). Due to the cost differential between peak and non-peak hour and the reduction in the volume of natural gas used to generate a specific amount of power, a CAES facility can be economically attractive method of producing peak power (RES 2005; PEI 2008).

No large scale, baseload CAES facilities are in operation anywhere in the world. No CAES facilities combined with either wind or solar power are in operation. However, a 200 to 300 MW CAES facility integrated with 75 to 150 MW wind farms is proposed in Iowa, referred to as the Iowa Stored Energy Park (ISEP, 2006; PEI 2008).

Two CAES facilities combined with natural gas power plants, a 110 MW facility in Alabama and a 290 MW plant in Germany, have been built and are in operation (ESC 2002). A CAES facility that is to be powered with energy from generation facilities on the power grid is proposed for Norton, Ohio. The Norton, Ohio CAES facility, which is still in the project development and permitting stage, is planned to eventually provide 2700 MW of peaking power generation (PEI 2008). These three CAES facilities, none of which is combined with either wind or solar power, are primarily for peaking purposes rather than baseload generation (PEI, 2008). The Norton, Ohio project is somewhat different from the other CAES projects in that a pre-existing mine will be utilized. The size and the mining engineered construction of the pre-existing mine allows a much greater planned capacity for the Norton, Ohio facility as compared to other CAES projects.

The development of CAES facilities in the relevant area, the ERCOT region, has a number of challenges. Large land areas that possess the suitable geologic formations for large scale underground storage capacity are required. A source of natural gas or another equivalent heat source is required as part of the CAES facility. For the amount of electricity to be generated, CAES has environmental impacts similar to a natural gas generation unit although on a smaller scale.

There are no large-scale CAES systems in Texas. As a result, the economics and feasibilities of such a system in Texas are speculative. The construction of the turbine generation portion of the design is probably on a scale similar to a gas turbine generation station of the same size since very similar equipment would be required. The identification of, and development of, the storage cavern is an additional cost which has not been assessed in Texas. While the existing projects in Alabama and Germany combined with natural gas power and the proposed ISEP are on the scale of 110 to 290 MW (ESC 2002), these facilities are peaking plants and do not approach the 3200 MW needed to be an alternative baseload energy storage method for CPNPP Units 3 and 4.

Of the energy storage options available, CAES appears to be the most suitable for evaluation in combination with wind power. Luminant, in association with Shell-Wind Energy, is evaluating the potential of combining CAES with wind power projects in Texas (EFH 2007). Since this option of combining technologies may be feasible, the potential impacts of combining wind power with CAES storage are evaluated in Section 9.2.2.11.3.1.

9.2.2.11.2.3 Batteries

Batteries are used for energy storage in many applications. When combined with intermittent sources, such as wind or solar power, batteries can help to supply more reliable power for off-grid applications. When used for in-grid connections, batteries can serve as backup sources of power. Advantages include the fact that batteries can be portable, the technology has been tested, energy can be stored for consumption at a later period of time, and batteries can be charged and discharged multiple times. Overall, however, batteries are expensive and have relatively short lives, which increase the long-term expense (DOE 2009; ESC 2002).

Battery storage on the scale needed to provide baseload energy from storage comparable to CPNPP Units 3 and 4 has not been accomplished in Texas or anywhere, in large part for the reasons stated above. Duke Energy is proposing a demonstration project that would combine battery storage to provide 20 MW of peak power from the 151 MW Notrees Windpower Project in

Texas (REW, 2009). If completed and successful, the Duke demonstration project would be the largest power operation combining battery storage with wind energy. However, this demonstration project is still in the planning stages and would provide peaking power that will be substantially less than the baseload power generation of CPNPP Units 3 and 4. Therefore, the use of renewable energy in combination with battery storage is not a reasonable alternative for producing baseload power equivalent to CPNPP Units 3 and 4.

9.2.2.11.2.4 Hydrogen

In theory, hydrogen can be used to store energy. Hydrogen can be generated and then used to generate electricity via a mechanism such as a fuel cell. Such techniques have only been demonstrated on a small scale. The use of such storage on a large scale is only theoretical and is not expected to be practical on a large scale in the near future if ever. Fuel cells were discussed as an alternative in Subsection 9.2.2.8 and the limitations cited in that subsection do not depend on the source of the energy applied to the fuel cells. Therefore, the use of renewable energy in combination with hydrogen storage is not a reasonable alternative for producing baseload power equivalent to CPNPP Units 3 and 4.

9.2.2.11.2.5 Molten Salt

Molten salt batteries, sometimes called thermal batteries, use molten salt as the electrolyte. Molten salt batteries have a high power density, which means these batteries are useful in applications that require high levels of power but for which space is limited. Molten salt batteries have been used to power devices like missiles and artillery fuses. The application of thermal batteries has been limited almost entirely to military uses. These batteries have varying designs and one of the most common is a lithium salt battery, which is being studied for use in automobiles. The cost of such batteries is high and in many cases the sources for construction are limited. While suitable for some applications, molten salt batteries have not been used for large-scale energy storage.

There are no commercial baseload power plants that operate in conjunction with molten salt batteries. However, some energy projects have been proposed that would utilize molten salt batteries to provide storage capacity for the power generated by concentrated solar power plants. These proposed projects include a 200 MW and a 340 MW concentrating solar thermal power (CSP) plants near Kingman, Arizona and a 280 MW CSP plant near Gila Pass, all of which are proposed to utilize molten salt storage (CSA 2009; Abengoa 2009; Technology for Life 2009). Although still in the development stages, molten salt batteries appear to be considered a promising potential storage options combined with CSP.

Molten salt can also be used to store heat. The sun's energy is concentrated by a field of hundreds or even thousands of mirrors (called "heliostats") onto a receiver located on top of a tower (NREL 2006; SNL 2009). This energy heats molten salt flowing through the receiver- and the salt's heat energy is then used to generate electricity in a conventional steam turbine generator. The molten salt retains heat efficiently, so it can be stored for hours or even days before it loses its capacity to generate electricity (SNL 2009). Solar Two, a demonstration power tower located in the Mojave Desert in California, generated about 10 MW of electricity before the project was discontinued in 1999 (NREL 2001).

In these systems, the molten salt at 550°F is pumped from a “cold” storage tank through the receiver, where it is heated to 1,050°F and then on to a “hot” tank for storage. When power is needed from the plant, hot salt is pumped to a steam generating system that produces steam to power a turbine generator. From the steam generator, the salt is returned to the cold tank, where it is stored and eventually reheated in the receiver (SNL 2009).

With thermal energy storage, power towers could have the potential to operate at an annual capacity factor of up to 65 percent (CEC 2003), which means a solar power facility could potentially operate for 65 percent of the year without the need for a back-up fuel source. Without thermal energy storage, solar technologies like this are limited to annual capacity factors near 25 percent. The ability of power towers to operate for extended periods of time on stored solar energy separates this technology from other solar energy technologies. However, these technologies are still in the demonstration phase of development (CEC 2003). Molten salt storage has potential and is being developed in conjunction with solar energy. Therefore, the use of solar power generation combined with molten salt storage is evaluated further in Section 9.2.2.11.3.2.

9.2.2.11.2.6 Flywheels

Flywheels store energy through the inertia of a spinning disk. The amount of energy that can be stored depends upon the size of the disk. Long-term storage (more than minutes) is difficult to achieve with the desired level of efficiency. Flywheels are best used in stability applications such as in smoothing out the performance of a combustion engine or in smoothing out the voltage and frequency on a circuit. Flywheels can serve as backup power for low-power applications or as a source of short-term power support for high-power applications (DOE 2009; ESC 2002). No large-scale applications exist and there are no known plans to build such a large-scale power facility utilizing flywheels. Therefore, the use of renewable energy in combination with flywheels is not a reasonable alternative for producing baseload power equivalent to CPNPP Units 3 and 4.

9.2.2.11.2.7 Supercapacitors

There are multiple designs for electrical energy storage in supercapacitors and these designs are best suited for fast response, short duration applications. Supercapacitors are characterized by relatively low storage capabilities but have high charging and discharging rates. Supercapacitors can be used for backup during outages, for stabilizing voltage and frequency, and as a bridging power source in applications that need an uninterruptible power supply. Although supercapacitors have low maintenance and may have long lives, these devices are relatively expensive. There are no current case studies of supercapacitors being used as a large-scale source of power (DOE 2009). Therefore, the use of renewable energy in combination with supercapacitors is not a reasonable alternative for producing baseload power equivalent to CPNPP Units 3 and 4.

9.2.2.11.2.8 Other Storage Options

Other energy storage methods are possible, such as superconducting magnets. These options are generally in the research and development stage and do not offer a potential for large-scale energy storage in the foreseeable future (DOE 2009; ESC 2002). Therefore, the use of renewable energy in combination with other energy storage, other than the storage options previously discussed, is not a reasonable alternative for producing baseload power equivalent to CPNPP Units 3 and 4.

9.2.2.11.3 New Generation and Energy Storage Combinations

As discussed in Subsection 9.2.2.11.2, there are no large-scale facilities in existence that combine renewable energy sources with energy storage to produce baseload power. Furthermore, this combination of technologies as a baseload power source has not been demonstrated and proven. The projects that are being proposed and/or developed in the US and around the world use renewable energy generation combined with energy storage as either a peaking or an intermediate, intermittent power source.

At this time, the two most promising alternatives appear to be wind power generation combined with CAES storage and solar power generation with molten salt storage. However, even with technological advances that have been made or appear to be feasible, renewable energy generation combined with storage methods and supplemental use of natural gas, do not offer the potential as an alternate baseload power generation comparable to the CPNPP Units 3 and 4 and are not environmentally preferable to CPNPP Units 3 and 4. To more fully demonstrate this conclusion, the options of wind power combined with CAES storage; solar power combined with molten salt storage; and these generation and storage combinations supplemented by natural gas are assessed in the subsections below using the environmental evaluation criteria listed in NUREG-1555.

9.2.2.11.3.1 Wind Power Generation in Combination with CAES

For this energy technology combination, it is conservatively assumed that wind would be used to generate electricity for both 3200 MW of baseload power and 3200 MW of storage capacity, when adequate wind is available. Sufficient baseload energy must be put into storage when the wind resources are available to account for the lack of power generation capabilities for the periods of time when adequate wind resources are unavailable and for the inefficiency of the CAES process. Under this alternative, natural gas would be needed to recover the energy captured in the CAES process, but would not be used as a source of supplemental power generation if wind generation or generation from the storage facility is not available for extended periods of time. The use of natural gas to generate supplemental power to compensate for the lack of wind power or generation from storage is evaluated in Subsection 9.2.2.11.3.3.

One of the restrictions to this alternative is the diurnal nature of the wind resource in Texas. The wind availability is the direct inverse of the electrical load demand; with the wind being the strongest during the nighttime and early morning hours and weakest during the daytime hours (RES 2005). Only about 8.7 percent of the wind power in Texas generates electrical power that is available to reliably meet peak power demand (PEL 2009). Not only is wind an intermittent and unpredictable source of power, but in Texas, the wind resource is mainly available during non-peak and intermediate load demand periods and predominantly unavailable during the peak demand periods for power (RES 2005).

By applying energy storage, such as with CAES, the lack of wind power during peak demand periods can be ameliorated, to an extent. The combination of wind power in Texas with CAES would be a typical utilization of the energy storage concept. The power would be placed into storage during the non-peak demand hours and would then be taken from storage and utilized during the peak demand hours. Therefore, with storage, wind could be utilized in Texas as a form of peaking power, whereas wind is currently primarily restricted to non-peak and intermediate power generation. However, the limitations caused by the intermittent and unpredictable availability of wind, as well as the finite storage capacity of a CAES facility, would prevent wind combined with storage from being a baseload power source comparable to CPNPP Units 3 and 4.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

Wind power, as a developed, proven, and available technology in the relevant region, was discussed in Subsection 9.2.2.1. However, wind power is not available as baseload power and only 8.7 percent of the wind power in Texas generates electrical power that is available as peak capacity (PEL 2009). There are no wind power and CAES storage facilities in operation in either Texas or any other place in the world. There are no power generation facilities combining wind power with any storage technology in operation in the world.

There are two CAES facilities in operation, the 290 MW Huntorf facility in Germany and the 110 MW McIntosh plant in Alabama. Neither of these plants is operated in conjunction with wind power generation and neither is used for baseload energy production. A 268 MW CAES plant has been proposed in conjunction with 75 to 100 MW of wind farms in Iowa, but this Iowa Stored Energy Park is only in the planning and development stage. A 2700 MW CAES project has been proposed in Norton, Ohio that would be connected to the power grid for the non-peak power required for compression. Luminant and Shell-Wind Energy are proposing wind farm projects in Texas totaling 3000 MW and are evaluating the potential for incorporating CAES facilities in conjunction with the wind farm projects. The ability to generate baseload power comparable to that proposed by CPNPP Units 3 and 4 using wind power combined with CAES has yet to be demonstrated and has not been developed or proven, and is not available in the relevant area, or at any location in the world.

Criterion 2 - Capacity equivalent to the planned generation

As discussed in Subsection 9.2.2.1, although wind power is a developed and available technology, wind power is not capable of generating baseload power comparable to that of the proposed CPNPP Units 3 and 4. As discussed above, wind power combined with CAES is not currently available and this combination of technologies is still under development. The only two CAES projects in operation, the 290 MW Huntorf facility in Germany and the 110 MW McIntosh plant in Alabama (ESC 2002), produce significantly less power, are charged by natural gas or other power sources on the power grid, and are used for peaking or contingency purposes. The proposed Iowa Stored Energy Park is much smaller than CPNPP Units 3 and 4, will not provide baseload power, and is still in the planning and development stage.

The proposed 2,700 MW CAES project in Norton, Ohio is planned to be connected to the power grid for non-peak power for compression (PEI 2008). Less than 80 percent the size of CPNPP Units 3 and 4, the Norton, Ohio CAES project will not be linked to wind farms, is not planned for baseload power, and is still in the planning and development stages. The Norton, Ohio project proposes to convert an existing mine into a CAES facility, which allows a project to be planned that is much larger in scale than the other existing and proposed CAES facilities. However, the feasibility of such a conversion has not been previously attempted and has not been demonstrated. The operation of a CAES facility in a bedded sedimentary formation also has not been attempted or demonstrated, as the existing CAES facilities are in salt formations specifically engineered for storage. The Norton, Ohio project proponents plan to utilize off-peak power from the power grid to charge the CAES and will not be utilizing wind power. Even if the full 2700 MW of peaking power capacity can be realized, the Norton, Ohio project will still not demonstrate the ability to provide 3200 MW of baseload from wind power.

Luminant and Shell-Wind Energy are evaluating wind farm projects in Texas that will collectively total 3000 MW. The feasibility of combining CAES to these wind farm projects to some extent is being considered. However, the feasibility to construct and operate these wind farm and CAES projects is still being evaluated and has not been demonstrated. In addition, these projects, if feasible to build and operate, will not generate baseload power comparable to CPNPP Units 3 and 4.

Therefore, the ability to generate baseload power on the scale comparable to CPNPP Units 3 and 4 through the combination of wind power and CAES has not been demonstrated. The feasibility of using wind power combined with storage with CAES for baseload power is still speculative. More realistically, the use of storage would help wind power, which is currently available during mainly non-peak hours to be more available during intermediate demand and peak demand hours, improving the value of wind power as an intermediate or peaking technology.

Criterion 3 - Available during the same time frame

As discussed in Subsection 9.2.2.1, wind power is considered to not be available as a technology capable of generating baseload power comparable to that of the proposed CPNPP Units 3 and 4 within the project time frame. As discussed above, wind power combined with CAES is not currently available and this combination of technologies is still under development. The most advanced project is the proposed Iowa Stored Energy Park (ISEP 2006). The Iowa Stored Energy Park is much smaller than CPNPP Units 3 and 4, will not provide baseload power, and is still in the planning and development stage. Luminant, in partnership with Shell Wind Energy, is proposing wind farms in Briscoe County, Texas that collectively would generate 3000 MW of power. Luminant and Shell Wind Energy are evaluating the feasibility of combining CAES facilities into the operations of the wind farms (EFH 2007).

No wind power projects exist that incorporate energy storage, such as CAES. The feasibility of combining these technologies to provide baseload power has not been demonstrated or proven. No facilities are currently proposed utilizing wind power generation with energy storage, such as CAES, that would yield baseload power comparable to that of CPNPP Units 3 and 4. Since this combination of technologies is not currently available, has not been demonstrated, and is not proposed on the scale of CPNPP Units 3 and 4, wind power combined with CAES storage is not considered to be available to provide comparable baseload power within the project timeframe.

Criterion 4 - No unusual environmental impacts or exceptional costs

As discussed in Subsection 9.2.2.1, wind power, as a technology by itself, is considered to have potential environmental impacts greater than those impacts expected of CPNPP Units 3 and 4.

Due to the large land requirements, wind power projects comparable to CPNPP Units 3 and 4 have the potential for LARGE impacts on land use and aesthetics, MODERATE impacts on ecological resources, protected species, and cultural resources, and SMALL impacts on water quality, air quality, human health, and waste management. A potential positive, MODERATE impact on socioeconomics would also be expected.

By combining CAES into a wind power generation scenario, the anticipated environmental impacts would be greater than the impacts from a wind power project alone. Therefore, a wind power project with CAES generating 3200 MW of power is expected to have greater environmental impacts than CPNPP Units 3 and 4. A wind power and CAES project would be expected to have MODERATE impacts on water quality, air quality, and waste management. The water quality impacts would be increased by the large amount of freshwater that would be required to create the CAES storage caverns in either salt dome or bedded salt deposits found in Texas. The disposal of the large volumes of salt water, along with other impurities in the rock formations, from the cavern creation process would further impact water quality and increase waste management impacts. The use of natural gas in the CAES compression and energy generation processes will increase air impacts related to a wind power facility.

The Princeton Environmental Institute (PEI 2008) estimated that a CAES facility capable of generating baseload power for 88 hours would require a land area of approximately 14 percent of the wind turbine array. In Subsection 9.2.2.1, based upon the size of the Horse Hollow Wind Energy Center, the size of a wind farm to generate 3200 MW of energy was estimated to be between 452,000 to 816,000 ac of land. For 88 hours of power generation, a CAES facility could therefore cover between 63,280 and 114,420 ac of land. Since the CAES facility and wind farm may not be in the same geographic location, the impacts related to the CAES acreage would be in addition to the impacts of the wind farm.

Combining CAES storage with wind power generation would actually increase the land area of the wind farm, and by extension, increase the anticipated environmental impacts. Under this alternative scenario, a wind farm would have to generate 3200 MW of power for baseload power and generate the equivalent of 3200 MW for storage for each hour that the wind power is not able to generate power. If wind power generation is available for 12 hours a day, the wind farm would have to generate enough energy to be stored in the CAES facility to provide power for the 12 hours when the wind farm is off-line. In this simplest of scenarios, 6400 MW of power would have to be generated during the wind farm operation; doubling the land size and impacts of the wind farm due to the CAES storage. The potential for LARGE impacts on land use, aesthetics and ecological resources would, therefore, be expected.

Based upon the evaluation criteria discussed above and in Subsection 9.2.2.1, wind power in combination with CAES is not a reasonable energy alternative to CPNPP Units 3 and 4. First, wind power combined with CAES storage is not developed, proven, or available in the relevant region. Second, wind power combined with energy storage, such as in a CAES facility, has not been shown to be feasible as a technology capable of producing baseload energy capacity equivalent to that proposed for CPNPP Units 3 and 4. Third, the combination of a wind power and CAES project comparable to CPNPP Units 3 and 4 are not expected to be available during the same time frame as CPNPP Units 3 and 4. Finally, a wind power project combined with CAES would be expected to have significant environmental impacts and this technology combination is not environmentally preferable to CPNPP Units 3 and 4.

9.2.2.11.3.2 Solar Power Generation in Combination with Molten Salt Storage

For this energy combination alternative, it is conservatively assumed that solar power technology would be used to generate electricity for both 3200 MW baseload power and to place 3200 MW of energy into storage when an adequate source of solar energy is available. The solar power facility would have to generate power both at a baseload level of 3200 MW and at a level to store sufficient power into storage to provide 3200 MW of power for the time period that solar power generation is not feasible. The design capacity of the solar generation would have to exceed the desired baseload rate to account for the unavailability of solar energy for potentially extended periods of time (both nighttime hours and hours during the daytime when there is insufficient incident sun light) and the inefficiency of the molten salt storage process.

Under this alternative, the combination of solar power generation with storage using molten salt is evaluated as a stand-alone technology option. Natural gas would not be used under this alternative for supplemental generation if solar generation is not available for extended periods of time or when the storage capacity in the molten salt structure has been exhausted. The option of using supplemental natural gas with solar power and energy storage is evaluated in Subsection 9.2.2.11.3.3.

Energy storage projects are basically a form of commodity trading. Like other types of commodities, the energy is purchased and placed into storage when the cost of energy is the least expensive, which occurs mainly during hours of non-peak energy use, particularly at night and on weekends. The energy is then taken out of storage to produce power and sold when the cost of energy is higher, mainly during the hours of peak energy usage, particularly during daylight hours during the work week. The energy storage units are operated based upon the lower cost to put the energy into storage during the non-peak usage hours compared to the higher price that can be charged when the power is generated out of the storage unit during the peak hours of energy usage. Due to the cost differential between the non-peak and peak hours, energy storage can be cost-effective means of energy generation even though more power is utilized in the power storage project than is produced from the storage project (ESC 2002; PEI 2008; REL 2005).

The concept of combining solar power with storage projects, either by molten salt, hydropower, gas, CAES, or other storage technology, is somewhat contrary to the driving forces behind storage projects and could make the energy storage concept infeasible. Electric storage projects are net consumers of electricity; i.e., the storage projects consume more power than the projects generate. However, storage projects are usually profit-makers because the storage projects consume power during the cheaper non-peak hours and produce electricity during the more expensive peak use hours (ESC 2002; PEI 2008; REL 2005).

If storage projects were combined with solar power, the energy input for energy storage would be produced during the peak use and cost hours; i.e., during the daytime when solar power can be produced. The power would then be generated from the storage units during the non-peak use and cost hours to balance the lack of power generation from the solar projects. The projects would consume a greater amount of expensive electricity during the peak power demands period and generate a lesser amount of cheaper power mainly during the non-peak power demand hours; possibly affecting the feasibility of a combined solar power and storage project.

Criterion 1 - Developed, proven, and available in the relevant region ERCOT

As discussed in Subsection 9.2.2.2, in the ERCOT region, solar energy has been developed as only small scale, local power sources. No large-scale, baseload solar power generation plants have been developed. As discussed in Subsection 9.2.2.2 (under Criterion 1), solar power generation could be combined with thermal storage tanks to allow greater flexibility in dispatching electric power but no large-scale or baseload storage facilities, including molten salt storage systems, have been developed. The combination of solar with molten salt storage is not a developed, proven, available energy source in the relevant region, the ERCOT area.

Nationwide, solar power plants with molten salt storage are being proposed but have not been built and the technology is still being developed and demonstrated. Four CSP plants with molten salt storage are being proposed in Arizona. These four power proposed projects would total 1100 MW, collectively about one-third the capacity of CPNPP Units 3 and 4, and would not be used as baseload power (CSA 2009; Abengoa 2009; Technology for Life 2009; Lockheed Martin 2009). The technology combination appears to be feasible but is not developed, proven, and available as a baseload power source comparable to CPNPP Units 3 and 4.

Criterion 2 - Capacity equivalent to the planned generation

As discussed Subsection 9.2.2.2, solar power cannot provide baseload generating capacity and availability equal to CPNPP Units 3 and 4. Combining solar power with molten salt storage could help address the availability challenge, but would also require significantly greater levels of power generation from solar. As discussed in Subsection 9.2.2.2, the total levels of solar power generation projected to be developed in Texas are significantly less than the power to be provided by proposed CPNPP Units 3 and 4. The combination of solar power generation with molten salt storage may increase the length of time that a solar power facility could provide power over the course of a typical day but would not satisfy the shortfall of equivalent capacity.

Four projects are being proposed in Arizona that would combine CSP with molten salt storage. These proposed projects are a 200 MW and a 340 MW CSP plants with molten salt storage near Kingman, a 280 MW CSP plant with molten salt storage near Gila Pass, Arizona and a 290 MW CSP plant with storage in the Harquahala Valley, Arizona (CSA 2009; Abengoa 2009; Technology for Life 2009; Lockheed Martin 2009). All of these plants are significantly smaller than CPNPP Units 3 and 4 and will be peaking and intermediate power generation plants, rather than baseload plants. The Arizona plants would collectively total one-third of the power generation of CPNPP Units 3 and 4. A number of solar power projects are proposed in California that would collectively generate 1300 MW of power, less than half of the CPNPP Units 3 and 4, and, again, these projects collectively would not provide baseload power. Therefore, as discussed in Subsection 9.2.2.2, solar power does not appear capable of generating baseload power generation equivalent to CPNPP Units 3 and 4, even when combined with a storage technology such as molten salt storage.

Criterion 3 - Available during the same time frame

As discussed in Subsection 9.2.2.2, generating baseload capacity equivalent to CPNPP from solar power is not considered achievable within the project time frame. The combination of solar power generation with molten salt storage is still being developed and the feasibility as a large-scale, baseload power plant has not been demonstrated. Therefore, this technology is not considered to be available as a comparable baseload option within the project time frame.

Criterion 4 - No unusual environmental impacts or exceptional costs

As discussed in Subsection 9.2.2.2, a solar power plant, with power capacity comparable to CPNPP Units 3 and 4, would be expected to have environmental impacts in excess of the CPNPP Units 3 and 4. Due to the large land area requirements, a solar power plant is expected to have LARGE impacts on land use and aesthetics; MODERATE impacts on ecological resources, protected species, and cultural resources; and SMALL impacts on water quality, air quality, human health, and waste management. A MODERATE positive impact on socio-economics would also be expected from solar power generation.

Combining molten salt facility with a CSP plant would increase the land area and related impacts associated with the solar power farm. As discussed in Subsection 9.2.2.2, a solar power plant capable of generating 3200 MW of power was projected to cover between approximately 27,755 ac and 38,000 ac of land. Therefore, if (in a best case scenario) sufficient sunlight is available to generate 12 hours of 3200 MW baseload power, the molten salt storage facility would have to provide the next 12 hours of 3200 MW power each day. Assuming that the energy transfer between generation to storage and back into generation is 100 percent efficient with no loss, the solar power plant would have to generate twice the baseload requirement, or 6400 MW of power to provide 24 hours of energy.

Just the simple requirement to generate power for both baseload and storage would double the size of the solar plant required. In terms of land requirements, the footprint of the solar power facility would, therefore, range from approximately 55,510 ac to 76,000 ac. Additional acreage would be needed for the molten salt storage towers and the various pieces of equipment needed to operate the molten salt storage facility and generate power from storage units. LARGE impacts on land use, aesthetics and ecological resources would be, therefore expected. The handling of the molten salt may also increase the waste management impacts.

In terms of socio-economics, the combination of solar power generation with storage would be expected to have a LARGE adverse impact. As discussed previously, under this technology combination, energy stored at the most expensive, peak hour prices would be placed into storage because solar power can only be generated during the daytime hours. The power would then be generated from storage at the lower intermediate and non-peak hour prices. With each day, substantial economic losses will be suffered due to the differential between the higher peak hour costs when the power is put into storage and the lower intermediate or non-peak costs when the power is generated from storage.

Based upon the evaluation criteria discussed above and in Subsection 9.2.2.2, solar power technologies in combination with storage, such as molten salt storage, is not a reasonable energy alternative to the proposed project. First, solar power combined with storage is not developed, proven, and available in the relevant region (ERCOT) or even in other areas of the United States. Second, solar power generation combined with storage has not been proven to provide power generation capacity equivalent to CPNPP Units 3 and 4. Third, solar power generation with storage with the capacity to generate baseload power equivalent to CPNPP Units 3 and 4 is not considered to be available during the same time frame as the proposed project.

Finally, if such a facility where feasible, a solar power generation and storage project would be expected to have significant adverse environmental impacts and those impacts are expected to be in excess of those associated with CPNPP Units 3 and 4.

9.2.2.11.4 Renewable Energy Sources Combined with Storage and Natural Gas Power Generation

There are two primary scenarios for the combination of renewable energy sources with energy storage and natural gas power generation. Under the first scenario, the baseload power would be generated principally by the renewable energy source and, when the renewable energy power generation is not available, the baseload power would be generated from the energy storage facility. The renewable energy source would also be used to charge the energy storage facility. The natural gas power plant would be used to supplement the baseload power from the renewable energy source and energy storage operations. The natural gas plant would generate baseload power when the renewable energy source and the energy storage operations cannot produce power; the natural gas plant would supplement the baseload power generation when either the renewable energy source or energy storage operations generate less than the requisite 3200 MW of energy; and the natural gas plant would be used to charge the energy storage facility when the renewable energy source can generate the baseload power but cannot generate enough surplus power to charge the energy storage facility. This scenario is referred to as the renewable energy sources combined with storage and supplemented by natural gas power generation.

Under the second scenario, the primary source of the baseload power would be the natural gas plant. Power from the renewable energy source or from the energy storage facility displace the natural gas plant generation at the times that power from the renewable energy source or the energy storage facility is available. Alternatively, the renewable energy source could be used primarily to charge the energy storage facility when the renewable energy source is available and the natural gas plant continues to provide the baseload power. Under this second scenario, the natural gas plant would be operating at a capacity less than 3200 MW when power is available from either the renewable energy source or from the energy storage facility. This scenario is referred to as natural gas power generation supplemented by renewable energy sources combined with storage in the subsequent sections.

The power generation scenario selected would affect the power capacity, and therefore size, of the facilities required. Under the first scenario, in which natural gas would supplement renewable power combined with energy storage, all three power sources (the renewable power facility, the energy storage facility and the natural gas plant) would all have to be sized to generate 3200 MW of baseload power. Under the second scenario, in which renewable power combined with energy storage would supplement the baseload natural gas plant, only the natural gas plant would have to be sized to provide 3200 MW of baseload power. The renewable energy facility and energy storage facility could be sized for a smaller generation capacity, provided that the natural gas plant is kept in operation at a level that would maintain the collective 3200 MW of baseload power. The two scenarios of combining renewable energy, energy storage and natural gas power production are reviewed in the following subsections.

9.2.2.11.4.1 Renewable Energy Sources Combined with Storage and Supplemented by Natural Gas Power Generation

The concept behind this alternative is that the primary baseload power could be produced by solar or wind units with some of the excess energy placed into storage and from the charged energy storage facility. The natural gas plant could be activated when the wind and solar power is interrupted and the stored energy supply exhausted. The natural gas plant could also be used as supplemental load when the energy available from either the renewable energy source or energy storage facility is at some level below the targeted 3200 MW.

As discussed in Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, neither wind power with storage nor solar power with storage is capable of providing baseload power comparable to CPNPP Units 3 and 4. In fact, there may be periods of time at which the renewable source may be unavailable and the storage units are depleted and there may be no energy generation possible. When the renewable power and storage units cannot produce sufficient power, a natural gas plant capable of generating 3200 MW of power would be needed under this alternative. This alternative, to provide baseload power comparable to CPNPP Units 3 and 4, would require:

- a 3200 MW renewable power plant (either wind or solar) to generate power when the renewable resource is available;
- a 3200 MW storage facility (either CAES with wind power or molten salt storage with solar power) to generate power when the renewable resource is not available; and
- a 3200 MW natural gas power plant to generate power when the renewable resource not available and the storage units are depleted and the baseload power cannot be generated.

Therefore, this alternative combination would increase the environmental impacts as compared to the alternative of generating 3200 MW of power from a natural gas plant alone. The alternative of using natural gas supply to provide baseload power comparable to CPNPP Units 3 and 4 was fully evaluated in Subsections 9.2.2.10 and 9.2.3.2. As discussed in those subsections, if a natural gas plant could generate baseload power comparable to CPNPP Units 3 and 4, the natural gas plant would not be environmentally preferable to CPNPP Units 3 and 4. As discussed below, supplementing the natural gas plant with either wind or solar power, with energy storage units, would not change the conclusions of those subsections, namely that natural gas generation is not a preferable alternative capable of generating baseload power comparable to CPNPP Units 3 and 4.

<u>Criterion 1 - Developed, proven, and available in the relevant region ERCOT</u>

As discussed in Subsection 9.2.2.10, in the ERCOT region, natural gas energy has been developed as a baseload energy provider. If properly sized, a natural gas power plant could generate baseload power comparable to CPNPP Units 3 and 4 without the need for solar or wind power generation or energy storage. However, as discussed in Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, neither wind power with CAES storage nor solar power with molten salt storage are developed, proven, or available in the relevant (ERCOT) region or any other area in the United States. Therefore, a renewable power source combined with an energy storage option supplemented by natural gas is not developed, proven, or available in the relevant (ERCOT) region.

Criterion 2 - Capacity equivalent to the planned generation

As discussed in Subsection 9.2.2.10, in the ERCOT region, natural gas energy has been developed as a baseload energy provider. If properly sized, a natural gas power plant could generate baseload power comparable to CPNPP Units 3 and 4 without the need for solar or wind power generation or energy storage. However, as discussed in Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, neither wind power with CAES storage nor solar power with molten salt storage have the capacity to generate baseload power equivalent to the power to be generated by CPNPP Units 3 and 4. Therefore, a renewable power source combined with an energy storage option supplemented by natural gas does not have the capacity to generate baseload power equivalent to the planned generation from CPNPP Units 3 and 4; unless the majority of the baseload power was provided by natural gas plant with only intermittent power from the renewable source or the storage units.

Criterion 3 - Available during the same time frame

As discussed in Subsection 9.2.2.10, in the ERCOT region, natural gas energy has the potential to be available as baseload power within the timeframe determined for CPNPP Units 3 and 4. As discussed Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, neither wind nor solar power combined with storage options is available as baseload energy sources within the project timeframe. Therefore, a renewable power source combined with an energy storage option supplemented by natural gas would not be available within the project time frame; unless the majority of the baseload power was provided by natural gas plant with only intermittent power from the renewable source or the storage units.

Criterion 4 - No unusual environmental impacts or exceptional costs

The potential environmental impacts associated with wind power combined with a CAES facility and with solar power combined with a molten salt storage facility are discussed in Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, respectively. The potential environmental impacts that could be attributed to natural gas power generation are discussed Subsections 9.2.2.10 and 9.2.3.2.

Combining either wind or solar power with natural gas generation with an additional energy storage facility would result in cumulative impacts since each technology would have to have the capacity to produce 3200 MW of power individually. As discussed in Subsection 9.2.2.11.3.1 and 9.2.2.11.3.2, LARGE impacts on land use, aesthetics, ecological resources, protected species and cultural resources would be, expected from either wind or solar power with storage. MODERATE impacts on water quality, air quality, and waste management could be expected depending on which of the renewable power options is used. Solar power generation with storage could have a LARGE adverse socioeconomic impact, as discussed in Subsection 9.2.2.11.3.2.

As discussed in Subsection 9.2.2.10, the use of natural gas as the energy source is expected to have SMALL to MODERATE impacts on land use, ecological resources, protected species, human health, aesthetics, cultural resources, water quality, waste management, air quality, and socio-economics. As discussed above, the technology combination alternative would require the renewable power plant, the energy storage units, and the natural gas plant must all have the capability to produce 3200 MW of energy in order to provide baseload capacity comparable to CPNPP Units 3 and 4. Therefore, the construction-based impacts of the renewable power source, the storage facility and the natural gas plant would be cumulative and additive. The operational impacts of the renewable and storage mechanisms would also be additive. The operational impacts of natural gas would be reduced, because the natural gas plant would not be operating when the renewable and storage mechanism are operating. Therefore, under this alternative, the adverse environmental impacts are expected to be either MODERATE or LARGE for a number of environmental parameter except for possibly gaseous emissions and human health, which might be reduced to SMALL due to the reduction in operation of the natural gas component of the combination.

Based upon the evaluation criteria discussed above and in Subsections 9.2.2.1, 9.2.2.2, 9.2.2.10, and 9.2.3.2, a renewable power technology (such as wind or solar power) in combination with a storage technology (such as CAES or molten salt batteries) and supplemented by natural gas is not considered to be a reasonable energy alternative to the proposed project. First, such a combination of power technologies, as a single project, is not developed, proven, and available in the relevant region (ERCOT) or even in other areas of the United States. Second, such a combination of power technologies, as a project, has not been proven to provide power generation capacity equivalent to CPNPP Units 3 and 4. Third, such a combination of power technologies, as a project, with the capacity to generate baseload power equivalent to CPNPP Units 3 and 4 is not considered to be available during the same time frame as the proposed project. Finally, if such a power project where feasible, such a combination of power technologies, as a project, would be expected to have significant adverse environmental impacts and would not be environmentally more preferable than CPNPP Units 3 and 4.

