CHAPTER 9
ALTERNATIVES TO THE PROPOSED ACTION

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
ac.	acre
AC	air conditioning
ACC	acid copper chromate
ACSR	aluminum conductor steel reinforced
AE	Account Executive
AEC	Advanced Energy Corporation; Atomic Energy Commission
AP1000	Westinghouse Electric Company, LLC’s AP1000 Reactor
APE	area of potential effects
APWRA	Altamont Pass Wind Resource Area
BAT	Best Available Technology
BMP	best management practice
BTU	British thermal units
CAAA	Clean Air Act Amendment
CBD	Center for Biological Diversity
CCA	chromated copper arsenate
CCS	carbon capture and storage
CEC	California Energy Commission
CF	counterflow
CFR	Code of Federal Regulations
CIG	Commercial Industrial and Governmental
cm	centimeter

ACRONYMS AND ABBREVIATIONS (CONTINUED)

CT	combustion turbine
m^3/sec	cubic meters per second
CO	carbon monoxide
CO_2	carbon dioxide
COL	Combined License
COLA	Combined License Application
CP&L	Carolina Power & Light Company
CWA	Clean Water Act
CWIS	cooling water intake structure
CWS	circulating water system
DENR	Department of Environment and Natural Resources
DIT	Design Information Transmittal
DSM	demand-side management
EAB	exclusion area boundary
EERE	Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
ELPC	Environmental Law and Policy Center
EPACT	Energy Policy Act of 2005
ER	Environmental Report
ESRP	Environmental Standard Review Plan
FBC	fluidized bed combustor
FERC	Federal Energy Regulatory Commission
FSAR	Final Safety Analysis Report

ACRONYMS AND ABBREVIATIONS (CONTINUED)

FWPCA	Federal Water Pollution Control Act
ft.	foot
ft^3/sec	cubic feet per second
gCO_2eq/kWh	grams of carbon dioxide equivalent kilowatt-hour
gpm	gallon per minute
gpm/ft^2	gallon per minute feet squared
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants
GEO	Geothermal Education Office
G.S.	General Statute
GTG	gas turbine generator
ha	hectare
HAR	proposed Shearon Harris Nuclear Power Plant Units 2 and 3
HAR 2	proposed Shearon Harris Nuclear Power Plant Unit 2
HAR 3	proposed Shearon Harris Nuclear Power Plant Unit 3
HEIP	Home Energy Improvement Program
HNP	existing Shearon Harris Nuclear Power Plant Unit 1
HVAC	heating, ventilation, air conditioning, and cooling
IGCC	Integrated Gasification Combined Cycle
in.	inch
IRP	Integrated Resource Plan
kcmil	thousand circular mils

ACRONYMS AND ABBREVIATIONS (CONTINUED)

km	kilometer
km^2	square kilometer
kV	kilovolt
kWe	kilowatts of energy
kWh	kilowatt-hour
L	liter
$l/(s/m^2)$	liters per second meter squared
LIAP	Low-Income Assistance Program
m	meter
m^2	square meter
m^3/s	cubic meters per second
mi.	mile
$mi.^2$	square mile
MSW	municipal solid waste
MW	Megawatt
MWe	Megawatt electric
MWh	Megawatt hour
MWt	Megawatt thermal
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCDWQ	North Carolina Division of Water Quality
NCSC	North Carolina Solar Center

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NCUC	North Carolina Utilities Commission
NEPA	National Environmental Policy Act
NGG	Nuclear Generation Group
NGVD29	National Geodetic Vertical Datum
NERC	North American Electric Reliability Corporation
NETL	National Energy Technology Laboratory
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
OUC	Orlando Utilities Commission
PEC	Progress Energy Carolinas, Inc.
PM	particulate matter
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
POST	Parliamentary Office of Science and Technology
ppsm	people per square mile
PURPA	Public Utility Regulatory Policies Act of 1978
PV	photovoltaic
RO	reverse osmosis
ROI	region of interest
ROW	right-of-way

ACRONYMS AND ABBREVIATIONS (CONTINUED)

RTO	Regional Transmission Organization
S&L	Sargent & Lundy, LLC
SEER	Seasonal Energy Efficiency Ratio
SEGS	Solar Electric Generating System
SEO	State Energy Office
SERC	Southeastern Electric Reliability Council
SHPO	State Historic Preservation Officer
SO_2	sulphur dioxide
SO_x	oxides of sulphur
SRS	Savannah River Site
SS	Siemens Solar
USACE	U.S. Army Corps of Engineers
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
$W(hr)/m^2/day$	watt hours per square meter per day
Westinghouse	Westinghouse Electric Company, LLC
XF	crossflow

9.0 ALTERNATIVES TO THE PROPOSED ACTION

This chapter identifies alternatives to the proposed action in four ways: (1) it identifies the impact of the no-action alternative; (2) reviews possible energy resources that could be used as alternatives to the proposed action; (3) identifies alternative sites; and (4) evaluates alternative plant and transmission systems for heat dissipation, circulating water, and power transmission at the proposed Shearon Harris Nuclear Power Plant Units 2 and 3 (HAR 2 and HAR 3).

For the purposes of this discussion and consistent with the information presented in the other chapters of this Environmental Report (ER), the following terms are used:

- **Plant Site**. The plant site is the area within the fence line (Figure 4.0-2). This area includes the footprint of HAR 2 and HAR 3 (HAR), including the reactor buildings and generating facilities.

- **HAR Site**. The HAR site is an irregularly shaped area comprised of the following site components: the plant site (area within the fence line), Harris Reservoir, Harris Reservoir perimeter, the dam at Harris Reservoir, the pipeline corridor, and the intake structure and pumphouse (Figure 2.0-2). The HAR site is located within Wake and Chatham counties.

- **Exclusion Zone**. The area with the exclusion area boundary (EAB). The exclusion zone is represented by two circles, each with a radius of 1245 meters (m) (4085 feet [ft.]), centered on the reactor building of each unit (Figure 4.0-3).

- **Pipeline Corridor**. The pipeline corridor includes the Harris Lake makeup water system pipeline and corridor connecting the Harris Reservoir and the Cape Fear River. The pipeline components will transport makeup water from the Cape Fear River to the Harris Reservoir (Figure 4.0-4).

- **Intake Structure and Pumphouse**. The Harris Lake makeup water system intake structure and pumphouse will be constructed on the Cape Fear River (Figure 4.0-5).

- **Harris Lake**. Harris Lake includes both the Harris Reservoir and the Auxiliary Reservoir.

- **Harris Reservoir**. The Harris Reservoir is also known as the Main Reservoir. It does not include the affiliated Auxiliary Reservoir.

- **Harris Reservoir Perimeter**. The Harris Reservoir perimeter describes the area impacted by the 6 m (20 ft.) change in the reservoir's water level.

- **Transmission Corridors and Off-Site Areas**. Transmission corridors and off-site areas describe areas outside the site boundary that may fall within the footprint of new or existing transmission lines.

- **Vicinity**. The vicinity is a band or belt 9.7 kilometers (km) (6 miles [mi.]) wide surrounding the HAR site (Figure 2.0-6). The vicinity includes a much larger tract of land than the HAR site. The vicinity is located within four counties: Wake, Chatham, Harnett, and Lee.

- **Region**. The region applies to the area within an 80-km (50-mi.) radius from the center point of the HAR power block footprint, excluding the site and vicinity (Figure 4.0-6). The following counties are located entirely within the region: Chatham, Durham, Harnett, Lee, Orange, and Wake. The following counties are located partially within the region: Alamance, Caswell, Cumberland, Franklin, Granville, Guilford, Hoke, Johnston, Montgomery, Moore, Nash, Person, Randolph, Richmond, Robeson, Sampson, Scotland, Vance, Wayne, and Wilson. The region includes the economic centers of Raleigh, Durham, Fayetteville, Cary, and Chapel Hill.

9.1 NO-ACTION ALTERNATIVE

The no-action alternative is a scenario under which the U.S. Nuclear Regulatory Commission (NRC) denies the application and HAR 2 and HAR 3 (HAR), as described in ER Chapter 2, is not constructed and no other generating station, either nuclear or non-nuclear, is constructed and operated. As stated in NUREG-1555, *Standard Review Plans for Environmental Reviews of Nuclear Power Plants*:

> The no-action alternative would result in the facility not being built, and no other facility would be built or other strategy implemented to take its place. This would mean that the electrical capacity to be provided by the project would not become available.

The most significant effect of the no-action alternative would be the loss of the potential 2000 megawatts electric (MWe) of energy, which could lead to a reduced ability of existing power suppliers to maintain reserve margins and supply lower-cost power to customers. ER Chapter 8 describes the evaluation of the need for power and discusses a 2-percent annual increase in electricity demand in North Carolina over the next 10 years. The no-action alternative would restrict the ability of Progress Energy Carolinas, Inc. (PEC) to provide safe, reliable baseload power within North Carolina and South Carolina to meet the projected demand obligations of approximately 900 megawatts (MW) additional baseload every 4 years as discussed in ER Section 8.4. Under the no-action alternative, PEC would not be able to satisfy the concerns about climate change and greenhouse gas reductions in North Carolina and the southeastern United States. As discussed in Chapter 8 and Subsection 9.2.1, because this area of the country already imports a portion of its electricity, the ability to import additional resources in a cost-effective manner is limited.

The options outlined above are not optimal from the standpoint of the cost of operation or the cost of supplied power. PEC's fuel supply within the Region of Interest (ROI) could become increasingly dependent on fossil-fuel generation and other alternatives. Without additional capacity, the region would not only remain heavily dependent on fossil fuel generation, it would not recognize the role of fuel diversity in the overall reliability of the State's power system, as discussed in Section 8.4. If PEC took no action at all to meet growth demands, the ability to supply low-cost, reliable power to their customers would be impaired. PEC would not be able to support national goals, as established in the Energy Policy Act (EPACT) of 2005, to advance the use of nuclear energy.

In addition to the benefits in ER Section 10.4, additional benefits of the construction and operation of the HAR include economic and tax impacts to the surrounding region that are described in ER Subsections 4.4.2.1, 4.4.2.2, 5.8.2.1, and 5.8.2.2. Under the no-action alternative, none of the benefits of the proposed project as described in this ER would be realized.

Under the no-action alternative, the predicted impacts from the project would not occur at the site. Impacts would result primarily from the construction of the facilities, increasing the operating level of Harris Reservoir and the withdrawal of water from the Cape Fear River. The impacts from construction of the HAR include impacts to land use, water-related impacts, ecological impacts, and socioeconomic impacts as summarized in Table 4.6-1. Impacts resulting from operation are summarized in Table 5.10-1. The benefits of implementing the no-action alternative would include avoiding the impacts resulting from the project as described in the sections referenced above; however, none of the project objectives would be realized.

9.2 ENERGY ALTERNATIVES

This section examines the potential environmental impacts associated with electricity-generating sources other than the HAR. The energy alternatives considered include the following:

- Purchasing electric power from other sources to replace power that would have been generated by the HAR.
- Combining new generating capacity and conservation measures.
- Resorting to other electricity generating alternatives that were deemed not to be viable replacements for the HAR.

The decision to develop a nuclear power plant on land adjacent to the existing Shearon Harris Nuclear Power Plant Unit 1 (HNP) was primarily based on factors such as the proximity to an already licensed station, the ability to incorporate existing environmental permits in the operation and plant parameters, property ownership, proximity to a substation and transmission grid, historic assessments of multiple plants at the HNP site and other location features conducive to the plant's intended generating objective.

Alternatives that do not require new generating capacity were evaluated. These include passive measures such as energy conservation and demand-side management (DSM).

Alternative energy supplies such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, energy crops, as well as any reasonable combination of these alternatives were also analyzed.

Alternatives that do not require new generating capacity are discussed in Subsection 9.2.1. Alternative energy supplies are discussed in Subsection 9.2.2. In Subsection 9.2.2, some of the alternatives that require new generating capacity were eliminated from further consideration and discussion based on availability in the region, overall feasibility, and environmental consequences. In Subsection 9.2.3, the alternatives that were not eliminated based on these factors are investigated in further detail relative to specific criteria such as environmental impacts, reliability, and economic costs.

9.2.1 ALTERNATIVES THAT DO NOT REQUIRE NEW GENERATING CAPACITY

This subsection is intended to provide an assessment of the economic and technical feasibility of supplying the demand for energy without constructing new generating capacity. Other alternatives considered include the following:

- Initiating conservation measures (including implementing DSM actions).
- Reactivating or extending the service life of existing plants within the power system.
- Purchasing power from other utilities or power generators.

Refer to ER Chapter 8 for descriptions and assessments of the regional power systems and assessments of alternatives for supply.