9.2.2.11.4.2 Natural Gas Power Generation Supplemented by Renewable Energy Sources Combined with Storage

Under this alternative, the primary source of the 3200 MW of baseload power would be generated from a natural gas-fired power plant. When available, power from the renewable power source and the energy storage facility would be used to supplement the power generated from the natural gas power plant, thereby reducing the operation of the natural gas power plant. The energy storage facility can be charged from either the natural gas power plant or the renewable energy source, when sufficient renewable energy is available. This alternative, to provide baseload power comparable to CPNPP Units 3 and 4, would require:

- a 3200 MW or lesser capacity renewable power plant (either wind or solar) to generate power when the renewable resource is available;
- a 3200 MW or lesser capacity energy storage facility (either CAES with wind power or molten salt storage with solar power) to generate power when the renewable resource is not available; and
- a 3200 MW natural gas power plant to generate baseload power that could be ramped back when supplemental power is available from the renewable resource and the energy storage units.

Since this alternative would require both renewable energy facilities and energy storage facilities in addition to a 3200 MW natural gas power plant, this combination technology alternative would have greater environmental impacts than just a natural gas power plant alone.

The alternative of using natural gas supply to provide baseload power comparable to CPNPP Units 3 and 4 was fully evaluated in Subsections 9.2.2.10 and 9.2.3.2. As discussed in those subsections, if a natural gas plant could generate baseload power comparable to CPNPP Units 3 and 4, the natural gas plant would not be environmentally preferable to CPNPP Units 3 and 4. As discussed below, supplementing the natural gas plant with either wind or solar power, with energy storage units, would not change the conclusions of those subsections, namely that natural gas generation is not a preferable alternative capable of generating baseload power comparable to CPNPP Units 3 and 4.

<u>Criterion 1 - Developed, proven, and available in the relevant region ERCOT</u>

As discussed in Subsection 9.2.2.10, in the ERCOT region, natural gas energy has been developed as a baseload energy provider. If properly sized, a natural gas power plant could generate baseload power comparable to CPNPP Units 3 and 4 without the need for solar or wind power generation or energy storage. However, as discussed in Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, neither wind power with CAES storage nor solar power with molten salt storage are developed, proven, or available in the relevant (ERCOT) region or any other area in the United States. Therefore, a 3200 MW baseload power operation consisting of a natural gas power plant supplemented by a renewable power source combined with energy storage is not developed, proven, or available in the relevant (ERCOT) region.

<u>Criterion 2 - Capacity equivalent to the planned generation</u>

As discussed in Subsection 9.2.2.10, in the ERCOT region, natural gas energy has been developed as a baseload energy provider. If properly sized, a natural gas power plant could generate baseload power comparable to CPNPP Units 3 and 4 without the need for solar or wind power generation or energy storage. However, as discussed in Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, neither wind power with CAES storage nor solar power with molten salt storage have the capacity to generate baseload power equivalent to the power to be generated by CPNPP Units 3 and 4. Therefore, although a renewable power source combined with an energy storage option supplemented by natural gas does not have the capacity to generate baseload power equivalent to the planned generation from CPNPP Units 3 and 4; the option of producing the majority of the baseload power from a natural gas plant with only intermittent power from the renewable source or the storage units might be feasible. This conclusion assumes that such a combination of energy technologies is feasible.

<u>Criterion 3 - Available during the same time frame</u>

As discussed in Subsection 9.2.2.10, in the ERCOT region, natural gas energy has the potential to be available as baseload power within the timeframe determined for CPNPP Units 3 and 4. As discussed Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, neither wind nor solar power combined with storage options is available as baseload energy sources within the project timeframe. Therefore, although a renewable power source combined with an energy storage option supplemented by natural gas would not be available within the project time frame; an option in which the majority of the baseload power was provided by natural gas plant with only intermittent power from the renewable source or the storage units may be available within the project time frame. This conclusion assumes that such a combination of energy technologies is feasible.

Criterion 4 - No unusual environmental impacts or exceptional costs

The potential environmental impacts associated with wind power combined with a CAES facility and with solar power combined with a molten salt storage facility are discussed in Subsections 9.2.2.11.3.1 and 9.2.2.11.3.2, respectively. The potential environmental impacts that could be attributed to natural gas power generation are discussed Subsections 9.2.2.10 and 9.2.3.2.

The technology combination of a natural gas plant capable of generating 3200 MW of baseload power supplemented by a renewable energy source combined with an additional energy storage facility would result in cumulative construction and land use impacts that would be greater than the impacts caused by a 3200 MW natural gas power plant alone. As discussed in Subsection 9.2.2.11.3.1 and 9.2.2.11.3.2, LARGE impacts on land use, aesthetics, ecological resources, protected species and cultural resources would be, expected from either wind or solar power with storage. The magnitude of these impacts could be moderated if the installed generating capacity of the wind and solar facilities were reduced and replaced with additional natural gas power generating capacity. However, in such an event, the reduction in construction impacts would be offset by the increase in the operational impacts resulting from the combination of the power technologies due to the greater use of natural gas.

As discussed in Subsection 9.2.2.10, the use of natural gas alone as the energy source is expected to have SMALL to MODERATE impacts on land use, ecological resources, protected species, human health, aesthetics, cultural resources, water quality, waste management, air quality, and socio-economics. As a result, a natural gas plant alone is not an environmentally preferable alternative to CPNPP Units 3 and 4.

If a renewable energy source combined with an energy storage facility were used to supplement the operation of a natural gas plant, the impacts from the operation of the natural gas plant on water and air quality would be reduced relative to the impacts of operating a natural gas plant alone. However, even under the best case scenario involving the lowest level of operation of the natural gas plant, the combination of power technologies would not be environmentally preferable to CPNPP Units 3 and 4 due to the environmental impacts associated with land use combined with the cumulative impacts of the three technologies. As the use of natural gas increases in this technology combination, the impacts on air and water quality increase. As the use of the renewable energy source and energy storage facilities increases in this technology combination, the impacts associated with land use increases. Thus regardless of the mix of the technologies, the combination of natural gas with renewable energy sources and energy storage facilities would not be environmentally preferable to CPNPP Units 3 and 4, even if it were feasible to generate comparable baseload power through these technology combinations.

Based upon the evaluation criteria discussed above and in Subsections 9.2.2.1, 9.2.2.2, 9.2.2.10, and 9.2.3.2, the option of combining a natural gas power plant with a renewable power technology (such as wind or solar power) in combination with a storage technology (such as CAES or molten salt batteries) is not a reasonable energy alternative to the proposed project. First, such a combination of power technologies, as a single project, is not developed, proven, and available in the relevant region (ERCOT) or even in other areas of the United States. Second, such a combination of power technologies, as a single project, has not been proven to provide power generation capacity equivalent to CPNPP Units 3 and 4, unless the vast majority of the power is generated by natural gas. Third, such a combination of power technologies, as a single project, with the capacity to generate baseload power equivalent to CPNPP Units 3 and 4 is not considered to be available during the same time frame as the proposed project unless the vast majority of the power is generated from natural gas. Finally, if such a power project where feasible, such a combination of power technologies, as a single project, would be expected to have significant adverse environmental impacts and would not be environmentally more preferable than CPNPP Units 3 and 4.

9.2.2.11.5 Conclusions of Combining New Generation Power Sources with Storage

A number of potential combinations of renewable energy sources with energy storage facilities either with or without natural gas have been evaluated and discussed in the preceding subsections. The use of solar or wind power combined with energy storage options and supplemented by natural gas to provide baseload power comparable to that proposed for CPNPP Units 3 and 4 has been evaluated and discussed in the subsections above. The use of natural gas supplemented by a renewable energy source in combination with energy storage has been evaluated and discussed in the subsections above. This evaluation does not change the conclusions in Subsections 9.2.2.1, 9.2.2.2, 9.2.2.10, 9.2.3.2 and 9.2.3.3 that natural gas, wind, solar; and energy storage either individually or in combination, are not viable alternatives that could both produce baseload power comparable to that generated by CPNPP Units 3 and 4 and be environmentally preferable to CPNPP Units 3 and 4. Renewable energy sources combined with energy storage facilities, operated either with or without natural gas, capable of generating baseload power comparable to CPNPP Units 3 and 4 are not environmentally preferable alternatives to CPNPP Units 3 and 4.

When compared to standard baseload options such as nuclear, natural gas and coal generation, none of the combinations of a renewable energy source with an energy storage technology can provide equivalent baseload electricity. Options which rely on renewable energy sources and energy storage are best suited for power peaking or stabilizing purposes. Renewable energy sources and energy storage options are not currently, or projected to be, used for baseload power applications.

9.2.3 ASSESSMENT OF ALTERNATIVE SOURCES AND SYSTEMS

Luminant has identified a broad range of strategies to generate baseload power. Subsection 9.2.2 discusses the pertinent options addressing the particular need for power to be addressed by the proposed CPNPP Units 3 and 4. This subsection further evaluates the environmental effects from the reasonable alternatives and compares them to the proposed CPNPP Units 3 and 4. For the reasons discussed in Subsection 9.2.2, these alternatives are coal and natural-gas-fired generation. The environmental impacts discussed in this subsection and summarized in Table 9.2-1 are representative of the alternate energy sources.

9.2.3.1 Coal-Fired Generation

Luminant has reviewed the NRC analysis of environmental impacts from coal-fired generation alternatives in NUREG-1437 that focused on combined-cycle plants and found the analysis to be reasonable. This subsection presents the basis for defining the coal-fired generation alternative as a combined-cycle plant to substitute for the proposed CPNPP Units 3 and 4. Luminant assumed six 530-MW units, having a total capacity of 3180 MW, as the coal-fired alternative at the CPNPP site. Although this alternative provides less capacity than two US-APWR units (3200 MW), it ensures against overestimating environmental impacts from the alternatives. The shortfall in capacity could be replaced by other methods.

The coal-fired alternative was defined as utilizing a closed-cycle cooling system consisting of conventional boiler units, each with a net capacity of 530 MW for a combined capacity of 3180 MW. This coal-fired alternative discussed in Subsection 9.2.2.9 would be located at the CPNPP site. Table 9.2-2 presents the assumed basic operational characteristics of the coal-fired units. The overall impacts associated with the construction and operation of the coal-fired alternative are summarized in Table 9.2-1 and are discussed in the following subsections.

9.2.3.1.1 Environmental Costs

The following subsections discuss the environmental cost of constructing and operating a large coal fired electric power plant including the evaluation of impacts on air quality, land use, local and regional ecosystems, water use and quality, waste generation, and human health effects.

9.2.3.1.1.1 Air Quality

The air quality effects of coal-fired generation vary considerably from those effects of nuclear generation. A coal-fired plant would emit sulfur dioxide (SO_2, as SO_x surrogate), oxides of nitrogen (NO_x), particulate matter (PM) and carbon monoxide (CO); all of which are regulated pollutants. A coal-fired plant would emit carbon dioxide (CO_2), which has been linked to global warming.

Emission control technology for the coal-fired plant design would minimize air emissions through a combination of boiler technology and post combustion pollutant removal. Luminant estimates the 3180-MW coal-fired alternative would use approximately 14,500,000 T of coal per year and would generate the following emissions:

SO_X = 4270 tons per year (Tpy)

NO_X = 3625 Tpy

CO = 3625 Tpy

CO_2 = 35 million Tpy

PM = 378 Tpy

PM_{10} = 87 Tpy

These emission totals are calculated based on the parameters and assumptions identified in Tables 9.2-2 and 9.2-3 and emission factors published in AP-42 (EPA 1998).

A new coal-fired generating plant would need to meet numerous federal and state requirements under the Clear Air Act prior to being issued a permit to commence construction and operation.

Texas has several regions designated as nonattainment areas, areas that have failed to meet federal standards for ambient air quality, with respect to the National Ambient Air Quality Standards for one or more criteria pollutants. As a result, the state of Texas is required to prepare and submit a State Implementation Plan (SIP) to the EPA. The SIP establishes control strategies to reduce criteria pollutant emissions to demonstrate compliance with the SIP. The Texas SIP creates a market-based cap-and-trade program for NO_X emissions. Stationary fossil fuel facilities in Texas are required to acquire trade credits to cover the potential emissions. Compliance with the NO_X standards identified in the SIP must be achieved by January 1, 2009 and January 1, 2010, respectively (TCEQ 2007).

The nine-county DFW metropolitan area is classified a “moderate” ozone nonattainment area under the 8-hr ozone standard and is the nearest nonattainment area to CPNPP. The DFW 8-hr ozone attainment area consists of two sets of counties: the original four nonattainment counties under the 1-hr ozone standard, core counties (Collin, Dallas, Denton, and Tarrant), and the five newly designated nonattainment counties under the 8-hr ozone standard (Ellis, Johnson, Kaufman, Parker, and Rockwall) (TCEQ 2007a). The DFW nonattainment area is located north and east of the CPNPP site and borders Hood County to the north and east, and Somervell County to the east.

Overall, the air quality impacts of coal-fired plants sized to substitute for the proposed CPNPP Units 3 and 4 capacities are considered MODERATE, and are substantially greater than nuclear generation as indicated in Table 9.2-1.

9.2.3.1.1.2 Land Use

The coal-fired alternative defined by Luminant in Subsection 9.2.2.9 is assumed to be located at the CPNPP site. Construction of the power block and coal storage area would impact approximately 5406 ac of land and associated terrestrial habitat, based on NUREG-1437 factor of 1.7 ac/MW as the land use requirement for a coal-fired plant. Waste disposal would require an additional 13,000 ac. Most of this construction would be in previously undisturbed areas, and impacts would be MODERATE. Visual impacts would be consistent with the industrial nature of the site. As with any large construction project, some erosion, sedimentation, and fugitive dust emissions could be anticipated, but would be minimized through application of best management practices. On-site disposal is assumed for debris generated when the area is cleared and grubbed. Other construction debris would be accepted at a nearby municipal disposal facility. Overall, land-use impacts for construction and operation of the coal-fired alternative plant are considered MODERATE.

9.2.3.1.1.3 Ecology

The coal-fired generation alternative would introduce construction impacts and additional incremental operational impacts. Even assuming siting at a previously disturbed area, the impacts would alter the ecology. Ecological impacts to a plant site and utility easements could include impacts on threatened or endangered species, wildlife habitat loss, reduced wildlife reproduction, habitat fragmentation, and a local reduction in biological diversity. Use of cooling makeup water from a nearby surface water body could have adverse aquatic resource impacts. If needed, maintenance of a transmission line and a rail spur would have ecological impacts. There could be impacts to terrestrial ecology from cooling tower drift. Overall, the ecological impacts would be considered SMALL, similar to the proposed CPNPP Units 3 and 4.

9.2.3.1.1.4 Water Use and Quality

Construction of each unit, including access roads, would affect surface water hydrology, but sites could be chosen to avoid extensive site excavation, filling, or grading. Construction would disturb the land surface, which may temporarily affect surface water quality. Potential water quality impacts would consist of suspended solids from disturbed soils, biochemical oxygen demand, nutrient loading from disturbed vegetation, and adverse environmental impacts from construction equipment. Construction activities would require a Texas Pollutant Discharge Elimination System (TPDES) permit for stormwater discharges from the site to ensure the implementation of best management practices and to minimize impacts to surface water during construction. To minimize the impacts of stormwater flow erosion during construction, on-site retention areas would be designed. Runoff detention ponds would be designed to detain runoff within the containment areas to allow for settling and to reduce peak discharges. Best management practices would also be required during construction to minimize water quality impacts. Construction would cause no significant consumption of surface water resources. Sanitary wastewater would most likely be routed to the CPNPP sanitary system. If a sanitary waste treatment system were not available, a system would be constructed.

During operation, a fraction of the plant intake water requirement for each unit would be for cooling tower makeup water flow. Consumptive water use through evaporation would be small. This amount of water consumption would be taken from Lake Granbury with a negligible impact on water availability downstream or in the vicinity of the plant. Cooling water for the main condensers and miscellaneous components would be recirculated through the cooling towers, with the blowdown (i.e., the fraction of circulated water that is discharged to prevent the buildup of dissolved salts and minerals) and other plant operational wastewater streams subsequently being discharged through diffusers. Overall, water use and quality impacts would be considered SMALL, similar to the proposed CPNPP Units 3 and 4.

9.2.3.1.1.5 Waste Management

The coal-fired alternative would generate substantial solid waste. Based on the assumed plant parameters (Table 9.2-2), the coal would have 5.21 percent ash content, and the facility would consume approximately 14.5 million tons of coal annually. Particulate control equipment would collect most, 99.9 percent, of this ash, approximately 755,000 Tpy. If 75 percent of the coal ash were recycled, an annual total of approximately 188,000 tons of ash would require disposal.

The SO_x control equipment would require approximately 1,049,400 Tpy of limestone for six 530-MW units. The amount of required limestone is extrapolated based on a usage of 132,000 Tpy of limestone for a single 400-MW coal-fired plant (NETL 1999). Over a 30-year plant life, ash and scrubber waste would total approximately 48,000,000 tons. The area required for waste disposal over a 30-year plant life would require approximately 13,000 ac. The area required for disposal is based on the total tonnage of limestone and ash divided by the density of pulverized limestone. The required area for waste disposal is based on a spreading the limestone waste at an approximate 2-ft thickness.

Based on the limited area available at the facility and the current waste requirements, waste disposal would destabilize resources in the area. There would not be sufficient space within the current CPNPP property for this disposal. Additional areas surrounding the facility would have to be utilized over the lifetime of the coal-fired plant. After closure of the waste sites and replacement of vegetation, the land would be available for other uses. The impacts of increased waste disposal would be clearly noticeable, and would impact undisturbed lands in the area of the facility. Overall, the increased waste disposal impacts would be considered MODERATE.

9.2.3.1.2 Health Effects

Coal-fired power generation introduces potential worker and public risks from coal and limestone mining, transportation, disposal of coal combustion wastes, and emissions.

Emission impacts are difficult to quantify.

Regulatory agencies including EPA and state agencies set air emission standards and requirements to protect human health and the environment. These agencies also impose site-specific emission limits as needed to meet the health standards. In the absence of more quantitative data, and with the limits imposed for the regulated constituents of air emissions, impacts from burning coal at a newly constructed coal-fired plant are considered SMALL.

9.2.3.1.3 Additional Impacts

Additional impacts discussed in this subsection include the effects on community services, local scenery, cultural resources, and minority populations.

9.2.3.1.3.1 Socioeconomics

The 3180-MW coal-fired alternative, if constructed on a staggered timeline, would be expected to employ approximately 3000 construction workers. The estimated amount of full-time workers employed upon completion of construction would be approximately 382 (BSII 2006). The peak number of workers would noticeably affect the local workforce, but the jobs would be temporary and many of the workers would commute from surrounding areas. The influx of workers could noticeably affect local school systems and other social services.

During construction, the communities immediately surrounding the CPNPP site would experience demands on housing and public services that could have noticeable impacts. These impacts would be tempered by construction workers commuting to the sites from cities that are more distant. After construction, the communities could be affected by the loss of jobs.

For transportation related to commuting of plant operating personnel for the coal-fired alternative, the impacts are similar to constructing the proposed CPNPP nuclear units. Transportation impacts would be temporary, noticeable, but not destabilizing during plant construction. Overall, socioeconomic impacts resulting from construction and operation of coal-fire facilities can be considered SMALL beneficial impacts.

9.2.3.1.3.2 Aesthetics

The additional stacks, boilers, and rail deliveries would be an incremental addition to the visual impact from existing structures and operations. Coal delivery would add noise and transportation impacts associated with unit-train traffic. Based on a unit train with 125 cars, where each car holds 100 tons, about 1160 unit trains per year, approximately 22 unit trains per week, would be needed to deliver coal and limestone to the coal-fired plant. Overall, aesthetic impacts resulting from construction and operation of coal-fired plants can be considered SMALL.

9.2.3.1.3.3 Historic and Archaeological Resources

The potential impacts of additional plant construction on historic and archaeological resources would be similar to those for construction of two nuclear units, which have been discussed and evaluated for the CPNPP site in Subsections 2.5.3 and 4.1.3. Impacts to cultural resources can be effectively managed under current laws and regulations and kept SMALL.

9.2.3.1.3.4 Environmental Justice

Environmental justice impacts would depend upon the sites chosen for the coal-fired power plants and the nearby population distribution. Similar to the discussion and evaluation for nuclear construction at the CPNPP site in Subsections 2.5.4 and 4.4.3, the impacts on minority populations resulting from the construction and operation of coal-fired power plants would not be disproportionate. Overall, environmental justice impacts would be considered SMALL.

9.2.3.1.4 Design Alternatives

The proposed CPNPP Units 3 and 4 location lends itself to coal delivery by rail. Subsection 9.4.1 analyzes alternative designs for the CPNPP Units 3 and 4 heat dissipation systems. Based on this analysis, Luminant assumed that cooling towers would be used for the coal-fired alternative. Use of cooling towers would minimize impingement, entrainment, and thermal impacts; consumptive water use through evaporation would be a SMALL impact, and 100-ft high mechanical towers or 600-ft high natural draft towers would introduce a visual impact.

The environmental impacts of constructing and operating a coal-fired generating plant using a once-through cooling system are more severe than a closed cycle system because of thermal and aquatic disturbance. Per the discussion in Subsection 9.4.1.2.1, a completely open system was not considered feasible based on insufficient flows in the reservoir to meet thermal standards for a limited number of days.

Several environmental differences between the closed-cycle and once-through cooling systems are noted here. There are no impacts to terrestrial ecology from cooling tower drift. Increased water withdrawal, associated with once-through cooling systems, may have possible greater impacts to aquatic ecology.

9.2.3.1.5 Conclusion for Coal-Fired Generation

A coal-fired power plant would have greater environmental impacts than CPNPP Units 3 and 4 primarily because of impacts on air quality, land use, and waste disposal.

9.2.3.2 Natural Gas Generation

Luminant has reviewed the NRC analysis of environmental impacts from natural gas-fired generation alternatives in NUREG-1437 that focused on combined-cycle plants and found it to be reasonable. Subsection 9.2.2.10 presents the basis for defining the natural gas-fired generation alternative as a combined-cycle plant to substitute for the proposed CPNPP Units 3 and 4. Luminant assumed six 530-MW units, having a total capacity of 3180 MW, as the natural gas-fired alternative at the CPNPP site. Although this substitution provides less capacity than two US-APWR units (3200 MW), it ensures against overestimating environmental impacts from the alternatives. The shortfall in capacity could be replaced by other methods, such as purchasing power. The overall impacts associated with the construction and operation of the natural gas-fired alternative using a closed-cycle cooling system are summarized in Table 9.2-1 and are discussed in the following subsections.

9.2.3.2.1 Environmental Costs

The following subsections discuss the environmental cost of constructing and operating a large natural gas electric power plant including the evaluation of impacts on air quality, land use, local and regional ecosystems, water use and quality, waste generation, and human health effects.

9.2.3.2.1.1 Air Quality

Natural gas is a relatively clean-burning fuel when compared to other fossil fuel combustion. Because the heat recovery steam generator does not receive supplemental fuel, the combined-cycle operation is highly efficient: 56.5 percent (GEPS 2000) versus 39 percent for the coal-fired alternative (NETL 2007). The natural gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative, and in much larger quantities than the nuclear alternative. A natural gas-fired power plant would also have unregulated carbon dioxide emissions that could contribute to global warming.

Emission control technology for natural gas-fired turbines focuses on the reduction of NO_X emissions. Luminant estimates the 3180-MW natural gas-fired alternative would use about 149 billion scf/year of natural gas and would generate the following emissions:

SO_x = 253 Tpy

NO_X = 2676 Tpy

CO = 1115 Tpy

PM = 142 Tpy (all particulates are $PM_{2.5}$)

CO_2 = 8.2 million Tpy

These emission totals are calculated based on the parameters and assumptions identified in Tables 9.2-4 and 9.2-5 and emission factors published in AP-42 (EPA 2000).

A natural gas-fired generating plant would need to meet numerous federal and state requirements under the Clean Air Act prior to being issued a permit to commence construction and operation.

Texas has several regions designated as nonattainment areas; areas that have failed to meet federal standards for ambient air quality with respect to the National Ambient Air Quality Standards for one or more criteria pollutants. As a result, the state of Texas is required to prepare and submit a SIP to the EPA. The SIP establishes control strategies to reduce criteria pollutant emissions to demonstrate compliance with the SIP. The Texas SIP creates a market-based cap-and-trade program for NO_X emissions. Stationary fossil fuel facilities in Texas are required to acquire trade credits to cover the new potential emissions. Compliance with the NO_X standards identified in the SIP must be achieved by January 1, 2009, and January 1, 2010, respectively (TCEQ 2007).

The nine-county DFW metropolitan area is classified a “moderate” ozone nonattainment area under the 8-hr ozone standard and is the nearest nonattainment area to CPNPP. The DFW 8-hr ozone attainment area consists of two sets of counties: the original four nonattainment counties under the 1-hr ozone standard, core counties (Collin, Dallas, Denton, and Tarrant), and the five designated nonattainment counties under the 8-hr ozone standard (Ellis, Johnson, Kaufman, Parker, and Rockwall) (TCEQ 2007a). The DFW nonattainment area is located north and east of the CPNPP site and borders Hood County to the north and east, and Somervell County to the east.

The combustion turbine portion of the combined-cycle plant would be subject to 40 CFR 63, Subpart YYYY, EPA National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines, if the site is a major source of hazardous air pollutants. Major sources have the potential to emit 10 Tpy or more of any single hazardous air pollutant (such as carbon monoxide) or 25 Tpy or more of any combination of hazardous air pollutants as defined in 40 CFR 63.6085 (b).

Overall, the air quality impacts of natural gas-fired plants sized to substitute for the proposed CPNPP Units’ 3 and 4 capacities are considered SMALL to MODERATE and are substantially greater than nuclear generation as indicated in Table 9.2-1.

9.2.3.2.1.2 Land Use

The natural gas-fired alternative defined by Luminant in Subsection 9.2.2.10 would be located on the CPNPP site. Construction of a natural gas pipeline from the plant location to a supply point where a firm supply of gas is available would be needed. Additional pipeline would need to be constructed from an existing 36-in transmission pipeline traversing the CPNPP Exclusion Area approximately 2.4 mi north of the plant location, north of SCR to the plant location, and south of SCR. It is anticipated that the environmental impacts of constructing an additional gas pipeline to the gas-fired unit location would be similar to those associated with constructing an additional transmission line ROW. Soil impacts for construction of the natural gas pipeline are considered small because of the disturbance to the topsoil along its route. The gas pipeline corridor may impact areas of wetlands, but those impacts would be temporary and potentially insignificant. The pipeline would have a slightly negative impact on geologic setting, land use, terrestrial ecology, and aesthetics and recreation. Gas storage facilities and upgrades to existing supply lines would also be required.

A 3180-MW natural gas-fired alternative to the proposed CPNPP Units 3 and 4 would require approximately 350 ac, based on NUREG-1437 factor of 0.11 ac/MW as the land use requirement for gas-fired plants. Additional land would be affected for construction of a natural gas pipeline to serve the plant. A 3180-MW natural gas-fired alternative to the proposed CPNPP Units 3 and 4 would require approximately 11,450 ac of additional land, based on NUREG-1437 factor of 3.6 ac/MW as the additional land use requirement for gas-fired plants. Overall, land-use impacts for construction and operation of the natural gas-fired alternative plant are considered MODERATE.

9.2.3.2.1.3 Ecology

Ecological impacts would depend on the nature of the land converted for the plant and additional gas pipelines that are required. Construction of a gas pipeline to serve the plant would be expected to have temporary ecological impacts. Ecological impacts to a plant site and utility easements could include impacts on threatened or endangered species, wildlife habitat loss, reduced wildlife reproduction, habitat fragmentation, and a local reduction in biological diversity.

Intake and discharge of makeup water for the cooling system could adversely affect aquatic resources. There could be impacts to terrestrial ecology from cooling tower drift. With proper project management that includes the use of best management practices, the ecological impacts are considered SMALL.

9.2.3.2.1.4 Water Use and Quality

Construction would be expected to increase erosion and stormwater runoff of suspended solids above existing levels, but this would be temporary and mitigated by the use of best management practices. Completion of a retention pond for the treatment of stormwater runoff early in the construction phase would significantly reduce potential increased solids loading to local surface drainage waterways. Application of best management practices to control erosion during construction should mitigate the construction impacts of pipelines (natural gas supply, potable water supply, process water supply, and wastewater discharge).

Wastewater discharges would be regulated by the state or by the EPA. Approximately 90 percent of the wastewater discharge flow would be cooling tower blowdown. Other sources of wastewater include steam cycle blowdown, water from inlet fogging, demineralizer rinse water, and miscellaneous low-volume wastewater. This water would be treated on-site as necessary to meet regulatory requirements before being discharged to local waters.

Stormwater runoff during plant operation would be drained to a retention pond to allow sediments to settle out prior to discharge to local waterways. Rainwater that would fall in secondary containment around oil-containing equipment would drain to an oil/water separator where the oil would be removed for disposal, and the water would subsequently drain to the process water pond. Excavation and grading associated with construction of the plant or any of the ancillary features, such as backup power, process and potable water pipelines, wastewater discharge pipelines, and natural gas pipelines, would not be expected to cause adverse impacts to groundwater. Excavations that penetrated the water table might require temporary construction dewatering. Any groundwater drawdown impacts associated with construction dewatering would be temporary. The long-term impact of these activities should be negligible because of the limited depth and relatively small area of disturbance. Structural damage to aquifer areas resulting from pipeline construction would not be anticipated because aquifers are not generally located within excavation depth.

The impact on the surface water would depend on the discharge volume and the characteristics of the receiving body of water. Intake from and discharge to any surface body of water would be regulated by the state or EPA.

Water quality impacts from sedimentation during construction of a natural gas-fired plant are small. Operational water quality impacts would be similar to, or less than, those impacts from other generating technologies. Overall, water use and quality impacts would be considered SMALL.

9.2.3.2.1.5 Waste Management

The only significant solid waste generated at a natural gas-fired plant would be spent selective catalytic reduction catalyst. The catalyst is used to control NO_X emissions. The spent catalyst would be regenerated or disposed off-site. Other than spent catalyst, waste generation at an operating natural gas-fired plant would be largely limited to typical office wastes; impacts would be so minor that they would not noticeably alter any important resource attribute. Construction-related debris would be generated during construction activities. Overall, the solid waste impacts associated with natural gas-fired alternative would likely be SMALL.

9.2.3.2.2 Health Effects

Potential accidents related to plant operations include the possible rupture of natural gas pipelines both on-site and off-site, and the possible release of ammonia. Ammonia is used in the Selective Catalytic Reduction process for control of NO_X emissions. Both events are considered very low probability.

Overall, the impacts on human health of natural gas-fired plants are considered SMALL.

9.2.3.2.3 Additional Impacts

Additional impacts discussed in this subsection include the effects on community services, local scenery, cultural resources, and minority populations.

9.2.3.2.3.1 Socioeconomics

For a single 400-MW facility, construction would take approximately 27 months. Up to 17 full-time jobs would be created at the site to support operations of the new plant. Construction personnel on-site would peak at about 400. A 1500-MW gas-fueled plant would require 1350 job-years of employment during the construction phase. Assuming a 3-year construction duration, this time would correlate to approximately 450 temporary jobs during construction. It is estimated that 78 permanent jobs are required to operate the plant. It is roughly estimated that a 3180-MW natural gas-fired alternative would create 150 permanent jobs and 800 jobs during construction.

During construction, the communities immediately surrounding the CPNPP site would experience demands on housing and public services that could have noticeable impacts. These impacts would be tempered by construction workers commuting to the sites from cities that are more distant. After construction, the communities could be affected by the loss of jobs. Jobs related to pipeline construction would not be centralized at one location for any significant period of time and would have no important impact on the local economy or on community and government services.

The socioeconomic impacts from constructing a natural gas-fired plant would not be noticeable and the small operational workforce would have the lowest socioeconomic impacts of any nonrenewable technology. Compared to the coal-fired and nuclear alternatives, the smaller size of the construction workforce, the shorter construction time frame, and the smaller size of the operations workforce would lessen socioeconomic impacts.

For transportation related to commuting of plant operating personnel for the natural gas-fired alternative, the impacts are considered negligible. Impacts related to the commuting of plant construction personnel would be noticeable, temporary, but not destabilizing. Overall, socioeconomic impacts resulting from construction and operation of natural gas-fired plants can be considered SMALL to MODERATE beneficial impacts.

9.2.3.2.3.2 Aesthetics

The natural gas-fired plants would alter the visual landscape character at each location. The tallest structures would be the 150-ft high auxiliary boiler and two heat recovery steam generator stacks, as well as the 100-ft high steam turbine building. Some portion of these structures would likely be visible for 1 mi or more. There would be more lighting visible across the night landscape, and sky brightness would increase somewhat. Noise from the plant may be detectable off-site, depending on the location.

The gas pipeline compressors also would be visible. Overall, the aesthetic impacts associated with replacement natural gas-fired plants are categorized as SMALL, at the CPNPP site.

9.2.3.2.3.3 Historic and Archaeological Resources

The potential impacts of plant construction on historic and archaeological resources would be similar to those for construction of two nuclear units, which have been discussed and evaluated for the CPNPP site in Subsections 2.5.4 and 4.4.3. Impacts to cultural resources can be effectively managed under current laws and regulations and are considered to be SMALL.

9.2.3.2.3.4 Environmental Justice

Similar to the discussion and evaluation for nuclear construction at the CPNPP site in Subsections 2.5.3 and 4.1.3, the impacts on minority populations resulting from the construction and operation of natural gas fired power plants would not be disproportionate. Overall, environmental justice impacts would be considered SMALL.

9.2.3.2.4 Design Alternatives

The environmental impacts of constructing and operating a natural gas-fired generating plant using a once-through cooling system are more severe than a closed cycle system because of thermal and aquatic disturbance. Per the discussion in Subsection 9.4.1.2.1, a completely open system was not considered feasible based on insufficient flows in the reservoir to meet thermal standards.

Several environmental differences between the closed-cycle and once-through cooling systems are noted here. There are no impacts to terrestrial ecology from cooling tower drift. Increased water withdrawal, associated with once-through cooling systems, may have possibly greater impacts to aquatic ecology.

9.2.3.2.5 Conclusion for Gas-Fired Generation

A gas-fired power plant would have greater environmental impacts than CPNPP Units 3 and 4 due primarily to impacts on air quality and land use.

9.2.3.3 Combination of Alternatives

This subsection reviews possible combinations of alternatives that could generate replacement baseload power in lieu of the proposed CPNPP Units 3 and 4. Section 8.3 provides the ERCOT capacity plan by fuel type.

As stated in the beginning of Section 9.2, the proposed CPNPP Units 3 and 4 have a capacity of 3200 MW of electrical generation, and is planned to supply baseload power to the grid. As a stand-alone technology, wind energy (Subsection 9.2.2.1) is not a feasible alternative for baseload power, because of its intermittent capacity and current level of cost effectiveness. Solar power (Subsection 9.2.2.2) has a similar problem with intermittent capacity and cost at the magnitude required. No hydropower (Subsection 9.2.2.3) project is feasible in Texas that could provide baseload generating capacity and availability equal to the proposed CPNPP Units 3 and 4. Hydropower, because of the large land requirements and other issues, is considered to have potential environmental impacts in excess of the proposed CPNPP Units 3 and 4. Geothermal power (Subsection 9.2.2.4) cannot be considered capable of generating a baseload equal to that of the proposed CPNPP Units 3 and 4. Also, there are no commercial geothermal plants in Texas, and the first leases for geothermal development were issued in 2007. As shown above, fossil and/or carbon fuel fired combustion technologies can produce baseload capacity generation, but not at environmental impact levels smaller or equal to the proposed CPNPP Units 3 and 4. These technologies include biomass-derived fuels (Subsection 9.2.2.5), municipal solid waste (Subsection 9.2.2.6), petroleum liquids (Subsection 9.2.2.7), pulverized coal (Subsection 9.2.2.9), and natural gas (Subsection 9.2.2.10). Only coal and natural gas are in full commercial use at this time for electrical generation because of the high cost and lack of clear environmental advantages of other technologies. Coal and natural gas are not environmentally preferable to nuclear power.

For the renewal of licenses pursuant to 10 CFR 54, the NRC has determined that comprehensive consideration of all possible combinations would be too unwieldy given the purposes of the alternative analysis. Instead, the NRC has determined that the analysis of combinations of alternatives should be sufficiently complete to aid the NRC in its analysis of alternative sources of energy pursuant to NEPA. The following text provides the basis for an evaluation of a reasonable number of combinations of alternative energy sources to the proposed CPNPP project.

Luminant reviewed combinations that because of technological maturity, economics, and other factors, could be reasonable alternatives to the proposed CPNPP Units 3 and 4. Although some alternatives may not by themselves provide the capacity needed, a mix of these alternatives could be sufficient. Several representative and bounding sets of these combination alternatives are addressed below out of the large number of possible combinations.

9.2.3.3.1 Determination of Alternatives

A possible alternative combination is a baseload capable source coupled with a renewable non-baseload capable source. Luminant expects the proposed CPNPP Units 3 and 4 to be baseload capable in its capacity planning, providing power in a predictable, consistent manner; any alternative combination would require the same performance. For this portion of the analysis, wind and solar are considered as renewable sources of power able to supplement the baseload capable source.