9.2.1.1 Initiating Conservation Measures

DSM programs consist of planning, implementing, and monitoring activities of electric utilities to encourage consumers to modify their level and pattern of electricity usage. This can reduce customers' demand for energy through conservation, efficiency, and load management so that the need for additional generation capacity is eliminated or reduced. Those environmental impacts that result from the construction of the proposed facility are avoided if DSM were sufficient to reduce the need for additional power.

These programs are in response to the rising cost of energy and the rising cost of building new electric generating units. A wide variety of conservation technologies are considered as alternatives to generating electricity at current nuclear plants. These technologies include hardware, such as more efficient motors in consumer appliances, commercial establishments, or manufacturing processes; more energy-efficient light bulbs; and improved heating, ventilation, and air conditioning (HVAC) systems. Structures consume less energy when weatherized with better insulation, weather stripping, and storm windows. Conservation measures on the utility side include the installation of more efficient equipment, as it retrofits its power plants and improves distribution and transmission technologies.

Conservation technologies and measures have proven to be popular with some utilities, public utility commissions, and members of the public. Energy conservation is viewed as a way of providing economical service while reducing the need to construct more electric generating facilities. Using integrated planning processes such as PEC's conservation technologies and measures are considered as potential new resources in the utility's portfolio of capabilities.

Under EPACT 2005, a rebate program was established for dwellings and small businesses that install energy efficient systems in their buildings. The rebate was set at $3000 or 25 percent of the expenses, depending on which was less. EPACT 2005 authorized $150 million for 2006 and up to $250 million in 2010. According to the act, renewable energy sources included geothermal, biomass, solar, wind, or any other renewable energy used to heat, cool, or produce electricity for a dwelling (Reference 9.2-001). This new act was established to encourage homeowners and small businesses to become more aware of energy efficient technologies, which could lead to decreased energy usage in the future.

Historically, state regulatory agencies have required regulated utilities to institute programs designed to reduce demand for electricity. DSM has shown great potential in reducing peak-load usage. In 2005, peak-load usage was reduced by approximately 25,710 megawatt electric (MWe), an increase of 9.3 percent from the previous year (Reference 9.2-002); however, DSM costs increased by 23.4 percent. Overall, nominal DSM costs have decreased over the past 10 years (Reference 9.2-003).

The following are additional programs that can be used to directly reduce summer or winter peak loads when needed but will not significantly reduce baseload demand:

- **Large Load Curtailment** — This program provides a source of load that may be curtailed at the company's request to meet system load requirements. Customers who participate in this program receive a credit on their bill.

- **Voltage Control** — This procedure involves reducing distribution voltage by up to 5 percent during periods of capacity constraints. This level of reduction does not adversely affect customer equipment or operations (Reference 9.2-004).

The impact of DSM and conservation programs implemented by PEC on peak and baseload power generation requirements is integrated into the Integrated Resource Plan (IRP) process. IRP Table 8.1-2 identifies an increase of 2803 MWe under the heading of Generation Additions as “Undesignated”. PEC’s historical data and future projections indicate that baseload generation is a significant portion of the power needs in the ROI, with peaking generation making up a smaller percentage of generation needs. To meet future generation requirements, PEC will require more than 2500 MWe of new capacity to be in service by 2017. While a portion of the peak load requirements may be deferred by the new DSM programs, which are projected to yield approximately 1000 MWe of peak load reductions, DSM and conservation programs will not eliminate the need for additional baseload generation.

9.2.1.1.1 Conservation Programs

PGN presents the conservation programs currently implemented and under consideration in PEC’s DSM Plan (Reference 9.2-004). Based on review of these programs, PEC concludes the following: (1) the benefits and impacts of these additional programs would lower peak demand and possibly slow the need to construct new peaking facilities, but they would result in a minor increase in baseload demand, and (2) the assessment of these potential programs is not yet complete. The final portfolio of DSM programs may include some or all of the above potential initiatives, as well as others being considered but not yet analyzed. PEC will develop more specific proposals and obtain any required regulatory approvals for those programs determined to be cost effective. When this process is complete, the energy and load impacts of the programs will be incorporated into PEC’s ongoing resource planning process. The programs discussed above will encourage energy efficiency and reduce peak demand but will not eliminate the need for additional baseload demand generation, as discussed in ER Chapter 8.

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

Retired fossil plants and fossil plants slated for retirement tend to be ones that are old enough to have difficulty in economically meeting today's restrictions on air contaminant emissions. In the face of increasingly stringent environmental restrictions, delaying retirement or reactivating plants to compensate for the closure of a large baseloaded plant would require major construction to upgrade or replace plant components. Currently PEC does not plan to retire any baseload generation plants between now and 2025, which is projected as the sixth year of commercial operation of HAR 3. PEC plans to retire the 12- to 18-MW Combustion Turbine (CT) #1 in Roxboro, North Carolina. The Roxboro CT #1 facility is used only for peak demand and does not provide baseload generation. The retirement of the Roxboro CT #1 facility has been factored into PEC's current power analysis.

PEC does not have any retired plants that would be suitable for reactivation. PEC has retired the Cape Fear Unit 3 and Unit 4 coal plants, which were rated at approximately 65 MW total. The retired Cape Fear coal plants do not provide a suitable alternative to the construction of a new nuclear power generating plant at HAR because these plants could not be refurbished to meet today's environmental standards. PEC has other retired plants, but none are larger than 20 MW or provide a suitable alternative for construction of a new nuclear power generating plant. PEC does not plan to retire any existing power generation plants between now and 2025.

Upgrading existing plants would be costly and, at the same time, power generation would remain the same. A new baseline facility would allow for the generation of needed power within the ROI. A new 157-MW CT facility (Wayne County Plant) in Goldsboro, North Carolina, is proposed to be online in June 2009 and a new 600-MW combined cycle facility in Richmond County, North Carolina, is proposed to be online in 2011.

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

PEC sells electric energy to supplement small production facilities in the ROI. Under the Public Utility Regulatory Policies Act of 1978 (PURPA), electric utilities are required to offer purchase of electric energy from any small production facilities or cogeneration plants that qualify under PURPA. In addition, North Carolina General Statute (G.S.) 62-156 requires the North Carolina Utilities Commission (NCUC) to determine the rates and contract terms to be observed by electric utilities in purchasing power from small power producers as defined in G.S. § 62-3(27a). The rates established pursuant to G.S. § 62-156 shall not exceed, over the term of the purchase power contract, the incremental cost to the electric utility of the electric energy which, but for the purchase from a small power producer, the utility would generate or purchase from another source. (Reference 9.2-005) Due to the limited number of small production facilities or cogeneration plants and the limitations on output from those facilities, the purchase of electricity from these sources is not a viable alternative for additional baseload capacity.

A list of wholesale purchase power commitments is provided in Table 9.2-1. In addition, PEC is currently negotiating a 150-MWe purchase power contract for the 2010–2019 timeframe. This method is not competitive and would not meet the needs that the 2000-MWe HAR facility would meet. Because there is not enough electricity to import from nearby states, purchasing power from other utilities or power generators is a less attractive option than the construction of new nuclear units at HAR.

9.2.2 ALTERNATIVES THAT REQUIRE NEW GENERATING CAPACITY

While many methods are available for generating electricity and combinations of those methods can be assimilated to meet system needs, such an expansive approach would be too unwieldy to thoroughly examine each in depth, given the purposes of the alternatives analysis. In keeping with the NRC's evaluation of alternatives to license renewal, a reasonable set of alternatives should be limited to analysis of single discrete electrical generation sources and those electricity generation technologies that are technically reasonable and commercially viable.

The following alternative energies were considered:

- Wind.
- Geothermal.
- Hydropower.
- Solar Power.
  - Concentrating Solar Power Systems.
  - PV Cells.
- Wood Waste (and other Biomass).
- Municipal Solid Waste.
- Energy Crops.
- Petroleum Liquids (Oil).
- Fuel Cells.
- Coal.

- Natural Gas.

Each of these alternatives will be further discussed in other sections, with an emphasis on coal, solar, natural gas, and wind energy. As a renewable resource, solar and wind energies, alone or in combination with one another, have gained increasing popularity over the years because these alternative energy sources have decreased greenhouse gas emissions. Also, air pollutant emissions from solar and wind facilities are much less than fossil fuel air emissions. Although the use of coal and natural gas has become less popular, it is still one of the most widely used fuels for producing electricity. However, based on the installed capacity of 2000 MWe that the HAR facility will produce, not all of the alternative energies discussed in this report will be competitive or viable.

The current mix of power generation options in North Carolina is one indicator of the feasible choices for electricity generation technology within the State. PEC evaluated North Carolina electricity generation capacity and utilization characteristics. “Capacity” is the categorization of the various installed technology choices in terms of its potential output. “Utilization” is the degree to which each choice is actually used.

This subsection identifies alternatives that PEC has determined are not reasonable and the basis for this determination. This Combined License Application (COLA) is premised on the installation of a facility that would serve as a baseload resource and that any feasible alternative would also need to be able to generate baseload power. In performing this evaluation, PEC relied heavily on NRC’s Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants.

The GEIS made is useful for analyzing alternative energy sources because the NRC has determinations regarding these potential alternative technologies for the agency to consider the relative environmental consequences of an action given the environmental consequences of other activities that also meet the purpose of the proposed action. To generate the reasonable set of alternatives used in the GEIS, the NRC included common generation technologies and consulted various state energy plans to identify the alternative energy sources typically being considered by state authorities across the country. From this review, the NRC had established a reasonable set of energy source alternatives to be examined. These energy source alternatives include wind energy, PV cells, solar thermal energy, hydroelectricity, geothermal energy, incineration of wood waste and municipal solid waste, energy crops, coal, natural gas, oil, and delayed retirement of existing non-nuclear plants. The NRC has considered these alternatives pursuant to its statutory responsibility under the National Environmental Policy Act (NEPA). Although the GEIS is for license renewal, the alternatives analysis in the GEIS can be compared with the proposed action to determine if the alternative represents a reasonable alternative to the proposed action.

Each alternative is analyzed in the subsequent sections based on the following criteria:

- Is the alternative energy conversion technology mature, proven, and will it be available in the region of interest within the life of the COL?
- Does the alternative energy source provide baseload-generating capacity equivalent to the capacity and to the same level as HAR?
- Do the costs of an alternative energy source exceed the costs that make it economically impractical?
- Is the alternative energy source environmentally preferable to HAR?

Each of the potential alternative technologies considered in this analysis are consistent with national policy goals for energy use and are not prohibited by federal, state, or local regulations. These criteria were not factors in evaluating alternative technologies.

Combined heat and power systems geographically dispersed and located near customers are another source of heat and electrical power. PEC continues to be involved in research and demonstration of the viability of promising new technologies. PEC is currently researching the potential application of fuel cells to deliver electrical energy in operating distributed generation on or near a customer’s property. The assessment of this and other potential distributed energy generation programs of fuel cell technology is years away. PEC will continue with research and development through active pilots and demonstrations to help to accelerate the process. Distributed energy generation was not seen as a competitive or viable alternative and was not further examined.

Based on one or more of these criteria, several of the alternative energy sources were considered technically or economically infeasible after a preliminary review and were not considered further. Alternatives that were considered to be technically and economically feasible are further discussed in Subsection 9.2.3.

9.2.2.1 Wind

In general, areas identified as Class 4 and above are regarded as potentially economical for wind energy production with current technology. Wind energy resource classifications are defined by the Department of Energy for the United States.

As a result of technological advances and the current level of financial incentive support, other areas with a slightly lower wind resource (Class 3+) could be suitable for wind development; however, they would operate at an even lower annual capacity factor and output than used by National Renewable Energy Laboratory (NREL) for Class 4 sites.

North Carolina has the potential to produce 7 percent of its electricity through suitable Class 3 and higher sites. This could produce approximately 8 million megawatt hours (MWh). Class 5 and 6 sites are abundant in the western mountains of North Carolina or ROI; however, because of the Mountain Ridge Protection Act of 1983, constructing structures taller than 10.7 m (35 [feet [ft.]) is prohibited in elevations above 915 m (3000 ft.). There are also Class 3 and 4 sites in the western mountains and along the eastern seaboard (Reference 9.2-006).

In any wind facility, the land use could be significant. Wind turbines must be sufficiently spaced to maximize capture of the available wind energy. If the turbines are too close together, one turbine can affect the efficiency of another turbine. A turbine with a generating capacity of 1.5 MWe would require approximately 10.8 hectares (ha) (26.7 acres [ac.]) of dedicated land for the actual placement of the wind turbine. For illustrative purposes, if all of the resources in Classes 3+ and 4 sites were developed using 2-MWe turbines, with each turbine occupying 0.10 ha (0.25 ac.), 9000 MWe of installed capacity would use 455 ha (1125 ac.) just for the placement of the wind turbines alone. Based on the North American Electric Reliability Corporation (NERC) capacity factor, his project would have an average output of 1530 MWe (approximately 0.30 ha [0.73 ac.]/MWe). This is a conservative assumption because Class 3+ sites will have a lower percentage of average annual output.

If a Class 3+ site was available and developed using 2-MWe turbines within the ROI, the equivalent of 12,800 MWe of installed capacity would be needed to produce 2000 MWe of full-time output, due to wind variability. This would encompass a footprint of approximately 648 ha (1600 ac.), which is more than twice the land area needed for HAR. This does not include supporting infrastructure for wind farms, such as access roads, which would require more area. Even if there was enough land area to develop wind turbines, the HNP site is a Class 1 site; therefore, it would not be feasible to construct a wind power facility at the site (Reference 9.2-007).

Although wind technology is considered mature, technological advances could make wind power a more economic choice for developers than other renewables (Reference 9.2-008). Technological improvements in wind turbines have helped reduce capital and operating costs. In 2000, wind power was produced in a range of $0.03 to $0.06/kWh (depending on wind speeds), but by 2020 wind power generating costs are projected to fall to $0.03 to $0.04/kWh) (Reference 9.2-009).

The EIA's *Annual Energy Outlook 2004* can provide the following limitations on the ability of the wind resource to provide baseload (Reference 9.2-010):

- In addition to the construction and operating and maintenance costs for wind farms, there are costs for connection to the transmission grid. Any wind project would have to be located where the project would produce economical generation and that location may be far removed from the nearest possible connection to the transmission system. A location far removed from the power transmission grid might not be economical, as new transmission lines will be required to connect the wind farm to the distribution system. Existing transmission infrastructure might need to be upgraded to handle the additional supply. Soil conditions and the terrain must be suitable for the construction of the towers' foundations. Finally, the choice of a location might be limited by land use regulations and the ability to obtain the required permits from local, regional, and national authorities. The farther a wind energy development project is from transmission lines, the higher the cost of connection to the transmission and distribution system.

- The distance from transmission lines at which a wind developer can profitably build depends on the cost of the specific project. Consider, for example, the cost of construction and interconnection for a 115-kilovolt (kV) transmission line that would connect a 50-MWe wind farm with an existing transmission and distribution network. The EIA estimated, in 1995, the cost of building a 115-kV line to be $130,000 per mile, excluding right-of-way (ROW) costs (Reference 9.2-011). This amount includes the cost of the transmission line itself and the supporting towers. It also assumes relatively ideal terrain conditions, including fairly level and flat land with no major obstacles or mountains (more difficult terrain would raise the cost of erecting the transmission line). In 1993, the cost of constructing a new substation for a 115-kV transmission line was estimated at $1.08 million and the cost of connecting a 115-kV transmission line with a substation was estimated to be $360,000 (Reference 9.2-012).

Another consideration on the integration of the wind capacity into the electric utility system is the variability of wind energy generation. Wind-driven electricity-generating facilities must be located at sites with specific characteristics to maximize the amount of wind energy captured and electricity generated. In addition, for transmission purposes, wind generation is not considered "dispatchable," meaning that the generator cannot control output to match load and economic requirements. Because the resource is intermittent, wind, by itself, is not considered a firm source of baseload capacity. The inability of wind alone to be a dispatchable, baseload producer of electricity is inconsistent with the objectives for the HAR facility.

Wind has environmental impacts in addition to the land requirements posed by large facilities:

- Some consider large-scale commercial wind farms to be an aesthetic problem. Local residents near the wind farms might lose what they consider their pristine scenic view of the area.

- High-speed wind turbine blades can be noisy, although technological advancements continue to lessen this problem.

- Wind facilities sited in areas of high bird use can expect to have fatality rates higher than those expected if the wind facility were not there.

The Center for Biological Diversity (CBD) recently voiced mixed reviews regarding wind farms along migratory bird routes. The CBD supports wind energy as an alternative energy source that would reduce environmental degradation. However, wind power facilities, such as the Altamont Pass Wind Resource Area (APWRA) in California, are increasing mortality rates in raptor populations as a result of turbine collisions and electrocution on power lines. The APWRA kills about 881 to 1300 birds of prey each year. Birds that have been affected to the greatest extent include golden eagles, red-tailed hawks, burrowing owls, great horned owls, American kestrels, ferruginous hawks, and barn owls (Reference 9.2-013).

With the inability of wind power to generate baseload power, the projected land use impacts of development of Class 3+ and Class 4 sites, the cost factors in construction and operation, along with the impacts associated with development, and cost of additional transmission facilities to connect all of these turbines to the transmission system, wind by itself is not a feasible alternative to the new plant. Because off-shore wind farms are non-competitive and not viable with a nuclear reactor at the HAR site, they are not discussed further in this report. The technical constraints associated with siting and construction of off-shore wind turbines are more significant than on-shore wind farms, making off-shore wind power not a feasible alternative to the new plant. Marine environments present a more corrosive setting and may lead to reliability problems with conventional on-shore turbine designs. The length of required transmission corridors associated with off-shore wind farms also presents significant challenges.

Wind power systems produce power intermittently, depending upon when the wind is blowing at sufficient velocity and duration. Despite advances in technology and reliability, capacity factors for wind power systems remain relatively low (25 to 45 percent) compared to 90 to 95 percent industry average for a baseload plant such as a nuclear plant.

Many renewable resources are intermittent, or are not consistently available. Wind is an example of this type of renewable resource. Storing energy from the renewable source allows supply to more closely match demand. An example would be a wind turbine with a storage system could capture energy on a continuous basis. Energy could then be dispatched during periods of peak demand (e.g., midday market) (Reference 9.2-014).

Based on availability of land and wind resources, a wind-powered facility is a less attractive option than the construction of new nuclear units at the HAR site.

9.2.2.2 Geothermal

As shown on Figure 8.4 in the GEIS, geothermal plants could be located in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent; however, meaningful geothermal resources do not exist in North Carolina.

Based on the hottest known geothermal regions of the United States, North Carolina is not a candidate for geothermal energy and could not produce the proposed 2000 MWe of baseload energy (Reference 9.2-015). North Carolina does not have sufficient resources to use geothermal technologies (Reference 9.2-016). Therefore, geothermal energy is not available in the ROI and is a non-competitive alternative to a new nuclear unit at the HNP site. Based on the geographic limitations associated with geothermal technologies, it is a less attractive option than the construction new nuclear units at the HAR site.

9.2.2.3 Hydropower

The GEIS estimates land use of 4144 square kilometers (km^2) (1600 square miles [$mi.^2$]) or approximately 1 million acres per 1000 MWe generated by hydropower. Based on this estimate, hydropower would require flooding more than 9034 km^2 (3488 $mi.^2$) or approximately 2.2 million ac. to produce a baseload capacity of 2000 MWe, resulting in a large commitment of land. Further, operation of a hydroelectric facility would alter aquatic habitats above and below the dam, which would affect existing aquatic species.

The Federal Energy Regulatory Commission (FERC) is required to take environmental issues into consideration when renewing or granting licenses for hydropower. Many environmentalists oppose hydropower dams because of the constraints these dams put on migrating fish species in the area. Also, new dams face opposition from local communities that might be displaced by flooding the new reservoir or use the current river system for recreational activities.

Currently, North Carolina supplies 3.5 percent of the states electricity through hydroelectric supplies. North Carolina has the potential to produce approximately 7 percent of its electricity (8 million MWh) through hydroelectric generation. According to a study performed by the Idaho National Engineering and Environmental Laboratory, North Carolina has 93 undeveloped sites with a 508-MWe generating capacity. Only one site had the potential generating capacity of more than 76 MWe. Furthermore, even if the remaining undeveloped sites were developed, baseload capacity would still not be met. Droughts that have occurred in the past decade could be the most significant hurdle to use of hydropower in North Carolina (Reference 9.2-006). As a result, hydropower is a less attractive option than the construction of new nuclear units at HAR.

9.2.2.4 Solar Power

Solar energy is dependent on the availability and strength of sunlight (strength is measured as kWh/m^2). Solar power is considered an intermittent source of energy. Solar power combined with fossil fuels is a viable power production alternative. However, solar facilities combined with fossil fuel facilities would have equivalent or greater environmental impacts relating to a new nuclear facility at the HNP site. Similarly, solar facilities combined with fossil fuel facilities would have higher costs than a new nuclear facility at the HNP site along with additional construction impacts and only moderately less significant environmental impacts compared to fossil fuel alternatives. A discussion of solar facilities combined with other alternatives is provided in Subsection 9.2.3.3.1.

All technologies provide a fuel-saving companion to a baseload source. These technologies can be divided into two groups. The first group concentrates the sun's energy to drive a heat engine (concentrating solar power systems). The other group of solar power technologies directly converts solar radiation into electricity through the photoelectric effect by using PV cells. Some solar thermal systems can also be equipped with a thermal storage tank to store heated transfer fluid. These solar thermal plants can then dispatch electric power on demand using this stored heat.

Construction of solar power generating facilities has substantial impacts on natural resources (such as wildlife habitat, land use, and aesthetics). As stated in the GEIS for License Renewal, land requirements are high — 141 km^2 (54.5 $mi.^2$) or 34,880 ac. per 1000 MWe for PV and approximately 60 km^2 (23.2 $mi.^2$) or 14,848 ac. per 1000 MWe for solar thermal systems The footprint needed to produce a 2000-MWe baseload capacity would be too large to construct at the proposed plant site.

To look at the availability of solar resources in North Carolina, two collector types must be considered: concentrating collectors and flat-plate collectors. Concentrating collectors are mounted to a tracker, which allows them to face the sun at all times of the day. In North Carolina, approximately 4000 to 4500 watt hours per square meter per day ($W[hr.]/m^2/day$) can be collected using concentrating collectors. Flat-plate collectors are usually fixed in a tilted position to best capture direct rays from the sun and also to collect reflected light from clouds or off the ground. In North Carolina, approximately 4500 to 5000 $W(hr.)/m^2/day$ can be collected using flat-plate collectors (Reference 9.2-016).

9.2.2.4.1 Concentrating Solar Power Systems

Concentrating solar power plants only perform efficiently in high-intensity sunlight locations, specifically the arid and semi-arid regions of the world (Reference 9.2-017). This does not include North Carolina.

Concentrating solar power plants produce electricity by converting the sun's energy into high-temperature heat using various mirror configurations. The heat is then channeled through a conventional generator through an intermediate medium (e.g., water or salt). Concentrating solar power plants consist of two parts: one that collects the solar energy and converts it to heat and another that converts heat energy to electricity.

There are three kinds of concentrating solar power systems — troughs, dish/engines, and power towers — classified by how they collect solar energy (Reference 9.2-018).

While concentrating solar power technologies currently offer the lowest-cost solar electricity for large-scale electricity generation, these technologies are still in the demonstration phase of development and cannot be considered competitive with fossil- or nuclear-based technologies (Reference 9.2-008).

9.2.2.4.2 "Flat-Plate" Photovoltaic Cells

The second main method for capturing the sun's energy is through the use of PV cells. A typical PV or solar cell might be a square that measures about 10 centimeters (cm) (4 inches [in.]) on a side. A cell can produce about 1 watt of power, which is more than enough to power a watch, but not enough to run a radio.

Available PV cell conversion efficiencies are in the range of approximately 15 percent (Reference 9.2-019). In North Carolina, solar energy can produce an average of 4- to 4.5 kWh/m^2/day and even slightly higher in the summer. This value is highly dependent on the time of year, weather conditions, and obstacles that might block the sun (Reference 9.2-020).

Currently, PV solar power is not competitive with other methods of producing electricity for the open wholesale electricity market. PV solar power will not be a viable alternative because it will not meet the baseload capacity necessary for HAR. When determining the cost of solar systems, the totality of the system must be examined. There is the price per watt of the solar cell, price per watt of the module (whole panel), and the price per watt of the entire system. Systems vary in quality and size, which make it challenging to determine an average price. The average price for modules (dollars per peak watt) increased 9 percent, from $3.42 in 2001 to $3.74 in 2002. For cells, the average price decreased 14 percent, from $2.46 in 2001 to $2.12 in 2002 (Reference 9.2-021). However, the module price does not include the design costs, land, support structure, batteries, an inverter, wiring, and lights or appliances. With all of these included, a full system can cost anywhere from $7 to $20 per watt (Reference 9.2-022). Costs of PV cells in the future could be expected to decrease with improvements in technology and increased production. Optimistic estimates are that costs of grid-connected PV systems could drop to $2275 per kWe ($0.15 per kWh) by 2020 (Reference 9.2-009). These costs would still be significantly more than the costs of power from a new nuclear plant. Therefore, use of PV cells is a less attractive option than the construction of new nuclear units at HAR.