Any combination of alternative sources that includes a variable renewable source of energy, offering all or part of the proposed CPNPP Units 3 and 4 capacities must be combined with a 100 percent load capacity fossil fuel fired source. This combination allows the fossil-fuel-fired portion to provide as much as the entire load during times when the output of the renewable source of energy is reduced or unavailable. When available, the output of the renewable source displaces the baseload supply, and the output of the fossil-fuel-fired portion can be reduced to accommodate the increase in renewable generation. For example, if the renewable resource is wind, when the wind blows and wind driven power becomes available, the fossil-fuel-fired power output can be reduced, so that the sum of the two sources continues to match the baseload capacity expected. The result is that the overall performance of the combination meets the demand with the same dependability as a fossil-fuel-fired plant.

Both coal- and natural-gas-fired generation were evaluated above (Subsections 9.2.3.1 and 9.2.3.2) and were shown to have environmental impacts that are greater than the proposed CPNPP Units 3 and 4. Of the two, natural-gas-fired generation has a smaller environmental impact. Natural gas is a better effective partner to a variable source because it can better tolerate the ramping up and down of the power level. Even cleaner burning technologies for coal do not approach the small environmental impact of natural gas. For this reason, in the environmental comparison portion of this alternative study, natural gas is used as the fossil fuel for baseload capacity.

This review examines the reduction in environmental impacts from a natural-gas-fired facility when generation from the facility is displaced by the renewable resource. The impacts of natural gas are those shown in Subsection 9.2.3.2. Also, the renewable part of the alternative combination is any combination of renewable technologies that could produce power equal to or less than the proposed CPNPP Units 3 and 4, when that resource is available.

In the economic comparison portion of this review, coal was chosen to be used in combination with the renewable power source. Coal was chosen as a fuel over natural gas because coal-fired power plants can generate electricity at a lower cost than natural gas plants. The economic comparison is based on generation costs for coal and natural gas identified in Subsections 9.2.2.9 and 9.2.2.10.

9.2.3.3.2 Environmental Impacts

The overall environmental impacts associated with the construction and operation of the natural gas-fired alternative are summarized in Table 9.2-1 and are discussed in Subsection 9.2.3.2. Depending on the amount of renewable output included in the combination alternative, the level of environmental impacts of the natural-gas-fired portion would be comparatively lower. If 100 percent of the power level of the natural-gas-fired portion were not available from the renewable alternative, then some level of environmental impact associated with the natural gas portion would remain. When 100 percent of the load is carried by the renewable portion, the environmental impact of the operation of the natural-gas-fired portion is eliminated. A determination of the types of environmental impacts that a combination of these alternatives would have can be made from the information previously evaluated.

The environmental impacts associated with a natural-gas-fired facility and equivalent renewable facilities are summarized in Table 9.2-1. The natural-gas-fired facility alone has impacts that are greater than the proposed CPNPP Units 3 and 4. Some of the environmental impacts of the renewable energy sources are equal to or greater than those of the proposed CPNPP Units 3 and 4. The combination of a natural gas-fired plant and wind or solar facilities would have environmental impacts that are equal to or greater than those of a nuclear facility.

The environmental impacts from a natural-gas-fired plant are SMALL to MODERATE. Land-use impacts from wind and solar facilities could be SMALL to LARGE, and the aesthetic impacts of wind could be SMALL to MODERATE, depending upon the size of the facilities: the smaller the size of the wind/solar facilities, the larger the air impacts from the gas-fired plant. The environmental impacts from the use of wind and solar facilities in combination with a natural-gas-fired facility would be SMALL, except for land use and aesthetic impacts from wind and solar facilities that range from SMALL to LARGE, and the air impacts from the gas-fired facility that would range from SMALL to MODERATE. In comparison, the environmental impacts of the proposed CPNPP Units 3 and 4 would be SMALL. A combination of alternatives would not be environmentally preferable to CPNPP Units 3 and 4. At best, the combination of wind and solar facilities, and a natural-gas-fired facility would have greater environmental impacts than the proposed CPNPP Units 3 and 4.

9.2.3.3.3 Health Effects

As indicated in Subsections 9.2.2 and 9.2.3, the health effects associated with any individual alternative energy source would be considered SMALL. Any combination of alternatives would also have a SMALL impact on human health, equivalent to the proposed CPNPP Units 3 and 4.

9.2.3.3.4 Economic Comparison

For the combination of alternatives to pass an economic comparison, the cost of the generation using all generation pairing levels of the combination are considered. That is, 100 percent wind power, or 100 percent coal power, or 90 percent wind and 10 percent coal, and so forth, must be shown to cost less to generate electricity as compared to the proposed CPNPP Units 3 and 4. Also in consideration is the fact that coal or other plants cost more per MW to operate when not running at 100 percent capacity, because the capital and fixed operating costs are loaded across fewer MWh, increasing the cost per MWh.

The overall costs of generation of electricity for nuclear are $0.02/kWh to $0.035/kWh (NINI 2004), $0.064/kWh for coal, and $0.068/kWh for natural gas. Solar ranges from $0.09/kWh to $0.23/kWh, and wind from $0.03/kWh to $0.05/kWh. The project costs associated with all other forms of generation are greater than that of the proposed CPNPP Units 3 and 4. Any combination of wind and solar facilities, and a coal-fired facility is not economically preferable to the proposed CPNPP Units 3 and 4, and need not be considered further.

9.2.3.3.5 Summary

Although other combinations of the various alternatives are not discussed here, the lower capacity factors, higher environmental impacts, immature technologies, and lack of cost competitiveness have not been found to assemble into a viable, competitive alternative combination that is either environmentally equivalent or preferable.

Wind and solar generation in combination with fossil-fuel-fired facilities could be used to generate baseload power and would serve the equivalent purpose of the proposed CPNPP Units 3 and 4. Wind and solar generation in combination with fossil-fuel-fired facilities would have equivalent or greater environmental impacts as compared to two additional nuclear units at the CPNPP site. Wind and solar generation in combination with fossil-fuel-fired facilities are not preferable to the proposed CPNPP Units 3 and 4.

9.2.4 CONCLUSION

As shown in detail in Table 9.2-1, based on environmental impacts, the analyses demonstrate that either a coal-fired or a natural-gas-fired plant would entail an appreciably greater environmental impact on air quality than would the proposed CPNPP Units 3 and 4. A combination of either of these two types of generation with renewable sources of energy such as wind or solar is possible, but to achieve a significantly smaller impact on the air quality, a MODERATE to LARGE impact on land would be required. Luminant concludes that neither a coal-fired, nor natural-gas-fired plant, nor a combination of alternatives would be environmentally preferable to the proposed CPNPP Units 3 and 4. Also, these alternatives would have higher economic costs and are not economically preferable to the proposed CPNPP Units 3 and 4.

However, per NUREG-1555, a full-cost benefit analysis is not required, as none of the alternatives have been found to be environmentally preferable.

9.2.5 REFERENCES

(Abengoa 2009) Projects In USA: Arizona: Location Gila Bend Near Phoenix: Type of Project 280 MWe, CPS. Abengoa Solar. http://www.abengoasolar.es/sites/solar/en/our_projects/usa/arizona/index.html. Accessed September 23, 2009.

(AWEA 2009) Annual Wind Industry Report Year Ending 2008. American Wind Energy Association. Washington, D.C.

(BSII 2006) Big Stone II Plant Project overview. http://www.bigstoneii.com/PlantProject/PlantProjectOverview.asp. Accessed February 2008.

(BTI 2000) Projects. Fuel Cells 2000. Breakthrough Technologies Institute (BTI). http://www.fuelcells.org/db/projects.php. Accessed February 2008.

(BW 2005) Alternate Power: A Change Is in the Wind. Business Week, July 4, 2005, News Analysis and Commentary. http://www.businessweek.com/magazine/content/05_27/b3941036_mz011.htm?chan=search. Accessed February 2008.

(CCI 2007) Chambers County Incinerator. Chambers County Resource Recovery & Recycling Facility http://chamberscountyincinerator.com/about.asp. Accessed February 2008.

(CEC 2003) “Renewable Resources Development Report.” Sacramento, CA. California Energy Commission Contract No. 500-03-080F http://www.energy.ca.gov/reports/2003-11-24_500-03-080F.PDF. November 2003. Accessed September 28, 2009.

(CEED 2006) Geothermal Energy in Gulf Coast Texas. Center for Energy and Economic Diversification. http://www.utpb.edu/ceed/renewableenergy/gulf_coast_texas.htm. Accessed February 2008.

(CGT 2007) Geothermal Powerplants. Cogeneration Technologies. http://www.cogeneration.net/geothermal_powerplants.html. Accessed January 2008.

(CSA 2009) Navajo County to host world’s largest solar project. Jayne Hanson, Today’s News Herald. Reprinted from County Supervisors Association of Arizona website. http://www.countysupervisors.org/news/view_article.cfm. Accessed September 23, 2009.

(CSP undated) CSP Technologies Overview. U.S. Department of Energy CSP Technologies. www.energylan.sandia.gov/sunlab/overview.htm#cost. Accessed January 2008.

(DOE 2001) How Hydropower Works. Idaho National Laboratory. June 2001.U.S. Department of Energy. http://hydropower.id.doe.gov/hydrofacts/pdfs/01-ga50627-01-brochure.pdf. Accessed February 2008.

(DOE 2009) Distributed Energy Program: Case Studies – Energy Storage Technologies. U.S. Department of Energy. http://www.eere.energy.gov/de/cs_energy_storage.html. Accessed September 4, 2009.

(EERE 2005) Wind Energy Resource Potential. U.S. Department of Energy. Energy Efficiency and Renewable Energy. www1.eere.energy.gov/windandhydro/wind_potential.html. September 2005. Accessed February 2008.

(EERE 2006) Furthering Energy Independence. U.S. Department of Energy. Energy Efficiency and Renewable Energy. Solar Energy Technology Program. www1.eere.energy.gov/office_eere/pdfs/solar_fs.pdf. July 2006. Accessed February 2008.

(EFH 2007) Luminant and Shell Join Forces to Develop a Texas-Sized Wind Farm. Energy Future Holdings News Release. http://www.energyfutureholdings.com/news/newsrel/detail.aspx Accessed September 9, 2009.

(EIA 2006) Net Generation by Energy Source by Type of Producer. October 2006. U.S. Department of Energy. Energy Information Administration. www.eia.doe.gov/cneaf/electricity/epa/epat1p1.html. Accessed February 2008.

(EIA 2006b) Assumptions to the Annual Energy Outlook. DOE/EIA-0554(2006). March 2006. U.S. Department of Energy. Energy Information Administration. www.eia.doe.gov/oiaf/aeo/assumption/pdf/ 0554(2006).pdf. Accessed February 2008.

(EIA 2007) Cost and Quality of Fuels for Electric Plants 2005 and 2006. Table 14.A. Receipts and Average Delivered Cost of Natural Gas by Type of Purchase, Census Division, and State: Total (All Sectors), 2006. October 2007. U.S. Department of Energy. Energy Information Administration. www.eia.doe.gov/cneaf/electricity/cq/cq_sum.html.

(EIA 2007a) Summary Statistics: Receipts and Cost of Fossil Fuels for the Electric Power Industry by Sector, Btus. October 2007. U.S. Department of Energy. Energy Information Administration. www.eia.doe.gov/cneaf/electricity/epm/tablees2b.html.

(EPA 1998) Bituminous and Subbituminous Coal Combustion. Air Pollutant Emission Factors. Volume 1, Stationary Point Sources and Area Sources, Section 1.1. September 1998. U.S. Environmental Protection Agency. www.epa.gov/ttn/chief/ap42/. Accessed February 2008.

(EPA 2000) Stationary Gas Turbines. Air Pollutant Emission Factors. Volume 1, Stationary Point Sources and Area Sources, Section 3.1, AP-42. April 2000. U.S. Environmental Protection Agency. www.epa.gov/ttn/chief/ap42/ch03/final/c03s01.pdf. Accessed February 2008.

(EPRI 2005) Status & Trends for Stationary Fuel Cell Power Systems. 2005. Electric Power Research Institute. http://www.mitstanfordberkeleynano.org/events_past/0507%20-%20Fuel%20Cell/Stanford%20Fuel%20Cell%20Symposium.pdf. Accessed February 2008.

(ERCOT 2006) Analysis of Transmission Alternatives for Competitive Renewable Energy Zones in Texas. ERCOT System Planning, December 2006. Electric Reliability Council of Texas, Inc.

http://www.ercot.com/news/presentations/2006/ATTCH_A_CREZ_Analysis_Report.pdf. Accessed April 2008.

(ERCOT 2007) ERCOT Quick Facts. May 2007. ERCOT fact sheet. Electric Reliability Council of Texas, Inc. www.ercot.com/about/profile/index.html. Accessed February 2008.

(ERCOT 2007a) System Planning 2007. Report on the Capacity, Demand, and Reserves in the ERCOT Region. Electric Reliability Council of Texas, Inc. http://www.ercot.com. Accessed February 2008.

(ERCOT 2007b) Nuts and Bolts of Connecting Projects to ERCOT, Impacts of CREZ on Transmission Build-out and Wind Power Opportunities in the Texas Market Workshop. November 28, 2007. Electric Reliability Council of Texas, Inc. http://www.ercot.com/news/presentations/2007/Bojorquez_-_Nuts_and_Bolts_of_Wind_Integration_-_11282007.ppt. Accessed February 2008.

(ERCOT 2007c) Unit Data121807. Unit Information. EXCEL data spreadsheet, December 18, 2007. Electric Reliability Council of Texas, Inc. (FCT undated) Advantages – Disadvantages. Fuel Cell Today. http://www.fuelcelltoday.com/media/pdf/education-kit/Advantage-Disadvantages.pdf. Accessed February 2008.

(ESC 2002) Energy Storage, The Missing Link in the Electricity Value Chain; an ESC White Paper. Energy Storage Council. St. Louis, Missouri.

(FCT undated) Advantages - Disadvantages. Fuel Cell Today. http://www.fuelcelltoday.com/media/pdf/education-kit/Advantage-Disadvantages.pdf. Accessed February 2008.

(FPL 2006) Horse Hollow Wind Energy Center now largest wind farm in the world. September 7, 2006 press release. Florida Power and Light. www.fplenergy.com/news/contents/090706.shtml. Accessed February 2008.

(FPL 2007) Horse Hollow Wind Energy Centers. project fact sheets, 2007. Florida Power and Light. http://www.fplenergy.com/portfolio/pdf/horsehollow.pdf. Accessed February 2008.

(FPSC 2003) An Assessment of Renewable Electric Generating Technologies for Florida. January 2003. Florida Public Service Commission and the Department of Environmental Protection. www.psc.state.fl.us/publications/ pdf/electricgas/Renewable_Energy_Assessment.pdf. Accessed February 2008.

(GAO 2004) Renewable Energy, Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities. GAO-04-756. September 2004. U.S. General Accountability Office. http://www.gao.gov/new.items/d04756.pdf. Accessed February 2008.

(GEA undated) All about Geothermal Energy – Basics. Undated. Geothermal Energy Association. http://www.geo-energy.org/aboutGE/basics.asp. Accessed February 2008.

(GEPS 2000) GE Combined-Cycle Product Line and Performance. Chase & Kehoe, GER-3574G, October 2000. Geothermal Energy Association. www.gepower.com/prod_serv/products/tech_docs/en/downloads/ger3574g.pdf. Accessed February 2008.

(GTC 2005) Reliability of IGCC Power Plants. Higman, DellaVilla, & Steele. October 2005. Gasification Technologies Conference, San Francisco. www.gasification.org/Docs/ 2005_Papers/38HIGM%20Paper.pdf. Accessed February 2008.

(IEC 2006) Wind Energy Economics. Wind Energy Manual. 2006. Iowa Energy Center. www.energy.iastate.edu/renewable/wind/wem/economic_issues.htm. Accessed February 2008.

(ISEP 2006) About the Iowa Stored Energy Park. Website for Iowa Stored Energy Park. http://www.isepa.com/about_isep.asp. Accessed September 4, 2009.

(Lockheed Martin 2009) Lockheed Martin to Support Utility-scale Solar Power Plant in Arizona. Lockheed Martin News Release. http://www.lockheedmartin.com/news/press_releases/2009/052209_LM_Starwood_Energy.html. Accessed September 23, 2009.

(NETL undated) Combustion - Fluidized-Bed Combustion, Program Overview. undated. U.S. Department of Energy. National Energy Technology Laboratory (NETL). www.netl.doe.gov/technologies/coalpower/Combustion/FBC/fbc-overview.html. Accessed February 2008.

(NETL 1999) Market-Based Advanced Coal Power Systems Final Report. DOE/FE-0400. 1999. U.S. Department of Energy. National Energy Technology Laboratory (NETL). http://www.netl.doe.gov/technologies/coalpower/refshelf/marketbased_systems_report.pdf. Accessed February 2008.

(NETL 2005) Final Technical Report for the JEA Large-Scale CFB Combustion Demonstration Project. Prepared by Black & Veatch. Submitted to U.S. Department of Energy National Energy Technology Laboratory (NETL). http://www.netl.doe.gov/technologies/coalpower/cctc/resources/pdfs/jacks/Final_Technical_Report_Compendium.pdf. June 24, 2005. Accessed February 2008.

(NETL 2007) Cost and Performance Baseline for Fossil Energy Plants. DOE/NETL 2007/1281. Bituminous Coal and Natural Gas to Electricity, Final Report (Original Issue Date, May 2007), Revision 1, August 2007.

(NINI 2004) Levelized Costs for Nuclear, Gas and Coal for Electricity, Under the Mexican Scenario. 2004. National Institute of Nuclear Investigations. www.osti.gov/bridge/servlets/purl/840500-YJxBpR/native/840500.pdf.

(NJCEP 2005) Frequently Asked Questions – Off Shore Wind Systems. April 14, 2005. NJ Clean Energy Program. http://www.njcleanenergy.com/renewable-energy/technologies/wind/wind-working-group/faqs/faqs. Accessed February 2008.

(NP 2007) Project Info. 2007. Nacogdoches Power. http://www.nacogdochespower.com/ProjectInfo.html. Accessed February 2008.

(NREL 2001) Concentrating Solar Power: Energy from Mirrors. National Renewable Energy Laboratory produced for U.S. Department of Energy report # DOE/GO-102001-1147 FS 128. Golden, Colorado.

(NREL 2002) Fuel from the Sky: Solar Power's Potential for Western Energy Supply. July 2002. US National Renewable Energy Laboratory. www.nrel.gov/csp/pdfs/32160.pdf. Accessed February 2008.

(NREL 2006) Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California. Black and Veatch Subcontract Report NREL/SR-550-39291 produced for National Renewable Energy Laboratory, Golden Colorado.

(NRRI 2007) What Generation Mix Suits Your State? Tools for Comparing Fourteen Technologies across Nine Criteria. 2007. National Regulatory Research Institute. http://coalcandothat.com/pdf/35%20GenMixStateToolsAndCriteria.pdf. Accessed February 2008.

(PEI 2008) Compressed Air Energy Storage: Theory, Resources, and Applications for Wind Power. Princeton Environmental Institute, Energy Systems Analysis Group. Princeton, New Jersey.

(PEL 2009). 2008 State of the Market Report for the ERCOT Wholesale Electricity Markets. Potomac Economics, LTD. Austin, Texas.

(PEPEI 2009) Duke to develop storage for Texas wind farm. Power Engineering/Power Engineering International website. http://pepei.pennnet.com. Accessed November 25, 2009.

(PG&E 2007) PG&E Signs Agreement with Solel for 553 Megawatts of Solar Power. news release July 25, 2007. PG&E. http://www.pge.com/news/news_releases/q3_2007/070725a.html. Accessed February 2008.

(REPP 2003) Geothermal Energy for Electric Power, Renewable Energy Policy Project. December 2003. Renewable Energy Policy Project. http://www.repp.org/repp/index.html. Accessed February 2008.

(RES 2005) The Economic Impact of CAES on Wind in TX, OK, and MN, prepared for the Texas State Energy Conservation Office. Ridge Energy Storage and Grid Services, L.P. Houston, Texas.

(REW 2009) Duke Receives US $22M Grant for Wind Power Storage. Renewable Energy World website. http://www.renewableenergyworld.com. Accessed November 25, 2009.

(RTII 2003) Beyond-The-Floor Analysis For Existing And New Coal- And Oil-Fired Electric Utility Steam Generating Units National Emission Standards For Hazardous Air Pollutants. December 2003. RTI International. www.epa.gov/ttn/atw/utility/beyond_floor_012804.pdf. Accessed February 2008.

(SECO 2007) Texas Solar Energy. 2007. State Energy Conservation Office. http://www.seco.cpa.state.tx.us/re_solar.html. Accessed February 2008.

(SECO 2007a) Texas Biomass Energy. 2007. State Energy Conservation Office. http://www.seco.cpa.state.tx.us/re_biomass.html. Accessed February 2008.

(SNL 2009) Concentrating Solar Power. Sandia National Laboratories. http://www.sandia.gov/csp/. Accessed September 8, 2009.

(Solarbuzz 2007) Fast Solar Energy Facts. Global Performance. March 2007. Solarbuzz LLC. www.solarbuzz.com/FastFactsIndustry.html. Accessed February 2008.

(SORR undated) Biomass Energy: Cost of Production. undated. State of Oregon, Renewable Resources. www.oregon.gov/ENERGY/RENEW/Biomass/Cost.shtml. Accessed February 2008.

(Technology for Life 2009) Albiasa Solar to Build a 200 MW Concentrating Solar Power Plant in Arizona. Technology for Life website. http://technology4life.wordpress.com/2009/04/21/albiasa-solar-to-build-a-200-mw-concentrating-solar-power-plant-in-arizona. Accessed September 23, 2009.

(TCEQ 2007) Air Quality and the State Implementation Plan. Texas SIP 101. January 2007. Texas Commission on Environmental Quality. www.tceq.state.tx.us/implementation/air/sip/sipintro.html. Accessed February 2008.

(TCEQ 2007a) History of the Texas State Implementation Plan. May 2007. Texas Commission on Environmental Quality. www.tceq.state.tx.us/assets/public/implementation/air/sip/miscdocs/SIPHistory_updated.pdf. Accessed February 2008.

(TCPS 1995) Texas Environmental Almanac. 1995. Texas Center for Policy Studies. http://www.texascenter.org/almanac/TXENVALMANAC.html. Accessed February 2008.

(TGLO 2007) Land Office Awards Texas' first geothermal lease. press release February 6, 2007. Texas General Land Office. http://www.glo.state.tx.us/news/docs/2007-Releases/02-06-07-Geothermal-AWARD.pdf. Accessed February 2008.

(UC 2004) The Economic Future of Nuclear Power. August 2004. The University of Chicago. http://www.anl.gov/Special_Reports/NuclEconSumAug04.pdf. Accessed February 2008.

(VERA 1995) Texas Renewable Energy Resource Assessment. 1995 Report to the Texas Sustainable Energy Development Council. Virtus Energy Research Associates. http://www.vera.com/re_home.htm. Accessed February 2008.

TABLE 9.2-1
COMPARISON OF ENVIRONMENTAL IMPACTS OF ALTERNATIVE ENERGY SOURCES TO A NUCLEAR UNIT

Category	Nuclear	Coal	Natural Gas	Combinations
Air Quality	Small	Moderate	Small to Moderate	Small to Moderate
Land Use	Small	Moderate	Moderate	Small to Large
Ecology (including threatened and endangered species	Small	Small	Small	Small to Medium
Water Use and Quality	Small	Small	Small	Small
Waste Management	Small	Moderate	Small	Small to Large
Human Health	Small	Small	Small	Small
Socioeconomic	Small (Beneficial) to Large (Beneficial)	Small (Beneficial)	Moderate (Beneficial)	Small (Beneficial) to Large (Beneficial)
Aesthetics	Small	Small	Small	Small to Moderate
Historic and Cultural Resources	Small	Small	Small	Small
Environmental Justice	Small	Small	Small	Small

TABLE 9.2-2 (Sheet 1 of 2)
COAL-FIRED ALTERNATIVE

CHARACTERISTIC	BASIS
Unit size = 530 MW ISO rating net[(a)]	Assumed.
Unit size = 562 MW ISO rating gross[(a)]	Calculated based on 6% on-site power consumption.
Number of units = 6	Assumed.
Boiler Type = PC, dry bottom, tangentially fired, Sub-bituminous, NSPS	Assumed boiler type (EPA 1998).
Fuel Type = Powder River Basin Sub-bituminous coal	Typical for coal used in Texas.
Fuel heating value = 8670 Btu/lb	2006 value for coal used in Texas (EIA 2007).
Fuel consumption = 14,500 Tpy (coal)	Calculated from above values.
Fuel ash content by weight = 5.21%	2006 value for coal **used** in Texas, Wyoming coal (EIA 2007).
Fuel sulfur content by weight = 0.31%	2006 value for coal **used** in Texas, Wyoming coal (EIA 2007).
Uncontrolled NO_x emission = 10 lb/ton	Typical for pulverized coal, tangentially fired, dry-bottom, NSPS (EPA 1998).
Uncontrolled CO emission = 0.5 lb/ton	Typical for pulverized coal, tangentially fired, dry-bottom, NSPS (EPA 1998).
Heat rate = 10,000 Btu/kWh	Assumed based on DOE data (NETL 1999).
Capacity factor = 0.85	Typical design value for large coal-fired units.
NO_x control = low NO_x burners, overfire air and selective catalytic reduction (95% reduction)	Best available to minimize NO_x emissions (EPA 1998).
Particulate control = fabric filters (baghouse-99.9% removal efficiency)	Best available for minimizing particulate emissions (EPA 1998).
SO_x control = Wet scrubber - limestone (95% removal efficiency)	Best available for minimizing SO_x emissions (EPA 1998).

TABLE 9.2-2 (Sheet 2 of 2)
COAL-FIRED ALTERNATIVE

CHARACTERISTIC	BASIS
Uncontrolled PM = 10 lb/ton	Typical value for pulverized coal, dry bottom (EPA 1998).
Uncontrolled PM10 = 2.3 lb/ton	Typical value for pulverized coal, dry bottom (EPA 2000).
Density of pulverized limestone = .0435 tons/ft^3	Typical value for pulverized limestone.

a) The difference between "net" and "gross" is electricity consumed on-site.

Btu = British thermal unit.
CO = carbon monoxide.
lb = pounds.
ISO rating = International Standards Organization rating at standard atmospheric conditions of 59°F, 60 percent relative humidity and 14.696 pounds of atmospheric pressure per square inch.
kWh = kilowatt hour.
MW = megawatt.
NSPS = New Source Performance Standards.
NO_x = nitrogen oxides.
PM = particulate matter.
PM_{10} = particulates having a diameter of 10 microns or less.
SO_x = sulfur oxides.

TABLE 9.2-3
AIR EMISSIONS FROM THE 3180 MW COAL-FIRED ALTERNATIVE

Parameter	Calculation	Result
Annual Coal Consumption	$6\text{units} \times \frac{562\text{MW}}{\text{unit}} \times \frac{10,000(\text{Btu})}{\text{kWh}} \times \frac{1000\text{kW}}{\text{MW}} \times 0.85 \times \frac{\text{lb}}{8670\text{Btu}} \times \frac{1\text{ton}}{2000\text{lb}} \times \frac{8760\text{h}}{\text{yr}}$	14,500,000 Tpy
SO_X	$38 \times \frac{0.31\text{lb}}{\text{ton}} \times 0.05 \times \frac{1\text{ton}}{2000\text{lb}} \times \frac{14,500,000\text{tons}}{\text{yr}}$	4270 Tpy
NO_X	$\frac{10\text{lb}}{\text{ton}} \times 0.05 \times \frac{1\text{ton}}{2000\text{lb}} \times \frac{14,500,000\text{tons}}{\text{yr}}$	3625 Tpy
CO	$\frac{0.5\text{lb}}{\text{ton}} \times \frac{1\text{ton}}{2000\text{lb}} \times \frac{14,500,000\text{tons}}{\text{yr}}$	3625 Tpy
CO_2	$\frac{4810\text{lb}}{\text{ton}} \times \frac{1\text{ton}}{2000\text{lb}} \times \frac{14,500,000\text{tons}}{\text{yr}}$	35,000,000 Tpy
PM (particulate matter)	$10 \times 5.21 \times 0.001 \times \frac{1\text{ton}}{2000\text{lb}} \times \frac{14,500,000\text{tons}}{\text{yr}}$	378 Tpy
PM_{10} (particulate matter less than 10 microns diameter)	$2.3 \times 5.21 \times 0.001 \times \frac{1\text{ton}}{2000\text{lb}} \times \frac{14,500,000\text{tons}}{\text{yr}}$	87 Tpy

Note: The calculation in this table is done only in English units.

TABLE 9.2-4
NATURAL GAS-FIRED ALTERNATIVE

CHARACTERISTIC	BASIS
Unit size = 530 MW ISO rating net[(a)]	Assumed.
Unit size = 551 MW ISO rating gross[(a)]	Calculated based on 4% on-site power consumption.
Number of units = 6	Assumed.
Fuel type = natural gas	Assumed.
Cost per MMBtu = 555 cents	(EIA 2006b).
Cost per Mcf = $5.57	(EIA 2006b).
Fuel heating value = 1004 Btu/cf	2006 value for gas used in Texas (EIA 2007) (combination of 555 cents per MMBtu with $5.57 per Mcf).
Fuel consumption = 148,091,150,438 cf/yr	Calculated from above values.
SO_x emission factor = 0.034 lb/MMBtu	(EPA 2000).
NO_x control = selective catalytic reduction (SCR) with steam/water injection	Best available technology for minimizing NO_x emissions (EPA 2000).
NO_x emission factor = 0.13 lb/MMBtu	(EPA 2000).
CO emission factor = 0.015 lb/MMBtu	(EPA 2000).
$PM_{2.5}$ emission factor[(b)] = 0.0019 lb/MMBtu	(EPA 2000).
Heat rate = 6040 Btu/kWh	(GEPS 2000).
Capacity Factor = 0.85	Assumed based on performance of modern plants.

a) The difference between “net” and “gross” is electricity consumed on-site.

b) All particulate matter is $PM_{2.5}$.

Btu = British thermal unit.
Mcf = thousand cubic feet.
ISO rating = International Standards Organization rating at standard atmospheric conditions of 59°F, 60 percent relative humidity and 14.696 pounds of atmospheric pressure per square inch.
kWh = kilowatt hour.
MMBtu = million Btu.
MW = megawatt.
NO_x = nitrogen oxides.
$PM_{2.5}$ = particulates having diameter of 2.5 microns or less.

TABLE 9.2-5 (Sheet 1 of 2)
AIR EMISSIONS FROM THE 3180 MW NATURAL GAS-FIRED ALTERNATIVE

Parameter	Calculation	Result
Btu/cu ft	$\frac{\$5.57}{\text{Mcf}} \times \frac{\text{MMBtu}}{\$5.55} \times \frac{1,000,000\text{Btu}}{\text{MBtu}} \times \frac{\text{Mcf}}{1000\text{cf}}$	1004 Btu/cf
Annual Gas Consumption	$6\text{units} \times \frac{551\text{MW}}{\text{unit}} \times \frac{6040\text{Btu}}{\text{kWh}} \times \frac{1000\text{kW}}{\text{MW}} \times 0.85 \times \frac{\text{cf}}{1004\text{Btu}}$	148,091,150,438 cf/yr
Annual Btu Input	$\frac{148,091,150,438\text{cf}}{\text{yr}} \times \frac{1004\text{Btu}}{\text{cf}} \times \frac{\text{MMBtu}}{1,000,000\text{Btu}}$	148,683,515 MMBtu/yr
SO_X	$\frac{0.0034\text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2000\text{lb}} \times \frac{148,683,515\text{MMBtu}}{\text{yr}}$	253 Tpy
NO_X	$\frac{0.036\text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2000\text{lb}} \times \frac{148,683,515\text{MMBtu}}{\text{yr}}$	267 Tpy
CO	$\frac{0.015\text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2000\text{lb}} \times \frac{148,683,515\text{MMBtu}}{\text{yr}}$	1115 Tpy
CO_2	$\frac{110\text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2000\text{lb}} \times \frac{148,683,515\text{MMBtu}}{\text{yr}}$	8,177,593 Tpy
PM (particulate matter)	$\frac{0.019\text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2000\text{lb}} \times \frac{148,683,515\text{MMBtu}}{\text{yr}}$	142 Tpy

TABLE 9.2-5 (Sheet 2 of 2)
AIR EMISSIONS FROM THE 3180 MW NATURAL GAS-FIRED ALTERNATIVE

Parameter	Calculation	Result
$PM_{2.5}$ (particulate matter less than 2.5 microns diameter)	142 Tpy (all PM is $PM_{2.5}$)	142 Tpy

Note: the calculation in this table is done only in English units.

$PM_{2.5}$ = particulates having diameter of 2.5 microns or less.

TABLE 9.2-6 (Sheet 1 of 2)
DESIGN ALTERNATES THAT HAVE BEEN CONSIDERED FOR WATER TREATMENT OPTIONS

OPTION NO. (Per Unit)	ADVANTAGES	DISADVANTAGES
1. Divert and treat 46% (~5940 gpm) of cooling tower blow down to produce a blended effluent concentration of 2500 mg/l.	• Continue to operate at 2.4 COC, thus maintaining BD and MU rates. • Blended effluent TDS is reduced to 2500 mg/l which is present Lake Granbury water quality standard.	• Diversion of ~46% of BD requires greatest amount of water treatment equipment and largest new evaporation pond (6 million gallons) for waste concentrates. • Additional facility with associated operation / maintenance.
2. Divert and treat ~30.7% % (~3964 gpm) of cooling tower blow down to produce a blended effluent concentration of 3000 mg/l.	• Continue to operate at 2.4 COC, thus maintaining BD and MU rates. • Blended effluent TDS is reduced to 3000 mg/l which is a reduction of 25% from 4000 mg/l	• Diversion of ~30.7% of BD requires large amount of water treatment equipment and large new evaporation pond (4.5 million gallons) for waste concentrates. • Additional facility with associated operation/maintenance. • requires variance in present 2500 mg/l Lake Granbury water quality standard
3. Divert and treat 18% (~2320 gpm) of cooling tower blow down to produce a blended effluent concentration of 3500 mg/l.	• Continue to operate at 2.4 COC, thus maintaining BD and MU rates. • Blended effluent TDS is reduced to 3500 mg/l which is a reduction of 12.5% from 4000 mg/l • 3500 mg/l is the Possum Kingdom present limit.	• Diversion of ~18% of BD requires least amount of water treatment equipment and smaller new evaporation pond (3 million gallons) for waste concentrates. • Additional facility with associated operation/maintenance. • Requires variance in present 2500 mg/l LG water quality std.
4. Divert excess cooling tower makeup (~28%, ~8626 gpm)) from Lake Granbury, treat and blend to produce an effluent concentration of 2500 mg/l	• Continue to operate at 2.4 COC, thus maintaining BD and MU rates. • Blended effluent TDS is reduced to 2500 mg/l which is present to LG water quality std. • MU is a less concentrated TDS ~1680mg/l which utilizes smaller and more efficient WT equipment (92.5% recovery).	• Gross Make-up pumping demand increased. • Gross BD rate increases. • Additional WT facility with associated operation/maintenance is required. • New 3 million gallon evaporation pond required for waste concentrates.

TABLE 9.2-6 (Sheet 2 of 2)
DESIGN ALTERNATES THAT HAVE BEEN CONSIDERED FOR WATER TREATMENT OPTIONS

OPTION NO. (Per Unit)	ADVANTAGES	DISADVANTAGES
5a. Increase tower COC to 5.0 with increased chemical feed and treatment. Produces 4540 gpm concentrated effluent @ 8400 mg/l to Possum Kingdom.	• Reduces the LG make-up requirement by over 25%. • Reduces the MU pumping costs and line sizes. • Potential to send softener regenerant flow to existing evaporation pond. • BD rate is significantly reduced, therefore reducing discharge lines.	• Approximately twice the chemical usage cost as 2.4 design. • Additional chemical feed storage and handling equipment. • Additional softening equipment required. • High effluent concentration of ~8400 mg/l. • Long pumping distance to PK. • Large new shallow evaporation pond >25 million gallons.
5b. Increase tower COC to 5.0 with increased chemical feed and treatment. Produces 4540 gpm concentrated effluent @ 8400 mg/l to deep well injection.		
5c. Increase tower COC to 5.0 with increased chemical feed and treatment. Produces 4540 gpm concentrated effluent @ 8400 mg/l to new 25 million gal. Evap. Pond.		
6. Hybrid Wet/Dry Tower Option. Partial recovery (15% approx) and blend of evaporation from hybrid cooling tower.		Option not considered. Cost is three times higher ($114 million vs. $34 million) when compared to Mechanical Draft Wet Type CT's.
7. Closed-cycle system. Divert and treat 65% (~8,400 gpm) of cooling tower blowdown to produce a blended returning water concentration equalize with MU from Lake Granbury.	• Continue to operate at 2.4 COC, thus maintaining BD and MU rates. • Returning water TDS is reduced to maintain in continuous operation of cooling tower.	• Continuous operation is generate to more solid waste. • BDTF need to be in continuous operation, redundancy will need to be considered for the design. • Discharge line is needed in order to maintenance on equipment such as cooling tower basin, pumps and evaporation pond.