Environmental impacts of solar power systems can vary based on the technology used and the site-specific conditions. Environmental impacts of solar power systems include the following:

- Land use and aesthetics are the primary environmental impacts of solar power.
- Land requirements for each of the individual solar energy technologies are large compared with the land required for a new nuclear plant. The land required for the solar-generating technologies could require up to 6 ha (14.8 ac.)/MWe compared with 0.09 ha (0.23 ac.) per MWe for a nuclear plant. In addition, this land use is pre-emptive; land used for solar facilities would not be available for other uses such as agriculture.
- Depending on the solar technology used, there could be thermal discharge impacts. These impacts would be minor (Subsection 9.2.3). During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.
- There are environmental impacts of PV cells related to manufacture and disposal. The process to manufacture PV cells is similar to that for producing a semiconductor chip. Chemicals used to manufacture PV cells include cadmium and lead. There are potential human health risks from manufacturing and deploying PV systems because there is a risk of exposure to heavy metals, such as selenium and cadmium, during use and disposal. (Reference 9.2-023) There is some concern that landfills could leach cadmium, mercury, and lead into the environment in the long term. Generally, PV cells are sealed and the risk of release is considered slight. However, the long-term impact of these chemicals in the environment is unknown. Another environmental consideration with solar technologies is the lead-acid batteries that are used with some systems. However, the impact of these lead batteries is lessening as batteries become more recyclable, batteries of improved quality are produced, and better quality solar systems that enhance battery lifetimes are created (Reference 9.2-024).

Concentrating solar power systems provide a viable energy source for small power-generating facilities; however, concentrating solar power systems are still in the demonstration phase of development and are not competitive with nuclear-based technologies. PV cell technologies are becoming more popular as costs gradually decrease. However, a supplemental energy source would be needed to meet the HAR facility baseload capacity and the large estimate of land required would make this alternative infeasible. Like wind, capacity factors are too low to meet baseload requirements.

Based on the lack of information regarding large-scale systems able to produce the proposed 2000-MWe baseload capacity and the large land area footprint needed for construction, concentrating solar power systems and “flat-plate” PV cells are less attractive options than the construction of new nuclear units at HAR.

9.2.2.5 Wood Waste (and Other Biomass)

The use of wood waste to generate electricity is mostly limited to those states with significant wood resources, such as California, Maine, Georgia, Minnesota, Oregon, Washington, and Michigan. Electric power is generated in these states by the pulp, paper, and paperboard industries, which consume wood and wood waste for energy, benefiting from the use of waste materials that could otherwise represent a disposal problem. However, the largest wood waste power plants are 40 to 50 MWe in size, which would not meet the proposed 2000-MWe baseload capacity.

Nearly all of the wood-energy-using electricity generation facilities in the United States use steam turbine conversion technology. The technology is relatively simple to operate and it can accept a wide variety of biomass fuels. However, at the scale appropriate for biomass, the technology is expensive and inefficient. Therefore, the technology is relegated to applications where there is a readily available supply of low, zero, or negative cost delivered feedstocks.

Construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, wood waste plants require large areas for fuel storage, processing, and waste disposal (i.e., ash). Additionally, operation of wood-fired plants has environmental impacts, including impacts on the aquatic environment and air.

Currently, the capacity for wood waste production in North Carolina from wood waste power plants is 330 MWe. According to a 1993 study performed by Research Triangle Institute for the North Carolina Division of Forest Resources, the potential for wood energy production in North Carolina including captive generation is 1017 MWe (Reference 9.2-025).

Biomass fuel can be used to co-fire with a coal-fueled power plant, decreasing cost from $0.023/kWh to $0.021/kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices. In today's direct-fired biomass power plants, generation costs are about $0.09/kWh (Reference 9.2-026).

Construction of a biomass-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste and agricultural residues for fuel would be built on smaller scales. Like coal-fired plants, biomass-fired plants require areas for fuel storage, processing, and waste (i.e., ash) disposal. In addition, operation of biomass-fired plants has environmental impacts, including potential impacts on the aquatic environment and air. Due to the small scale of biomass generating plants, high cost, and lack of an obvious environmental advantage, biomass energy is not a reasonable alternative for baseload power.

9.2.2.6 Municipal Solid Waste

The initial capital costs for MSW plants are greater than for comparable steam turbine technology at wood waste facilities. This difference in cost is caused by the need for specialized waste separation and handling equipment required for MSW plants.

The decision to burn MSW to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of the numerous obstacles and factors that could limit the growth in MSW power generation, most of which are environmental regulations and public opposition to siting MSW facilities. The conversion of waste to energy is not a viable option because there is a lack of MSW available in the area.

Estimates suggest that the overall level of construction impacts from an MSW-fired power generation plant should be approximately the same as that for a coal-fired plant. Additionally, MSW-fired power generation plants have the same or greater operational impacts, including impacts on the aquatic environment, air, and waste disposal. Some of these impacts would be MODERATE (see Subsection 9.2.3), but more significant than those from the proposed action.

From 2004 to 2005, 9,112,403 metric tons (10,044,705 tons) of MSW was disposed of in North Carolina. This total includes approximately 108,138 metric tons (119,202 tons) or 1.2 percent from other states. At a population of 8,541,263, this produced a per capita disposal rate of 1.29, which was a 21-percent increase from 1991 to 1992 (Reference 9.2-027). As an MSW reduction method, incineration can be implemented to generate energy and reduce the amount of waste by up to 90 percent in volume and 75 percent in weight (Reference 9.2-028).

There have been cases where coal-fired power plants have mixed pulverized MSW to create a waste consisting of 10 percent MSW and 90 percent coal. Currently, the city of Wilmington, North Carolina, has an MSW direct-combustion system containing 100 percent MSW. This system is able to produce over 7.5 MWe. However, North Carolina currently transports most of its MSW to landfills. From an environmental standpoint, the burning of MSW to create an energy source is the least environmentally favorable option because of particulate and gas emissions, which contradict the State’s cleaner smokestack initiative (Reference 9.2-006).

The United States has about 89 operational MSW-fired power generation plants, generating approximately 2500 MWe, or about 0.3 percent of total national power generation. This comes to approximately 28 MWe per MSW-fired power generation plant. This would not meet the proposed 2000-MWe baseload capacity. However, economic factors have limited new construction. Burning MSW produces nitrogen oxides and sulphur dioxide as well as trace amounts of toxic pollutants, such as mercury compounds and dioxins. MSW-fired power generation plants, much like fossil fuel power plants, require land for equipment and fuel storage. The non-hazardous ash residue from the burning of MSW is typically deposited in landfills (Reference 9.2-029). Therefore, MSW-fired power generation is a less attractive option than the construction of new nuclear units at HAR.

9.2.2.7 Energy Crops

In addition to wood and MSW fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive), and gasifying energy crops (including wood waste). None of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload capacity of 2000 MWe.

The National Research Council has evaluated other biomass-derived fuels for the purposes of alternative energy source analysis. These include burning crops, converting crops to a liquid fuel such as ethanol, and gasifying crops (including wood waste). The National Research Council 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. The other biomass-derived fuels do not represent an acceptable alternative to the proposed project.

Estimates suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as that for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts, including impacts on the aquatic environment and air. In addition, these systems have significant impacts on land use because of the acreage needed to grow the energy crops.

Ethanol is perhaps the best known energy crop. It is estimated that 769 ha (1900 ac.) of corn is needed to produce 3,785,412 liters (L) (1 million gallons) of ethanol, and in 2001, North Carolina produced approximately 287,327 ha (710,000 ac.) of corn. Currently in North Carolina, more corn is used for livestock feed than for any other purpose. If ethanol were to be proposed as an energy crop, North Carolina would have to supplement its corn production from nearby states (Reference 9.2-006). Surrounding states also use corn for grain products and do not have the resources to supplement ethanol-based fuel facilities. Therefore, use of energy crops as an alternative source of energy is a less attractive option than the construction of new nuclear units at HAR.

9.2.2.8 Petroleum Liquids (Oil)

From 2002 to 2005, petroleum costs almost doubled, increasing by 92.8 percent. The period from 2004 to 2005 alone produced an average petroleum increase of more than 50 percent (Reference 9.2-030). As a result, from 2005 to 2006, production of electricity by petroleum-fired plants dropped by about 15 percent in North Carolina (Reference 9.2-031). In the GEIS for License Renewal, the staff estimated that construction of a 1000-MWe oil-fired plant would require about 49 ha (120 ac.). Operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant. Based on this, oil-fired power generation is not considered a reasonable alternative to a new nuclear unit at the HNP site.

Oil-fired plants have one of the largest carbon footprints of all the electricity-generating systems analyzed. Conventional oil-fired plants result in emissions of greater than 650 grams of carbon dioxide (CO_2) equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 130 times higher than the carbon footprint of a nuclear power generation facility (about 5 gCO_2eq/kWh). Future developments, such as carbon capture and storage (CCS) and co-firing with biomass, have the potential to reduce the carbon footprint of oil-fired electricity generation (Reference 9.2-032).

The economics, apart from fuel price, of oil-fired power generation are similar to those of natural gas-fired power generation. Distillate oil can be used to run gas turbines in a combined-cycle system; however, the cost of distillate oil usually makes this combined-cycle system much less competitive where gas is available. Oil-fired power generation has experienced a significant decline since the early 1970s. Increases in world oil prices have forced utilities to use less expensive fuels; however, certain regions of the United States still depend on oil-fired power generation (Reference 9.2-032). An oil-fired power generation plant as an alternative energy source is not a reasonable or viable alternative.

9.2.2.9 Fuel Cells

Phosphoric acid fuel cells are the most mature fuel cell technology, but they are only in the initial stages of commercialization. During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications but progress has been slow. Today, the most widely marketed fuel cells cost about $4500 per kWh of installed capacity. By contrast, a diesel generator costs $800 to $1500 per kWh of installed capacity, and a natural gas turbine can cost even less. DOE has launched an initiative, the Solid State Energy Conversion Alliance, to significantly reduce fuel cell cost. DOE’s goal is to cut costs to as low as $400 per kWh of installed capacity by the end of this decade, which would make fuel cells competitive for virtually every type of power application (Reference 9.2-033).

As market acceptance and manufacturing capacity increase, natural-gas-fueled fuel-cell plants in the 50- to 100-MWe range are projected to become available.

This will not meet the proposed 2000-MWe baseload capacity. Currently, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation and, therefore, are a less attractive option than the construction of new nuclear units at the HAR.

9.2.2.10 Coal

Coal-fired steam electric plants provide most of the electricity-generating capacity in the United States, accounting for about 52 percent of the electric utility industry's total generation, including co-generation, in 2000 (Reference 9.2-034). Conventional coal-fired plants generally include two or more generating units and have total capacities of 100 MWe to more than 2000 MWe. Coal is likely to continue to be a reliable energy source in the future assuming environmental constraints do not cause the gradual substitution of other fuels (Reference 9.2-035). Concerns over CO_2 emissions and other greenhouse gases and costs have resulted in recent courts, regulatory commissions, state officials, and local and national environmental groups blocking or challenging coal-fired power plants proposed for Kansas, Florida, Illinois, Montana, Colorado, Utah, Nevada, South Dakota, and Texas.

The United States has abundant low-cost coal reserves, and the price of coal for electricity generation is likely to increase at a relatively slow rate. Even with recent environmental legislation, new coal capacity is expected to be an affordable technology for reliable, near-term development and for potential use as a replacement technology for nuclear power plants.

The environmental impacts of constructing a typical coal-fired steam plant are well known because coal is the most prevalent type of power generating technology in the United States. The impacts of constructing a 1000-MWe coal plant on a location that has not previously been developed for any use (i.e., a greenfield site) can be substantial, particularly if it is sited in a rural area with considerable natural habitat. An estimated 688 ha (1729 ac.) would be needed, and this could amount to the loss of about 7.77 km^2 (3 $mi.^2$) or 1920 acres of natural habitat and/or agricultural land for the coal-fired plant site alone, excluding land required for mining and other fuel cycle impacts.

Currently, PEC has eight utility-owned, coal-fired power plants in the ROI. Combustion of coal, particularly in older power plants, is increasingly becoming an issue from an emission standpoint. Recently, the North Carolina legislature passed the Smokestacks Bill which reduced emissions of sulphur dioxide and nitrogen oxides from coal-fired plants by 50 percent by 2009 and 75 percent by 2013 (Reference 9.2-006).

A coal-fueled power plant usually averages about $0.023/kWh. However, co-firing with inexpensive biomass fuel can decrease the cost to $0.021/kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices (Reference 9.2-026). Coal is a reasonable alternative energy source and is further discussed in Subsection 9.2.3.

9.2.2.11 Natural Gas

The electric utility sector in North Carolina historically used very little natural gas; however, this has begun to change. According to U.S. Energy Information Administration's North Carolina Profile, gas-fired utility generation increased by an annual growth rate of 22.5 percent (1 percent in 1990 to 7.3 percent in 1999). There are currently 14 natural gas-fired plants being considered for North Carolina. Together, they would be able to generate over 9000 MWe of energy (Reference 9.2-006).

Most environmental impacts of constructing natural gas-fired power generation plants will be similar to those of other large power generating stations. Land use requirements for gas-fired plants are 45 ha (110 ac.) for a 1000 MWe plant; thus land-dependent ecological, aesthetic, erosion, and cultural impacts should be minimal. Siting at a greenfield location would require new transmission lines and increased land-related impacts; whereas, co-locating the gas-fired plant with an existing nuclear plant would help reduce land-related impacts. Also, gas-fired plants, particularly combined cycle and gas turbine, take significantly less time to construct than other plants.

Based on well-known technology, fuel availability, and known environmental impacts associated with constructing and operating a natural gas-fired power generation plant, this source of energy is considered a competitive alternative and is further discussed in Subsection 9.2.3.

9.2.2.12 Integrated Gasification Combined Cycle

Integrated Gasification Combined Cycle (IGCC) is an emerging, advanced technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is substantially cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream before combustion.

The IGCC alternative generates substantially less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, which is a black, glassy, sand-like material that could be a marketable byproduct. Slag production is a function of ash content. The other large-volume byproduct produced by IGCC plants is sulphur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes.

IGCC technology still has insufficient operating experience for widespread expansion into commercial-scale utility applications. Each major component of IGCC has been broadly used in industrial and power generation applications. However, the integration of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new and has been demonstrated at only a handful of facilities around the world, including five in the United States.

System reliability is still relatively lower than conventional pulverized coal-fired power plants. There are also problems with integrating gasification and power production. For example, a problem with gas cleaning resulting in uncleaned gas can cause damage to the gas turbine (Reference 9.2-036).

To advance the technology, Southern Company and the Orlando Utilities Commission (OUC) are building a $557 million advanced IGCC facility in Central Florida as part of the U.S. Department of Energy (DOE) Clean Coal Power Initiative. The 285-MWe plant will be built at OUC's Stanton Energy Center near Orlando and will gasify coal using state-of-the-art emissions controls. DOE will contribute $235 million and OUC and Southern Company will contribute $322 million (Reference 9.2-037).

IGCC plants are about 15 to 20 percent more expensive than comparably sized pulverized coal plants partly because of the need for coal gasifier and other specialized equipment. Recent estimates indicate that overnight capital costs for coal-fired IGCC power plants range from $1400 to $1800 per kilowatt (Reference 9.2-038). The production cost of electricity from a coal-based IGCC power plant is about $0.033 to $0.045 per kWh.

Because IGCC technology is currently not cost effective, requires further research to achieve an acceptable level of reliability, and is not a proven technology for baseload generation, an IGCC facility is a less attractive option than the construction of new nuclear units at the HAR.

9.2.3 ASSESSMENT OF REASONABLE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

PEC has identified the significance of the impacts associated with each issue as SMALL, MODERATE, or LARGE. This characterization is consistent with the criteria that NRC established in 10 Code of Federal Regulations (CFR) 51, Appendix B, Table B-1, Footnote 3 as follows:

- SMALL — Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE — Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.
- LARGE — Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

Table 9.2-2 presents the impacts associated with various impact categories.

9.2.3.1 Coal-Fired Power Generation

NRC evaluated environmental impacts from coal-fired power generation alternatives in the GEIS and concluded that construction impacts could be substantial partly because of the large land area required for the plant site alone (688 ha [1700 ac.] for a 1000-MWe plant) and the large workforce needed to construct and operate a coal-fired power generation plant. According to NRC, siting a new coal-fired power generation plant where an existing nuclear plant is located would reduce many construction impacts. NRC identified major adverse impacts from operations as human health concerns associated with air emissions, waste generation, and losses of aquatic biota resulting from cooling water withdrawals and discharges.

Operating impacts of new coal plants would be substantial for several reasons. Concerns over adverse human health effects from coal combustion have led to important federal legislation in recent years, such as the Clean Air Act Amendments (CAAA). While emissions from coal-fired power plants are continually improving (i.e., decreasing), these type of facilities emit particulates and chemicals of concern which remain a concern for human health. Air quality would be affected by the release of regulated pollutants, and radionuclides. Public health risks such as cancer and emphysema are considered likely results. Sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) have been identified with acid rain. Substantial solid waste, particularly fly ash and scrubber sludge, would be produced and require constant management. Losses to aquatic biota would occur through impingement and entrainment, and discharge of cooling water to natural water bodies. Socioeconomic benefits can be considerable for surrounding communities in the form of several hundred jobs, substantial tax revenues, and plant spending.

9.2.3.1.1 Air Quality

The air quality impacts of coal-fired power generation are considerably different from those of nuclear power. A coal-fired power plant emits sulphur dioxide (SO_2, as oxides of sulphur [SO_x] surrogate), NO_x, particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Air quality impacts from fugitive dust, water quality impacts from acidic runoff, and aesthetic and cultural resources impacts are all potential adverse consequences of coal mining.

Air emissions were estimated for a coal-fired power generation facility based on the emission factors contained in U.S. Environmental Protection Agency (USEPA) document, AP-42, Fifth Edition, as posted in the Technology Transfer Network, Clearinghouse for Inventories and Emission Factors (Reference 9.2-039). The emissions from this facility are based on a nominal power generation capacity of 2000 MW with a maximum generation capacity of approximately 2200 MW.

The coal-fired power generation facility assumes the use of bituminous coal fired in a pulverized coal, dry bottom, wall-fired combustor. The sulphur content of the coal was assumed to be 2 percent by weight. Emissions control included the use of lime in the combustor unit, a wet scrubber system to control acid gas emissions, selective catalytic reduction to minimize NO_x emissions and a baghouse to control PM. Table 9.2-3 summarizes the air emissions produced by a 2200-MW coal-fired power generation facility.

Coal burning power systems have the largest carbon footprint of all the electricity generation systems analyzed. Conventional coal systems result in emissions of greater than 1000 gCO_2eq/kWh. This is approximately 200 times higher than the carbon footprint of a nuclear power generation facility (about 5 gCO_2eq/kWh). Lower emissions can be achieved using new gasification plants (less than 800 gCO_2eq/kWh), but this is still an emerging technology and is not as widespread as proven combustion technologies. Future developments, such as CCS and co-firing with biomass, have the potential to reduce the carbon footprint of coal-fired power generation (Reference 9.2-032).

According to the NRC, air emission impacts from fossil fuel power generation are greater than nuclear plant air emission impacts; human health effects from coal combustion are also greater, and acid rain is one potential impact. Therefore, air impacts from coal combustion power generation would be considered MODERATE to LARGE.

9.2.3.1.2 Waste Management

Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management.

With proper placement of the HAR facility, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources.

An estimated 8900 ha (22,000 ac.) for mining the coal and disposing of the waste could be committed to supporting a coal plant during its operational life (Table 9.2-2).

Based on these factors, waste management impacts would be MODERATE.

9.2.3.1.3 Economic Comparison

DOE has estimated the cost of generating electricity from a coal facility to be approximately \$0.043 to \$0.049 per kWh. The projected cost associated with operating a new nuclear facility similar to the HNP facility is in the range of \$0.031 to \$0.046 per kWh (Reference 9.2-040).

9.2.3.1.4 Other Impacts

Construction of a coal facility could affect as much as 700 ha (17,000 ac.) of land for a 1000 MWe and associated terrestrial habitat, and additional land would be needed for waste disposal. As a result, land use impacts would be MODERATE.

Impacts on aquatic resources and water quality would be minimized and could be construed as SMALL.

New power plant structures and tall stacks, potentially visible for 64 km (40 mi.) in a relatively non-industrialized area, would need to be constructed along with a possible cooling tower and associated plumes. As a result, aesthetic impacts would be LARGE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed HNP site.

Socioeconomic impacts would result from the approximately 250 people needed to operate the coal-fired facility, and would include several hundred mining jobs and additional tax revenues associated with the coal mining. As a result, socioeconomic impacts would be MODERATE (beneficial). Adverse impacts for socioeconomics would be SMALL.

As a result of increased safety technologies, accident impacts would be SMALL.

As a result of increased air emissions and public health risks, human health impacts would be MODERATE.

9.2.3.1.5 Summary

A coal-fired plant is not environmentally preferable when compared to a nuclear plant. Also, if a coal-fired plant was constructed on the HNP site it would need to generate power in excess of 2000 MWe. The nuclear plant requires a dry land footprint of 78 ha (192 ac.) and an additional 1497 ha (3700 ac.) of inundated footprint; whereas, the coal-fired plant would require dry land and a footprint of 688 ha (1700 ac.) and a similar amount of inundated footprint as a nuclear plant. Therefore, a 2000-MWe coal-fired power generation plant would not be an environmentally preferable alternative with the land area currently available.

9.2.3.2 Natural Gas Power Generation

Most environmental impacts of constructing natural gas-fired plants should be approximately the same for steam, gas-turbine and combined-cycle plants. These impacts might be similar to those of other large power generating stations. The environmental impacts of operating natural gas-fired plants are generally less than those of other fossil fuel technologies of equal power generation capacity. The consumptive water use is comparatively lower for a steam plant than for a combined cycle plant. Water consumption is likely to be less for gas-turbine plants.

9.2.3.2.1 Air Quality

Natural gas is a relatively clean-burning fossil fuel. Also, because the heat recovery steam generator does not receive supplemental fuel, the combined-cycle operation is highly efficient (56 percent versus 33 percent for the coal-fired alternative). Therefore, the gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative. Control technology for gas-fired turbines focuses on the reduction of NO_x emissions.

Generally, air quality impacts for all natural gas technologies are less than for other fossil fuel technologies because fewer pollutants are emitted and SO_2, a contributor to acid precipitation, is not emitted at all.

Air emissions were estimated for a natural gas-fired power generation facility based on the emission factors contained in USEPA document, AP-42, Fifth Edition as posted in the Technology Transfer Network, Clearinghouse for Inventories and Emission Factors (Reference 9.2-039). The emissions from this facility are based on a nominal power generation capacity of 2000 MW with maximum generation capacity of approximately 2200 MW.

Current gas-powered electricity generation has a carbon footprint that is about half that of coal (about 500 gCO_2eq/kWh), because gas has a lower carbon content than coal. This is approximately 100 times higher than the carbon footprint of a nuclear power generation facility (about 5 gCO_2eq/kWh). Like coal-fired plants, gas plants could co-fire biomass to reduce carbon emissions in the future (Reference 9.2-032).

The natural gas-fired power generation facility assumes the use of a combined cycle gas turbine generator (GTG). Water injection is used to control nitrogen oxides emissions. Table 9.2-3 summarizes the air emissions produced by a 2200-MW natural gas-fired power generation facility. Based on emissions generated from a natural gas-fired power generation facility, air quality impacts would be MODERATE.

9.2.3.2.2 Waste Management

Gas-fired power generation would result in almost no waste generation, producing minor (if any) impacts; therefore, impacts associated with waste management would be SMALL.

9.2.3.2.3 Other Impacts

Construction of the power block would disturb approximately 24 ha (60 ac.) of land and associated terrestrial habitat, and 4 ha (10 ac.) of land would be needed for pipeline construction. Inundated land requirements of 45 ha (110 ac.) would be similar to those of a proposed nuclear plant. As a result, land use impacts would be SMALL to MODERATE.

The consumptive water use is comparatively lower for a steam plant than for a combined cycle plant. There are potential impacts on aquatic biota through impingement and entrainment, and increased water temperatures in receiving water bodies. Water consumption is likely to be less for gas-turbine plants. Water quality impacts would be SMALL.

Structures to support gas-fired power generation would not be significantly different from that proposed for the HAR site. As a result, aesthetic impacts would be SMALL.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed HNP site.

Socioeconomic impacts would result from the approximately 150 people needed to operate the gas-fired power generation facility, as estimated in the GEIS. As a result, socioeconomic impacts would be SMALL.