9.3 ALTERNATIVE SITES

The National Environmental Policy Act (NEPA) of 1969 and the U.S. Nuclear Regulatory Commission (NRC) implementing regulations require that reasonable alternatives to federal proposed projects be evaluated. The concept of candidates includes alternative locations for siting a proposed project. The NRC Regulatory Guide (RG) 4.2, “Preparation of Environmental Reports for Nuclear Power Stations,” offers the following terms and definitions for discussion of the site-selection process.

Site Selection Category	Definition
Region of Interest (ROI)	The geographical area initially considered in the site selection process. This area may represent the applicant’s system, the power pool or area within which the applicant’s planning studies are based, or the regional reliability council or the appropriate sub region or area of the reliability council.
Candidate Areas	Reasonable homogeneous areas within the ROI investigated for potential sites. Candidate areas may be made out of a single large area or several unconnected ones. The criteria governing a candidate area are the same resources and populations on which the potential plant would have an impact and similar facility costs.
Potential Sites	Sites which are within the Electric Reliability Council of Texas (ERCOT) service area (Figure 8.1-1). They have been identified through preliminary assessment and are accessible to the basic plant requirements such as water, transmission corridors, land area, and rail. These sites become the pool for establishing the candidate sites.
Candidate Sites	“Potential Sites” suitable for further evaluation then become “Candidate Sites” To be a candidate site, the site must be considered to be potentially licensable and capable of being developed.
Proposed Site	Sites for which an applicant seeks a license to construct and operate a power station.

The site selection process began by defining a ROI consisting of the Luminant Generation Company LLC (Luminant) service territory (which consists of the ERCOT market area). That market area is depicted by a map (Figure 8.1-1) showing the majority of the counties in Texas as highlighted in pink. This map is from the ERCOT.com website and is current as of February 19, 2008.

Consistent with this direction, Luminant performed a systematic site-selection process to assess locations that were deemed to be reasonable candidate sites and to select the proposed site for the anticipated nuclear power plant.

As dictated by 10 Code of Federal Regulations (CFR) 52.17(a)(2), the following subsection describes the site assessment process that identifies and evaluates potential locations, including the existing CPNPP for construction and operation of the two proposed reactor units. The NRC RG 4.2, Revision 2, Preparation of Environmental Reports for Nuclear Power Stations, states that "the applicant is not expected to conduct detailed environmental studies at alternate sites; only preliminary reconnaissance-type investigations need be conducted."

The information presented in this subsection was obtained from the plant siting report prepared by consultants in the first part of 2007. [Attachment A: (McCallum-Turner 2007)]. Luminant's site-selection process (Subsection 9.3.1) was performed in accordance with direction provided in the NRC RG 4.7 and the Electric Power Research Institute's (EPRI) Siting Guide, referred to as the "Siting Guide" in this subsection (EPRI 2002). The purpose of the site-selection process was to identify a nuclear power plant site that:

- Complies with NEPA requirements regarding the consideration of alternate sites.
- Satisfies applicable NRC site assessment and suitability requirements.
- Complies with applicable requirements of state power plant siting laws and regulations.
- Meets Luminant's business objectives for a nuclear power plant.

Luminant's business objectives are to:

- Identify and assess sites accessible to the ERCOT service area that are suitable for a proposed nuclear power plant; that is, sites that possess necessary resource and infrastructure requirements to support a large two-unit nuclear reactor plant.
- Select a site capable of being acquired and characterized in time to meet the schedule of submitting a combined construction and operating license application (COLA).
- Select a site that minimizes transmission losses.
- Select a site that minimizes capital and operating costs.
- Construct two nuclear units on the proposed site that support baseload power for the ERCOT service area.
- Identify a site that is complimentary with the environment and with the local community.

Pursuant to the Council on Environmental Quality's (CEQ) NEPA Implementing Regulations, agencies are instructed to prepare an EIS so as to present the environmental effects "…of the proposal and the alternates in *comparative form, thus sharply defining the issues and providing a clear basis for choice among options* by the decisionmaker ……." (40 CFR 1502.14, emphasis added). Consistent with this regulatory direction, the siting criteria are presented on an issue-by-issue basis, which allow candidate sites to be evaluated and compared with one another. This comparative format is specifically designed to facilitate the decision-maker understanding of the succinct similarities and distinctions between the alternative sites. Table 9.3-1 summarizes the key environmental impacts of constructing and operating two nuclear reactor plants at the alternative sites.

The final alternative locations described and compared in Table 9.3-2 are:

- The CPNPP site
- Luminant A site
- Luminant B site
- Luminant C site

9.3.1 SITE SELECTION PROCESS

This site assessment was based on the dual unit U.S. advanced pressurized water reactor (US-APWR) facility output. The total electrical generation from both units would be approximately 3250 megawatts electrical (MWe) of baseload nuclear generation.

Site selection was conducted in accordance with the general process outlined in the EPRI Siting Guide, and site suitability considerations set forth in NRC RG 4.7, Revision 2, General Site Suitability Criteria for Nuclear Power Stations. Subsection 9.3.1.1 provides an overview of the siting process. Additional detail on component steps in the site-selection process and results of executing these steps are provided in succeeding subsections.

9.3.1.1 Overview of the Site Selection Process

Site selection was conducted in accordance with the overall process outlined in the Siting Guide (EPRI 2002). This process, as adapted for the Luminant site-selection study, is depicted in Figure 9.3-1.

The site-selection process began by defining a ROI identifying possible sites and reducing the sites under consideration in successive steps. Luminant's ROI (Figure 8.1-1) and its service territory is the ERCOT market area. ERCOT is totally within the state of Texas and because of the tight geographical area, Luminant can market power anywhere within ERCOT.

This process proceeded through the following steps that successively reduced the number of sites down to a final proposed site:

- Identifying candidate areas.
- Selecting potential sites.
- Selecting the candidate sites.
- Selecting the final proposed site.

In the ROI, candidate areas were identified using maps and other publicly available documents. These candidate areas included sites with general access to water, sufficient land to accommodate at least two plants, outside of large populated cities, and reasonable access to Oncor Electric Delivery Company LLC (Oncor) transmission corridors. For those sites that appeared the most promising, aerial helicopter reconnaissance flights were performed to provide additional details and to locate specific potential sites for further investigation; potential sites included both existing plant sites and greenfield sites. Multiple sites were initially identified for further consideration and evaluation as candidate sites. Each was assessed using a set of screening criteria (Subsection 9.3.2.1)(Subsection 9.3.2.2)(Table 9.3-1A)(Table 9.3-2) with site suitability requirements of primary importance.

Following the initial screening, the number of potential sites was expanded based on additional management and consultant input. Once again the sites were evaluated against the criteria. The resulting sites were identified as having the best potential for locating two new nuclear units.

This final group of potential sites went through yet another screening to settle on the four sites that would undergo a detailed assessment as candidate sites. On the ground reconnaissance visits were conducted at each of these four candidate sites as the initial step of an even more detailed evaluation and assessment. Using available data and criteria from the EPRI general site criteria ((EPRI 2002), Section 3.0), specific site suitability evaluations of these four sites were then conducted.

Overall composite site suitability ratings were used for validating the four candidate sites as well as checking the results of the other potential and candidate sites. A proposed site for the nuclear power plant was selected from the set of the four candidate sites, based on the composite ratings and other applicable considerations related to proactive environmental stewardship, and Luminant's business plans and objectives; e.g., public acceptance, nearby population, and COLA schedule considerations, etc.

9.3.2 DETAILS OF THE SCREENING EVALUATIONS

This subsection describes the specific criteria and requirements of the site screening process, the second screening evaluation, the site reconnaissance, and how Luminant identified the final four candidate sites.

9.3.2.1 Initial Site Screening Evaluation

The objective of initial site screening evaluation was to provide initial insights into the relative suitability of the potential sites and to provide guidance on important issues that merit additional detailed evaluation in selection of a proposed site. An overall site suitability was assigned to each site based on a qualitative screening evaluation of the criteria using the following rating definitions:

- Highly suitable – The site appeared to meet or exceed the screening criteria. Highly suitable sites are recommended for consideration for real estate acquisition. Further investigation beyond the scope of this evaluation was required to determine the actual acceptability of this site for final development.

- Moderately suitable – The site appeared to meet the screening criteria; however, these sites are unlikely to be as favorable as other highly suitable sites because some information on the site was not obtainable, or the site was unfavorable compared to other sites in a similar geographic area. Moderately suitable sites were further considered if Luminant determined that an adequate parcel of land could not be acquired at an apparently more favorable site, or if more information became available to re-categorize a specific site as highly suitable.

- Not suitable – The site failed one or more screening level criteria and was not suitable for plant siting.

The following criteria were used for the initial screening evaluation:

- Environmental Acceptability – The sites were examined on a screening level basis for population, adjacent land use, and National Register of Historic Places (NRHP). Criteria ratings are defined as follows: (1) High: The site has no large population centers nearby, no known incompatible land uses, and no known NRHP sites or archaeological sites within 1 mi or within visibility of the site. (2) Medium: The site has no large population centers nearby; is not located on, but may be adjacent to, a sensitive land use, or may be adjacent to a NRHP site or archaeological site. (3) Low: A Low rating means the site is not a feasible location because it is located in or near a large population center, or on a sensitive or incompatible land use. Else, the site severely impacts a known NRHP site or archaeological site.

- Water Availability – The sites with less water availability than design requirements for the US-APWR were considered unacceptable, based on a two-unit requirement.

- Area Availability – Greenfield sites with less than the US-APWR design recommendations were considered unacceptable.

- Transmission Access – Distance to existing transmission lines was considered; capacity of the existing transmission network was not evaluated in the initial screening evaluation.

- Railroad Access – Distance to existing rail infrastructure was considered.

- Geotechnical Acceptability – Sites were examined on a screening basis for (1) soil or rock foundation and general soil type based on the 1:250,000 Geologic Atlas of Texas; rock is preferred, and (2) relative seismic risk based on 2002 USGS National Seismic Hazard Maps. A rating of High has a rock foundation and low seismic risk. A rating of Medium has a soil foundation and low seismic risk. A rating of Low has a soil foundation and moderate seismic risk. There are no high seismic risk areas in Texas.

Several of the sites evaluated were identified as highly suitable and warranted further assessment. One of the sites, initially identified as highly suitable pending confirmatory information regarding water availability, was subsequently shown to be not suitable as the required plant cooling water is not available in the area.

9.3.2.2 Second Screening Evaluation

On completing the initial site screening evaluation, additional modified sites were identified for consideration, and a second site screening evaluation was conducted. The additional sites considered in the second site screening evaluation included sites evaluated initially whose locations were (1) later refined or (2) additional tracts of land were identified at the site.

Several additional sites were identified as candidate sites over the initial screening by management and consultants. These were selected for additional review using the initial site screening criteria in the site-selection process.

9.3.2.3 Site Reconnaissance

On completing the second screening evaluation, sites that were deemed suitable as possible locations for nuclear power plants were visited by Luminant personnel in October 2006. The purpose of these visits was to review site-specific issues at each site. The results of this site reconnaissance visit are provided in [Table 9.3-1.].

9.3.3 EVALUATION OF GENERAL SITE CRITERIA OF THE CANDIDATE SITES

This component of the site-selection process was designed to:

- Further evaluate the potential sites and select a set of candidate sites for detailed evaluation.
- Select the highest priority site (preferred site) for the COLA.

Subsection 9.3.3.1 describes the process used for evaluating candidate sites, while Subsection 9.3.5 describes the process results and the selection of the proposed site.

9.3.3.1 Detail Process for Evaluating Candidate Sites

General siting criteria used to evaluate the candidate sites were derived from those presented in the Siting Guide, Chapter 3 (EPRI 2002). Criteria from the Siting Guide were tailored to reflect issues applicable to – and data available for – the candidate sites. A list of the criteria appears in Table 9.3-2.

The overall process for applying the general site criteria was composed of the three elements identified below.

- Criterion Ratings**.** Each site was assigned a rating for each of the general site evaluation criteria. Only publicly available data sources were used in the site evaluations and analyses. No contacts were made with agency or other sources outside of the Luminant project team.
- Weight Factors. Weight factors reflecting the relative importance of these criteria were developed using methodology consistent with the modified Delphi process.

- Composite Suitability Ratings. Ratings reflecting the overall suitability of each site were developed by multiplying criterion ratings by the criterion weight factors and summing all criteria for each site.

The overall environmental suitability of the candidate sites was approximated by applying the process described above to only the Table 9.3-2 environmental criteria, 2.1.1 through 2.4.1.

The final Candidate sites described and compared in Table 9.3-2 are

- The CPNPP site
- Luminant A site
- Luminant B site
- Luminant C site

Figure 9.3-2 shows the locations of these four candidate sites.

9.3.4 CANDIDATE SITE CRITERIA

The Siting Study evaluated the final candidate sites (Luminant A, CPNPP site, Luminant B, and Luminant C) identified in Subsection 9.3.3.1. The siting study evaluated and compared the candidate sites based on relevant siting criteria presented in the Siting Guide, Chapter 3 (EPRI 2002). The following analysis summarizes and compares the results of the Siting Study for each of the candidate sites.

9.3.4.1 Health And Safety Criteria

This subsection investigates health and safety criteria used in assessing and comparing the candidate sites.

9.3.4.1.1 Accident - Cause Related Criteria

The following subsection considers accident-related criteria and their relationship to site suitability.

9.3.4.1.1.1 Geology and Seismic Hazards

This subsection assesses geologic and seismic hazards for each of the candidate sites. The objective of this criterion was to assess the suitability of the candidate sites with respect to the geologic and seismic setting.

As described below, a numerical system of weights and ratings based upon site suitability criteria was assigned to each of the following geologic/seismic categories:

- Vibratory ground motion.
- Capable tectonic sources.
- Surface faulting and deformation.
- Geologic hazards.
- Soil stability.

The weight and ratings were used to compute an index number for each of these categories. The index numbers for each site were summed to compute an overall geological (GEOL) index that was used to rate and compare candidate sites. With respect to composite GEOL index numbers, higher values indicate more suitable sites.

Vibratory Ground Motion

A seismic measure known as peak ground acceleration (PGA) quantifies the maximum force experienced by a small mass located at the surface of the ground during an earthquake. The PGA provides a hazard index for rating certain types of structures. The units for PGA are in percent of gravity (percent g). For example, an acceleration of 0.35 g is expressed as 35 percent g. As used in this study, PGA is based on a probability of exceedances (PE) of 2 percent in 50 years, or once in 2500 years.

The candidate sites have PGA values shown in Table 9.3-4. Based upon this information, the effects from a potential seismic event are considered to be SMALL for all candidate sites.

Capable Tectonic Structures

The Capable Tectonic Structures subcriterion was used to identify capable or potentially capable tectonic structures within 200 mi of each site. Candidate sites that are furthest from capable or potentially capable, tectonic structures are considered more suitable.

A geologic database (USGS 2000) was utilized to identify capable and potentially capable tectonic sources within 200 mi of each candidate site. It was assumed that capable and potential capable tectonic structures are quaternary features that may generate strong ground motion. These structures fall into two categories:

Class A features have good geologic evidence of tectonic origin and are potentially seismogenic.

Class B features have geologic evidence that supports the existence of a seismogenic fault or suggests quaternary deformation, but the currently available geologic evidence for quaternary tectonic activity is less compelling than for a Class A feature.

Class A Features

No Class A features have been identified within 200 mi of the candidate sites.

Class B Features

Class B Features are detailed on [Table 9.3-5].

Surface Faulting and Deformation

The surface faulting and deformation subcriteria were used to assess site suitability in terms of surface faulting and deformation near the vicinity of each site. Suitability criteria have been established based on the occurrence of surface faulting, and tectonic and non-tectonic structures within a 5-mi and 25-mi radius of the candidate sites, as discussed in the Siting Guide, pages 3 – 7 (EPRI 2002):

Within 5 mi:
No such structures (most suitable).
Potential non-capable structures.
Potential capable structures.
Fault exceeding 1000 ft long (least suitable).

Within 25 mi:
No such structures (most suitable).
Potential non-capable structures.
Potential capable structures (least suitable).

The effects from a potential seismic event are considered to be SMALL for all candidate sites. A thorough investigation and evaluation of the proposed site is expected to be required.

Geologic Hazards

The following Geologic Hazard applies to the proposed site:

CPNPP site. The area is deemed to have a low landslide incidence; less than 1.5 percent of the area has been subject to landslides. Somervell County is classified as a Risk Zone 0 for subsidence.

The effects related to potential geologic hazards are considered to be SMALL for all candidate sites.

Soil Stability

The objective of the soil stability criterion was to evaluate the sites in terms of adverse soil conditions. No absolute exclusionary criteria were identified with respect to soil stability. Sites with the highest PGA values in combination with deleterious site soils received relatively lower assessments. Sites having rock foundations or more suitable soil conditions were considered better locations.

Existing evidence indicates that each candidate site is located over deep soil. Deep soil sites are expected to require specific site investigations to determine if deleterious soil conditions exist, including evaluations for potential liquefaction.

Overall Rating for Geology and Seismology

The CPNPP site was deemed to be marginally superior over the other three sites. The overall geological and seismic effects are considered to be SMALL for all candidate sites.

9.3.4.1.1.2 Cooling System Requirements

Cooling system requirements are important siting considerations for power generating facilities. The objective of this criterion is to assess the candidate sites with respect to specific cooling system requirements.

The principal requirements of interest are the quantity of cooling water available and the ambient air temperature. Exclusionary and avoidance conditions apply to the evaluation of candidate sites with respect to these cooling system requirements. The water requirements for the site-selection study are presented below.

Cooling System

The candidate sites were evaluated with respect to the cooling water criterion during the initial screening phase, and all were found to have an adequate flow or some potential to develop capacity to support the requirements of a closed-cycle cooling water system. The potential effects related to securing and maintaining an adequate supply of cooling water are considered to be SMALL for all candidate sites.

Ambient Temperature Requirements

The candidate sites were compared to one another to assess their relative suitability with respect to selected temperature extremes and frequency values. Temperature data were obtained from local weather stations. These data indicated that each site meets the ambient temperature exclusionary and avoidance criteria. With the exception of extreme low temperature values, sites with the lowest dry bulb temperatures are considered to be the most suitable.

Based on a comparison of highest and lowest temperature (daily extremes), average high and low temperature records, annual average monthly mean temperatures, and consideration of general climate conditions, the candidate sites were found to be very similar with respect to the maximum temperature readings, and all had periods of record highs that exceeded 100°F.

Cooling System Summary Rating

The sites were evaluated to determine the suitability of the cooling water supply and the ambient air temperature characteristics for a potential plant. The effects resulting from cooling water usage and maintaining a sufficient supply of cooling water are considered to be SMALL for all candidate sites.

9.3.4.1.1.3 Flooding

The objective of this criterion was to evaluate the suitability of the candidate sites with respect to potential flooding.

A summary of pertinent flood-related information for the candidate sites is shown in Table 9.3-6. Based on these data, the potential environmental implications of flooding are considered to be SMALL for all candidate sites.

9.3.4.1.1.4 Nearby Hazardous Land Uses

A criterion for assessing nearby land use hazards was used in evaluating the candidate sites in terms of NRC guidance for considering the nature and proximity of man-induced hazards including dams, airports, transportation routes, and military and chemical manufacturing and storage facilities.

The suitability of the candidate sites was evaluated based on the relative number and distance to off-site man-made hazards. To the extent such information was available, the evaluation was limited to only hazards within a 5- to 10-mi radius of the sites. These hazards primarily included: airports, pipelines, and railroads. Nearby hazardous land uses for the candidate sites are compared in Table 9.3-7.

None of the sites had a large metropolitan airport within 5 mi. The potential effects related to nearby hazardous land uses are considered to be SMALL for all candidate sites.

9.3.4.1.1.5 Extreme Weather Conditions

The objective of this criterion was to evaluate the candidate sites with respect to extreme weather conditions. Extreme weather conditions of interest are related to specific design criteria regarding tornado, wind, and precipitation as discussed in the Siting Guide, Subsection 3.1.1.5 (EPRI 2002). Available extreme weather data were obtained from government sources including the National Climate Data Center (NCDC) and Southern Regional Climate Center, including NCDC Climatic Wind Data for the U.S. (NCDC 2007).

All the sites were similar. The results of this review are summarized in Table 9.3-8. Based on siting data, the effects of extreme weather conditions in terms of safety and environmental implications for the proposal are considered to be SMALL for all candidate sites.

9.3.4.1.2 Accident Effects

The objective of this criteria category was to evaluate sites with respect to the evaluation of design-related accident evaluations and potential effects of accidents. Sites were assessed in terms of three subcriteria that address site characteristics relevant to accident considerations: population, emergency planning considerations, and atmospheric dispersion.

Population

The objective of this criterion is to evaluate the relative suitability of the candidate sites with respect to the population density in the vicinity of the sites. Online data for the years 2000 or 2006, where appropriate and available, were obtained from the U.S. Census Bureau (Census Bureau 2007). The suitability of the candidate sites was evaluated with respect to population information, including distance to nearest communities, recent development, and county population projections for 2010.

Based on population data, potential effects as a result of an accident on nearby populations is considered to be relatively SMALL for all candidate sites.

Emergency Planning

The candidate sites were compared with respect to emergency planning characteristics of the area surrounding each site. In particular, this evaluation relied on information pertaining to general population in the surrounding areas, road conditions near each site, access to major traffic networks, terrain features, and climatic conditions.

Sites with the least constrained evacuation planning issues, low population, good access from the site to major traffic networks, and no terrain or climate limitations were considered the most suitable. Sites were assessed according to the extent of development in the general area, number of roads providing egress from the site area, and proximity to major U.S. highway systems.

None of the candidate sites had any substantial limitations with respect to climate or terrain conditions. Based on emergency planning considerations, potential effects on nearby populations as a result of an accident are considered to be relatively SMALL for all candidate sites.

Atmospheric Dispersion

The candidate sites were compared with respect to short-term atmospheric dispersion characteristics, as a measure of the relative level of radioactive concentrations that could result from accident conditions at the candidate sites.

The efficiency of atmospheric diffusion is primarily dependent on the wind speed, wind direction, and change in air temperature with height that affects atmospheric stability. These factors are used to calculate an atmospheric dispersion function referred to as X/Q.

Accurate, site-specific characterization of this function requires input from on-site meteorological data; however, such data were not readily available for all of the sites. Annual average values cannot be extrapolated with confidence to approximate the X/Q value. The equation to determine X/Q is driven by wind speed, with higher wind speeds proving more beneficial for diffusing an accidental release of radiological material (Table 9.3-9).

Accident - Related Summary Rating

The assessment of this criterion, Design-Related Accident Effects, is a composite of the aforementioned three subcriteria; e.g., population, emergency planning, and X/Q. The safety and environmental factors associated with a potential accident are considered to be relatively SMALL for all candidate sites.

9.3.4.1.3 Operational -Related Effects

The subsections under the category of operational effects compare the candidate sites in terms of radionuclide pathways. These criteria all have important implications with respect to potential safety and environmental effects.

9.3.4.1.3.1 Surface Water – Radionuclide Pathway

The purpose of this criterion is to evaluate candidate sites with respect to potential liquid pathway dose consequences. The following subsections compare the candidate sites in terms of radionuclide pathways:

Proximity to Consumptive Users - The objective of this subcriterion is to assess sites in accordance with the proximity of the plant effluent release point to the location of public water supply withdrawal.

Dilution Capacity - The candidate sites were compared based on the overall capacity of the receiving water body to dilute effluents from a nuclear power plant. Dilution capacity is directly related to average annual river flow.

Baseline Loadings - The capacity of a stream to affect the health and safety of downstream consumers is related to the existing or baseline loadings of radionuclides that are present in the system or can be anticipated in the future.

Potential effects from radionuclide pathway are considered to be SMALL for all candidate sites.

9.3.4.1.3.2 Groundwater Radionuclide Pathway

This criterion is designed to gauge and compare the sites with respect to the relative vulnerability of shallow groundwater resources to potential contamination.

The candidate sites overlie aquifers that have not been designated by the EPA 1986 classification scheme. EPA guidelines were used to assign a designation to candidate site aquifers. The relative vulnerability of these aquifers to groundwater pollution was evaluated using a standard numerical assessment system called DRASTIC (Aller, Bennett, Lehr, and Hackett 1987).

The DRASTIC model assigns a weighted numeric value to each variable depending on its relative contribution to risk of groundwater contamination. This index results in a numeric ranking for each site, allowing the sites to be ranked in order of suitability. The higher an area scores on the DRASTIC index, the more susceptible a site is to groundwater contamination. Tables 9.3-10, 9.3-11, 9.3-12, and 9.3-13 provide a summary of the DRASTIC evaluations for the candidate sites.

Groundwater resources underlying the candidate sites are either currently used or are potential sources of drinking water. These resources are expected to be considered Class II aquifers according to the EPA classification guidelines. There are no sole-source aquifers at the candidate sites.

DRASTIC indexes for all typical hydrogeologic settings range from 65 to 223, as discussed in DRASTIC, page 82 (Aller, Bennett, Lehr, and Hackett 1987). This range of indexes was used to develop a ranking system to compare vulnerability of candidate sites depicted in Table 9.3-14. Table 9.3-15 compares the candidate sites in terms of their relative vulnerability.

9.3.4.1.3.3 Air Radionuclide Pathway

This criterion is designed to assess the candidate sites with respect to the potential for exposure to the public from routine airborne releases from a nuclear power plant. The criterion is composed of two suitability characteristics:

Topographic Effects

X/Q

None of the sites are believed to have significant potential for undesirable negative topographic effects on long-term dispersion. Site-specific meteorological data are not available for all of the candidate sites. Annual average wind speeds for the regions were used to calculate an estimated annual average X/Q function value.

Based on the available information, all sites meet the suitability criteria (0.5 mi value < 7.2×10^{-5} sec/m^3, 1.0 mi value < 1.5×10^{-5} sec/m^3). The potential effects from the air radionuclide pathway due to the proposed project are considered to be SMALL for all candidate sites.

9.3.4.1.3.4 Air-Food Ingestion Pathway

The purpose of the air-food ingestion pathway criterion was to assess the candidate sites in terms of the relative potential for exposure of humans to radioactive emissions through deposition of radioactive materials on food crops with subsequent consumption of foodstuffs by exposed individuals. One radionuclide exposure pathway involves the emission of radionuclides into the food chain of local crops and pastures. While the exposure of the public through food pathway exposures is negligible, sites with lower amounts of crop and pasture land use are considered to be more suitable. Sites with less crop production nearby are rated higher than those with larger agricultural industries.

General information regarding croplands and pastures near the sites, including air-food ingestion pathway ratings, is summarized in Table 9.3-16 The potential effects from the air-food ingestion pathway are considered to be SMALL for all candidate sites.

9.3.4.1.3.5 Surfacewater – Food Radionuclide Pathway

The purpose of this criterion was to rate the sites in terms of the use of irrigation water at downstream locations as a potential pathway for exposure. Sites with the fewest number of downstream irrigation uses are deemed to be more suitable and are rated higher than sites with a large number of downstream irrigation withdrawals. Based on data from the National Agricultural Statistics Service, a very small percentage of cropland is irrigated.

Differences in overall county percentages are minimal. The potential effects from the surface water-food radionuclide pathway are considered to be SMALL for all candidate sites.

9.3.4.1.3.6 Transportation Safety

The objective of the Transportation Safety criterion was to evaluate the suitability of the candidate sites with respect to the potential of plant cooling systems to create fog and ice hazards to local transportation. Potential impacts from plant operations on transportation safety could occur as a result of increased hazards from cooling towers. Both natural draft and mechanical cooling towers can increase area fogging conditions and ice formation on local roads and highways. Sites with high frequencies of naturally-occurring fog and ice events are expected to be more adversely affected by cooling tower operations.

Ice hazards are not anticipated to be of significance in the regions where the candidate sites are located. None of the proposed locations are expected to have a significant effect on transportation safety.

9.3.4.2 Environmental Criteria

The subsection investigates environmental criteria used in comparing the candidate sites.

9.3.4.2.1 Construction-Related Effects on Aquatic Ecology

The following subsection considers construction-related effects on aquatic ecology.

9.3.4.2.1.1 Disruption of Important Species and Habitats

The purpose of this criterion was to evaluate the candidate sites with respect to potential construction related impacts on important aquatic or marine ecology.

None of the available data indicated that any of the sites under consideration would exceed the exclusionary or avoidance criteria relative to ecology. The evaluation focused on the relative suitability of the site based on the number of areas where limited potential impact is expected.

<u>The CPNPP Site</u>

No federally-listed aquatic species are known to occur in the vicinity of the CPNPP Units 3 and 4 site. However, one fish species, one reptile species, and one mussel species were recognized in consultation with the U.S. Fish and Wildlife Service (FWS) or Texas Parks and Wildlife Department (TPWD) as threatened, candidate, or species of concern by either the state or federal government. Sharpnose shiners (*Notropis oxyrhynchus*) are identified as a federal candidate fish species by FWS and potentially reside in Somervell County. Brazos water snakes (*Nerodia harteri harteri*) are listed as threatened by the state and identified by TPWD as potentially utilizing habitat in the vicinity of the CPNPP Units 3 and 4 site. One species of mussel has also been identified as a species of concern in waters in the vicinity of the CPNPP Units 3 and 4 site by TPWD. Threatened and endangered species in the vicinity of the CPNPP Units 3 and 4 site are further discussed in Subsection 2.4.2.5.1. Subsection 5.3.4 contains thermophyllic microorganisms information.

Results

None of the candidate sites had any federally-listed threatened or endangered aquatic species. Potential effects upon important aquatic species and habitats are considered to be SMALL for all candidate sites.

9.3.4.2.1.2 Bottom Sediment Disruption Effects

This criterion was used to evaluate the potential short-term impacts to aquatic and marine resources resulting from construction-related dredging activities at the candidate sites. This assessment used available data on the amount of contaminated sediments near the candidate sites and the grain size of sediments in the area. Sites with the lowest concentration of heavy metals and toxic organic compounds, and the highest sediment grain size are considered to be the most suitable.

No information regarding sediment grain size was obtained for this evaluation. Because sediment grain size is highly variable, even within a small area of coastline or river reach, the following evaluation of potential bottom sediment disruption effects was limited to available information regarding sediment contamination levels in principal water bodies at the candidate sites.

Only limited information was available regarding the site-specific level of sediment contamination that exists in water bodies near the candidate sites. The majority of the available information was obtained from the EPA National Sediment Quality Survey (EPA 2004). Because dredging is not one of the parameters considered for this particular evaluation, and information on grain size was not readily available for most of the sites, the estimated potential for contaminated sediments to affect the cost and schedule of any construction related dredging operations was based on the limited information available and professional judgment.

9.3.4.2.2 Construction-Related Effects on Terrestrial Ecology

The following subsection investigates construction-related effects on terrestrial ecology.

9.3.4.2.2.1 Disruption of Important Species/Habitats and Wetlands

No data were obtained indicating that any of the candidate sites would exceed the exclusionary or avoidance criteria relative to ecology. The assessment focused on the relative suitability of the site based on the number of areas where limited potential impact is expected.

The number of potential impact areas was directly correlated to the number of rare, threatened, and endangered terrestrial species that may occur in the host county (species habitat). This number was also based on existing reports and professional judgment of the amount and quality of habitat available for species, and flexibility, or the ability to avoid known locations of protected species during construction.

An additional subcriterion was evaluated that involved the total acreage of wetland within a 2000-acre (ac) site, not including the lake or reservoir that would be the primary source of cooling water. This subcriterion was also broken out into three components: total wetlands, total acreage of higher quality wetlands, and flexibility, or the ability to avoid wetlands during construction.

The CPNPP Site

A total of two federally-listed terrestrial bird species are found in Somervell County and have the potential to occur in the vicinity of the CPNPP site. They are identified in Table 9.3-18. No other terrestrial species were identified by FWS as potentially residing in the vicinity of the CPNPP Units 3 and 4 site.

Additional state-listed species that are not on the federal list include three bird and three reptile species.

Summary

Tables Tables 9.3-18, 9.3-19, and 9.3-20 list federally-listed species at the three other candidate sites.

The total number of federally protected species was very similar between sites (5 – 10), and all sites had a similar range of additional protected species (5 to 10) along with rare species with no regulatory status. Because the CPNPP site is an already developed site, it was given a modestly higher assessment.

The overall acreage of mapped wetlands indicated by the National Wetlands Inventory (NWI) and associated siting flexibility were also considered in the evaluation. This approach provides only a rough approximation and often does not map wetlands that are identified during wetland delineation. Table 9.3-21 compares the candidate sites in terms of wetlands considerations.

Potential disruptive effects from construction on important species/habitats and wetlands are considered to be SMALL for all candidate sites.

9.3.4.2.2.2 Dewatering Effects on Adjacent Wetlands

The objective of this criterion is to evaluate the sites with respect to potential impacts from construction related dewatering activities on area wetlands. The evaluation included a review of information related to the depth of the water table and the distance to nearby wetlands.

Wetlands have been evaluated previously. In light of the previous ratings and groundwater information, the sites were assessed in terms of dewatering effects on adjacent wetlands.

Potential disruptive effects from construction on adjacent wetlands are considered to be SMALL for all candidate sites.

9.3.4.2.3 Operational-Related Effects on Aquatic Ecology

This subsection assesses operational-related impacts on aquatic ecology.

9.3.4.2.3.1 Thermal Discharge Effects

The objective of this criterion is to address the relative suitability of the candidate sites with respect to potential thermal impacts. No exclusionary or avoidance criteria apply to condenser cooling water system thermal discharges on receiving water bodies.

In December 2001, the EPA published a final regulation that affects the location, design, construction, and capacity of intake structures for additional power plants (EPA 2001). The EPA rule strongly encourages the use of closed-cycle designs to reduce adverse cooling water system effects, and it is assumed that additional nuclear reactors at any one of the candidate sites would include closed-cycle cooling water systems.

Information on migratory species, also identified in EPRI criteria, was not collected at each site and is not evaluated as part of this criterion. The assessment was based on limited flow and water quality data for the cooling water sources and on-site ratings for disruption of aquatic species and habitat. Ratings were based on the use of the source water body as the receiving water for this evaluation.

Potential thermal effects on aquatic ecology are considered to be SMALL for all candidate sites.

9.3.4.2.3.2 Entrainment/Impingement Effects

The objective of this criterion is to address the relative suitability of the candidate sites with respect to potential entrainment and impingement impacts. No exclusionary or avoidance criteria apply to entrainment and impingement impacts as a result of operating condenser cooling water systems. As indicated above, the EPA rule strongly encourages the use of closed-cycle designs to reduce adverse cooling water system effects, and it is assumed that additional nuclear reactors at any one of the candidate sites would include closed-cycle cooling water systems.

Entrainment refers to the removal of small, drifting organisms with the cooling water. Impingement refers to larger organisms that are screened out of the cooling water at the intake structure. Typically, power plants with once-through cooling water systems have higher entrainment and impingement impacts than power plants with closed-cycle cooling water systems. With respect to an assessment of aquatic effects presented in NUREG 1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, the candidate sites were evaluated with respect to relative potential for entrainment and impingement impacts for the closed-cycle cooling water system.

Given the lack of site-specific entrainment and impingement data at all candidate sites, the potential presence of state-protected fish species at each of the sites including mollusks at all sites and a candidate federal species at the CPNPP site, and uncertainties associated with any additional EPA ruling on cooling water intake structures that are considered to be relevant even though they would only apply to existing power plants, all sites were given an equivalent assessment with respect to this impact category. The potential entrainment and impingement effects on aquatic ecology are considered to be SMALL for all candidate sites.

9.3.4.2.3.3 Dredging/Disposal Effects

This subsection evaluates the candidate sites for potential environmental impacts related to maintenance dredging at the intake structure. No specific exclusionary or avoidance criteria apply to this issue. Sites with high levels of contaminated sediment deposition at the intake structure are expected to experience higher maintenance costs for the removal and disposal of the dredged material.

The sites were rated according to the expected levels of contamination and sedimentation rates for the general area of the sites. Sites with the lowest concentration of heavy metals and toxic organic compounds, and the lowest sediment rates are the most suitable and received the highest assessment. No site-specific information about the level of sediment contamination at the sites was identified. All sites are assumed to have relatively-low fine sediment deposition rates, which are preferred. The Luminant A site is expected to have even better deposition rates relative to the other sites given its location.

9.3.4.2.4 Operational-Related Effects on Terrestrial Ecology

The following subsection investigates operational-related effects on terrestrial ecology.

9.3.4.2.4.1 Drift Effects on Surrounding Areas

This criterion was used to evaluate the relative suitability of the candidate sites with respect to potential concerns with cooling tower drift effects. This evaluation considered the potential effects on surrounding areas and the suitability of the cooling water source.

Cooling-Tower Drift

In every cooling tower, there is an evaporative loss of water through the cooling tower. Drift is the undesirable loss of liquid water to the environment through small unevaporated droplets that become entrained in the exhaust air stream of a cooling tower. Minimizing drift losses in a cooling tower conserves water and reduces potential environmental impacts. The principal environmental concern with cooling tower drift impacts are related to the emission and downwind deposition of cooling-water salts. Salt deposition can adversely affect sensitive plant and animal communities through changes in water and soil chemistry.

Sites deemed to be the most environmentally sensitive were assigned lower ratings. Sites with highest concentrations of dissolved solids and other potential contaminants in cooling-tower makeup were also assigned lower ratings. With respect to drift effects, all candidate sites received an equivalent overall assessment. The potential drift effects on terrestrial ecology are considered to be SMALL for all candidate sites.

9.3.4.3 Socioeconomics Criteria

This subsection assesses socioeconomic criteria considered in evaluating the candidate sites.

9.3.4.3.1 Socioeconomics – Construction Related Effects

This criterion evaluated the relative suitability of the sites with respect to the number of construction workers who are anticipated to move into the site vicinity with their families; it also considers the capacity of the communities surrounding the site to absorb this temporary (in-migrant) population. Exclusionary and avoidance criteria were not applicable to this criterion. The plant construction workforce is likely to be available at any of the sites under consideration. The issue in siting is the potential socioeconomic impact associated with any temporary influx of construction workers who live too far away to commute daily from their residence. With respect to suitability of the sites under consideration, socioeconomic impacts of nuclear power plant construction are directly related to two factors:

Number of construction workers who are expected to move into the site vicinity with their families.

Capacity of the communities surrounding the site to absorb this additional temporary (in-migrant) population.

The following assumptions were used in this analysis:

Ratings are based on the assumption that two units would be constructed at a given site.

The siting study assumed that construction would require a peak construction workforce of 4300 workers (2150 per unit); this estimate is not necessarily the “worst-case” but is assumed to be a “realistic” estimate for purposes of site comparison. Detailed description associated with calculating number of construction workers and the impacts associated with the influx of construction workers is presented in Section 4.4.

The analysis assumes that no other major construction project would occur in the site vicinity concurrently with the plant construction and operation. Sites were rated without consideration of potential cumulative impacts of other potential demands for labor.

Available population and economic data were obtained from the U.S. Census Bureau for each site. The impacts were determined by comparing the number of direct and indirect jobs created by plant’s construction with total employment of the local study area at the time of construction. Sites were rated according to economic impacts based on the following criteria:

SMALL - if economic effects of peak construction related employment accounted for less than 5 percent of total study area employment.

MODERATE - if economic effects of peak construction related employment accounted for 5 – 10 percent of total study area employment.

LARGE - if economic effects of peak construction related employment accounted for more than 10 percent of total study area employment.

The study area for evaluating socioeconomic impacts from construction included the host county, adjacent counties, and any other nearby counties with a major population center within a reasonable commuting distance from the site.

Results

The assessment showed a significantly higher population and workforce available at the CPNPP site due to its proximity to the Dallas-Fort Worth (DFW) area. The overall employed workforce levels for all sites in 2010, when construction is anticipated to start, are assumed to be sufficiently large such that the impact on study area employment from construction of two additional units would be low at each site. This assessment is based on conservative workforce levels using 2000 Census Bureau data, without expected increases in 2010; although, such increases might be used to support other large, non-nuclear, construction projects at that time.

All sites show a percentage increase less than 2 percent when compared to total study area workforce; and all sites show a percentage increase less than 10 percent when compared to the total construction workforce.

Because of the significantly higher population projections and available workforce from Fort Worth area that could work at the CPNPP site, the siting study assumed that 100 percent of the workforce would commute from within the area, and there would be no in-migrant workforce population; the reader should note that Chapter 4 uses a more reasonable estimate of 50 percent in-migrant construction workers.

As such, there would be no demands on housing and community services. Based on this information alone, the CPNPP site would receive the highest assessment. Table 9.3-22 provides a comparison of the candidate sites in terms of workforce requirements.

Given the lower general population estimates and the lower, existing, and more scattered construction workforce to draw from at the remaining three sites, an additional analysis was conducted to consider the impacts of in-migrating workers to these three areas.

50 percent of workers are expected to in-migrate (1000 workers).

50 percent of these workers bring their families resulting in 2.5 additional persons per family, or 1250 family members.

Influx of direct workers also brings an influx of indirect workers. There is a 0.4 ratio of direct to indirect workers – in absence of site-specific information – pertaining to the Regional Industrial Multiplier System direct/indirect ratios calculated for each plant, as found in NUREG/CR-2749, Socioeconomic Impacts of Nuclear Generating Stations - Three Mile Island Case Study. This ratio resulted in 400 indirect workers.

50 percent of these indirect workers bring their families, 2.5 additional persons per family. This percentage resulted in 500 family members.

An influx of 1000 workers is predicted to result in a total population influx of 4300 persons. Based on the projected influx and using best professional judgment, a comparison of socioeconomic conditions between the candidate sites reveals minimal differences. A set of more conservative ratings has been assigned based on the primary differentiator between sites: total population, percent increase in existing workforce, and percent increase in existing construction workforce at each site.

Based on the larger workforce available, the CPNPP site received the highest assessment. The potential use of a national workforce also helps to minimize any site differences. The potential construction impacts on local socioeconomics are considered to be SMALL to MODERATE for all candidate sites.

9.3.4.3.2 Socioeconomics – Operation

Socioeconomic impacts of operation relate primarily to the benefits afforded to local communities as a result of the plant's presence; e.g., tax plans, local emergency planning support, and educational program support. These benefits tend to be a function of negotiations between the plant owner and local government; they are not indicative of inherent site conditions that affect relative suitability between sites. This criterion is not applicable to a comparison of the candidate sites, and in accordance with guidance in the Siting Guide (EPRI 2002), suitability scores were not developed.

9.3.4.3.3 Environmental Justice

The environmental justice (EJ) criterion assesses whether the proposed action would result in disproportionate adverse impacts to minority and low-income communities. In comparing sites, this criterion is evaluated on the basis of whether any disproportionate impacts to these communities are significantly different when comparing one site to another.

The following two factors must be addressed in evaluating impacts upon minorities and low income communities:

- Does the proposed action result in significant adverse impacts?
- Are impacts to minority or low-income populations significantly different between sites?

If the answer to the first question is “no” for all sites; i.e., no significant health and safety impacts are identified, then there would be no EJ concerns, regardless of the percentage of minority or low-income populations found within the surrounding communities of a site. If the answer to the first question is “yes,” and significant health and safety impacts are anticipated, then EJ concerns are relevant to site selection only if the answer to the second question is also “yes,” and disproportionate adverse impacts on minority or low-income populations are identified at one or more sites, thereby resulting in significant differences between sites.

The first step in this evaluation is to collect and compare population data for minorities and low-income populations across sites. The study area for evaluating EJ concerns included the host county and immediately surrounding counties. Environmental justice information based on U.S. Census Bureau data for Texas (Census Bureau 2007) is summarized for each candidate site in Table 9.3-23.

Analysis of the socioeconomic data resulted in the following conclusions:

Large minority populations, 20 percent or higher, are found at each of the sites; the CPNPP site having the highest percentage, 58 percent, due to the high minority population found in Tarrant County, Fort Worth, and Arlington.

No significant health impacts to human populations were identified at any of the sites under consideration.

Low-income population in other counties across the United States that host a nuclear power plant has directly benefited from economic impacts of the existing plant, including CPNPP. Similar beneficial economic impacts are expected to occur for additional units at other sites with large minority populations as well.

Given that no significant impacts to any human populations are expected to occur at any of the sites under consideration, there cannot by definition be significant disproportionate impacts to minority or low-income populations. Based on actual employment experience, positive economic benefits have been shown to be available to all members of the population, without regard to income or ethnicity.

Based on this analysis, there is no basis for differentiation between sites from an EJ perspective, despite differences in the percentages of minority and low-income populations found within the surrounding communities of each site. With respect to EJ issues, all sites were found to be equally and highly suitable.

9.3.4.3.4 Land Use

This criterion evaluates the suitability of the candidate sites with respect to potential conflicts in existing land uses at each site. No exclusionary or avoidance criteria apply to this issue. The following assessment is based on the compatibility of an additional nuclear plant with existing land uses, including existing and future land uses and zoning ordinances, as well as any significant historic and ecological resources. Historic resources include those currently listed on the NRHP, or known, active, archaeological sites or Native American lands. This analysis is based on publicly available data.

All candidate sites are located in counties that are largely rural in nature and where agriculture comprises a large part of the economy. Some have more industrial development than others; some have more sites listed on the NRHP than others. NRHP listings were not considered to be a determining factor as all NRHP sites are confined to nearby towns, and none are in the vicinity of any of these sites.

Assessments were based largely on the presence of existing industry, as well as the presence of any specially protected historic, recreation, or ecological areas, and perceived difficulties in changing current rural and agricultural land use to industrial zoning.

9.3.4.4 Engineering and Cost-Related Criteria

This subsection considers engineering and cost-related criteria.

9.3.4.4.1 Health and Safety-Related Criteria

Health and safety-related criteria are considered in the following subsection.

9.3.4.4.1.1 Water Supply

This criterion assesses the relative differences in the design and construction cost of developing water supply facilities. Sites with local conditions that would require additional engineering costs to develop water supply capability such as reservoirs to address water supply limitations or reliability issues such as low flow constraints are rated lower than sites with no such requirements.

Site assessment was based on professional judgment, taking into account cooling water sources and the difficulties in constructing water supply facilities.

9.3.4.4.1.2 Pumping Distance

The pumping distance criterion evaluates the relative differences in the operational costs associated with pumping makeup water from the water source to the plant. Sites located large distances from their makeup water supply source are rated lower than those located adjacent to the source. The cost differential is expected to be a linear function of distance from the water source.

As final plant locations, and reservoir requirements and locations have yet to be determined, precise intake and discharge locations are undetermined for candidate sites. It is assumed that cooling facilities are expected to be located as close to the water supply as possible.

9.3.4.4.1.3 Flooding

The purpose of this criterion was to rate sites with respect to differential costs associated with construction of flood protection structures necessary to address probable maximum floods at the sites under consideration. Sites with the largest differences between site-grade elevation and likely flood elevations are rated highest; sites with plant grade at or near flood level are rated lowest.

While final plant layout locations have not been set for candidate sites, an initial comparison of potential site locations with floodplain information indicate that none of the proposed plant facilities are anticipated to require protection from flooding. For this reason, each of the sites was assigned a high and equivalent assessment.

9.3.4.4.1.4 Vibratory Ground Motion (Eliminated From the Site Assessment Study*)*

This criterion is used to assess the relative costs associated with designing to different seismic requirements at different sites. Because the sites under consideration are expected to meet the site parameters for seismic design of the standardized designs under consideration, this criterion is not applicable to the site selection process.

9.3.4.4.1.5 Civil Works

The objective of the civil-works criterion, formerly referred to as “soil stability,” was to rate sites based on differences in the cost of civil works; i.e., non-flood related terms, and stabilizing of graded slopes and banks necessary to prepare the site for nuclear plant development. Sites are rated highest to lowest according to the estimated cost of civil works required at each site based on past incidence and future susceptibility to landslides. The CPNPP site and Luminant B sites are located near areas of higher relief, and may incur higher slope stabilization costs. Because the Luminant C site is located in an area of moderate landslide incidence, the generally low topographic relief in the area should offset the moderate area landslide incidence.

9.3.4.4.2 Transportation or Transmission-Related Criteria

This subsection assesses sites with respect to transportation or transmission-related criteria.

9.3.4.4.2.1 Railroad Access

The railroad-access criterion assesses sites according to the relative costs associated with providing rail access. Sites are assessed from highest to lowest according to the estimated construction costs necessary to provide rail access to the site. The following unit cost estimates are assumed:

Row, Grading, and Rail Construction - $1.5 million per mile.

Large Open Deck Tressel (major river crossing) - $14 million each.

Small Open Deck Tressel (major stream crossing) - $100,000 each.

Box Culvert (minor stream crossing) - $25,000 each.

Crossing Protection with Lights and Gates - $150,000 each.

Mainline Turnout - $65,000 each.

Some of the sites are located near abandoned rail lines. The site-specific condition of abandoned rail lines is unknown and could range from removal or revegetation to operable with minimal upgrade. Distances used in this analysis are to the nearest rail line in service and assume abandoned rail lines have been removed or revegetated. Should rail access become a sensitive criterion for site selection, site-specific conditions of abandoned rail lines would be expected to be more fully evaluated. Distances to rail service at each of the sites were measured assuming that:

Passenger lines may be used for a one-time delivery of plant equipment to the site.

Abandoned lines have been removed or revegetated.

Sites were assigned assessments based on minimal impact to overall project costs. The sites were assessed from highest, the CPNPP site, to lowest

9.3.4.4.2.2 Highway Access

This criterion was used to assess sites according to the relative costs associated with providing highway access. Sites are rated from highest to lowest in accordance with the length of additional or additional highway construction required to provide car and truck access. Construction of an undivided three-lane rural road (including center turn lane) from the nearest active roadway is assumed. Construction costs are estimated at $3 million per mi, and existing road improvement costs are estimated at $1.5 million per mi.

All sites are located near existing roads, and construction of site access is predicted to be minimal. As estimated costs range up to $22 million, sites were rated based on minimal impact to overall project costs.

9.3.4.4.2.3 Barge Access

The purpose of the barge-access criterion is to assess sites according to the relative costs associated with providing barge access. Sites were rated from highest to lowest in accordance with estimated cost of facility construction required to provide barge access.

Construction of barge access is not practical at any of the candidate sites.

9.3.4.4.2.4 Transmission Cost and Market Price Differentials

This criterion is used to assess sites according to the relative costs associated with construction of power-transmission systems and issues related to market price differentials. Sites were rated from highest to lowest in accordance with estimated transmission system construction costs and consideration of other identified issues related to power transmission. Because all candidate sites are located within the Luminant service area, no electricity market price differentials are expected between the sites, and this subcriterion was not evaluated.

Transmission access was evaluated in terms of distance to the nearest existing transmission line, as shown in Table 9.3-24. Transmission lines in the vicinity of the candidate sites are operated and managed by the ERCOT. System upgrade costs are incurred by ERCOT and are not considered as part of this evaluation

9.3.4.4.3 Criteria Related to Land Use and Site Preparation

This subsection evaluates land use and site preparation criteria.

9.3.4.4.3.1 Topography

The purpose of the topographic criterion is to rate sites according to the relative costs associated with site preparation; i.e., grading, blasting, and earth-moving necessary to prepare the site for construction of a nuclear power plant. Ratings are based on the amount of topographic relief currently found at the site, approximately 500 ac, with the greatest degree of relief resulting in the highest estimated grading costs and therefore the poorest rating. Sites are rated from highest to lowest in accordance with estimated grading costs. Areas with mean slopes greater than 12 percent or relief greater than 400 ft are undesirable.

9.3.4.4.3.2 Land Rights

This criterion is used to rate sites according to the relative costs associated with purchasing land required to construct and operate a nuclear plant on the site. The number of parcels and owners of large land tracts, and the willingness to sell were also considered. Sites were rated from highest to lowest in accordance with estimated local land costs.

Land acreage, cost, and availability have been a siting consideration from the beginning of the site-selection process. Previous results are factored in again for this evaluation, which include additional information from a land analysis conducted by Luminant Real Estate. U.S. Census of Agriculture data were also examined for comparison (NASS 2007).

9.3.4.4.3.3 Labor Rates

The purpose of this criterion was to rate sites according to the relative costs associated with local labor costs that would be incurred during plant construction. Sites were rated from highest to lowest in accordance with estimated local labor costs, with the lower cost resulting in higher ratings.

For purposes of consistency, this evaluation relied on data from U.S. Department of Labor (DOL 2006). Average hourly rates were evaluated for construction and extraction workers; i.e., structural iron and steel workers, sheet metal workers, plumbers, pipefitters, and steamfitters in the vicinities near each of the candidate sites from where the workforce would draw from. Table 9.3-25 provides representative labor rates in the vicinity of these sites.

Comparisons of the above construction labor category rates, including the average construction-worker rollup rate across all construction labor categories reveals similar wages across all sites with respect to average construction labor category, $13 – 15 per hour.

A significant portion of the construction workforce is expected to come from a national workforce of journeymen, whose rates are expected to be set based on supply and demand within the overall nuclear industry rather than by local workforce rates or skill sets. While the ratings below are based solely on current and local wage differentials, this additional factor could further mitigate differences in labor costs between the sites.

9.3.5 SUMMARY OF CANDIDATE SITES AND SELECTION OF PROPOSED SITE

As described in Subsection 9.3.3.1, the CPNPP site, and Luminant A, B, and C sites were selected as candidate sites for the COLA. Based on the comprehensive evaluations conducted to this point, each of these sites appear to be a feasible location for an additional nuclear power plant; although, the CPNPP site appears to be more suitable based on evaluation against the general site criteria (Table 9.3-2). As part of the analysis, the discussions considered just environmental issues. Overall environmental suitability of the candidate sites was approximated by applying the process described in the McCallum-Turner report to only the environmental criteria (2.1.1 through 2.4.1)(McCallum-Turner 2007). This process resulted in Luminant B being the least environmentally suitable site, with the other candidate sites being approximately equal with respect to environmental suitability. Table 9.3-1 compares principal environmental attributes in terms of environmental significance indicators: “SMALL,” “MODERATE,” and “LARGE.” This summary table is based on the evaluations presented for the candidate sites in Subsection 9.3.2. Further analysis (Table 9.3-1A) using the suggested criteria from the Environmental Standard Review Plan and Chart and the weighted scores from the site analysis (McCallum-Turner 2007)(Table 4-2) resulted in the environmental preference descending order as follows: CPNPP, Luminant C, Luminant B, and Luminant A – the first two and the last two being relatively close in score, respectively.

Summary

All four candidate sites are varied with regard to general visual and environmental issues. Three are greenfield sites and the CPNPP Units 3 and 4 site is obviously a brownfield site. Both CPNPP Units 3 and 4 and Luminant C are owned by Texas Utilities Corporation (TXU) and are located on the same property boundary as existing generating stations.

Luminant A is on the property of a working cattle ranch with relatively level topography. Little clearing of land would be necessary and is in relatively close proximity to a water source, transmission lines, and low level populous.

Luminant B is an open area with some wooded rolling hills. Some clearing and leveling of land would be required. Close proximity to a source of water and limited populous but a significant investment for transmission lines and right-of-way (ROW) issues would need addressing.

Both approaches to the environmental issues resulted in CPNPP Units 3 and 4 being selected as the most environmental suited for siting a plant.

Table 9.3-26 summarizes and contrasts the principal environmental siting factors between the candidates, while Table 9.3-27 compares the principal nonenvironmental siting factors.

In addition to the criteria already applied to select a proposed site for the combined construction and operating license (COL), the overall top two sites, CPNPP Units 3 and 4 and the Luminant C sites, were considered in greater detail for three risk factors. This was to provide further insight on the site's ability to support Luminant's objectives for the COLA and a future nuclear plant. The risk factors analyzed include:

- Public acceptance
- Area population
- COLA time frame

Scope and results of this analysis are described in Subsection 9.3.5.1 The rationale for selecting a proposed site from the candidates considered is provided in Subsection 9.3.5.2.

9.3.5.1 Analysis of Candidate Sites

The objective of these additional considerations for the candidate sites is to provide further insight into site conditions and bolster confidence on specific issues that were viewed as important to the site-selection decision. The resulting analysis, observations, and conclusions are provided in Table 9.3-3.

9.3.5.2 Selection of Proposed Site

To summarize, a rigorous site evaluation and selection process was used to narrow a large list of potential sites down to selected candidate sites that minimized the environmental impacts, while reducing potential risk factors. The candidate sites were compared with each other. The results of these detailed studies confirmed that each of the candidate sites was a viable location for a nuclear power plant. As discussed in Subsection 9.3.5 and illustrated in Table 9.3-1, with the exception of socioeconomic construction effect and site preparation – topographic modification, the key environmental impacts of constructing and operating a nuclear plant at the candidate sites were all gauged to be SMALL.

Results of the additional risk factor considerations, combined with the results of the general criteria evaluations, were used to identify a recommended site as described below.

An assessment of the general criteria evaluations confirms that each of the candidate sites is a viable location for a nuclear power plant. The evaluations contained in Table 9.3-3 further distinguish the two primary candidate sites and served in identifying the proposed site. The following advantages led to identification of the CPNPP site as the proposed site:

- Anticipated public acceptance due to existing nuclear operations.
- Reduced area population.
- Readily available data for COLA.

Thus, taking into consideration the results of each evaluation conducted, including satisfying Luminant's business objectives, the CPNPP site was selected as the proposed site for CPNPP Units 3 and 4.

9.3.6 REFERENCES

(Aller, Bennett, Lehr, and Hackett 1987) DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings. Aller, L., Bennett, T., Lehr, J., Petty, R. and G. Hackett. EPA/600/2-87/035. June 1987.

(BRAZOS G 2006) Potentially Occurring Species that are Rare or Federal- and State-Listed at the City of Wheeler Branch Off-Channel Reservoir Site, Somervell County. Brazos G Regional Water Plan. Brazos G Water Planning Group. http://www.brazosgwater.org/229.html. Accessed December 2007.

(Census Bureau 2007) Texas QuickFacts from the U.S. Census Bureau. http://quickfacts.census.gov/qfd/states/48000.html. Accessed November 2007.

(USGS 2000) Data for Quaternary Faults, Liquefaction Features, and Possible Tectonic Features in the Central and Eastern United States, East of the Rocky Mountain Front. Anthony J. Crone and Russell L. Wheeler. U.S. Geological Survey Open-File Report 00-0260. http://pubs.usgs.gov/of/2000/ofr-00-0260/. Accessed January 2, 2008.

(DOL 2006) May 2006 Metropolitan Area Occupational Employment and Wage Estimates. Department of Labor Bureau of Labor Statistics. http://www.bls.gov/oes/current/oes_19100.htm. Accessed November 2007.

(EPA 2001) Fact sheet: cooling water intake structures at new facilities – final rule. Environmental Protection Agency. EPA-821-F-01-017. http://www.epa.gov/waterscience/316b/phase1/316bph1fs.html. Accessed November 2007.

(EPA 2004) The Incidence and Severity of Sediment Contamination in Surface Waters of the United States, National Sediment Quality Survey: Second Edition. Environmental Protection Agency. http://epa.gov/waterscience/cs/report/2004/nsqs2ed-complete.pdf. Accessed 2007.

(EPRI 2002) Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application, Palo Alto, California. Electric Power Research Institute. Product ID: 1006878. http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=ObjMgr&parentid=2&control=SetCommunity&CommunityID=221&PageIDqueryComId=0
March 2002.

(McCallum-Turner 2007) Luminant Nuclear Power Plant Siting Report, February 09, 2009, with a modified Luminant Power NuBuild Project Nuclear Power Plant Siting Report. August 28, 2007, Enclosed.

(NASS 2007) 2007 Census of Agriculture, Vol. 1. National Agricultural Statistics Service Geographic Area Series Census, State-County Data; http://151.121.3.33:8080/Census/Create_Census_US_CNTY.jsp. Accessed December 2007.

(NCDC 2007) NOAA Satellite and Information Service. National Climatic Data Center. http://www.ncdc.noaa.gov/oa/ncdc.html. Accessed November 2007.

TABLE 9.3-1 (Sheet 1 of 2)
ENVIRONMENTAL IMPACTS OF CONSTRUCTING AND OPERATING TWO NUCLEAR REACTOR PLANTS AT THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A	Luminant B	Luminant C
Geologic / Seismic	Seismic: Vibratory ground motion	SMALL	SMALL	SMALL	SMALL
	Surface Faulting and Deformation	SMALL	SMALL	SMALL	SMALL
	Geologic Hazards	SMALL	SMALL	SMALL	SMALL
Water	Adequate Cooling Water	SMALL	SMALL	SMALL	SMALL
Weathe0r-Related Hazards	Flooding	SMALL	SMALL	SMALL	SMALL
	Nearby Hazards	SMALL	SMALL	SMALL	SMALL
	Extreme Weather Conditions	SMALL	SMALL	SMALL	SMALL
Accident Effects	Nearest Population Center	SMALL	SMALL	SMALL	SMALL
	Emergency Planning	SMALL	SMALL	SMALL	SMALL
Operational Effects	Surfacewater Radionuclide pathway (distance)	SMALL	SMALL	SMALL	SMALL
		SMALL	SMALL	SMALL	SMALL
	Air Radionuclide Pathway	SMALL	SMALL	SMALL	SMALL

TABLE 9.3-1 (Sheet 2 of 2)
ENVIRONMENTAL IMPACTS OF CONSTRUCTING AND OPERATING TWO NUCLEAR REACTOR PLANTS AT THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A	Luminant B	Luminant C
Aquatic Ecology	Construction-related disruption to important aquatic species/habitats	SMALL	SMALL	SMALL	SMALL
	Operational effects (thermal discharge effects) on aquatic ecology	SMALL	SMALL	SMALL	SMALL
	Operational (entrainment and impingement) effects on aquatic ecology.	SMALL	SMALL	SMALL	SMALL
Terrestrial Ecology	Construction-related disruption to important terrestrial species/habitat	SMALL	SMALL	SMALL	SMALL
	Construction-related impacts on wetlands	SMALL	SMALL	SMALL	SMALL
	Operational-related (cooling tower drift) drift effects on terrestrial ecology	SMALL	SMALL	SMALL	SMALL
Socioeconomic Impacts	Construction-related impacts	SMALL-MODERATE	SMALL-MODERATE	SMALL-MODERATE	SMALL-MODERATE
	Operational-related impacts	SMALL	SMALL	SMALL	SMALL
Site Preparation	Topographic modification	SMALL	SMALL	MODERATE	SMALL

TABLE 9.3-1A
ENVIRONMENTAL STANDARD REVIEW PLAN CHART USING MCCALLUM-TURNER 2007 WEIGHTED SCORES

Subject Area for Candidate Site Selection and Screening	CPNPP	Luminant A Coastal	Luminant B Pineland	Luminant C Trading House	M-T Report Reference #[a]
Land use, Including availability and areas requiring special consideration	28.5	17.1	11.4	28.5	3.4
Hydrology, water quality and water availability	41.5	24.9	41.5	41.5	4.1.1
Terrestrial resources (including endangered species)	38	38	30.8	38	2.2, 2.4
Aquatic biological resources, including endangered species	71.1	71.8	71.1	71.1	2.1, 2.3.1, 2.3.2
Socioeconomics (including aesthetics, archeological, and historic preservation and environmental justice)	52	41	41	46.5	3.1.1, 3.3.1
Transmission corridors (approximate length and general location, feasibility, and resources affected)	37.5	30	15	37.5	4.2.4
Population distribution and density	28.8	28.8	28.8	21.6	1.2
Industrial constraints as they affect site availability	11.8	11.8	29.5	17.7	1.1.4
Is this site a candidate site?	Yes	Yes	Yes	Yes	
Is this candidate site a good alternative to the proposed site?	Yes	Yes	Yes	Yes	
Ranking Total	309.2	263.4	269.1	302.4	

a)Numbers represent the weighted scoring from (McCallum-Turner 2007). The reference numbers are the sections which most closely reflect the subject categories from that report.

TABLE 9.3-2 (Sheet 1 of 2)
GENERAL SITE EVALUATION CRITERIA

Siting Criteria	Siting Criteria
1.1 Health and Safety Criteria: Accident Cause-Related Criteria	**Environmental Criteria: Operational-Related Effects on Aquatic Ecology, cont'd.**
1.1.1 Geology and Seismology	2.3.2 Entrainment/Impingement Effects
1.1.2.1 Cooling System Requirements: Cooling Water Supply	2.3.3 Dredging/Disposal Effects
1.1.2.2 Cooling Water System: Ambient Temperature Requirements	**2.4 Environmental Criteria: Operational-Related Effects on Terrestrial Ecology**
1.1.3 Flooding	2.4.1 Drift Effects on Surrounding Areas
1.1.4 Nearby Hazardous Land Uses	**3 Socioeconomic Criteria**
1.1.5 Extreme Weather Conditions	3.1 Socioeconomic – Construction Related Effects
1.2 Health and Safety Criteria: Accident Effects-Related	3.2 Socioeconomics – Operation (deleted from evaluation, Appendix D)
1.2.1 Population	3.3 Environmental Justice
1.2.2 Emergency Planning	3.4 Land Use
1.2.3 Atmospheric Dispersion	**4.1 Engineering and Cost-Related Criteria: Health and Safety-Related Criteria**
1.3 Health and Safety Criteria: Operational Effects-Related	4.1.1 Water Supply
1.3.1 Surfacewater – Radionuclide Pathway	4.1.2 Pumping Distance

TABLE 9.3-2 (Sheet 2 of 2)
GENERAL SITE EVALUATION CRITERIA

Siting Criteria	Siting Criteria
1.3.2 Groundwater Radionuclide Pathway	4.1.3 Flooding
1.3.3 Air Radionuclide Pathway	4.1.4 Vibratory Ground Motion (deleted from evaluation, Appendix D)
1.3.4 Air – Food Ingestion Pathway	4.1.5 Civil Works
1.3.5 Surfacewater – Food Radionuclide Pathway	**4.2 Engineering and Cost: Transportation or Transmission Related Criteria**
1.3.6 Transportation Safety	4.2.1 Railroad Access
2.1 Environmental Criteria: Construction-Related Effects on Aquatic Ecology	4.2.2 Highway Access
2.1.1 Disruption of Important Species/Habitats	4.2.3 Barge Access
2.1.2 Bottom Sediment Disruption Effects	4.2.4 Transmission Access
2.2 Environmental Criteria: Construction-Related Effects on Terrestrial	**4.3 Engineering and Cost-Related Criteria: Related to Socioeconomic & Land Use**
2.2.1 Disruption of Important Species/Habitats and Wetlands	4.3.1 Topography
2.2.2 Dewatering Effects on Adjacent Wetlands	4.3.2 Land Rights
2.3 Environmental Criteria: Operational-Related Effects on Aquatic Ecology	4.3.3 Labor Rates
2.3.1 Thermal Discharge Effects	

TABLE 9.3-3
CANDIDATE SITE RISK FACTOR ANALYSIS

Site	Public Acceptance	Area Population	COL Application Timeframe
CPNPP Site	Nuclear operations currently exist at the site. Additional plant construction would not introduce new radiological concerns to the area.	The site is located in a relatively remote area without significant population centers nearby.	Data needed for the COL application (including meteorological, surfacewater and groundwater data) are readily available from the existing plant licensing basis. COL application schedule would not be delayed by data collection activities.
Luminant C-Trading House	New plant construction would introduce additional radiological concerns to the area, including potential dose pathways due to area agriculture.	The site is located near Waco, a significant population center.	Data needed for the COL application would have to be collected through data development programs, resulting in a longer timeframe required to complete the COL application.

TABLE 9.3-4
PROBABILISTIC GROUND MOTION VALUES IN %g

Site	PGA (%g) with 2% PE in 50 yr
CPNPP Site	3.78
Luminant A - Coastal	4.13
Luminant B - Pineland	6.46
Luminant C- Trading House	4.00

TABLE 9.3-5
LIST OF CLASS B FEATURES WITHIN 200-MI RADIUS OF EACH SITE

Site	Class	Feature	Distance from site (mi)
CPNPP Site	B	Gulf-margin faults	100 – 200 mi
Luminant A - Coastal	B	Gulf-margin faults	0 – 25 mi
Luminant B - Pineland	B	Gulf-margin faults	0 – 25 mi
Luminant C- Trading House	B	Gulf-margin faults	25 – 50 mi

TABLE 9.3-6 (SHEET 1 OF 2)
PERTINENT FLOOD RELATED INFORMATION FOR THE CANDIDATE SITES

Site	Evaluation
CPNPP Site	Site elevation = 850 ft msl (Note: the ER now uses a figure of 830 ft msl). SCR typical water elevation = 775 ft. Site is located in Flood Zone X (outside 100/500-yr flood zone). No dams or other unique features are present upstream of the candidate site that may cause flooding concerns.
Luminant A - Coastal	Site elevation = 55 ft. Guadalupe River at Bloomington flood stage = 20 ft. San Antonio River at McFaddin, level = 35 ft. Site is located in Flood Zone X (outside 100/500-yr flood zone). The reservoir dam is located ~ 17 mi northwest of the candidate site. The reservoir was created as a cooling water source for a neighboring power plant; the dam is not a flood control dam. The capacity of the reservoir is approximately 35,000 ac-ft. The Coleto Creek Dam is a high hazard-potential dam meaning that dam failure would likely result in the loss of human life. Failure of this dam would flow into Coleto Creek and the Guadalupe River. No dams or flooding concerns are located on the San Antonio River within 50 mi upstream of the site. The site could experience adverse conditions from tropical storms impacting the Texas Gulf Coast. The elevation at the site would prevent any direct impact from Gulf of Mexico storm surge.
Luminant B - Pineland	Site elevation = 222 ft. The reservoir typical water elevation = 164 ft. Site is location outside of Flood Zone A (100-yr flood zone). Because of topography and local drainages, some areas of the site may approach the 100-yr flood zone boundary. No dams or other unique features are present upstream of the candidate site that may cause flooding concerns.

TABLE 9.3-6 (SHEET 2 OF 2)
PERTINENT FLOOD RELATED INFORMATION FOR THE CANDIDATE SITES

Site	Evaluation
Luminant C- Trading House	Site elevation = 452 ft. The reservoir typical water elevation = 447 ft. Site is located in Flood Zone Z (outside 100/500-yr flood zone). Three small spillways are located upstream of the site on the reservoir (elevations 477 ft, 472 ft, and 462 ft). Breach of these spillways could cause some minor increase in reservoir elevations, but are not expected to present significant flooding hazards to the site.

TABLE 9.3-7 (SHEET 1 OF 2)
POTENTIAL HAZARDS LAND USES NEAR EACH SITE

Site	Evaluation
CPNPP Site	Airports (within 10 mi): 3.7 mi NW; 5.2 mi SE; 5.4 mi SW; 7.1 mi SW; 7.3 mi NE; 9.1 mi NE; 9.7 mi S.; 10.0 mi N. Rail: Nearest rail line potentially transporting hazardous cargo located 9.6 mi northwest (near Tolar). Rail spur provides access to CPNPP. Pipelines: There are four pipelines that cross the site. Two cross the very northern tip of SCR and two skirt the southwestern boundary. Military Installation: None located near site. Other: The site is co-located with two nuclear power plants (CPNPP Units 1 and 2). A fossil-fueled power plant is located 8.7 mi northeast.
Luminant A -Coastal	Airports (within 10 mi): 5.6 mi east and 7.8 mi southeast. Regional airport located 19.9 mi north. Rail: Nearest rail line potentially transporting hazardous cargo located 2.3 mi to northwest. Rail line also located 6.3 mi northeast. Pipelines: Pipeline easement through site; pipelines also located immediately adjacent to south, 3.1 mi southeast, 4.6 mi southeast, 5.3 mi northwest, 7.0 mi northeast, 7.5 mi northwest. Military Installation: None located near site. Other: transportation canal located 3.2 mi northeast (potential to transport hazardous cargo). Oil field located 3.7 mi southwest; Oil field located 6.3 mi northeast. Manufacturing plant located 8 mi north.

TABLE 9.3-7 (SHEET 2 OF 2)
POTENTIAL HAZARDS LAND USES NEAR EACH SITE

Site	Evaluation
Luminant B - Pineland	Airports (within 10 mi): 5.8 mi northeast. Rail: Nearest rail line potentially transporting hazardous cargo located 5.0 mi east. Pipelines: None identified. Military Installation: None located near site. Other: Hydroelectric plant located 8.0 mi southwest.
Luminant C - Trading House	Airports (within 10 mi): 0.3 mi southeast; 3.8 mi northwest; 7.7 mi northwest; and 8.5 mi southwest; 15.9 mi west. Rail: Nearest rail line potentially transporting hazardous cargo located 4.0 mi southwest. Pipelines: One pipeline within 1.5 mi of the site that extends around the eastern edge of the reservoir. Military Installation: Fort Hood military installation located 52 mi southwest of site. Other: The site is co-located with a fossil-fueled power plant. However, operation of a nuclear power plant at the site would coincide with shutdown of the fossil power plant.

TABLE 9.3-8 (SHEET 1 OF 2)
COMPARISON OF WIND AND PRECIPITATION DATA FOR EACH OF THE CANDIDATE SITES

Site	Peak Gust Maximum wind speed (mph)	Tornado Frequency Strong violent tornadoes Average per 10,000 sq mi State average	Proximity to Coast/ Hurricane Threat	Hurricane direct hits on Texas Gulf region[(a)] (1851-2004)	Maximum 24-hr precip.
CPNPP Site	81 mph peak gust (DFW). 73 mph maximum wind speed (DFW). 51-76 mph fastest mile winds – 2 yr return versus 100 yr return (CPNPP).	139 overall state average. 29 5.2 per 10,000 sq mi. In/near tornado alley with >15 per 1000 sq mi; F5 in Waco.	Inland	N/A	8.48 in (Glen Rose).
Luminant A - Coastal	78 mph peak gust (Houston). 67 mph peak gust (Corpus Christi). 75 maximum wind speed (Victoria).	139 overall state average. 29 5.2 per 10,000 sq mi. 6–10 per 1000 sq mi[(b)].	Coast/semi-coast.	16	9.87 in (Victoria).