As a result of increased safety technologies, accidents and human health impacts would be SMALL.

9.2.3.2.4 Summary

The gas-fired alternative defined by PEC in Subsection 9.2.2.11 would be located at the HNP site. The natural gas generation alternative at the HNP site would require less land area than the coal-fired plant but more land area than the nuclear plant. The gas-fired alternative alone would require 45 ha (110 ac.) for a 1000-MWe generating capacity. An additional 1457 ha (3600 ac.) of land would be required for wells, collection stations, and pipelines to bring the natural gas to the generating facility. Therefore, constructing a natural gas generation plant would not be an environmentally preferable alternative for the HNP site.

9.2.3.3 Combination of Alternatives

The HAR facility will have a baseline capacity of approximately 2000 MWe. Any alternative or combination of alternatives would be required to generate the same baseline capacity.

Because of the intermittent nature of the resource and the large land requirements, wind and solar energies are not sufficient on their own to generate the equivalent baseload capacity or output of the HAR facility, as discussed in Subsections 9.2.2.1 and 9.2.2.4. The large land requirements and other limitations, such as the proven reliability of large-scale operations, result in a combined wind-solar powered facility as a less attractive option than new nuclear units at the HAR site. As discussed in Subsections 9.2.3.1 and 9.2.3.2, fossil-fired power generation could meet baseload capacity but its environmental impacts are greater than those of a nuclear facility.

Alternatives may be combined, but such combinations should be sufficiently complete, competitive and environmentally preferable for NRC to appropriately compare them with the proposed nuclear plant.

9.2.3.3.1 Determination of Viability of Hybrid Alternatives

Many possible combinations of alternatives could theoretically satisfy the baseload capacity requirements of the HAR. Some combinations can include renewable sources, such as wind and solar. Wind and solar do not, by themselves, provide a reasonable alternative energy source to match the baseload power to be produced by the HAR. However, wind and solar, combined with fossil fuel-fired power plant(s), could generate baseload power to be considered a reasonable alternative to nuclear energy produced by the HAR. However, as noted in Subsection 9.2.3.3 and discussed in detail in the sections below, environmental impacts, such as land requirements and aesthetics and lack of guaranteed reliability of wind and solar, make this not a viable combination of alternatives.

The ability to generate baseload power in a consistent, predictable manner meets the business objective of the HAR. Therefore, when assessing combinations of alternatives to the HAR, their ability to generate baseload power must be the determining feature when analyzing their effectiveness. This subsection reviews the ability of the combination alternative to have the capacity to generate baseload power equivalent to the HAR.

When examining a combination of alternatives that would meet the business objectives similar to that of the HAR, any combination that includes a renewable power source (either all or part of the capacity of the HAR) must be combined with a fossil-fuel power generation facility equivalent to the generating capacity of the HAR. This combination would allow the fossil-fueled portion of the combination alternative to produce the needed power if the renewable resource is unavailable and to be displaced when the renewable resource is available. For example, if the renewable portion is some amount of potential wind generation and that resource became available, then the output of the fossil-fuel power generation portion of the combination alternative could be lowered to offset the increased power generation from the renewable portion. This facility, or facilities, would satisfy business objectives similar to those of the HAR in that it would be capable of supporting fossil-fuel baseload power.

CO_2 is the principal greenhouse gas from power-generating facilities that combust solid or liquid fuels. If the source of the carbon is biomass or derived from biomass (ethanol), then the impact is carbon neutral. If the source of the carbon is fossil fuel, then there is a net increase in atmospheric CO_2 concentrations and global climate change unless the carbon emissions are offset or sequestered.

Coal- and gas-fired power generation has been examined as having environmental impacts that are equivalent to or greater than the impacts of HAR. Based on the comparative impacts of these two technologies, as shown in Table 9.2-2, it can be concluded that a gas-fired power generation facility would have less of an environmental impact than a comparably sized coal-fired power generation facility. In addition, the operating characteristics of gas-fired power generation are more amenable to the type of load changes that could result from including renewable generation such that the baseload generation output of 2000 MWe is maintained. “Clean coal” power plant technology could decrease the air pollution impacts associated with burning coal for power. Demonstration projects show that clean coal programs reduce NO_x, SO_x, and particulate emissions. However, clean coal technology is not a proven technology for baseload generation and environmental impacts are still greater than the impacts from natural gas (Reference 9.2-041). Therefore, for the purpose of examining the impacts from a combination of alternatives to the HAR, a facility equivalent to that will be used in the environmental analysis of combination alternatives. The analysis accounts for the reduction in environmental impacts from a gas-fired facility when power generation from the facility is displaced by the renewable resource. Use of renewable in conjunction with fossil only marginally reduces fossil-fuel use and environmental impacts by the renewable’s capacity factor. Additionally, the renewable portion of the combination alternative would be any combination of renewable technologies that could produce power equal to or less than the HAR at a point when the resource was available. This combination of renewable energy and natural gas-fired power generation represents a viable mix of non-nuclear alternative energy sources.

Many types of alternatives can be used to supplement wind energy, such as solar power. PV cells are another source of solar power that would complement wind power by using the sun to produce energy while wind turbines use windy and stormy conditions to generate power. Wind and solar facilities combined with fossil fuel facilities (coal, petroleum) could also be used to generate baseload power, but depend on capacity factors and would result in construction impacts associated with building two facilities. Therefore, wind and solar facilities combined with fossil fuel facilities would have equivalent or greater environmental impacts compared with those of a new nuclear facility at the HNP site. Similarly, wind and solar facilities combined with fossil fuel facilities would cost more than a new nuclear facility at the HNP site. Therefore, wind and solar facilities combined with fossil fuel facilities are a less attractive option than the construction of new nuclear units at HAR.

9.2.3.3.2 Environmental Impacts

The environmental impacts associated with a gas-fired power generation facility sized to produce power equivalent to the HAR have already been analyzed. Depending on the level of potential renewable output included in the combination alternative, the level of impact of the gas-fired portion will be comparably lower. If the renewable portion of the combination alternative were not enough to displace the power produced by the fossil-fuel power generation facility, then there would be some level of impact associated with the fossil-fuel power generation facility. Consequently, if the renewable portion of the combination alternative were sufficient to displace the output of the gas-fired power generation facility, then, when the renewable resource is available, the output of the fossil-fuel power generation facility could be eliminated; thereby, eliminating its operational impacts. Types of environmental impacts from these hybrid plants or combination of facilities can be determined by studying impacts from similar projects.

For instance, in 1984, Luz International, Ltd. built the Solar Electric Generating System (SEGS) plant in the California Mojave Desert. The SEGS technology consists of modular parabolic-trough solar collector systems, which use oil as a heat transfer medium. The Luz technology uses a natural-gas-fired boiler as an oil heater to supplement the thermal energy from the solar field or to operate the plant independently during evening hours. SEGS I was installed at a total cost of $62 million (about $4500/kW) and generates power at $0.24/kWh (in 1988 real levelized dollars). The improvements incorporated into the SEGS III-VI plants (about $3400/kW) reduced generation costs to about $0.12/kWh, and the third-generation technology, embodied in the 80-MWe design at an installed cost of $2875/kW, further reduced power costs to $0.08 to $0.10/kWh. Because solar energy is not a concentrated source, the dedicated land requirement for the Luz plants is large compared with conventional plants, on the order of 5 ac/MWe (2 ha/MWe), compared with 0.23 ac/MWe for a nuclear plant (Reference 9.2-042).

Parabolic-trough solar power plants require a significant amount of land; typically the use is pre-emptive because parabolic troughs require the land to be graded level. According to a California Energy Commission (CEC) report, 5 to 10 ac/MWe is necessary for concentrating solar power technologies such as trough systems (Reference 9.2-023).

The environmental impacts associated with a solar and a wind facility equivalent to the HAR has already been analyzed. It is reasonable to expect that the impacts associated with an individual unit of a smaller size would be similarly scaled. It is anticipated that the renewable portion of the combination alternative would not generate power equivalent to that of the HAR due to capacity factors and the combination alternative would have to rely on the gas-fired portion to meet the equivalent capacity of the HAR. Consequently, if the renewable portion of the combination alternative has a potential output that is equal to that of the HAR, then the impacts associated with the gas-fired portion of the combination alternative would be somewhat lower in terms of operation but the impacts associated with the renewable portion would be greater. The gas-fired power generation facility alone has impacts that are greater than those of the HAR; some environmental impacts of renewables are also greater than or equal to those of the HAR. The combination of a gas-fired power plant and wind or solar power facilities would have environmental impacts that are equal to or greater than those of a nuclear facility:

- Environmental impacts of a new nuclear plant at the HNP and environmental impacts from a gas-fired power plant are SMALL, except for air quality impacts from a gas-fired power generation facility, which are MODERATE. Impacts from wind and/or solar power generation facilities combined with a gas-fired power generation facility would be SMALL and, therefore, would be equivalent to the air quality impacts from a nuclear facility.

- Environmental impacts of a new nuclear plant at the HNP and environmental impacts from wind and solar power generation facilities are SMALL, except for land use and aesthetic impacts from wind and solar power generation facilities, which range from MODERATE to LARGE. Use of a gas-fired power generation facility combined with wind and solar facilities would reduce the land use and aesthetic impacts from the wind and solar power generation facilities. However, at best, those impacts would be SMALL and, therefore, would be equivalent to the land use and aesthetic impacts from a nuclear facility.

Based on these findings, the combination of wind, solar, and gas-fired power generation facilities is not environmentally preferable to the HAR.

9.2.3.3.3 Summary

Wind and solar power generation facilities combined with fossil fuel power plants could be used to generate baseload power and would serve the purpose of the HAR facility. However, wind and solar power generation facilities combined with fossil fuel facilities would have equivalent or greater environmental impacts compared with those of a new nuclear facility at the HNP site. Similarly, wind and solar power generation facilities combined with fossil fuel facilities would cost more and require more land than a new nuclear facility at the HNP site. Therefore, wind and solar power generation facilities combined with fossil fuel facilities are not environmentally preferable to a new facility at HNP site.

9.2.4 CONCLUSION

Based on environmental impacts, PEC has determined that neither a coal-fired, nor a gas-fired power generation facility, nor a combination of alternatives, including wind and solar power generation facilities, would provide an appreciable reduction in overall environmental impacts relative to a nuclear plant. Furthermore, each of these types of alternatives, with the possible exception of the combination alternative, would entail a significantly greater environmental impact on air quality than would a nuclear plant. To achieve the SMALL air quality impact in the combination alternative, a MODERATE to LARGE impact on land use would be needed. Therefore, PEC concludes that neither a coal-fired, nor a gas-fired power generation facility, nor a combination of alternatives would be environmentally preferable to a nuclear plant.

9.2.5 REFERENCES

9.2-001 U.S. Department of Energy, Energy Information Administration, “Impact of Energy Policy Act of 2005 Section 206 Rebates on Consumers and Renewable Energy Consumption, with Projections to 2010,” Website, www.eia.doe.gov/cneaf/solar.renewables/page/epact/background.html, accessed February 12, 2007.

9.2-002 U.S. Department of Energy, Energy Information Administration, “Demand-Side Management Actual Peak Load Reductions by Program Category,” Website, www.eia.doe.gov/cneaf/electricity/epa/epat9p1.html, accessed February 12, 2007.

9.2-003 U.S. Department of Energy, Energy Information Administration, “Demand-Side Management Program Direct and Indirect Costs,” Website, www.eia.doe.gov/cneaf/electricity/epa/epat9p7.html, accessed February 12, 2007.

9.2-004 Progress Energy Carolinas, Inc. “Progress Energy Carolinas Demand-Side Management (DSM) Plan,” December 2007.

9.2-005 North Carolina Utilities Commission: Raleigh, “Biennial Determination of Avoided Cost Rates for Electric Utility Purchases From Quality Facilities,” Docket No. E-100, Sub 81, Order Establishing Biennial Proceeding, Requiring Data and Scheduling Public Hearings, March 22, 1998, Website, www.pubstaff.commerce.state.nc.us/pselec/eacost1.htm, accessed January 30, 2007.

9.2-006 State Energy Office, “North Carolina State Energy Plan 2003,” Prepared for the North Carolina Energy Policy Council, Raleigh, North Carolina, June 2003, revised November 2004.

9.2-007 National Renewable Energy Laboratory, “North Carolina Wind Resource Maps,” Website, www.eere.energy.gov/windandhydro/windpoweringamerica/images/windmaps/nc_50m_800.jpg, accessed January 26, 2007.

9.2-008 California Energy Commission, “Renewable Resources Development Report,” Contract No. 500-03-080F, Sacramento, California, November 2003.