TABLE 9.3-8 (SHEET 2 OF 2)
COMPARISON OF WIND AND PRECIPITATION DATA FOR EACH OF THE CANDIDATE SITES

Site	Peak Gust Maximum wind speed (mph)	Tornado Frequency Strong violent tornadoes Average per 10,000 sq mi State average	Proximity to Coast/ Hurricane Threat	Hurricane direct hits on Texas Gulf region[(a)] (1851-2004)	Maximum 24-hr precip.
Luminant B - Pineland	63 mph (Shreveport, LA).	139 overall state average. 29 5.2 per 10,000 sq mi. 6–10 per 1000 sq mi[(b)].	Inland	N/A	9.04 in (Sam Rayburn Dam).
Luminant C - Trading House	58 mph (Waco). 78 mph (Houston). Maximum wind speed – 69 mph (Waco).	139 overall state average. 29 5.2 per 10,000 sq mi. In/near tornado alley with >15 per 1000 sq mi; F5 in Waco.	Inland	N/A	7.98 in (Bay City).

a) Hurricane that may strike more than one region in Texas would be counted separately for each region; i.e., individual regional totals may exceed state totals. Central Texas quadrant was assumed to be the coastal area between Galveston and Corpus Christi, containing the potentially affected Luminant A - Coastal site.

b) Luminant A - Coastal and Luminant B - Pineland sites seem to be in band of 6–10 per 1000 sq mi; CPNPP and Luminant C- Trading House sites next to/just inside tornado alley (southern tip) – one spot they appear to be near shows >15 tornadoes per 1000 sq mi with an F5 in Waco in 1953 – one of deadliest (Waco is approximately 10 mi west of the Luminant C- Trading House site).

TABLE 9.3-9
ESTIMATED WIND SPEED AND X/Q

Site	Evaluation
CPNPP Site	Annual average wind speed = 9.0 – 9.9 mph. Estimated X/Q = 1.72E-5 sec/m^3 at 0.5 mi, 5.23E-6 sec/m^3 at 1.0 mi. CPNPP Final Safety Analysis Report (FSAR) for Units 1/2 reports X/Q = 2.5E-5 sec/m^3 at 0.5 mi (NNW) and 6.1E-6 sec/m^3 at 1.0 mi (NNW).
Luminant A - Coastal	Annual average wind speed = 9.0 – 9.9 mph. Estimated X/Q = 1.72E-5 sec/m^3 at 0.5 mi, 5.23E-6 sec/m^3 at 1.0 mi.
Luminant B - Pineland	Annual average wind speed = 7.0 – 7.9 mph. Estimated X/Q = 2.18E-5 sec/m^3 at 0.5 mi, 6.62E-6 sec/m^3 at 1.0 mi.
Luminant C - Trading House	Annual average wind speed = 9.0 – 9.9 mph. Estimated X/Q = 1.72E-5 sec/m^3 at 0.5 mi, 5.23E-6 sec/m^3 at 1.0 mi.

TABLE 9.3-10
DRASTIC EVALUATION FOR THE CPNPP SITE

Groundwater region = 6 (Non-glaciated Central Groundwater Region)
Groundwater subregion = K (Unconsolidated and Semi-consolidated Aquifers)
Underlying Basin = Trinity (outcrop)
Predicted groundwater classification = Class IIB
Potential evapotranspiration exceeds annual precipitation by 5-10 in/yr

DRASTIC Variable	Range and Source of Information	Weight	Rating	Number
Depth to Water	100+ ft bgs (Groundwater Level Reports).	5	1	5
Net Recharge	0–2 in/yr (DRASTIC).	4	1	4
Aquifer Media	Sand and gravel (DRASTIC).	3	8	24
Soil Media	Sandy loam (DRASTIC).	2	6	12
Topography	2-5% (USGS site topographic maps).	1	9	9
Impact Vadose Zone	Sand and gravel with significant silt and clay (DRASTIC).	5	6	30
Hydraulic Conductivity	300 - 700 gpd/ft^2 (DRASTIC).	3	4	12
			INDEX	96

TABLE 9.3-11
DRASTIC EVALUATION FOR THE LUMINANT A - COASTAL SITE

Groundwater region = 10 (Atlantic and Gulf Coastal Plain)
Groundwater subregion = Ba (River Alluvium with Overbank Deposits)
Underlying Basin = Gulf Coast Aquifer
Predicted groundwater classification = Class IIB
Potential evapotranspiration exceeds annual precipitation by 5-10 in/yr

DRASTIC Variable	Range and Source of Information	Weight	Rating	Number
Depth to Water	30–50 ft bgs (Groundwater Level Reports).	5	5	25
Net Recharge	7–10 in/yr (DRASTIC).	4	8	32
Aquifer Media	Sand and gravel (DRASTIC).	3	8	24
Soil Media	Silty loam (DRASTIC).	2	4	8
Topography	Less than 1% (USGS site topographic maps).	1	10	10
Impact Vadose Zone	Silt/Clay (DRASTIC).	5	3	15
Hydraulic Conductivity	700 – 1000 gpd/ft^2 (DRASTIC).	3	6	18
			INDEX	132

TABLE 9.3-12
DRASTIC EVALUATION FOR THE LUMINANT B - PINELAND SITE

Groundwater region = 10 (Atlantic and Gulf Coastal Plain)
Groundwater subregion = Aa (Regional Aquifer)
Underlying Basin = Gulf Coast Aquifer
Predicted groundwater classification = Class IIB
Annual precipitation exceeds potential evapotranspiration by 10-15 in/yr

DRASTIC Variable	Range and Source of Information	Weight	Rating	Number
Depth to Water	30–50 ft bgs (Groundwater Level Reports).	5	5	25
Net Recharge	0–2 in/yr (DRASTIC).	4	1	4
Aquifer Media	Sand and gravel (DRASTIC).	3	8	24
Soil Media	Sandy loam (DRASTIC).	2	6	12
Topography	2–5% (USGS site topographic maps).	1	9	9
Impact Vadose Zone	Silt/Clay (DRASTIC).	5	3	15
Hydraulic Conductivity	300 – 700 gpd/ft^2 (DRASTIC).	3	4	12
			INDEX	101

TABLE 9.3-13
DRASTIC EVALUATION FOR THE LUMINANT C - TRADING HOUSE SITE

Groundwater region = 6 (Non-glaciated Central Groundwater Region)
Groundwater subregion = K (Unconsolidated and Semi-consolidated Aquifers)
Underlying Basin = Trinity (subcrop)
Predicted groundwater classification = Class IIB
Potential evapotranspiration exceeds annual precipitation by 5-10 in/yr

DRASTIC Variable	Range and Source of Information	Weight	Rating	Number
Depth to Water	100+ ft bgs (Groundwater Level Reports).	5	1	5
Net Recharge	0–2 in/yr (DRASTIC).	4	1	4
Aquifer Media	Sand and gravel (DRASTIC).	3	8	24
Soil Media	Sandy loam (DRASTIC).	2	6	12
Topography	0–2% (USGS site topographic maps).	1	10	10
Impact Vadose Zone	Sand and gravel with significant silt and clay (DRASTIC).	5	6	30
Hydraulic Conductivity	300 – 700 gpd/ft^2 (DRASTIC).	3	4	12
			INDEX	97

TABLE 9.3-14
DRASTIC INDEXES USED TO DEVELOP A SYSTEM TO COMPARE VULNERABILITY OF CANDIDATE SITES

DRASTIC Index Range	Relative Vulnerability
65 – 80	Low
81 – 110	Low to Moderate
111 – 140	Moderate
141 – 170	High
171+	Very High

TABLE 9.3-15
DRASTIC INDEX RANGES FOR CANDIDATE SITES

Candidate Site	DRASTIC Index	Relative Vulnerability
CPNPP Site	96	Low to Moderate
Luminant A - Coastal	132	Moderate
Luminant B - Pineland	101	Low to Moderate
Luminant C - Trading House	97	Low to Moderate

TABLE 9.3-16 (SHEET 1 OF 4)
COMPARISON OF AIR-FOOD INGESTION PATHWAYS

Site	Evaluation
CPNPP Site	As the candidate site is near the border of Somervell County and Hood County, statistics for both counties are considered in the evaluation. Agriculture (farmland) represents 84,262 ac out of 119,789 ac in Somervell County (70%). Out of the total farmland, 21,777 ac are planted in crop (26%). Other farmland is used for cattle (6,876 head), sheep (489 head), and poultry (421 layers). Agriculture (farmland) represents 202,131 ac out of 269,830 ac in Hood County (75%). Out of the total farmland, 75,814 ac are planted in crop (38%). Other farmland is used for cattle (30,059 head), sheep (606 head), and poultry (1386 layers and 210 broilers). Aerial imagery indicates that the candidate site is in the general vicinity of agricultural operations, and the actual impact to local crops, pastures, and livestock from radionuclide emission exposure would be greater than the county-wide percentages. Nuclear power plant operations are currently located near the site, and construction of an additional nuclear power plant would not introduce a pathway concern to the area.

TABLE 9.3-16 (SHEET 2 OF 4)
COMPARISON OF AIR-FOOD INGESTION PATHWAYS

Site	Evaluation
Luminant A - Coastal	As the candidate site is near the border of Victoria County and Calhoun County, statistics for both counties are considered in the evaluation. Agriculture (farmland) represents 513,828 ac out of 564,800 ac in Victoria County (91%). Out of the total farmland, 166,089 ac are planted in crop (32%). Other farmland is used for cattle (69,544 head), hogs (236 head), sheep (305 head), and poultry (731 layers). Agriculture (farmland) represents 247,827 ac out of 327,878 ac in Calhoun County (76%). Out of the total farmland, 94,647 ac are planted in crop (38%). Other farmland is used for cattle (23,892 head), sheep (96 head), and poultry (175 layers). Aerial imagery indicates that the candidate site is in the general vicinity of agricultural operations, and the actual impact to local crops, pastures, and livestock from radionuclide emission exposure would be greater than the county-wide percentages. The most predominant area wind direction is toward the northwest. Winds in this direction would have neither a beneficial nor detrimental effect on radioactive material deposition on farmland.

TABLE 9.3-16 (SHEET 3 OF 4)
COMPARISON OF AIR-FOOD INGESTION PATHWAYS

Site	Evaluation
Luminant B - Pineland	As the candidate site is near the border of San Augustine County and Sabine County, statistics for both counties are considered in the evaluation. Agriculture (farmland) represents 58,723 ac out of 337,837 ac in San Augustine County (17%). Out of the total farmland, 19,589 ac are planted in crop (33%). Other farmland is used for cattle (11,981 head) and poultry (12,837,054 broilers). Agriculture (farmland) represents 30,808 ac out of 313,773 ac in Sabine County (10%). Out of the total farmland, 11,627 ac are planted in crop (38%). Other farmland is used for cattle (7499 head) and poultry (3,110,000 broilers). Aerial imagery indicates that the candidate site is not in the immediate vicinity of agricultural operations (agricultural operations are concentrated ~ 12 mi north of the candidate site and ~ 12 mi southeast of the candidate site), and the actual impact to local crops, pastures, and livestock from radionuclide emission exposure would be slightly less than the county-wide percentages. The most predominant area wind direction is toward the north. Winds in this direction would have neither a beneficial nor detrimental effect on radioactive material deposition on farmland.

TABLE 9.3-16 (SHEET 4 OF 4)
COMPARISON OF AIR-FOOD INGESTION PATHWAYS

Site	Evaluation
Luminant C- Trading House	As the candidate site is near the border of McLennan County and Limestone County, statistics for both counties are considered in the evaluation. Agriculture (farmland) represents 578,473 ac out of 666,803 ac in McLennan County (81%). Out of the total farmland, 298,447 ac are planted in crop (55%). Other farmland is used for cattle (98,194 head), hogs (944 head), sheep (2649 head), and poultry (4049 layers and 544 broilers). Agriculture (farmland) represents 529,924 ac out of 581,683 ac in Limestone County (91%). Out of the total farmland, 205,322 ac are planted in crop (39%). Other farmland is used for cattle (117,280 head), hogs (142 head), and sheep (609 head). Aerial imagery indicates that the candidate site is in the general vicinity of agricultural operations, and the actual impact to local crops, pastures, and livestock from radionuclide emission exposure would be greater than the county-wide percentages. The most predominant area wind direction is toward the north. Winds in this direction would have neither a beneficial nor detrimental effect on radioactive material deposition on farmland.

TABLE 9.3-17
FEDERALLY-LISTED SPECIES THAT MAY POTENTIALLY BE FOUND IN THE VICINITY OF THE CPNPP SITE

Scientific Name	Common Name	Federal Status
Vireo atricapilla	Black capped vireo	E (also state endangered)
Dendroica chrysoparia	Golden-cheeked warbler	E (also state endangered)
Sterna antillarum athalassos	Interior least tern	E (also state endangered)
Grus americana	Whooping crane	E (also state endangered)
Canis lupus	Gray wolf	E (also state endangered)
Canis rufus	Red wolf	E (also state endangered)

PDL – Proposed for Delisting
T – Federally Threatened
E – Federally Endangered

TABLE 9.3-18
FEDERALLY-LISTED SPECIES THAT MAY BE POTENTIALLY FOUND IN THE VICINITY OF THE LUMINANT A - COASTAL SITE

Scientific Name	Common Name	Federal Status
Tympanuchus cupido attwateri	Attwater's Greater Prairie Chicken	E (also state endangered)
Pelecanus occidentalis	Brown pelican	E (also state endangered)
Sterna antillarum athalassos	Interior least tern	E (also state endangered)
Grus americana	Whooping crane	E (also state endangered)
Ursus americanus luteolus	Louisiana black bear	T (also state threatened)
Canis rufus	Red wolf	E (also state endangered)

PDL – Proposed for Delisting
T – Federally Threatened
E – Federally Endangered

TABLE 9.3-19
FEDERALLY-LISTED SPECIES THAT MAY POTENTIALLY BE FOUND IN THE VICINITY OF THE LUMINANT B - PINELAND SITE

Scientific Name	Common Name	Federal Status
Charadrius melodus	Piping plover	T (also state threatened)
Picoides borealis	Red-cockaded woodpecker	E (also state endangered)
Ursus americanus luteolus	Louisiana black bear	T (also state threatened)
Canis rufus	Red wolf	E (also state endangered)

PDL – Proposed for Delisting
T – Federally Threatened
E – Federally Endangered

TABLE 9.3-20
FEDERALLY-LISTED SPECIES THAT MAY POTENTIALLY BE FOUND IN THE VICINITY OF THE LUMINANT C - TRADING HOUSE SITE

Scientific Name	Common Name	Federal Status
Dendroica chrysoparia	Golden-cheeked warbler	E
Sterna antillarum athalassos	Interior least tern	E (also state endangered)
Grus americana	Whooping crane	E (also state endangered)
Canis rufus	Red wolf	E (also state endangered)

PDL – Proposed for Delisting
T – Federally Threatened
E – Federally Endangered

TABLE 9.3-21
COMPARISON OF WETLANDS FOR EACH OF THE CANDIDATE SITES

Site Wetland Information	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C - Trading House
Wetland Acreage	53[(a)]	65[(b)]	214[(a)]	220[(a)]
Wetland Percentage	<1%	3.2%	10.7%	11%

a) Denotes wetlands estimated from satellite/aerial images; estimated acreage within 2000-ac area.

b) Includes wetlands on proposed plant site only (see below).

TABLE 9.3-22
COMPARISON OF THE CANDIDATE SITES IN TERMS OF WORKFORCE REQUIREMENTS

Site	Percent increase in total workforce	Percent increase in total construction workforce
CPNPP Site	0.1%	0.9%
Luminant A - Coastal	1.5% (0.7% if include Corpus Christi)	14.7% (or 6.7% if include Corpus Christi)
Luminant B - Pineland	1.1%	8.1%
Luminant C - Trading House	0.6%	5.6%

TABLE 9.3-23

ENVIRONMENTAL JUSTICE DATA FOR THE CANDIDATE SITES[(A)],[(B)]

Site	Population (2005)	White (%)	Minority (%)	Low Income (%)
CPNPP Site	4,061,000	1,716,000 (42%)	2,342,000 (58%)	641,000 (15.8%)
Luminant A - Coastal	277,000	147,000 (53.2%)	130,000 (46.8%)	48,000 (17.3%)
Luminant B - Pineland	304,000	216,000 (71.2%)	87,000 (28.7%)	56,000 (18.4%)
Luminant C - Trading House	682,000	407,000 (60%)	275,000 (40%)	107,000 (15.8%)

a) State Average for TX is 49.2% White, not Hispanic; with remaining 50.8% comprised of Hispanic or Latino origin; Black; American Indian/Alaskan, Asian, and Hawaiian; and 16.2% below poverty line. Note that state average for LA (two parishes in LA are included in Pineland area) for both minority and low income population is higher than TX).

b) White= white persons, not Hispanic, 2005 percentages; Hispanic= persons of Hispanic or Latina origin, 2005 percentages; remaining balance (to total 100%) consists of black persons, American Indian, Asian persons, and Native Hawaiian/Other Pacific persons.

TABLE 9.3-24
TRANSMISSION ACCESS FOR THE CANDIDATE SITES

Site	Evaluation
CPNPP Site	The candidate site is an existing power plant location, and transmission access is currently available at the site.
Luminant A - Coastal	ERCOT 345 kV transmission line is located ~ 1.8 mi southeast of the candidate site.
Luminant B - Pineland	ERCOT 345 kV transmission line is located ~ 45 mi northwest of the candidate site. Entergy 500 kV transmission line is located ~ 25 mi southeast of candidate site. Construction of an additional transmission line (345 kV Houston-Lufkin line) is planned for the area.
Luminant C - Trading House	The candidate site is an existing power plant location, and transmission access is currently available at the site.

TABLE 9.3-25
REPRESENTATIVE LABOR RATES IN THE SITE VICINITY

Site/ Metropolitan Statistical Areas (MSA)	Average construction overall (mean hourly)	Pipefitter/Steamfitter[a] (mean hourly)
CPNPP Site Vicinity	$14.85	$18.97
Luminant A - Coastal Vicinity	$14.51	$17.91
Luminant B - Pineland Vicinity	$15.27	$18.57
Luminant C - Trading House Vicinity	$13.18	$16.09

a) Higher end hourly wage earning was used when comparing sheet metal workers and structural iron and steel workers; less than supervisors and electricians. Electrician category had highest mean hourly wage in many cases, but not all. It was not used as basis for comparison.

TABLE 9.3-26 (SHEET 1 OF 7)
PRINCIPAL ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C- Trading House
Geologic	Seismic: Vibratory ground motion	PGA 3.78 %g with 2% PE in 50 yr.	Peak ground acceleration (PGA) 4.13 %g with 2% probability of exceedance (PE) in 50 yr.	PGA 6.46 %g with 2% PE in 50 yr.	PGA 4.00 %g with 2% PE in 50 yr.
	Geologic Hazards and Soil Stability	The site is not located near geologic hazards. The Comanche Peak site is a deep soil site that overlies sands that may have a potential for liquefaction.	The site is located in an area of potential subsidence. The site is a deep soil site that overlies sands that may have a potential for liquefaction.	The site is not located near geologic hazards. The site is a deep soil site that overlies sands that may have a potential for liquefaction.	The site is located in an area of potential subsidence and moderate landslide potential. The site is a deep soil site that overlies sands that may have a potential for liquefaction.
Water	Adequate Cooling Water	27,000 ac-ft/yr are available to Luminant from Possum Kingdom for units on the BRA. Luminant has solicited the BRA for an additional approximately 82,000 ac-ft/yr. Luminant is currently working with the BRA for purchase of this additional water. Use of this cooling water supply would decrease the amount available to potential additional units at the Luminant C- Trading House site.	50,000 ac-ft/yr is currently available to the candidate site. An additional 15,000 ac-ft/yr can be obtained with reasonable assurance. If the entire 65,000 ac-ft/yr can be obtained, two units could be operated at the site with ~ 5% (minimal) excess capacity.	In excess of 1 million ac-ft/yr is available to the candidate site. Four units can be operated at the site with abundant excess capacity available.	27,000 ac-ft/yr is currently available to the candidate site (15,000 ac-ft/yr allocated to the existing gas generating units and 12,000 ac-ft/yr allocated for additional generation capacity at the site). Additional cooling water supplies (~35,000 ac-ft/yr) would be required and would necessitate large releases from upstream reservoirs to meet inflow requirements. Construction of potential additional units at the Comanche Peak site would decrease the amount of cooling water available to this site.
	Normal Daily Mean temperature (degrees F)	64.4	70	65.5	66.6

TABLE 9.3-26 (SHEET 2 OF 7)
PRINCIPAL ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C- Trading House
Hazards	Flooding	The candidate site is not located in the 100-yr flood zone. No other neighboring flooding concerns exist. Construction of flood protection features is not anticipated.	The candidate site is not located in the 100-yr flood zone. No other neighboring flooding concerns exist. Construction of flood protection features is not anticipated.	The candidate site is not located in the 100-yr flood zone. No other neighboring flooding concerns exist. Construction of flood protection features is not anticipated provided construction of structures is limited to the higher elevations of the site.	The candidate site is not located in the 100-yr flood zone. No other neighboring flooding concerns exist. Construction of flood protection features is not anticipated.
	Nearby Hazards (airports, rail, pipelines, military installations, and others facilities)	Airports within 10 mi: 3.7 mi NW; 5.2 mi SE; 5.4 mi SW; 7.1 mi SW; 7.3 mi NE; 9.1 mi NE; 9.7 mi S; 10.0 mi N. Rail: Nearest rail line potentially transporting hazardous cargo located 9.6 mi NW. Pipelines: 1.7 mi W; 2.3 mi E; 2.4 mi N; 2.9 mi NE; 3.6 mi S. Military Installation: None located near site. Other: The site is co-located with two nuclear power plants (CPNPP, Units 1 and 2). A fossil power plant is located 8.7 mi NE.	Airports within 10 mi: 5.6 mi E.; 7.8 mi SE. Regional Airport located 19.9 mi N. Rail: Nearest rail line potentially transporting hazardous cargo located 2.3 mi NW. Rail line also located 6.3 mi NE. Pipelines: Pipeline easement through site; pipelines also located immediately adjacent to S; 3.1 mi SE; 4.6 mi SE; 5.3 mi NW; 7.0 mi NE; 7.5 mi NW. Military Installation: None located near site. Other: Barge Canal located 3.2 mi NE (potential to transport hazardous cargo).	Airports within 10 mi: municipal airport (5.8 mi NE). Rail: Nearest rail line potentially transporting hazardous cargo located 5.0 mi E. Pipelines: None identified. Military Installation: None located near site. Other: Hydroelectric plant located 8.0 mi SW.	Airports within 10 mi: 0.3 mi SE; international airport 3.8 mi NW; 7.7 mi NW); 8.5 mi SW. Municipal airport located 15.9 mi W. Rail: Nearest rail line potentially transporting hazardous cargo located 4.0 mi SW. Pipelines: One pipeline within 1.5 mi of the site that extends around the eastern edge of the reservoir Military Installation: military installation located ~ 52 mi southwest of site. Other: The site is co-located with a fossil power plant. However, operation of a nuclear power plant at the site would coincide with shutdown of the fossil power plant.

TABLE 9.3-26 (SHEET 3 OF 7)
PRINCIPAL ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C- Trading House
Accident Considerations	Tornado Frequency	139 overall state average.	139 overall state average.	139 overall state average.	139 overall state average.
	Strong violent tornadoes	29	29	29	29
	Average per 10,000 sq mi	5.2 per 10,000 sq mi.	5.2 per 10,000 sq mi.	5.2 per 10,000 sq mi.	5.2 per 10,000 sq mi.
	Population	7773 (2006)	86,191 (2006)	8946 (2006)	226,189 (2006)
	Population density in persons per sq mi (psm)	36.4 psm Immediately adjacent county: 49,238; 97.4 psm.	95.2 psm	16.9 psm Immediately adjacent county: 10,457 (2006); 21.4 psm.	204.9 psm Immediately adjacent county: 22,729 (2006) 24.3 psm.
	Emergency Planning	Area evacuation is adequate in all directions, although immediate evacuation to the east is limited by the SCR and the traffic network leading from the candidate site is limited to local, low volume roads.	Area evacuation is possible in three directions, being limited to the southeast by the Gulf of Mexico (~30 mi southeast of the candidate site) and limited crossings over the Guadalupe and San Antonio Rivers. The candidate site is located ~ 6 mi east of U.S. Highway 77, providing primary access to the area.	Area evacuation is adequate in all directions, although immediate evacuation is only available to the north due to location on a peninsula on the Sam Rayburn Reservoir. The candidate site is located ~ 4 mi west of U.S. Highway 96, providing primary access to the area.	Area evacuation is adequate in all directions, although immediate evacuation to the south is limited by the reservoir, and the traffic network leading from the candidate site is limited to local, low volume roads. The candidate site is located ~ 9 mi east of U.S. Highway 77, providing primary access to the area.
Operational Effects	Air Radionuclide Pathway	Atmospheric dispersion not expected to be materially affected by area topography. Estimated X/Q = 1.72E-5 sec/m^3 at 0.5 mi, 5.23E-6 sec/m^3 at 1.0 mi. CPNPP FSAR for Units 1/2 reports X/Q = 2.5E-5 sec/m^3 at 0.5 mi (NNW) and 6.1E-6 sec/m^3 at 1.0 mi (NNW).	Atmospheric dispersion not expected to be materially affected by area topography. Estimated X/Q = 1.72E-5 sec/m^3 at 0.5 mi, 5.23E-6 sec/m^3 at 1.0 mi.	Atmospheric dispersion not expected to be materially affected by area topography. Estimated X/Q = 2.18E-5 sec/m^3 at 0.5 mi, 6.62E-6 sec/m^3 at 1.0 mi.	Atmospheric dispersion not expected to be materially affected by area topography. Estimated X/Q = 1.72E-5 sec/m^3 at 0.5 mi, 5.23E-6 sec/m^3 at 1.0 mi.

TABLE 9.3-26 (SHEET 4 OF 7)
PRINCIPAL ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C- Trading House
	Construction-related effects on aquatic species/habitats	There are no federally-listed aquatic species (fish species) in Somervell County; however, the sharpnose shiner (Notropis oxyrhynchus) and smalleye shiner (Notropis buccula) are Federal candidate fish species listed in Somervell County; there are also three mollusk species that are considered rare but with no regulatory status.	There are no federally-listed or state-listed aquatic species found in the county. Other sensitive species include one fish (American eel) and one mollusk (Creeper/squawfoot) species; these are considered rare but with no regulatory status.	There are no federally protected species; two state protected species in San Augustine County and three state protected species in Sabine County.	There are no federally-listed aquatic species in the county; however, the sharpnose shiner (Notropis oxyrhynchus) and smalleye shiner (Notropis buccula) are two Federal candidate fish species listed in the county. There are no other state protected species, however, there is a third fish and five mollusk species considered to be rare with no regulatory status.
Aquatic Ecology	Operational effects (thermal discharge effects) on aquatic ecology	The site is located near a reservoir and is believed to have sufficient volume to dilute the heated discharge and minimize any thermal impacts.	This site might result in some limited adverse impact to aquatic ecology.	The site is located on a reservoir and is believed to have sufficient volume to dilute the heated discharge and minimize any thermal impacts.	The site is located on a reservoir and is believed to have sufficient volume to dilute the heated discharge and minimize any thermal impacts.
	Operational (entrainment and impingement) effects on aquatic ecology.	See description for Luminant A - Coastal .	Given the lack of site-specific entrainment and impingement data at all sites, the presence of state protected fish species at each of the sites (including mollusks at all sites and a candidate federal species at Comanche Peak), and the uncertainties associated with any additional EPA ruling on cooling water intake structures, which are considered to be relevant even though they would only apply to existing power plants, all candidate sites were given an equivalent and conservative rating.	See description for Luminant A - Coastal	See description for Luminant A - Coastal

TABLE 9.3-26 (SHEET 5 OF 7)
PRINCIPAL ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C- Trading House
Terrestrial Ecology	Construction-related impacts on terrestrial species/habitat	Seven federally-listed species, including five bird and two mammal species, are found in Somervell County and have the potential to occur in the vicinity of the Comanche Peak site. Additional state-listed species that are not on the federal list include three bird and three reptile species. Finally, there are two bird, one mammal, one reptile and one plant species that are considered rare but with no regulatory status. Bald eagles are found on SCR.	Seven federally-listed terrestrial species, including five bird and two mammal species, have the potential to occur in Victoria County and therefore in the vicinity of the candidate site. Additional state-listed species that are not on the federal list include one amphibian, seven bird, and one mammal species. Finally, there are three bird, two insect, and one mammal species that are considered rare but with no regulatory status.	Five federally-listed terrestrial species, including three bird and two mammal species, have the potential to occur in the county and therefore in the vicinity of the candidate site. Additional state-listed species that are not on the federal list include six bird and two mammal species. Finally, there are one bird, one insect, and two mammal species that are considered rare but with no regulatory status.	Five federally-listed bird and one mammal species have the potential to occur in McLennan County and therefore in the vicinity of the candidate site. Additional state-listed species that are not on the federal list include five bird species. Finally, there are two bird, one mammal, and one reptile species that are considered rare but with no regulatory status.
	Operational-related (Cooling Tower Drift) drift effects on terrestrial ecology	See description for Luminant A - Coastal .	In NUREG-1437, NRC concludes potential adverse impacts due to drift from cooling towers to surrounding plants, including crops and ornamental vegetation, natural plant communities, and soils, is expected to be minor. This potential impact can be minimized with the use of drift eliminators on the cooling towers. In addition, from previous evaluations, NRC staff does not believe that salt is expected to accumulate in the soil to levels potentially harmful to vegetation due to the diluting effect of rainfall. Based on the staff's knowledge of drift studies at plants having freshwater natural draft cooling towers, expected drift levels from operation of the additional plants are not likely to adversely impact terrestrial biota.	See description for Luminant A Coastal.	See description for Luminant A - Coastal

TABLE 9.3-26 (SHEET 6 OF 7)
PRINCIPAL ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C- Trading House
Socioeconomics	Construction impacts on local vicinity	The site would experience a percentage increase less than 1% when compared to total study area workforce; the site would experience a percentage increase less than 10% when compared to the total construction workforce.	The site would experience a percentage increase less than 1% when compared to total study area workforce; the site would experience a percentage increase less than 10% when compared to the total construction workforce; although the increase would rise to 14.7% if Corpus Christi is NOT included in the commuter population.	The site would experience a percentage increase less than 2% when compared to total study area workforce; the site would experience a percentage increase less than 10% when compared to the total construction workforce.	The site would experience a percentage increase less than 1% when compared to total study area workforce; the site would experience a percentage increase less than 10% when compared to the total construction workforce.
	Operational impacts on local vicinity	See description for Luminant A - Coastal .	Socioeconomic impacts of operation relate primarily to the benefits afforded to local communities as a result of the plant's presence; i.e., tax plans, local emergency planning support, and educational program support. These benefits tend to be a function of negotiations between the plant owner and local government; they are not indicative of inherent site conditions that affect relative suitability between sites. This criterion is not applicable to a comparison of the candidate sites, and in accordance with guidance in the Siting Guide, suitability scores were not developed.	See description for Luminant A - Coastal	See description for Luminant A - Coastal

TABLE 9.3-26 (SHEET 7 OF 7)
PRINCIPAL ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Principal Environmental Attributes	CPNPP Site	Luminant A - Coastal	Luminant B - Pineland	Luminant C- Trading House
Site Preparation	Grading	The candidate site is located in an area with little relief. The site generally slopes from west to east toward the SCR. Costs associated with site preparation are expected to be relatively low. Approximate slope = 2.5% – 4.4%. Approximate relief = 100 ft.	The candidate site is located in an area with minimal relief. The site generally slopes from north to south toward the river. Costs associated with site preparation are expected to be relatively low. Approximate slope = 0.4% – 0.8% Approximate relief = 15 ft.	The candidate site is located in an area with little to moderate relief. The site generally slopes to the west, south, and east toward the reservoir. As the site is on a narrow peninsula, flexibility in locating the plant in an area with lesser relief may not be possible. Costs associated with site preparation are expected to be higher than other sites. Approximate slope = 2.0% – 2.5% with site areas over 5%. Approximate relief = 60 ft.	The candidate site is located in an area with minimal relief. The site generally slopes from north to south toward reservoir. Costs associated with site preparation are expected to be relatively low. Approximate slope = 0.3% – 1.1%. Approximate relief = 30 ft.

TABLE 9.3-27 (SHEET 1 OF 3)
PRINCIPAL NON-ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Luminant A - Coastal	CPNPP Site	Luminant B - Pineland	Luminant C- Trading House
Local labor rates	Mean average construction: $14.51; Mean average Pipefitter/ Steamfitter worker: $17.91.	Mean average construction: $14.85; Mean average Pipefitter/ Steamfitter worker: $18.97.	Mean average construction: $15.27; Mean average Pipefitter/ Steamfitter worker: $18.57.	Mean average construction: $13.18; Mean average Pipefitter/ Steamfitter worker: $16.09.
Transmission access in terms of distance to the nearest existing transmission line	A 345 kV transmission line is located ~ 1.8 mi southeast of the candidate site.	The candidate site is an existing power plant location, and transmission access is currently available at the site.	A 345 kV transmission line is located ~ 45 mi northwest of the candidate site. A 500 kV transmission line is located ~ 25 mi southeast of candidate site. Construction of a additional transmission line (345 kV) is planned for the area.	The candidate site is an existing power plant location, and transmission access is currently available at the site.
Relative costs to provide rail access	Rail is located ~ 2.3 mi northwest of site. This rail line does not support passenger service. Line length = 2.3 mi.	Rail is immediately accessible at the site due to co-location with existing power plants. Costs associated with construction of a rail spur would be minimal.	Rail is located ~ 10.2 mi north of site. This rail line does not support passenger service. Rail construction could be complicated by rough area terrain. Line length = 10.2 mi.	Rail is located ~ 8.4 mi west of site. This rail line does not support passenger service. Line length = 13.0 mi.

TABLE 9.3-27 (SHEET 2 OF 3)
PRINCIPAL NON-ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Luminant A - Coastal	CPNPP Site	Luminant B - Pineland	Luminant C- Trading House
Relative cost of developing water supply facilities	Highest cost. The other 3 sites are assigned an equivalent and lower cost rating.	See Luminant A - Coastal.	See Luminant A - Coastal.	See Luminant A - Coastal.
Relative pumping costs (distance)	Luminant A - Coastal and Comanche Peak are assigned equivalent but higher relative costs than the Luminant B - Pineland and **Luminant C- Trading House** sites.	See Luminant A - Coastal.	Luminant B - Pineland and **Luminant C- Trading House** are assigned equivalent but lower relative costs than Luminant A - Coastal or Comanche Peak.	See Luminant B - Pineland.
Relative cost of flood protection structures cost	The candidate site is not located in the 100-yr flood zone. No other neighboring flooding concerns exist. Construction of flood protection features is not anticipated. All candidate sites are assumed to have approximately equivalent costs.	Construction of flood protection features is not anticipated provided construction of structures is limited to the higher elevations of the site (See Luminant A - Coastal).	See Luminant A - Coastal.	See Luminant A - Coastal.

TABLE 9.3-27 (SHEET 3 OF 3)
PRINCIPAL NON-ENVIRONMENTAL ATTRIBUTES BETWEEN THE CANDIDATE SITES

	Luminant A - Coastal	CPNPP Site	Luminant B - Pineland	Luminant C- Trading House
Relative cost of civil works (e.g., non-flood related berms, stabilizing of graded slopes and banks)	Candidate site is in an area having low landslide incidence (<1.5% of area involved in landslides). Compounded with minimal area sloping, costs associated with civil works (slope stability) are estimated to be low.	Candidate site is in an area having low landslide incidence (<1.5% of area involved in landslides). Compounded with moderate area sloping, costs associated with civil works (slope stability) are estimated to be low to moderate.	Candidate site is in an area having low landslide incidence (<1.5% of area involved in landslides). Compounded with moderate area sloping, costs associated with civil works (slope stability) are estimated to be low to moderate.	Candidate site is in an area having low landslide incidence (<1.5% of area involved in landslides). Compounded with moderate area sloping, costs associated with civil works (slope stability) are estimated to be low to moderate.
Relative costs associated with providing highway access	Estimated construction cost = $16.2M.	Costs associated with construction of additional/ improved roads would be minimal.	Estimated construction cost = $22.5M.	Costs associated with construction of additional/ improved roads would be minimal.
Relative costs associated with providing barge access	The candidate site is located ~ 9.4 mi from a barge pier. Luminant A - Coastal has a substantially lower cost than Comanche Peak or Luminant B - Pineland and C **Luminant C- Trading House** sites.	Barge access is not available in the vicinity of the candidate site (See Luminant A - Coastal).	Barge access is not available in the vicinity of the candidate site (See Luminant A - Coastal).	Barge access is not available in the vicinity of the candidate site (See Luminant A - Coastal).

9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

This section discusses alternatives in each of three system areas for CPNPP Units 3 and 4. This information is provided to enable a comparison of the environmental impact on each alternative to those impacts of the proposed systems.

Following the guidance in NUREG-1555, Subsection 9.4.1 presents alternatives to the plant heat dissipation system. Subsection 9.4.2 evaluates alternatives to the circulating water system (CWS). These evaluations are presented as alternatives in the areas of intake designs and locations, discharge designs and locations, water supplies, and water treatment. These subsections evaluate the alternatives, in comparison with the proposed CWS, to identify those systems that are (1) environmentally preferable to and (2) environmentally equivalent to the proposed CWS.

Environmentally preferable alternatives, if found, are compared with the proposed systems on a benefit-cost basis to determine if any such system needs to be considered as an alternative to the proposed systems. This subsection is limited to the review of alternative heat dissipation systems considered feasible for construction and operation, and not prohibited by federal, state, regional or local regulations, or Native American tribal agreements. The proposed systems must also be consistent with the Federal Water Pollution Control Act also known as the Clean Water Act (CWA) and be judged as practical from a technical standpoint with respect to the proposed dates of plant construction and operation.

Subsection 9.4.3 contains the currently available information pertaining to the transmission system proposed for CPNPP Units 3 and 4. As provided for in Texas law and regulation, Luminant works with the transmission and distribution company, Oncor Electric Delivery Company LLC (Oncor). Since Oncor is responsible for the transmission system and has the authority and responsibility to establish and maintain the transmission infrastructure, Subsection 9.4.3 is based on information supplied mainly by Oncor. Luminant has no authority to determine transmission system alternatives but works to support Oncor as appropriate.

Following the guidance in NUREG-1555, Subsection 9.4.3 is expected to present information on alternatives such as: alternatives to the proposed system design, practicality of alternatives, compatibility with the network, construction, and maintenance practices. Many of these items are not included in this report based on the structure and organization of the electric industry in Texas and Luminant’s role as a merchant plant in the unregulated sector of the electric industry in Texas. Oncor is required to follow all the applicable Federal and State laws and regulations in establishing the proposed transmission system to support this project. Oncor has proposed five modifications at this time to support the proposed project, and none of the modifications involve an increase of line voltage above the existing 345 kV.

9.4.1 HEAT DISSIPATION SYSTEMS

This subsection considered the following alternative heat dissipation facilities to support the proposed project, CPNPP Units 3 and 4:

- Once-through cooling.

- Dry cooling towers.
- Cooling lake.
- Mechanical draft cooling towers (MDCTs).
- Natural draft cooling towers (NDCTs).

Considering design characteristics, feasibility, environmental impact, operational impact, and cost, the MDCTs represented the best choice and were selected as the heat dissipation facilities for the proposed project. Special consideration was given to provide the best technical option balanced with environmental considerations, the cost of construction and operation and with the least impact on the continued operation of CPNPP Units 1 and 2. Table 9.4-1 provides a listing of the major alternatives reviewed for CPNPP Units 3 and 4.

CPNPP Units 1 and 2 are pressurized water reactors that have been in operation Because 1990 and 1993, respectively. To meet cooling requirements for CPNPP Units 1 and 2, a cooling water lake, Squaw Creek Reservoir (SCR), was constructed as well as a safety-related ultimate heat sink (UHS) water body called the Safe Shutdown Impoundment (SSI). Along the southern shoreline of SCR is the circulating water intake structure with conventional traveling screens supplying water to the once-through condensers for the steam driven turbine generators. Some makeup water for SCR is supplied from natural runoff within the local Squaw Creek watershed but most of the makeup water is supplied by makeup pipelines from Lake Granbury. SCR provides sufficient cooling for the continued operation of CPNPP Units 1 and 2 as long as the SCR water level is maintained.

CPNPP Units 3 and 4 are also pressurized water reactors but SCR could not support the addition of the added heat load in the same design configuration used for CPNPP Units 1 and 2. This subsection discusses the possible heat dissipation alternatives, and the decisions made to determine the appropriate heat dissipation system and allow for the successful operation of CPNPP Units 3 and 4 without affecting the operation of CPNPP Units 1 and 2.

Three systems of operation were considered for the several heat dissipation alternatives:

- Open cycle system in which the cooling water cycles once through the system for heat dissipation.
- Closed cycle system in which the cooling water circulates in a loop through the closed cycle system.
- Combined cycle system in which the system can be operated in any of three modes as required.

The three modes in which the combined cycle system can operate are as follows:

- Open mode - Operates as a once-through system with heat dissipated to the lake or river.

- Helper or topping mode - Heated condenser water is circulated through a supplemental cooling facility for initial cooling then discharged to the lake or river.

- Closed mode - Operates in a closed-loop system with heat dissipated to the environment by, for example, a tower.

The open mode would possibly increase plant efficiency due to lower condenser cooling water temperature but there is not a sufficient body of water for once-through use. In December 2001, the EPA published a final regulation that affects the location, design, construction, and capacity of intake structures for new power plants. The EPA rule strongly encourages the use of closed-loop designs to reduce adverse cooling water system effects and prohibits once-through designs in some applications (ERM 2005).

The closed mode is adaptable to either MDCTs or NDCTs, a cooling lake, or a spray canal. Figure 9.4-1 shows the schematic arrangement for a typical closed-loop system.

The cooling tower, spray canal, or cooling lake may be utilized as the supplemental heat dissipation device for a combined cycle system. Figure 9.4-2 shows the schematic arrangement for a typical combined cycle system.

9.4.1.1 Proposed Heat Dissipation System

The purpose of the plant cooling systems is to dissipate thermal energy to the environment. The performance of these dissipation cooling systems largely depend on the inlet temperature and the wet bulb temperature (ERM 2005). The turbine condenser creates the low pressure required to drag steam through and increase the efficiency of the turbines. The balance between the pressure of the exhaust steam leaving the low-pressure turbine and the vacuum in the condenser significantly affects the gross electrical output. One of the limiting factors in the efficiency of the plant is the inlet temperature of the cooling water entering the single pressure condenser. The inlet temperature partially determines the condenser pressure that relates directly to the gross electrical output of the plant.

The various heat dissipation system options differ in how the heat energy transfer takes place; therefore, each option has a different potential environmental impact. The potential alternatives are generally included in the broad categories of once-through and closed-loop systems. The once-through method involves the use of large quantities of cooling water, withdrawn from and returned to a large water source following its circulation through the main condenser. Closed-loop cooling systems involve a potentially lower water usage. The water performing the cooling is continually re-circulated (each recirculation is called a cycle) through the main condenser and dissipation equipment, and only makeup water for normal system losses is required. Normal system losses include evaporation, blowdown, and drift. Evaporation occurs as part of the cooling process in wet systems. The plant heat removal rates are dependent on many factors but most systems such as MDCTs, NDCTs, and spray canals rely on evaporative cooling for 80 percent of their cooling (ERM 2005) with the remaining heat removed by sensible heat exchange. The purpose of blowdown is to control salts and solids in the water that accumulate due to evaporation, which helps protect surfaces from scaling or corrosion problems and helps control water quality. Drift is liquid water that escapes from the heat dissipation system in the form of unevaporated droplets during operation.

The alternatives were evaluated with respect to the performance of each type of system in relation to the evaporation, blowdown, and drift. Values for closed-loop systems are presented here as well as some work on combination systems of operation. Open mode systems discussed here as once-through cooling, were eliminated after the evaluation was performed for a variety of reasons (Subsection 9.4.1.2.1). The analysis of each alternative heat dissipation system considers various factors for comparison with those of the proposed system. These factors are discussed below.

The proposed cooling system is designed to meet the cooling requirements for the proposed project. The cooling system must minimize any effect upon the operation of CPNPP Units 1 and 2 and at the same time provide environmental protection for the waters of SCR and Lake Granbury. Luminant chose a closed-loop MDCT system. This type of condenser cooling water system, with the changes to the water source option, would enable CPNPP Units 3 and 4 to operate with no thermal effect on SCR. This type of closed-loop system also minimizes the thermal effects while conserving surface water in Lake Granbury.

The proposed system would use cooling water from Lake Granbury piped directly to the MDCT basin. The existing cooling water pipeline ROW for CPNPP Units 1 and 2 would be used for the additional pipelines that are planned to be installed for the proposed project. (The Lake Granbury intake structures for CPNPP Units 1 and 2 provide a makeup source of water for SCR and are not used directly for normal plant operations. As noted earlier, cooling water for CPNPP Units 1 and 2 is drawn from SCR.) The cooling water for the proposed system would not be released into SCR. The cooling water would supply the closed-cycle system to achieve the recirculation that reduces the quantity of water consumed. Blowdown from the MDCTs would return directly to Lake Granbury via return pipelines along the existing ROW for CPNPP Units 1 and 2. The intake structures for CPNPP Units 3 and 4 would be shoreline structures with submerged intakes fitted with fine-mesh passive screen strainers (Subsection 9.4.2).

No UHS water body impoundment is required for the MHI US-APWR design. The makeup water for the UHS system would come from Lake Granbury but the small flow required, approximately 274 gpm for each unit, is a small fraction of the water being supplied by the proposed system (Luminant 2008). The UHS system utilizes water basins that contain sufficient storage capacity to meet the safety requirements (30 days) for accident conditions and has separate closed-loop MDCTs of much smaller size to provide the required cooling for the essential service cooling water (ESW) heat loads. The UHS is part of the safety-related structure of the plant for CPNPP Units 3 and 4 and is not fully described in this subsection. The UHS water system provides a small percentage of the heat load and was eliminated from this analysis (TXU 2007).

The proposed heat dissipation system would provide cooling water for three cooling water systems that transfer heat to the environment during normal modes of plant operation. These systems are the CWS, the essential service water (ESW), and the non-essential service water cooling system (NESW). The service water systems are a small percentage of the total heat load dissipation system and were eliminated from this analysis. Heat generated during each operational mode could be released by these systems to the atmosphere via the MDCT and to Lake Granbury via the blowdown return. Operation of the heat dissipation system is detailed in Section 3.4.

There are two banks of MDCTs for each unit that are made of fiberglass reinforced plastics and PVC. Figure 9.4-3 provides a simplified diagram of the proposed heat dissipation system. Figure 2.1-1 provides the site plot plan including the location of the proposed cooling towers. The tower widths are approximately 124 ft while the lengths are approximately 811 ft (Luminant 2008). The designed thermal heat load (cooling tower duty) is 9970 MMBtu/hr. MDCTs use fans to force convection within the cooling tower and allow water to drain to the blowdown sump. The volumetric flow of air required in the tower varies with the mode of operation and the weather conditions. MDCTs have long piping runs that spray water downward. Large fans pull air across the dropping water to remove the heat. As the water drops downward onto the slats in the cooling tower, the drops break into finer spray. The CWS makeup would be provided by the water supplied from Lake Granbury.

Water chemistry is maintained in the circulating water to sustain a non-corrosive, non-scale-forming condition and limit biological growth in components. Blowdown water would be extracted from the cold water basin of each MDCT and returned to Lake Granbury through the blowdown return lines. The concentration of dissolved solids in the circulating water is dependent on the dissolved solids content of the supplied water and the number of cycles of recirculation allowed. The analysis performed for the proposed system was based on 2.4 cycles of concentration. The blowdown rate is determined by the desired level of concentration of dissolved salts and solids in the circulating water, and is limited by the TPDES permit on discharge to waterways. A blowdown treatment facility (BDTF) is being built along the blowdown return pipeline to aid in ensuring the limits set in the TPDES can be met at all times.

The environmental impact of the proposed heat dissipation system during station operation on the atmospheric and terrestrial ecosystems is discussed in greater detail in Subsection 5.3.3.

These impacts include:

- Heat dissipation to the atmosphere.
- Length and frequency of elevated plumes.
- Frequency and extent of ground level fogging and icing in the site vicinity.
- Solids deposition (i.e., drift deposition) in the site vicinity.
- Cloud formation, cloud shadowing, and additional precipitation.
- Interaction of vapor plume with existing pollutant sources located within 1.25 mi of the site.
- Ground level humidity increase in the site vicinity.

Environmental impact from operating MDCTs includes some cloud development and plume shadowing as discussed in Subsection 5.3.3.1.4. From NUREG 1437; about 10 percent of the vapor escaping in the exhaust flow recondenses after release, forming the visible plume leaving the tower. MDCTs cause a larger plume impact than NDCT plumes because the MDCT plume is created closer to ground level. On colder days, plumes can be seen rising from an MDCT; on occasion, the plumes travel downwind near ground level.

Ground level fogging and icing are generally not a significant problem with MDCTs. Surface fogging at CPNPP occurs infrequently and would not increase significantly by the operation of the MDCTs (Subsection 5.3.3.1.2). The height of the MDCTs and their evaluated plume make it unlikely that significant fogging would occur in any populated areas surrounding the plant site. Icing that is associated with fogging can result during periods of extended sub-freezing temperatures. Because fogging is infrequent and extended periods of sub-freezing weather are infrequent, icing events are expected to be infrequent as well. No mitigation is warranted.

MDCTs do not significantly alter local meteorology, and no mitigation is warranted. The MDCT would be the appropriate choice for the proposed project.

Salts and TDS concentration occurs with MDCT operation. As stated in NUREG 1437, impacts on air quality measurements indicate that beyond 1 mi from nuclear power plant cooling towers, salt deposition is not significantly above natural background levels. Environmental impacts on water quality indicate the most limiting salt is calcium sulfate (TXU 2007) but by limiting the number of cycles of concentration, the limits would not be exceeded. The number of cycles of concentration, along with the aid of the BDTF, would be controlled to prevent any other concentration limits from being exceeded in accordance with the TPDES permit.

Potential environmental impacts on the aquatic ecosystems are presented in Subsection 5.3.2.2. Potential environmental impacts on the terrestrial ecosystems are presented in Subsection 5.3.3.2. Drift has been estimated by the cooling tower manufacturers to be small.

The use of MDCTs would increase noise levels at the plant site. This increase would be due to both the fans and the falling water, but the fan noise would be dominant. The towers would be located on the northwestern edge of the site property, bound by the SCR on the north, away from the operational and support personnel, and in proximity of the site boundary with a widely scattered rural population. Based on the predicted increase in noise levels, MDCTs for CPNPP are acceptable for use.

The MDCT technology, considered one of the best available technologies by the EPA, was selected on the basis of environmental impact, design functions and adequacy to meet the plant's heat load requirements as well as not interfering with operation of CPNPP Units 1 and 2. The cooling towers dimensions, layout and airflow rates are provided in Table 5.3-3. Subsection 5.3.3.1 discusses the location of the cooling towers in reference to the proposed project.

9.4.1.2 Screening of Alternatives to the Proposed Heat Dissipation System

Existing classes of heat dissipation systems reviewed include:

- Once-through cooling systems (open systems)
- Dry cooling towers (closed systems)
- MDCTs (closed-combination-open systems)

- Cooling lake (closed-open systems)
- Wet/dry cooling towers (combination systems)
- NDCTs (closed-open systems)

An initial environmental screening of the above alternative designs was done to eliminate those systems that are obviously unsuitable for use to support the proposed project. The screening criteria included: on-site land and water use, atmospheric, thermal and physical effects, noise levels, etc. that might preclude the use of any of the alternatives. As NUREG-1437 states, the effects of cooling tower discharges on water quality, aquatic ecology and vegetation are all SMALL impacts. Results of cost comparisons of the various heat dissipation alternative systems are presented in Table 9.4-2 and are discussed in the following subsections.

Considering feasibility, environmental impact and cost, the MDCT was selected as the best heat dissipation alternative for the proposed project. Based on the analysis above, two banks of closed-loop MDCTs (wet) for each reactor unit were chosen to be used in the proposed project's plant heat dissipation system.

9.4.1.2.1 Once-Through Cooling Systems

Once-through cooling is the process whereby water is drawn from a water body, directed through the steam condenser where its temperature is raised, and discharged directly into the same water body. The water body could be a closed system if there is no outlet to another water body such as a nearby river or downstream lake (Subsection 9.4.1.2.4), or the water body can be an open system when there is a continuous supply of new water into the lake, and the new water can be released to another water body after use. Once-through cooling utilizes an intake from SCR and a discharge directly back to SCR. This process is currently used for CPNPP Units 1 and 2 and was considered for this proposed project. SCR could not support the additional heat load of the new units. To use this methodology, the SCR would have to be enlarged, or new lands would have to be purchased and a new lake would have to be created. To use this technology, the impact on CPNPP Units 1 and 2 would be significant to build or replace intake and discharge structures on SCR, restructure the SCR dam to allow an increase in lake level, and evaluate the analysis previously done for CPNPP Units 1 and 2.

The cost of a new lake and pipelines and corridors would be significant even if land were available. The new lake would have to be located off-site making it more difficult to purchase the land and ROWs, and maintain required security.

The completely open system was not considered feasible for this project. As discussed in NUREG-1437, the quantities of blowdown are significant compared with the discharge from closed cycle systems, typically on the order of 10 times greater. Any lake constructed for once-through cooling would be of significant size (Subsection 9.4.1.2.4), significant cost, and would require bringing water from another source such as an existing lake or river in the local area. Natural gas exploration and mineral rights as well as land prices are a limiting factor in this vicinity. Other once-through cooling options such as spray canals, MDCT, and NDCT systems use large volumes of water and large tracts of land and were eliminated. As NUREG-1437 states, the impacts on the environment, while considered small (i.e., water quality, hydrology and use issues, and aquatic ecology) would be significant compared to other alternatives. Therefore, it is concluded that once-through cooling is not an environmentally preferable or practical option for the proposed project.

9.4.1.2.2 Dry Cooling Towers

Dry cooling is an alternative cooling method in which heat would be dissipated directly to the atmosphere using a tower. Dry cooling is a closed system. Because dry cooling systems do not evaporate water for heat transfer, dry cooling towers are large in comparison to wet cooling towers with similar heat loads to dissipate. This tower would transfer the heat to the air by conduction and convection rather than by evaporation. The condenser coolant would be enclosed within a piping network with no direct air to water interface. Heat transfer would then be based on the temperature differential between the coolant temperature and the air temperature, and the relative humidity and the thermal transport properties of the piping material. Both NDCTs and MDCTs designs for dry towers could be used to move the air. While water loss would be less for dry cooling towers than wet cooling towers, some makeup water would typically be required.

Because there are no evaporative or drift losses in this type of system, many of the problems of conventional cooling systems would be eliminated. For example, there would be no problems with blowdown disposal, water availability, chemical treatment, fogging, or icing if dry cooling towers were utilized. Although the elimination of such problems is beneficial, the dry towers have associated technical obstacles such as high turbine backpressure that could potentially reduce the plant thermal efficiency and create a slight possibility of freezing in the cooling coils during periods of light load and startup.

This process is inherently less efficient and would require an extensive heat transfer surface area of metal fin tubing within the tower, which could be either mechanical or natural draft. Large volumes of air would be required to remove the heat. In this system, the temperature of the water leaving the tower could only approach the dry-bulb temperature of air, which would invariably be higher than the wet-bulb temperature approached by the wet towers. For the proposed project, the dry bulb temperature in the summer months could be high enough to cause significant loss in thermal plant efficiency.

Because of the high circulating water temperatures, expensive supplemental cooling must be provided for the plant auxiliaries using dry cooling systems. Dry cooling systems dictate severe performance restrictions on the turbines, which may have to operate over a wide range of backpressures with a maximum of 10 – 14 in Hg Absolute compared to a maximum backpressure of conventionally cooled plants of less than 5 in of Hg Absolute (TXU 2007). Substantial turbine design challenges are associated with the higher-than-normal exhaust pressure of dry cooling tower applications. These challenges include such factors as possible overheating of the last-stage bucket; possible flutter damage to the last-stage bucket at high exhaust pressures and low loads; possible water damage due to recirculation from the direct condenser; rapid exhaust temperature changes due to load changes that cause cycling thermal stresses; distortion of the exhaust hood and bearing supports; and difficulties in providing adequate clearance control.

This alternative was eliminated based on the lower efficiency production cost penalty and unproven technical obstacles while balancing the positive previously mentioned advantages. It is concluded that dry cooling towers would not be a viable alternative heat dissipation system for nuclear units of the size required to be installed for the proposed project (TXU 2007).

9.4.1.2.3 Natural Draft Cooling Towers

NDCTs were considered as a viable alternative method of heat dissipation to closed-loop MDCTs chosen for CPNPP. These two types of cooling towers operate on the same basic thermodynamic principles; that is, cooling takes place by evaporation and sensible heat transfer. The major benefits associated with NDCTs are reduced maintenance and reduced auxiliary power requirements, because no fans are required (ERM 2005).

NDCTs at several power plant sites have been observed to cause broken cloud decks to become overcast, make thin clouds thicker, and create separate cloud formations several thousand feet aboveground. Localized light drizzle and snow occasionally are noted within a few hundred feet downwind from NDCTs, and some enhancement of small rain showers is noted. Large thunderstorms do not appear significantly affected. Regional augmentation of natural precipitation is inconsequential compared to the total annual rainfall in the area. Induced snowfall due to operating NDCTs is observed but is infrequent and only affects small localized areas.

The construction of NDCTs for waste heat dissipation for the proposed project is a technically feasible alternative. There are designs that include open, combination, and closed systems. For a closed-loop tower system, the main circulating water pumps would circulate water through the condenser and to the towers where the heat is transferred to the air, the flow of air is induced by the shape of the tower structure, and the required 20°F differential temperature is created between the water inlet temperature (99°F) and the cold water temperature (79°F). For an open-loop system, the NDCTs could not function for the proposed project because this differential temperature could not be achieved at all times (TXU 2007).

Water returning from the towers would flow by gravity back to the circulating water pumps. Makeup water and blowdown is the only intake and discharge required, and that would come from and return to Lake Granbury. The total makeup that would be required is based upon the concentrations of dissolved solids desired in the CWS. The chemical concentrations present in the blowdown flow must be controlled to meet water quality standards. Controlling the number of cycles of recirculation, by controlling the quantity of blowdown and makeup, along with the possibility of blowdown water treatment, would maintain an appropriate dissolved solids concentration within the required TPDES limits. Drift has been estimated by the cooling tower manufacturers to be small.

For ecological considerations, NDCTs rank intermediate in water demand of the alternatives considered (TXU 2007). Makeup water requirements for the closed-loop NDCTs were approximately 30,000 gpm while the closed-loop MDCTs would require approximately 31,000 gpm.

The advantages of this NDCT alternative over the spray canal alternative would be the absence of impingement and reduced entrainment losses. The entrainment losses are solely a function of the relatively smaller water demand. Thermal discharge effects are approximately the same as for the spray canal, given the same considerations regarding design and location of the discharge device. No significant differences in entrainment losses are expected for MDCTs versus NDCTs.

Atmospheric effects from the operation of the NDCTs for the proposed project would include some fogging and icing. There are no public roads or communities within close proximity, within 1.5 mi, of the proposed project cooling towers. If localized fogging or icing were to occur, it would not severely affect the local population. For the proposed project, the MDCTs are at a slight disadvantage when compared to the atmospheric effects of the NDCTs. The potential effects are more significant than those effects from the higher plumes of the NDCTs because of their lower emission height. In general, MDCTs are short compared to NDCTs; therefore, it is estimated that about three times the amount of fogging incidents and ten times the number of icing incidents would occur when MDCTs are used. For the proposed project, the occurrence of fogging or icing is not significant and would not be a determinate factor.

The intensifying effects of these low-level plumes during periods of natural fog are of interest. Most lake effect and cooling tower fogging occur south-southeast of the plant.

Farm to Market Highway 51, greater than 1.5 mi away and not in the prevailing winter wind flow path, should not experience any interruption due to fogging or icing from the proposed project's cooling towers.

The data indicate that cooling tower induced icing might occur most often during the 3-month period, December to February. Duration of heaviest icing would depend on the persistency of the sub-freezing temperatures. The direction with the maximum frequency of plume travel is to the south-southeast sector. Light-to-moderate icing would occur on nearby site structures located south-southeast of the cooling towers.

The relatively high profile of the NDCTs does present a very large vertical barrier or landmark on the terrain. The off-site view of the NDCT is of high impact. As stated in NUREG-1437, the relatively high structure of NDCTs has shown to cause an increased mortality rate for birds due to impact. However, for this proposed project, this mortality rate is of small significance because of the limited number of endangered species potential habitats. (The Golden Cheeked Warbler has not been found on the plant site but the habitat is compatible with this bird and several studies have been performed to confirm their absence). The use of NDCTs as an alternative means of cooling does not require the acquisition of additional land beyond that now required for the plant site but the cost of construction is greater than four times as expensive as the MDCTs (ERM 2005). For the proposed project, the use of MDCTs is considered to be superior to NDCTs for these reasons.

9.4.1.2.4 Cooling Lake

A cooling lake is a reservoir having a large surface area for removing heat from water. The cooling potential is related to the surface area exposed to the air and the turnover of the stratification of temperature layers in the reservoir. A cooling lake is typically used where land is relatively inexpensive, cooling water is scarce or expensive, or where there are strict thermal loading restrictions in place. If a cooling lake were used for the proposed project, water in the lake could be reused, thus reducing the overall water-withdrawal requirement. If the water were discharged to a river, its return to the river might be delayed by routing it through a spray canal or cooling lake first.

The construction of a cooling lake for waste heat dissipation for the proposed project would not be a feasible alternative at this site. The cooling lake requires a surface area of about 4875 acres (ac) based upon a rule of thumb of 1.5 ac of surface area per megawatt electrical (MWe) of nuclear generation (3200 MWe based on projected summertime demands on the heat dissipation system) for this project. No land is available on-site for a cooling lake, so additional land would have to be purchased. Land in this vicinity is relatively expensive, and the area is in the location of a high quality natural gas field with extensive drilling in progress. Mineral rights and land acquisition are a significant issue. Pumping water for a new lake would require new ROWs and new pipelines, and additional intake and discharge structures.

For environmental considerations, the physical and chemical characteristics of liquid effluents would not present a problem. There would be no anticipated drift losses or blowdown losses with a cooling lake. A large volume of makeup water would be required to replace water lost due to evaporation. As stated in NUREG-1437, accumulation of such water quality constituents as metals and chlorinated organic compounds in water, sediments, and aquatic biota is a potential issue for locations on cooling lakes.

For ecological considerations, this alternative would require a continuous demand for makeup water. The effect of a cooling lake on the aquatic biota due to impingement and entrainment would be no greater than for other closed-loop alternative cooling systems. The aquatic life of the impounded streams and the terrestrial life of the flooded area would be affected. The increased temperature of the lake water over time would impact the aquatic environment that would become a part of the new lake, effectively lowering plant efficiency. Trace metals, total dissolved solids, and scaling elements would increase in the lake system over the period of plant operation, and water quality would require additional makeup water and an outlet to another water body to maintain the water quality standards within the cooling lake.

The atmospheric effects would be visually apparent but not significant. Steam fogging and icing conditions occur more often due to the heated lake waters. The maximum effect would be in the prevailing wind direction of south-southeast during the winter months. SCR has experienced many years of operation with no significant impact from fogging and icing.

Another disadvantage would be the large amount of land area used. Aesthetically, impounding a natural basin is more attractive than other fabricated cooling systems while the efficiency of the plant is dependent on maintaining a lower condenser inlet temperature. Pumping noise at intake structures would present an increase in the noise levels at the lake. Noise levels at the plant site would not increase. Considering all of these effects, the use of a cooling lake would not be a viable or environmentally preferable option.

9.4.1.2.5 Wet/Dry Cooling Towers (Hybrids)

A wet/dry cooling tower, such as Air2air cooling towers, functions in principle like a wet cooling tower. An additional dry section installed in the upper part of the cooling towers for the proposed project would reduce visible plume by condensing wet air coming from the lower wet zone. The visible plume from an MDCT is not considered a significant impact to this project, and the additional expense to reduce that plume would not be warranted. The construction of a wet/dry cooling tower for waste heat dissipation for the proposed project would require the use of PVC heat exchanger packs in the tower plenum using cooler ambient air to condense moisture before it exits the tower. The wet/dry cooling tower would be significantly more expensive but would be a technically feasible alternative.

In a wet/dry cooling tower, efficient wet cooling cold water temperatures are achieved with reduced visible plume similar to dry cooling systems. Fans are located in both the wet section and the dry section of the tower requiring additional electrical power consumption and increasing the noise levels. In the dry section, the fans would be located above the wet level in front of the heat exchangers. Because of the increased cost, noise, aesthetics, and power consumption, the use of wet/dry cooling towers would be inferior to MDCTs.

9.4.1.2.6 Open-Cycle Natural Draft Cooling Towers

Open-cycle NDCT is considered as an alternative to the proposed closed-cycle cooling towers. The significant differences between the once-through and closed-loop NDCTs, in addition to their physical size, are the increased losses of larvae and small fish due to larger water requirements and the increased capital expenditure for the once-through cooling tower. This increased investment cost is due to the additional channels, gates, and diffusers typically required of the once-through system. This system would require a cooling system basin separate from SCR to accomplish the task. This separate system would involve additional land and water to be pumped from an off-site source such as a flowing river. There are no sources of water from a reliable flowing source (such as a river) for one time use. Being a once-through system without recirculation, the consumptive use would increase significantly, and the cost of construction would be too large to be considered a practical alternative.

The flow of water required to achieve the desired change in temperature for a steam condenser and cooled in once-through cooling NDCTs before release would be significant. The 20°F difference to establish the natural draft could not be achieved in the open system (TXU 2007). Release of this heated water back into a river has the effect of raising the river temperature based on mixing assumptions. This heat input could cause the river temperature to exceed the maximum allowable value during low flow and/or hot weather. During some summer months, the Brazos River has low flow conditions, so there would be no mixing or dilution from the blowdown flow into the river. Discharging large amounts of hot water might raise the temperature of the receiving river body to an unacceptable level for the local thermophilic ecosystem. For the above reasons, the once-through NDCTs would not be an environmentally feasible alternative.

9.4.1.3 Potential Alternatives to the Proposed Heat Dissipation System

Based on the initial results of the screening as described in Subsection 9.4.1.2, the following alternatives were given further consideration as alternatives for use with the proposed project.

- Mechanical draft wet cooling tower (closed loop).
- Wet/dry cooling tower.
- Natural draft wet cooling tower (closed loop).

- Dry cooling towers.

Some of these alternatives, although environmentally less preferable, may still have the potential for being environmentally acceptable, and are therefore given further consideration as discussed below.

The heat dissipation system for the proposed project is the closed loop MDCT (wet) presented in Subsection 9.4.1.1. The environmental impact from MDCT is discussed in Subsection 5.3.3.

Wet/dry cooling towers are primarily used in areas where plume abatement is necessary for aesthetic reasons, or for consideration of minimizing fogging and icing produced by the tower plume. Due to the rural setting of the CPNPP site, neither of these advantages/features would be significant. Additionally, somewhat more land would be required for the wet/dry cooling tower due to the additional equipment (fans and cooling coils) required in the tower assembly. This alternative could be utilized for the proposed project but would not be considered environmentally preferable to the wet cooling towers for the proposed project.

The primary differences between MDCTs and NDCTs relative to environmental impacts are the potential for fogging, icing, and salt deposition. These impacts are greater for MDCTs because the plumes would be lower to the ground. In addition, the MDCT requires slightly more land area than the NDCT but the land is already part of the proposed facility. The difference due to the amount of land use is so small that it can be considered insignificant. The MDCT would cause an increase in fogging and icing but due to the location of the proposed project site, this increase would have no additional impact on the local population. In this light, because the impacts are similar with no major differences, the cost of construction makes MDCTs the clear choice for the proposed project.

The dry cooling tower environmentally evaluates about the same as the NDCT, with a savings in water consumption, but the dry tower could cause generating efficiency to be significantly lower. Based on the above analyses, the closed-loop MDCTs would provide the most effective method of waste heat dissipation of all the alternatives from an economic and environmental standpoint.

The final alternative systems investigated for this plant are designated below:

Alternative 1 is the proposed system discussed previously and is used as a baseline for the environmental comparison of the alternatives. Evaluation of alternative heat dissipation facilities' analyses were performed using the following factors as a basis: feasibility, environmental considerations, and economic considerations. The analyses were carried to the extent required to determine the acceptability of each alternative when considering these factors. Details of environmental impacts for the alternatives and estimates of environmental impacts were made as discussed in Subsection 9.4.1. The results are summarized in Table 9.4-3.

Among the alternatives listed below, Table 9.4-2 summarizes in closer detail the present worth differential cost comparison based on one 1600-megawatt (MW) unit in 2007 dollars. The comparison of alternatives shown in this table indicates the relative economic differences in present worth evaluated costs that include such things as the capital cost of installing the facilities, water value and cost, and the present worth of the operation and maintenance costs.

Alternative 1 is the MDCT closed-loop alternative and is used as the baseline because this alternative has the lowest total evaluated cost. Alternative 2, NDCT closed loop has the second highest evaluated cost, and Alternative 3, MDCT (wet) once-through is the middle of the four alternatives in cost and is a good indicator of the magnitude of differences involved. Alternative 4, MDCT air-to-air closed loop is the most expensive and was included to show the cost of new and unproven technology.

Alternative	Heat Dissipation System Type
1	MDCT (wet) closed loop
2	NDCT closed loop
3	MDCT (wet) once through
4	MDCT air-to-air closed loop

All alternatives were estimated to be compatible with the construction schedule for the proposed project.

The cooling lake alternative would not be considered practical, therefore no cost estimates were obtained. This alternative would require the acquisition of greater than 4875 ac of additional land from many land owners, and the ROW for the pipelines connecting the lake to the site and source of water. There is extensive natural gas exploration from the Barnett Shale formation in the vicinity of the proposed project, which would inflate the land price beyond reason and make securing the mineral rights even more difficult and costly.

Operational experience with ground fogging and icing from SCR for CPNPP Units 1 and 2 indicates that this is not a concern in this rural environment even with the addition of the proposed system. The MDCT closed system (Alternative 1), in addition to having an evaluated cost of slightly less than four times that of natural draft towers would create increased fogging and icing, but the impact of the fogging and icing would be SMALL. Therefore, no mitigation would be required.

MDCTs would raise the noise level more than any of the other alternatives, but the impact on the population surrounding the plant site would be small. As stated in NUREG-1437, NDCTs and MDCTs emit noise of a broadband nature that is indistinguishable and less obtrusive than transformers or loudspeaker noise.

For the proposed project, numerous alternatives for heat dissipation were investigated, and for each alternative compared for cost, environmental impacts, and operational effects upon CPNPP Units 1 and 2, none would offer any significant advantage over the MDCTs. The anticipated environmental impact (physical and chemical characteristics of the tower effluent, local fogging and icing, effects of MDCTs, aesthetics, noise), as a result of the construction and operation of this system is described in Subsection 5.3.3.

Because of the weighted economic advantage, the overall small potential for environmental impacts, and the minimal impact on the operational CPNPP Units 1 and 2, for the proposed project, the closed cycle MDCTs (wet) would be the best choice for heat dissipation.

9.4.2 CIRCULATING WATER SYSTEM

The CWS is an integral part of the heat dissipation system discussed in Subsection 9.4.1. The CWS provides the heat transfer medium between the main condenser and the heat dissipation system. The proposed system is considered feasible for construction and operation based on the existing experience of CPNPP Units 1 and 2 makeup water system that has worked well since 1990. The CWS is designed and operated to comply with all TPDES and Clean Water Act 316(b) requirements. The construction and operation is not prohibited by any federal, state, regional, local, or affected Native American tribal agreements. The proposed system would be considered practical, both technically and for being available to support the construction and operational required dates.

9.4.2.1 Proposed Circulating Water System

The proposed heat dissipation system would utilize closed-loop MDCTs (wet) to meet condenser cooling requirements for the proposed project, and would provide the lowest practical environmental impact to the area without interfering with the continued operation of CPNPP Units 1 and 2. The proposed condenser cooling water system would allow CPNPP Units 3 and 4 to operate with minimal impact on SCR, and would minimize the water consumption and thermal effects on Lake Granbury. The condenser cooling water system would cycle cool water from the cooling towers through the condensers, and discharge the warmed water back to the cooling towers in a closed-loop system rather than discharging directly to Lake Granbury.

In the operation of the cooling towers, a certain portion of the circulating water would be continuously lost as a result of evaporation, small leaks, drift, and blowdown. To compensate for the loss, makeup water would be continuously added to the system. To provide this makeup, water would be withdrawn from Lake Granbury at the intake structure along the edge of the lake and pumped to the cooling tower basins at the site. Blowdown from the cooling towers would gravity flow back to Lake Granbury via pipelines to the discharge structure, which would also be located along the edge and extend into Lake Granbury. The intake structure would be located on Lake Granbury adjacent to the existing intake structure for CPNPP Units 1 and 2 makeup water supply for SCR. The discharge structure would be located in the same proximity as the existing SCR makeup water return line to Lake Granbury.