9.2-009 Environmental Law and Policy Center, “Repowering the Midwest: The Clean Energy Development Plan for the Heartland,” Chicago, Illinois, 2001.

9.2-010 U.S. Department of Energy, Energy Information Administration, “Annual Energy Outlook, 2004: With Projections to 2025.” DOE/EIA-0383 (2004), Washington, D.C., January 2004.

9.2-011 U.S. Department of Energy, Energy Information Administration, “Table FE2–Typical Costs and Capacity of New Transmission Lines (1995 Dollars),” Website, www.eia.doe.gov/cneaf/pubs_html/feat_trans_capacity/table2.html, accessed February 9, 2007.

9.2-012 U.S. Department of Energy, Energy Information Administration, “Renewable Energy Annual 1995,” DOE/EIA-0603(95), Washington, D.C., December 1995.

9.2-013 The Center for Biological Diversity, “Altamont Pass Wind Resource Area,” Website, www.biologicaldiversity.org/swcbd/Programs/bdes/altamont/altamont.html, accessed February 8, 2007.

9.2-014 National Renewable Energy Laboratory, “Energy Storage Basics.” Website, www.nrel.gov/learning/eds_energy_storage.html, accessed June 12, 2007.

9.2-015 Geothermal Education Office, “Hottest Known Geothermal Regions.” Website, geothermal.marin.org/GEOpresentation/sld015.htm, accessed January 26, 2007.

9.2-016 U.S. Department of Energy, Energy Efficiency and Renewable Energy, “Alternative Energy Resources in North Carolina,” Website, www.eere.energy.gov/states/alternatives/resources_nc.cfm, accessed February 1, 2007.

9.2-017 National Renewable Energy Laboratory, “The Potential for Low-Cost Electricity from Concentrating Solar Power Systems,” NREL/CP-550-26649, May 1999.

9.2-018 U.S. Department of Energy, Energy Efficiency and Renewable Energy, “Concentrating Solar Power.” Washington DC, Website, www1.eere.energy.gov/solar/csp.html, accessed May 31, 2007.

9.2-019 Siemens Solar, “Facts About Solar Energy: Facts About Photovoltaic Panels/Solar Cells,” Website, www.siemenssolar.com/facts.html, accessed February 6, 2007.

9.2-020 Gery, Michael, “Solar Energy in North Carolina,” *Carolina Country*, May 2006.

9.2-021 U.S. Department of Energy, Energy Information Administration, “Renewable Energy Annual 2002: With Preliminary Data For 2002,” USDOE/EIA-0603(2002), Washington, D.C., November 2003.

9.2-022 Fitzgerald, Mark, “Frequently Asked Questions: Solar Electric,” 2004. Website, www.solareco.com/articles/article.cfm?id=121, accessed February 8, 2007.

9.2-023 California Energy Commission, “Potential Health and Environmental Impacts Associated with the Manufacture and Use of Photovoltaic Cells,” P500-04-053, August 2004.

9.2-024 Real, Markus, H.P Bader, and R. Scheidegger, “Minimizing the Environmental Impact of Large-Scale Rural PV,” Renewable Energy World, Vol. 4, No. 1, 2001.

9.2-025 North Carolina Solar Center, “Biomass Energy Sources for North Carolina,” 2005. Website, www.ncsu-engineering-resources.com/store/trans/productDetailForm.asp?maxItems=4&imgid=99&Seq=4&CatID=7, accessed January 29, 2007.

9.2-026 U.S. Department of Energy, Energy Efficiency and Renewable Energy, “State Energy Alternatives: Biomass Energy,” Website, www.eere.energy.gov/states/alternatives/biomass.cfm, accessed February 1, 2007.

9.2-027 North Carolina Department of Environment and Natural Resources, “North Carolina Solid Waste Management Annual Report: July 1, 2004 – June 30, 2005,” Website, www.wastenotnc.org/swhome/SW04-05_AR.htm, accessed January 29, 2007.

9.2-028 U.S. Environmental Protection Agency, “Municipal Solid Waste: Basic Facts,” 2006, Website, www.epa.gov/msw/facts.htm, accessed January 29, 2007.

9.2-029 U.S. Environmental Protection Agency, 2006, “Electricity from Municipal Solid Waste,” Website, www.epa.gov/cleanenergy/muni.htm, accessed March 29, 2007.

9.2-030 U.S. Department of Energy, Energy Information Administration, “Electric Power Annual: Overview,” “Figure ES3, Fuel Costs for the Electric Power Industry, 1993-2005,” 2006, Website, www.eia.doe.gov/cneaf/electricity/epa/figes3.html, accessed January 29, 2007.

9.2-031 U.S. Department of Energy, Energy Information Administration, “Table 1.8.B - Net Generation from Petroleum Liquids by State by Sector, Year-to-Date through October 2006 and 2005,” Website, www.eia.doe.gov/cneaf/electricity/epm/table1_8_b.html, accessed January 29, 2007.

9.2-032 Parliamentary Office of Science and Technology, “Carbon Footprint of Electricity Generation,” No. 268, October 2006.

9.2-033 U.S. Department of Energy, Energy Information Administration, “Future Fuel Cells R&D,” Website, www.fossil.energy.gov/programs/powersystems/fuelcells/, accessed February 8, 2007.

9.2-034 U.S. Department of Energy, Energy Information Administration, “Annual Energy Outlook, 2002: With Projections to 2020,” DOE/EIA-0383(2002), Washington, D.C., December 2001.

9.2-035 U.S. Department of Energy, Energy Information Administration, “Renewable Resources in the U.S. Electricity Supply,” DOE/EIA-0561(92), Washington, D.C., February 1993.

9.2-036 Rardin, Ronald, Zuwei Yu, Forrest Holland, Anthony Black, Jesse Oberbeck, “Factors that Affect the Design and Implementation of Clean Coal Technologies in Indiana,” Website, www.purdue.edu/dp/energy/pdf/Purdue-InterimReport-Jun10-2005.pdf.

9.2-037 Orlando Utilities Commission, “Department of Energy Selects OUC, Southern Company to Build Clean Coal Technology Plant,” Website, www.ouc.com/news/arch/20041021-cleancoal_proj.htm, accessed May 31, 2007.

9.2-038 U.S. Department of Energy, Energy Information Administration, 2005 Annual Energy Outlook 2005: With Projections to 2025, USDOE/EIA-0383(2005), Washington, D.C., February 2005..

9.2-039 U.S. Environmental Protection Agency, AP-42, Fifth Edition, Volume I, as posted in the Technology Transfer Network, Clearinghouse for Inventories and Emission Factors. 1995. Available at Website, www.epa.gov/ttn/chief/ap42.

9.2-040 U.S. Department of Energy, “The Economic Future of Nuclear Power,” Office of Nuclear Energy, Washington, D.C., August 2004.

9.2-041 U.S. Department of Energy/National Energy Technology Laboratory, “Topical Report 18: Environmental Benefits of Clean Coal Technologies.” Washington, D.C., Website, www.fossil.energy.gov/programs/powersystems/publications/Clean_Coal_Topical_Reports/Enviromental_Benefits.pdf, April 2001.

9.2-042 National Renewable Energy Laboratory, 1993, “Profiles in Renewable Energy: Case Studies of Successful Utility-Sector Projects.” Washington D.C. Website, www.osti.gov/accomplishments/NRELprofiles.html, accessed June 11, 2007.

9.2-043 North Carolina General Assembly, “North Carolina General Statute 62−2. Declaration of policy,” Website, www.ncleg.net/gascripts/Statutes/StatutesTOC.pl?Chapter=0062, accessed March 21, 2007.

Table 9.2-1
Wholesale Purchase Power Commitments

Purchase	In-Service Date	Contract End Date	Summer Rating MWe	Winter Rating MWe
SEPA	various	perpetual	95	95
NUG–Cogeneration	various	various	179	179
NUG–Renewables	various	various	4	4
AEP/Rockport #2	01/01/90	12/31/09	250	250
Broad River CTs #1-5	2001-2002	2021-2022	816	841

Source: Reference 9.2-043

Table 9.2-2 (Sheet 1 of 2)
Impacts Comparison Table

Impact Category	Proposed Action (HAR)	Coal-Fired Power Generation	Gas-Fired Power Generation	Combinations of Alternatives
Air Quality	**SMALL**	**MODERATE to LARGE** SO_2 = 565 (623) NO_2 = 1000 (1102) CO = 6000 (6610)	**MODERATE** SO_2 = 24 (26) NO_2 = 900 (993) CO = 208 (229)	**SMALL to LARGE**
Waste Management	**SMALL**	**MODERATE** Substantial amount of scrubber sludge and fly ash produced	**SMALL**	**SMALL to MODERATE**
Land Use	**SMALL to MODERATE**	**MODERATE** Waste disposal 243 ha (600 ac.) Coal storage and power block area 121 ha (300 ac.)	**SMALL to MODERATE**	**SMALL to LARGE**
Water Quality	**SMALL**	**SMALL**	**SMALL**	**SMALL**
Aesthetics	**SMALL**	**LARGE** Plant structures and tall stacks potentially visible for 64 km (40 mi.) in a relatively non-industrialized area	**SMALL**	**SMALL to LARGE**
Cultural Resources	**SMALL**	**SMALL**	**SMALL**	**SMALL**
Ecological Resources	**SMALL**	**SMALL**	**SMALL**	**SMALL**
Threatened & Endangered Resources	**SMALL**	**SMALL**	**SMALL**	**SMALL**
Socioeconomics	**SMALL (Adverse) and MODERATE (Beneficial)**	**SMALL (Adverse) and MODERATE (Beneficial)** 250 people needed to operate facility, several hundred mining jobs, and additional tax revenues	**SMALL**	**SMALL (Adverse) and MODERATE (Beneficial)**

Table 9.2-2 (Sheet 2 of 2)
Impacts Comparison Table

Impact Category	Proposed Action (HAR)	Coal-Fired Power Generation	Gas-Fired Power Generation	Combinations of Alternatives
Accidents	**SMALL**	**SMALL**	**SMALL**	**SMALL**
Human Health	**SMALL**	**MODERATE** (See Air Quality)	**SMALL**	**SMALL to MODERATE**

Notes:
SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE - Environmental effects are sufficient to alter noticeably, but not destabilize, any important attribute of the resource.

LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Table 9.2-3
Air Emissions from Alternative Power Generation Facilities

Fuel	Bituminous Coal[(a)]	Natural Gas[(b)]
Combustion Facility	Pulverized coal, dry bottom, wall fired	Combined Cycle GTG
Nominal Generation Capacity	2000 MW	2000 MW
Air Pollutant Emissions (tons per year) (c)		
Sulphur Dioxide (SO_2)	5,431	197
Nitrogen Dioxide (NO_2)	16,011	7,516
Carbon Monoxide (CO)	1,668	1,735
Particulate Matter (PM)	167	382
PM. Less than 10 um (PM_{10})	39	272
Carbon Dioxide, equiv. (CO_2e)	20,180,000	6,423,000

Notes:
a) AP-42 Section 1.1, Tables 1.1-3, 1.1-4, 1.1-19, and 1.1-20.

b) AP-42 Section 3.1, Table 3.1-1 and 3.2-2a.

c) Emissions based on maximum generation capacity of 2200 MW.

9.3 ALTERNATIVE SITES

In accordance with NUREG-1555, Section 9.3, this section identifies and evaluates a set of alternatives to the HAR, which will be co-located with existing HNP. The objective of this evaluation is to verify that there are no “obviously superior” sites for the eventual construction and operation of the HAR facilities.

9.3.1 SITE COMPARISON AND SELECTION PROCESS

The site comparison and selection process focuses on identifying and evaluating locations that represent a range of reasonable alternative sites for the proposed project. The primary objective of the site selection process is to determine if any alternative site is “obviously superior” to the preferred site for eventual construction and operation of the proposed reactor units.

The components of the site-comparison process as defined in the Environmental Standard Review Plan (ESRP) include the ROI, candidate areas, potential sites, candidate sites, and preferred site. The components are defined as follows:

- The ROI is the largest area considered, and is the geographic area within which sites suitable for the size and type of nuclear power plant proposed by the applicant are evaluated. The basis for an ROI can be the state in which the proposed site is located, or the relevant service area for the proposed plant.

- Candidate areas are areas located within the ROI containing desirable sites. Areas of the ROI that are unacceptable in terms of safety considerations, prohibited areas, geographic or engineering restrictions, and environmental restrictors are omitted from the site selection process. These can initially be determined with reconnaissance level information.

- Potential sites are locations within candidate areas. Whether or not a potential site is evaluated further depends on criteria such as general safety issues, environmental criteria, transmission capability, and market analysis.