9.4.2.1.1 Intake System

The normal water surface level of Lake Granbury is about 693 ft msl and is designated as a “constant level” lake. The water intake structure is located on Lake Granbury adjacent to the existing makeup water intake structure for CPNPP Units 1 and 2 with a 2-in expansion joint between the structures. The design is a shoreline structure with submerged intakes fitted with fine-mesh passive screen strainers (Luminant 2008). The intake structure is 35 ft 6 in wide and 72 ft long with housing for the pumps and motors. The proposed intake structures would result in no significant adverse environmental impacts. On balance, the proposed shoreline intake structure is considered the best alternative available. Alternative intake designs are discussed in Subsection 9.4.2.2.1.

The proposed project is designed with one intake structure for both CPNPP Units 3 and 4 (Subsection 3.4.2.1). Pumps would provide the driving force to move the water from Lake Granbury to the cooling towers for makeup flow. The number of supply pumps running would vary based on system demand. Intake velocity would be low, and the inlet would be screened to minimize the intake of material other than water. The surface area of the screen is sized to provide a flow of 0.5 fps or lower through the screen slots to minimize the potential for impingment of aquatic organisms per the 316(b) requirements (Luminant 2008).

Based on the analysis above, no adverse impact is identified in the intake system portion of the proposed CWS, and no mitigation is warranted.

9.4.2.1.2 Discharge System

The proposed project is designed with a single discharge system for each unit. This system consists of blowdown piping, which travels back to Lake Granbury where the blowdown is discharged through a multi-port diffuser system. The discharge system is described in Subsection 3.4.2.2. The primary purpose of the discharge system is to disperse cooling tower blowdown into Lake Granbury, returning as much water as possible to the lake to minimize consumptive use of the lake water while maintaining the water quality.

Each unit would have a 42-in blowdown pipe that would run from the MDCTs to the outfall structure on Lake Granbury. At the end of the blowdown pipe would be a submerged, multi-port diffuser. The diffuser would be 82 ft 4 in long. Each diffuser would be equipped with 18 nozzles; each nozzle would have a 4-in diameter with a spacing of 4 ft 4 in, center-to-center distance. Figure 9.4-4 provides a diagram of the proposed multi-port diffuser system. The diffuser and angled nozzles would provide proper mixing with the lake water.

During each operational mode, the return water requirements vary, therefore the discharge flow rates and velocities also vary. No adverse impacts are identified in the discharge system portion of the proposed CWS, and no mitigation is warranted.

9.4.2.1.3 Water Supply

The water supply for the proposed heat dissipation system is from Lake Granbury. Sufficient volume is provided for maximum system requirements, and intake structure geometry is designed to function under the worst expected lake conditions. Lake Granbury was determined to be the only viable source of water for the cooling water system.

Water quality is a concern in this watershed area. The Brazos River system and the lakes associated with this river exhibit a highly variable TDS content. These solids and salt load on the system would dictate the number of cycles of recirculation possible through the cooling towers. Because of the limited number of cycles, a larger volume of water would be required to operate the plants. The TPDES permit ensures that the limits of water quality are not exceeded.

Based on the analysis above and the results presented in Section 5.2, no adverse impacts are identified in the water supply portion of the proposed CWS, and no mitigation is warranted.

9.4.2.1.4 Water Treatment

The water treatment or circulating water chemistry, for the influent water of the proposed projects' CWS is maintained by a chemical feed system (Subsection 3.3.2). Chemical equipment would inject the required chemicals into the circulating water downstream of the CWS pumps. The chemicals used would be divided into six categories based upon function: biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor, and silt dispersant. The pH adjuster, corrosion inhibitor, scale inhibitor, and dispersant would be metered into the system continuously or as required to maintain proper concentrations. The biocide application frequency might vary with seasons. The algaecide would be applied, as necessary, to control algae formation on the cooling tower.

The water treatment of the blowdown water portion of the proposed projects' CWS is performed by a Blowdown Treatment Facility (BDTF) with associated evaporation ponds and misters. The design allows for a diversion of approximately 83 percent of the blowdown flow for treatment and returning 80 percent of the diverted (cleaned water) flow back into the main blowdown line back to Lake Granbury (URS 2008).

The basic equipment in the BDTF consists of parallel trains of course prefilters, ultrafilters, and reverse osmosis membranes. Also included are appropriate chemical dosing/cleaning equipment, interconnecting piping, sump/tanks and transfer pumps. One evaporation pond with multiple sections and misters will be installed along with one retention pond to store up to three months of evaporation pond overflow (URS 2008).

Ponds are expected to be lined with impermeable clay and two high density polyethylene liners to achieve the required permeability ratings. The BDTF will utilize approximately 400 ac (400 ac is a bounding number for the available acreage in the proposed location) of CPNPP site property (URS 2008). This area is a previously undisturbed area. No additional land will be required to be purchased. The BDTF will be constructed in the southeast corner of the site property. This area of the site shares the boundary with a sparsely populated area.

The noise from the BDTF is expected to be of a SMALL impact. There is little fogging and icing in this area normally and there are no public roads of significant population areas in close proximity to the BDTF. There are no crops grown in the immediate area and the impact due to salt drift is SMALL.

The system design provides for 80 percent return of diverted flow back into the main blowdown line and into Lake Granbury. The consumptive water loss impact of this system is SMALL and the impact on the water quality returned to Lake Granbury is beneficial. This system helps ensure the TPDES requirements for release to waterways will be met even with the highly variable TDS and salt concentrations of the influent water withdrawn from Lake Granbury.

Based on the analysis above and the results of Subsection 5.5.1, no adverse impacts are identified in the influent water treatment and blowdown water treatment system portion of the proposed CWS, and no mitigation is warranted.

9.4.2.2 Alternatives to the Proposed Circulating Water System

The purpose of this subsection is to identify and analyze reasonable alternatives to the proposed system. The analysis of each alternative system considers various factors during construction and operation, for comparison with those of the proposed system. This is covered in separate sections - intake system, discharge system, water supply, and water treatment system. Benefit-Cost analysis is detailed in Section 10.4 where applicable. Socioeconomic impacts for construction and operation of the proposed heat dissipation and CWS system is described in Sections 4.4 and 5.8 and is determined to be SMALL.

The depth of analysis presented in this section is governed by the proposed system impacts provided in further detail in Chapters 4 and 5.

9.4.2.2.1 Alternatives to the Proposed Intake System

Lake Granbury is considered the only viable alternative for a water source. To support the proposed heat dissipation system, all alternative intake systems analyzed would withdraw makeup water from Lake Granbury. The layout and geometry of each proposed system was analyzed. Structures would be located on the lake and the only exit from the lake would be controlled by gates and overflow from the dam to the area downstream (Brazos River). There are periods of time during some years, based on rainfall, when there is little flow through or over the dam. The section of the lake chosen for the intake structures would be located in the deepest portion of the lake (greatest volume of water and best possible thermal properties of the lake) and close to the Lake Granbury dam. Alternative intake system types for the proposed project would include both shoreline structures and offshore intake structures. An intake located at the shoreline would result in slightly greater impingement and entrainment of aquatic organisms. An offshore intake would extend into Lake Granbury creating a larger impact on the lake during construction and maintenance and was therefore eliminated. There would be little interference with recreational activities on the lake for either type system once it is operational. Several alternative intake designs for the proposed project are summarized below.

Alternative system designs considered included:

- Conventional traveling screens located in the pumphouse.
- Traveling screens with fish buckets and fish return systems.
- Traveling screens with fish by-pass systems.
- Mesh fabric screening systems.
- Offshore bottom mounted passive screens.

Subsection 9.4.2.1.1 describes the chosen passive screen design, while Subsection 9.4.2.2.2 provides an evaluation of the alternative systems that were eliminated. The chosen design is considered to be the best technology available and is fully compliant with section 316(b) Phase 1 requirements. The design minimizes the potential for entrainment of all but the smallest aquatic organisms by virtue of the screen size selected and eliminates the impingement potential on the screens by both the design of the screens and the velocity of the intake flow through the screens.

A brief evaluation of the alternatives to the chosen passive screening system include the systems discussed below.

Conventional traveling screens located in the pumphouse were considered. It was determined that they offered little help with impingement or entrainment. There is an increase in the opportunity for entrapment on organisms.

Traveling screens with fish buckets and fish return systems were considered. They provide essentially the same entrainment as conventional traveling screens. Impingement rates are essentially the same as conventional screens, but impacts are reduced by returning organisms to the water body, with some added stress due to handling in the fish return system.

Traveling screens with fish by-pass systems were considered but they greatly increase the complexity of the system. They also add additional velocity induced stresses to fish in bypass stream. There is a requirement for increased pumping volume to induce a bypass current. Entrainment is essentially the same as for conventional traveling screens.

Consideration was given to mesh fabric screening systems. The mesh fabric is extremely fine material used to exclude all but the smallest aquatic organisms and all life stages of fish species, but may not be significantly more effective than the design proposed. The fine-mesh fabric is not as strong as the metal screens and largely untested in major power plant applications. Cleaning of the fabric screens is unproven and their performance when clogged is not known.

Offshore bottom-mounted passive screens with piping back to the intake pumphouse were considered but eliminated based on greater difficulty providing maintenance and inspection. There were reliability concerns and the potential impacts increased due to the larger area of land required on the bottom of Lake Granbury.

9.4.2.2.2 Evaluations of Alternative Intake Designs

The existing intake structure on Lake Granbury for CPNPP Units 1 and 2 has been in operation for many years, and the impact to aquatic ecology (fish) has been minimal to date. Impingement of healthy fish is expected to be minor with the proposed intake structure as well.

The proposed system’s pumping facilities would have insignificant environmental impact. No substitution is apparent that would result in an environmentally preferable system as compared to the proposed system. No alternative method of intake defouling, including chemicals, has been proposed that would be environmentally superior or equivalent.

The proposed alternative intake systems have been analyzed. No improvements are apparent where substitution of components or modifications to the size or function of components would improve the operation of the system for its intended purpose. No adverse impacts are identified, and no mitigation is warranted. The originally proposed shoreline intake structure would be the best alternative available, and the impacts would be SMALL.

9.4.2.2.3 Alternatives to the Proposed Discharge System

Discharges of heated effluents have the potential to affect water quality in five ways.

- Water temperature increases, including altered thermal stratification of lakes.
- Temperature effects on sediment transport capacity.
- Scouring.
- Lowered dissolved oxygen concentrations.
- Eutrophication.

A multi-port diffuser blowdown discharge would be used for the proposed project. This discharge system would consist of a 42-in blowdown line for each unit. The multi-port diffusers would be 82 ft 4 in long with 4-in diameter nozzles; each nozzle would be spaced 4 ft 4 in center-to-center. The diffusers would lie below the minimum water level for Lake Granbury.

Heated water discharges tend to remain at, or move toward, the surface of lakes. These discharges form a plume of warm water that dissipates with distance from the source by rejecting heat to the atmosphere or mixing with cooler ambient waters. Mixing tends to occur more rapidly in rivers than in lakes because of increased turbulence. Effects of thermal discharges on water quality are of small significance if discharges are within thermal effluent limitations; that is, limits set by TPDES permit, and if ongoing discharges have not resulted in adverse effects on the five attributes of water quality identified above.

The submerged, multi-port diffuser has been engineered in geometry and size to accommodate the expected volume and temperature of the plant blowdown under a range of possible lake reservoir conditions. Any change in the discharge location to one of the alternative locations would be significant and require considerable design change. The possible alternative locations of discharge; SCR, Brazos River downstream of Lake Granbury, Possum Kingdom Lake, or Squaw Creek all have limiting conditions associated with them and have been eliminated. SCR cannot support the thermal load of CPNPP Units 3 and 4 without affecting CPNPP Units 1 and 2, so it is eliminated. The Brazos River downstream of Lake Granbury has periods of limited flow and the thermal plume of blowdown from the proposed units has little dilution or dissipation in the receiving water in the river causing significant impact to the ecology along the river. Squaw Creek is a very small stream with flow existing mainly from letdown from SCR dam. It joins the Brazos River a few miles downstream from SCR and would create the same significant environmental conditions along Squaw Creek and the Brazos River at the confluent with Squaw Creek and the Paluxy River. Possum Kingdom Lake would require pumping blowdown many miles from the CPNPP site at a high cost.

A full range of plume characteristics is analyzed and presented for the proposed discharge system (Subsections 5.3.2 and 5.3.3). Alternative discharge structures are not environmentally preferred, as they do not decrease the small effect of plume or potential physical scour problems. As illustrated in Figure 2.3-13, the discharge structure is approximately 1.14 mi downstream of the intake structure and is on the deepest portion of the Lake Granbury reservoir and the impact is minimal.

The following presents the potential effects of discharging heated water to an aquatic system:

- Thermal discharge effects.
- Cold shock.
- Effects on movement and distribution of aquatic biota.
- Premature emergence of aquatic insects.
- Stimulation of nuisance organisms.
- Losses from predation.
- Parasitism and disease.
- Gas super saturation of low dissolved oxygen in the discharge.
- Accumulation of contaminants in sediments or biota.

In general, for plants employing cooling tower systems, the impact is minor. The thermal plume discharged by the proposed project is expected to be small; therefore, adverse impact on biota is not expected.

In winter, fish attracted to the elevated temperature of the plume of the proposed project might affect the normal travel patterns of the fish. Being a lake reservoir, there is no major migration or change-over of lake fish species present at any one time. Fish such as white bass would move to cooler waters up-lake as normal to spawn. Drifting benthos, plankton, and larval fish might be effected passing through the thermal plume at various stages of their normal life cycles. Any resulting effect of the thermal plume would be considered small due to the plume size.

Alternatives to a multi-port diffuser would include the multiple-nozzle jet diffuser, an open pipe with headwall, and a single buoyant jet. The least costly alternative to construct and operate would be the open-ended pipe to discharge back to the reservoir. However, the open-pipe discharge and the buoyant jet would not achieve the required degree of mixing to help maintain the water quality standards. A submerged (on the bottom) multi-port diffuser system would be used for discharging the blowdown to Lake Granbury. The proposed alternative discharge systems have been reviewed. No improvements are apparent where substitution of components or modifications to the size or function of components would improve on the operation of the system for its intended purpose. No adverse impact is identified, and no mitigation is warranted.

9.4.2.2.4 Alternatives to the Proposed Water Supply

CPNPP’s plan is to reduce usage of groundwater at the site therefore groundwater was eliminated from being a possible alternative water source (Subsections 2.3.1 and 2.3.2). The proposed water supply for the heat dispersion system at CPNPP Units 3 and 4 is Lake Granbury reservoir. No alternate sources of water are available for this purpose; alternate sources would require the development of a new lake and sufficient water supply from the Brazos River System to fill the new lake. The time required obtaining land and mineral rights, ROWs, and permission to build a new lake does not support the scheduled activities of the project. Land and water are not available to provide any viable alternate water sources. The Lake Granbury proposed water supply system is designed so that the intake would be at sufficient depth to insure flow during all anticipated lake low water levels. No shortages are anticipated. Based on the maximum intake flow with both units in operation, Lake Granbury reservoir would supply sufficient water to meet the operational requirements of the cooling water systems.

Withdrawal volumes are regulated by the Brazos River Authority (BRA). The withdrawal would be controlled by allocation agreement with the BRA. The environmental impact of the use of this water supply would be SMALL. No alternative source is identified that would be environmentally equivalent or superior. No adverse impact is identified, and no mitigation is warranted.

9.4.2.2.5 Alternatives to the Proposed Water Treatment System

Water treatment of the influent water is applied to the CWS water for the proposed project (Subsection 3.3.2.1). Treatment typically consists of adjustments to water chemistry using several chemicals: biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor, and silt dispersant. Water quality effects could occur from the concentration and discharge of chemicals added to the re-circulating cooling water. These additives are present in the blowdown.

Concentration of dissolved salts in the makeup water resulting from evaporative water losses would require the discharge of a certain percentage of the mineral-rich stream (blowdown) and its replacement with fresh water (makeup). The concentration of total dissolved solids in the cooling tower blowdown would be monitored to meet the values on the TPDES permit. Dilution of the low-volume blowdown by the receiving water would also reduce water quality effects of contaminants discharged from closed-loop cooling systems. The number of cycles that water is used before the blowdown is removed is changed to meet the limitations of the TPDES contaminant concentrations in the system. The treatment of the blowdown water may be required to remove chemicals, salts and TDS to meet TDPES discharge limits and not adversely impact the water quality in the lower part of Lake Granbury. Any water treatment depends on the TPDES permit requirements that is expected to be modified prior to construction of CPNPP Units 3 and 4.

Based upon expected TPDES permit requirements, design alternatives for the BDTF water treatment included a number of possible designs and variations on the designs. The proposed system consists of a approximately 83% diversion and treatment of the blowdown and then returning 80% of the diverted water to the blowdown returning to Lake Granbury with a blended effluent TDS concentration of 2500 mg/l. The proposed system satisfies the expected effluent TDS concentration less than 2500 mg/l and chloride concentration less than 1000 mg/l of 2500 mg/l discharge into Lake Granbury. Alternatives of this same design were evaluated using 31% and 18% diversion values and returning blended effluent TDS concentrations of 3000 mg/l and 3500 mg/l respectively. (URS 2008a)

An alternative BDTF design considered was routing both treated and untreated blowdown water to the cooling tower basins for reuse (closed-cycle cooling), thus eliminating the need for constructing a discharge structure to Lake Granbury. This alternative was eliminated from consideration for several reasons.

In order to maintain the TDS concentration of the cooling tower basins, the dimension of this system would need to be 1.4 times larger in size than the proposed system. The proposed system is projected to be operational during the seasonally low-flow period of Lake Granbury (approximately three-months) when the TDS concentrations are naturally high. In comparison, this system would need to be continuously operated to maintain the TDS concentrations of the cooling tower. Both systems will generate solid waste (mostly salts) when operational. This system, due the need of continuous operation, will generate more solid waste than the proposed system. The options were considered and the proposed system was selected as it is considered the most robust and the operation of the system can be altered to meet the projected future requirements.

An alternative to increase makeup supply to the system and divert the excess makeup into a water treatment facility was evaluated also. This option treated the excess makeup water and then blended it with the blowdown from the CWS to provide a blended effluent TDS concentration of 2500 mg/l returning to the discharge outfall. This alternative requires an additional 8626 gpm makeup water flow, more blowdown returning to the discharge outfall, additional water treatment facilities, and a new 3 million gallon evaporation pond for effluent waste concentrates. (URS 2008a)

Alternative system designs for increasing the cycles of concentration from 2.4 to 5.0 were evaluated utilizing increased chemical feed and treatment bringing blowdown effluent TDS concentration to 2500 mg/l but producing a high waste concentrate effluent of 8400 mg/l that would require special handling methods such as a new 25 million gallon evaporation pond, deep well injection, or acquire permission to pump the waste concentrates to be released into Possum Kingdom Lake. These alternatives reduce the amount of water required for makeup and the amount of blowdown returning to the discharge outfall, but they require twice the chemical usage, additional equipment and storage, and they produce a waste concentrate of approximately 8400 mg/l that exceeds all the current local waterway permit release limits. (URS 2008a)

Hybrid cooling tower design was also evaluated for the ability to recover (approximately 15% with Air2Air CT design) water from the cooling tower plume and use that water to blend along with treated blowdown to provide a blended effluent TDS concentration of 2500 mg/l at the discharge outfall. The resultant effluent TDS concentration is the same as other alternatives, but the cost of the hybrid type design is much higher and therefore, this option was not considered as viable. (URS 2008a)

All nuclear power plants in Texas are required to obtain a TPDES permit to discharge effluents. This permit is periodically renewed to ensure the continued operation of the units is within the bounds of the controls specified and that no unanticipated impacts go unaddressed. The TPDES permit renewals provide the opportunity to require modification of power plant discharges or to alter discharge monitoring in response to water quality concerns.

Effects of cooling tower discharges would have small significance assuming compliance with water quality criteria (e.g., TPDES permits). In considering the effects of closed-cycle cooling systems on water quality, the NRC evaluated the same issues that were evaluated for once-through systems. Based on review of literature and operational monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft Generic EIS for License Renewal of Nuclear Plants, discharge of cooling tower effluents has not been a problem at existing nuclear plants. Although occasional violations of National Pollutant Discharge Elimination System (NPDES) permits have occurred at many plants (e.g., minor spills), water quality effects have been localized and temporary. Effects are considered to be of small significance for all nuclear plants. Cumulative effects to water quality would not be expected because the small amounts of chemicals released by these low-volume discharges are readily dissipated in the receiving water body.

A detailed description of treatment system operating procedures, including plant operational and seasonal variations is discussed in Section 3.6. The frequency of treatment for each of the normal modes of operation is described, as well as the quantities and points of addition of the chemical additives. All methods of chemical use are monitored. The environmental impact on the use of this water treatment is SMALL. No alternative treatment is identified that is environmentally equivalent or superior. No adverse impact is identified, and no mitigation is warranted.

9.4.3 TRANSMISSION SYSTEMS

The power transmission system performs the bulk transfer of electrical power between the electrical generation power plant and a substation to allow distribution to the areas it is needed. The electricity distribution system performs the delivery from the substation to the consumers. In a transmission system, redundant paths and lines are often provided so that power can be routed from any power plant to any load center, through a variety of routes, based on the economics of the transmission path and the cost of power. Analyses are performed by transmission companies to determine the maximum reliable capacity of each line, which, due to system stability considerations, may be less than the physical or thermal limit of the line. Because CPNPP is a merchant plant, the responsibility for transmission and distribution falls upon a separate company. For the proposed project, Oncor would be the transmission and distribution company working with the Electric Reliability Council of Texas (ERCOT) and in conjunction with the PUC to supply the design, transmission corridors, transmission system, and required interconnections to safely and reliably deliver the electrical power to the proper service areas (Section 8.0).

9.4.3.1 Proposed Transmission System

An addition of electrical generation of the magnitude of the proposed project requires an evaluation of the transmission facilities within the service area to appropriately locate and size transmission components. The primary choices and major additions to the system are outlined below and shown in Table 9.4-4 (Oncor 2008).

- A new double-circuit 345-kV line (one circuit in place) to Whitney using two1590-kcmil ACSR conductors with a rating of 1631 MVA, (approximately 45 mi) - New corridor may be required.

- A new 345-kV circuit to Johnson Switch on existing structures using two 1590-kcmil ACSR conductors with a rating of 1631 MVA, (22.4 mi)
- A new 345-kV circuit from Johnson Switch to Everman on existing structures using two 1590-kcmil ACSR conductors with a rating of 1631 MVA, (23.4 mi)
- A new double-circuit 345-kV circuit (one circuit in place) to DeCordova using two 1926.9-kcmil ACSS/TW conductors at 100 C to obtain a rating of 1969 MVA, (approximately 17 mi) - New corridor may be required.
- A new 345-kV line to Parker Switch on existing structures using two 1590 kcmil ACSR conductors with a rating of 1631 MVA, (41.6 mi)

Two of the modifications require new transmission corridors to support the proposed project and none of the alternatives involve an increase in line voltage above the existing 345 kV.

The existing transmission system and new transmission system siting and design are described in Section 3.7. The siting and design efforts are affected by several other factors: (1) future growth estimates, (2) additional generation proposed/planned, (3) equipment condition, (4) regulation, and (5) public involvement. These issues are described in Chapters 4, 5, and 8. Environmental impacts to humans from construction and operation of the proposed transmission system and corridors are described in Subsection 5.1.2 and Section 5.6.

No adverse environmental impact of the use of components or operation of the proposed transmission system is identified. The measures and controls to limit adverse transmission system impacts that were developed are described in Subsection 4.1.2 and Sections 4.6 and 5.10.

The potential impacts to the aquatic or terrestrial ecology from the transmission system that could be avoided or mitigated through alternative design or maintenance procedures are described in Subsections 5.6.1 and 5.6.2.

Minority or low-income population’s impact from the transmission systems are discussed in Section 5.8.

The power transmission and electrical distribution systems are designed to be capable of distributing the electricity generated by the proposed project. Changes, additions, and upgrades to the current system are continually being evaluated to ensure the transmission system is able to handle this base load addition to the power grid.

9.4.3.2 Alternatives to the Proposed Transmission System

The analysis of each alternative transmission system considers various factors during construction and operation, for comparison with those of the proposed system. This responsibility rests with Oncor, ERCOT, and the PUC. The preliminary design and current proposed switching station is illustrated in Figure 9.4-5 (Oncor 2008).

9.4.3.2.1 Alternative Corridor Routes

The existing power transmission system is discussed Section 3.7. A preliminary evaluation of the proposed transmission corridor routes is complete. Oncor has not provided alternate corridors at this time. The primary choices and major additions to the system are described in Subsection 9.4.3.1 above.

The transmission system and corridors' impacts to historic properties are described in Subsection 4.1.3 and Section 2.8.

9.4.3.2.2 Alternative System Design

System design alternatives include changes made to the power transmission system design to increase the safety of the public or utility workers or to enable the system to transport the energy more efficiently.

Transmitting electricity at high voltage reduces the current and thus the resistive losses in the conductor. Long distance transmission is typically done with overhead lines at voltages of 110 – 1200 kV. Transmission lines designed for voltage levels less than 765 kV reduce adverse effects from ozone formation. At extremely high voltages, more than 2000 kV between conductor and ground, corona discharge losses are so large that they can offset the lower resistance loss in the line conductors. Underground power transmission is used only in densely populated areas, such as large cities, because of the high cost of installation and maintenance and because the power losses increase dramatically compared with overhead transmission.

Adverse effects of transmission systems include electric shock, electromagnetic field effects, and visual effects. Effects of proposed transmission lines on members of the public are discussed in Subsection 5.6.3. The highest voltage line associated with the proposed project is 345 kV. A change to alternative voltage levels or current types different from planned are not indicated. This does not indicate any significant effect associated with the proposed voltage levels and frequency requiring mitigation. Standard clearances between conductors and anticipated grounding objects are used throughout the transmission corridor to minimize any electric shock potential. Additional mitigation of electric shock potential is not necessary. No alternative tower designs, tower heights, conductor-to-ground clearances, conductor designs, or ROW widths are necessary (Sections 3.7 and 5.6). Auxiliary transmission facilities do not require alternative locations.

Federal, state, regional, local, and affected Native American tribal agency laws or regulations that affect transmission facility design or operation are satisfied.

9.4.3.2.3 Alternative System Construction

Standard electric utility construction practices appropriate to the voltage and climate are used in the Oncor electrical distribution system. Alternative construction practices are not necessary as discussed in Sections 4.1, 4.3, and 4.4. No alternative construction methods are indicated to mitigate effects from vegetation, erosion control, access roads, towers, conductors, equipment, or timing.

9.4.3.2.4 Alternative System Maintenance Practices

Potential effects of routine maintenance to terrestrial and aquatic ecosystems are discussed in Subsections 5.6.1 and 5.6.2. Additional and existing transmission lines are to be maintained in accordance with long-standing procedures that consider environmental and visual values. Oncor maintains important viewsheds by minimizing the visual intrusion. Natural vegetation is often retained at road crossings to help minimize visual effects where possible. No alternative maintenance practices are indicated to mitigate environmental impact.

9.4.4 REFERENCES

(ERM 2005) Evaluation of Circulating Water Temperature Reduction Options Using Three-dimensional Modeling and Economic Analysis. ERM, Inc and Chuck Bowman Associates, Inc. December 30, 2005.

(Oncor 2008) Final Steady-State Analysis Report. Oncor Electric Delivery Company LLC. Luminant Generation Company LLC GIR 15INR0002. January 14, 2008.

(TXU 2007) TXU – Comanche Peak Units 3 and 4 Optimization Study For Secondary-Side Cooling Water System. April 30, 2007.

(TXU 2007a) TXU – Comanche Peak Units 3 and 4 Optimization Study For Primary Side Cooling Water System. April 30, 2007.

(Luminant 2008) “Luminant Comanche Peak Units 3 and 4 System Description Makeup Water and Blowdown for Circulating Water System (Non Safety),” Document No. CWS-15-08-200-002, Rev E. June 2, 2008.

(URS 2008) “Blowdown Treatment Facility - Conceptual Design Discussion,” May 30, 2008.

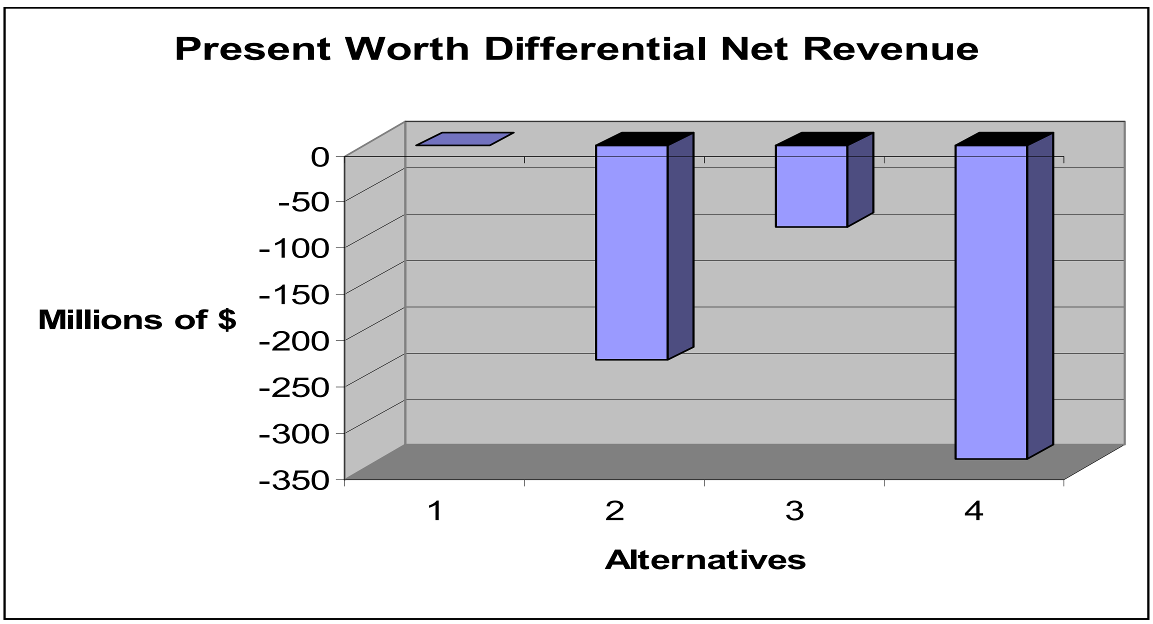
(URS 2008a) URS “Investigation of Alternatives to Lower the TDS at Lake Granbury.” March 4, 2008.

TABLE 9.4-1
CPNPP UNITS 3 AND 4 MAJOR ALTERNATIVES REVIEWED FOR HEAT DISSIPATION SYSTEMS

Alternative Heat Dissipation Types	Closed System	Combined System	Open System
	Mechanical Draft (wet)	Mechanical Draft (wet/dry) (hybrid)	Mechanical Draft (wet)
	Cooling Lake	N/A	Cooling Lake
	Spray Canal	Spray Canal	Spray Canal
	Natural Draft	Natural Draft	Natural Draft
	Dry Cooling	N/A	N/A
	Air-2-Air	(wet/dry)	N/A
	Parallel Air Cooled Condenser	N/A	N/A

TABLE 9.4-2
DESIGN, PERFORMANCE, AND COST - BASED ON ONE 1600-MW UNIT

Case	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Circulating Water System	Closed	Closed	Open	Closed
Cooling Tower Drift	Mechanical	Natural	Mechanical	Mechanical
Cooling Tower Type	Wet	Wet	Wet	Air-2-Air
Power Production Revenue – 10^6 $	7954	7925	8003	7790
Present Worth Makeup Water Cost – 10^6 $	299	293	293	246
Capital Cost – 10^6 $	623	831	766	850
Differential Net Revenue – 10^6 $	Base	-232	-88	-338



(TXU 2007)

TABLE 9.4-3 (Sheet 1 of 3)
DETAILS OF ENVIRONMENTAL IMPACTS, TECHNOLOGY, AND DIFFERENTIAL COST FOR THE PROPOSED ALTERNATIVES

Factors Affecting System Selection	Alternate 1 (Proposed system) MDCTs (Wet) (Closed Cycle)	Alternate 2 NDCTs (Closed Cycle)	Alternate 3 MDCTs (Open Cycle)	Alternate 4 Mechanical Draft Air to Air Cooling (Closed Cycle)
Aesthetics	• Tower height below containment height • Plume elevation is closer to the ground • Technology is used in the vicinity (Wolf Hollow) and is familiar to the public	• Tower height greatly above containment height • Plume elevation extends hundreds of feet above containment	• Tower height below containment height • Plume elevation is closer to the ground • Technology is used in the vicinity (Wolf Hollow) and is familiar to the public	• No impact, not visible to public
Water Use	• Uses slightly more water than Alternate 2 • Allows recirculation and reuse of water	• Uses slightly less water than Alternate 1 • Allows recirculation and reuse of water	• Uses large quantity of water compared to all other alternates	• Uses significantly less water than all Alternates
Aquatic Ecology	• By using less water than Alternate 3 it is less of an impact on impingement, larva and mollusk.	• By using less water than Alternate 3 it is less of an impact on impingement, larva and mollusk.	• Open cycle uses greater water and therefore causes greater impact on aquatic ecology	• Minimal impact on the aquatic ecology

TABLE 9.4-3 (Sheet 2 of 3)
DETAILS OF ENVIRONMENTAL IMPACTS, TECHNOLOGY, AND DIFFERENTIAL COST FOR THE PROPOSED ALTERNATIVES

Factors Affecting System Selection	Alternate 1 (Proposed system) MDCTs (Wet) (Closed Cycle)	Alternate 2 NDCTs (Closed Cycle)	Alternate 3 MDCTs (Open Cycle)	Alternate 4 Mechanical Draft Air to Air Cooling (Closed Cycle)
Terrestrial Ecology	• Spray and drift cause minimal damage to plant in close proximity to the towers • Salts and solids have small impact on crops – none expected at CPNPP	• Spray and drift cause minimal damage to plant in close proximity to the towers • Salts and solids have small impact on crops – none expected at CPNPP	• Spray and drift cause minimal damage to plant in close proximity to the towers • Salts and solids are less than Alternates 1 and 2 and have small impact on crops – none expected at CPNPP	• Minimal impact on the terrestrial ecology
Land Use	• Land is currently available – no new land needed	• Land is currently available – no new land needed	• Land is currently available – no new land needed	• Large area of land needed • Additional land is expensive and difficult to obtain in this area
Noise	• Increased noise from fans • Noise is small impact due to rural nature of location and sparse population	• Natural Draft requires no fans • Noise is smaller than Alternates 1 and 3	• Increased noise from fans • Noise is small impact due to rural nature of location and sparse population	• Very minimal noise increase

TABLE 9.4-3 (Sheet 3 of 3)
DETAILS OF ENVIRONMENTAL IMPACTS, TECHNOLOGY, AND DIFFERENTIAL COST FOR THE PROPOSED ALTERNATIVES

Factors Affecting System Selection	Alternate 1 (Proposed system) MDCTs (Wet) (Closed Cycle)	Alternate 2 NDCTs (Closed Cycle)	Alternate 3 MDCTs (Open Cycle)	Alternate 4 Mechanical Draft Air to Air Cooling (Closed Cycle)
Icing and Fogging	• Small increase in number of icing and fogging events • No increase to members of the public due to location • Plume closer to the ground increases the number of events	• Small increase in number of icing and fogging events and less than Alternates 1 and 3 • No increase to members of the public due to location	• Small increase in number of icing and fogging events • No increase to members of the public due to location • Plume closer to the ground increases the number of events	• No increase in events
*********				
Technology	• Proven technology • Fits plant design needs	• Proven technology • Fits plant design needs	• Proven technology • Fits plant design needs • Large water use required	• Currently unproven for large scale power units • Large areas of land needed • Loss of power generation efficiency
Cost Impact Differential	Base Cost	$232 Million greater than Base	$88 Million greater than Base	$338 Million greater than Base

(TXU 2007)

TABLE 9.4-4
CPNPP UNITS 3 AND 4 NEW TRANSMISSION SYSTEM AND CORRIDOR PROPOSAL

Type of Circuit	kV Rating	Connection From / To	Distance
Double-circuit	345 kV	CPNPP / Whitney (one circuit in place) New corridor may be required.	45 miles
Single-circuit	345 kV	CPNPP / Johnson Switch (existing structures)	22.4 miles
Single-circuit	345 kV	Johnson Switch / Everman (existing structures) (off-site only)	23.4 miles
Double-circuit	345 kV	CPNPP / DeCordova (one circuit in place) New corridor may be required.	17 miles
Single-circuit	345 kV	CPNPP / Parker Switch (on existing structures)	41.6 miles

(Oncor 2008)