- Candidate sites are those sites that are within the ROI and that are considered in the comparative evaluation of sites to be among the best that can reasonably be considered for the siting of a nuclear power plant. These are sites that would be expected to be granted construction permits and operating licenses. Candidate sites are chosen from the list of potential sites using a defined site selection methodology. To be considered as candidate sites, a location must meet the following criteria as outlined in NUREG-1555, Environmental Standard Review Plan (ESRP), Section 9.3(III)(4c):

- Consumptive use of water should not cause significant adverse effects on other users.

- There should not be any further endangerment of federal, state, regional, local, and affected Native American tribal listed threatened, endangered, or candidate species.
- There should not be any potential significant impacts to spawning grounds or nursery areas of populations of important aquatic species on federal, state, regional, local, and affected Native American tribal lists.
- Discharges of effluents into waterways should be in accordance with federal, state, regional, local, and affected Native American tribal regulations and would not adversely affect efforts to meet water quality objectives.
- There would be no preemption of or adverse effects on land specially designated for environmental, recreational, or other special purposes.
- There would not be any potential significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.
- Population density and numbers conform to 10 CFR 100.
- There are no other significant issues that affect costs by more than 5 percent or that preclude the use of the site.
- The proposed (or preferred) site is the candidate site that is submitted to the NRC by the applicant as the proposed location for a nuclear power plant. The alternative sites are those candidate sites that are further evaluated to determine if there is an obviously superior site for the location of the new nuclear power plant.

The site comparison process, as defined in the ESRP, first evaluates the ROI (ER Chapter 8) and identifies candidate areas. Within the candidate areas, potential sites are chosen. From the potential sites, candidate sites are chosen and evaluated. Finally, a preferred site is selected from among the candidate sites. The preferred site is compared with the candidate sites to determine if any are environmentally preferable. The basic constraints and limitations of the site selection process are the currently implemented rules, regulations, and laws within the federal, state, and local agency levels. These provide a comprehensive basis and an objective rationale under which this selection process is performed.

The review of alternative sites consists of a two-part sequential test for whether a site is “obviously superior” to the ESRP preferred site. The first part of the test determines whether there are “environmentally preferred” sites among the candidate sites. The standard is one of “reasonableness,” considering whether the applicant has performed the following:

- Identified reasonable alternative sites.
- Evaluated the likely environmental impacts of construction and operation at these sites.
- Used a logical means of comparing sites that lead to the applicant’s selection of the proposed site.

If one or more alternative sites are environmentally preferable, the estimated “costs” of the new plant at the proposed site and the alternative sites are compared (e.g., environmental, socioeconomic, cost, construction time, and others identified in NUREG-1555). To find an obviously superior alternative site, the applicant may determine the following:

- One or more important aspects, either individually or in combination, of a reasonably available alternative site are obviously superior to the corresponding aspects of the applicant’s proposed site.
- The alternative site does not have offsetting deficiencies in other important areas.

Siting new units at existing nuclear sites has provided another option in the way alternatives are reviewed and selected. Existing sites offer decades of environmental and operational information about the effect of a nuclear plant on the environment. The NRC recognizes (in NUREG-1555, ESRP, Section 9.3[III][8]) the following regarding proposed sites:

> Recognize that there will be special cases in which the proposed site was not selected on the basis of a systematic site-selection process. Examples include plants proposed to be constructed on the site of an existing nuclear power plant previously found acceptable on the basis of a National Environmental Policy Act (NEPA) review and/or demonstrated to be environmentally satisfactory on the basis of operating experience, and sites assigned or allocated to an applicant by a state government from a list of state-approved power plant sites. For such cases, the reviewer should analyze the applicant’s site-selection process only as it applies to candidate sites other than the proposed site, and the site comparison process may be restricted to a site-by-site comparison of these candidates with the proposed site. As a corollary, all nuclear power plant sites within the identified region of interest having an operating nuclear power plant or a construction permit issued by the NRC should be compared with the applicant’s proposed site.

In addition to meeting all applicable regulations and guidelines, the following factors, based on the applicant’s preference, influenced the decision to review sites:

- The selected site must be suitable for the design parameters for the new plant design.
- The location must be compatible with the applicant's current system and transmission capabilities.
- The selected site's expected licensing and regulatory potential must minimize the schedule and financial risk for establishing new baseload generation.

A greenfield site is a location that has not been previously developed for any use. For the purposes of this site analysis, PEC reviewed potential effects of developing a greenfield site. PEC assumed that the greenfield site would be located in an area that met the siting criteria of 10 CFR 100. As a result, the characteristics of the site could be largely rural. For the purposes of this analysis, PEC further assumed that the site would be near a supply of cooling water. PEC assumed that the site would consist of at least 200 to 400 hectares (ha) (500 to 1000 acres [ac.]) to accommodate construction and operation needs. PEC assumed that the general environmental considerations associated with construction and operation at a greenfield site would be similar to those discussed in NUREG-1555 and ER Chapters 4 and 5.

9.3.1.1 PEC's Site Selection Process

This subsection describes processes and criteria used to identify and evaluate alternative sites and select a proposed site as the geographic location for the PEC COLA. The information in this subsection is consistent with the special case noted in NUREG-1555, ESRP, Section 9.3(III)(8). The overall objective of the site selection process was to verify that no site is "environmentally preferable," (and thus no site is "obviously superior") for the siting of a new nuclear plant and to identify a nuclear power plant site that 1) meets PEC's business objectives for the COL project, 2) satisfies applicable NRC site suitability requirements, and 3) is compliant with NEPA requirements regarding the consideration of alternative sites.

The PEC Nuclear Power Plant Siting Study Report (Reference 9.3-001) was used to determine whether or not any ESRP alternative sites are environmentally preferable to the ESRP proposed site. As discussed in the PEC siting study, site selection evaluation was conducted in accordance with the overall process outlined in the industry standard EPRI *Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application* (*Siting Guide*), March 2002.

The EPRI Siting Guide, as adopted for the PEC siting study, provides four steps in the site selection process whereby the ROI is initially subjected to exclusionary considerations. The EPRI Siting Guide does not identify candidate areas. The ESRP guidance recommends the evaluation of candidate areas. The ROI is conservative and includes all potential candidate areas. Therefore, a separate evaluation of candidate areas as recommended by the ESRP is not required. The identification of “potential sites” resulting from the site selection process within the ROI is further analyzed against avoidance considerations that are reduced to a small number of “candidate sites.” To identify EPRI alternative sites, EPRI candidate sites are evaluated based on 10 criteria that are consistent with the ESRP siting criteria. EPRI alternative sites are further evaluated with a more stringent process that includes 26 siting criteria, which are more stringent than the ESRP criteria in some cases. The terminology used to describe sites considered under the EPRI and ESRP criteria are similar but have slight differences. The discussion that follows defines which criteria (i.e., EPRI or ESRP) are applicable to the site terminology.

A suitability evaluation of specific criteria then determines the highest ranked EPRI “alternative sites” best suited for a nuclear plant. These sites are finally subjected to business strategy considerations to determine the EPRI “preferred site.” The four-step evaluation and selection process is summarized below:

Step 1 Exclusionary considerations for the potential sites in the ROI:

- Lack of Water.
- Population Restrictions.
- Federal or State Parks.
- Geologic Features.

Step 2 Avoidance considerations for the candidate sites:

- Water Use Moratoriums.
- Cultural or Historical Limitations.
- State or Local Governmental Restrictions.
- Presence of Wetlands.

Step 3 Application of Suitability Criteria to score and rank alternative sites:

- Health and Safety Criteria.
- Environmental Criteria.
- Socioeconomic Criteria.
- Engineering and Cost-Related Criteria.

Step 4 Verification and confirmation whereby site differentiation draws conclusion to the preferred site for PEC:

- Business Strategic Considerations.
- Transmission Modeling and Analysis.

Sites were evaluated based on the assumption that a twin-unit plant, AP1000 design will be built and operated. This assumption provided a realistic, consistent basis for evaluation of site conditions against site requirements for a nuclear power plant design.

During the evaluation process for locating an optimal site for building and operating an advanced reactor type for new nuclear baseload generation, certain key assumptions and/or criteria were used as "bounding conditions" to aid in the evaluation process. By invoking these key assumptions and/or criteria, the relative values for a particular attribute of the various siting locations were determined.

- The new nuclear baseload generation must reach commercial in-service status by mid-2015.
- The new nuclear plant siting location must be suitable to envelope the range of specific design parameters contemplated for deployment of a standard plant design as certified by the NRC.
- The location must be compatible with PEC's System Operation and Transmission Delivery capabilities.
- The recommended site's expected licensing path and regulatory outlook must reduce PEC's schedule and financial risk for establishing new nuclear baseload generation.
- The cost of the new nuclear generation as affected by the location must be reasonable and fair, and methods to ensure greater certainty of the cost/schedule during the licensing, design engineering, and construction phases of the project must be included.
- Evaluation criteria and methodology established as part of the EPRI Early Site Permit Demonstration Program will be employed in the nuclear plant site selection process. Specifically, the EPRI Siting Guide: *Site Selection and Evaluation Criteria for an Early Site Permit Application*, dated March 2002, will be utilized.
- The evaluation and selection process will include "greenfield" (e.g., locations with no current generation facilities), existing nuclear generation plant locations, and other sites previously characterized by PEC.
- Compliance with current NRC regulations and NRC guidance (as of November 2005), including 10 CFR Part 50–"Domestic Licensing of Production and Utilization Facilities," 10 CFR Part 52, "Early Site Permits, Standard Design Certifications, and Combined Licenses for Nuclear Power Plants," SECY-05-0139, "Semi-annual Update of the Status of New Reactors Licensing Activities and Future Planning for New Reactors," dated August 4, 2005.
- Compliance with NEPA of 1996 requirements.

The site selection process typically involves sequential application of exclusionary, avoidance, and suitability criteria evaluation (includes site reconnaissance, topographic data collection), and technical screening by application of scoring and associated weighting factors applied to the suitability criteria. The exclusionary, avoidance, and suitability criteria address a full range of considerations important in nuclear power facility siting, including health and safety, environmental, socioeconomic and land use, and engineering and cost aspects.

The evaluation and selection process involves a series of activities starting with identification of an ROI or a geographic area within which a site must be located. For the Carolinas, the ROI became the PEC service territory. This geographic area was derived from PEC fundamental business decisions on the economic viability of a nuclear facility, the market for the facility's output, and the general geographic area where the facility should be deployed to serve the market. ER Chapter 8 further discusses the need for power in this region.

The site selection process followed by PEC was consistent with the siting process outlined in ESRP Section 9.3 as discussed in ER Subsection 9.3.1. The first step of PEC's site selection process was to identify the Region of Interest (ROI). The next step in the site selection process was to identify suitable candidate areas by screening the ROI using exclusionary criteria. Candidate areas refer to one or more areas within the ROI that remain after unsuitable areas have been removed. ROI screening was done at a high level with the purpose of identifying areas within the ROI that would not be suitable for the siting of a nuclear power station.

The criteria used in the ROI screening process to identify candidate areas were consistent with those identified in NUREG-1555 ESRP Section 9.3. The exclusionary criteria used in screening the ROI to identify candidate areas include:

- Proximity to major population centers (that is, not located in an area with greater than or equal to 300 ppsm [or 300 persons per 2.6 km^2]).
- Proximity of adequate transmission lines (that is, within 30 mi. [48.3 km]) of 345-kV or 500-kV transmission lines). The 345-kV or 500-kV transmission lines are needed for the standard grid connection design. It should be noted that areas with proximity to 230-kV lines that could potentially be upgraded were also considered.
- Lack of a suitable cooling water source (that is, within 15 mi [24.1 km] of an adequate cooling water source).
- Dedicated land (that is, not located within national, state parks, historic sites, or tribal lands).

Publicly held information on geographic information system (GIS) database Web sites were used to obtain the screening information. The GIS information was layered to produce the suitable candidate areas for the potential placement of a nuclear power facility.

Next, the candidate areas were screened and evaluated in order to develop a list of potential geographic locations for the placement of the proposed nuclear station. Information used in the screening and evaluation of the candidate areas was obtained from PEC personnel, GoogleEarth™ images, publicly held information on GIS database Web sites, topographic maps showing roads, urban areas, wetlands, parks, and other dedicated lands.

Per NUREG-1555 ESRP Section 9.3, the screening process used to identify the potential sites considered discretionary criteria (that is, distance of a site from population centers, proximity of transmission lines, proximity to suitable source of cooling water) similar to those used in the process of identifying the candidate areas. However, identifying potential sites required a more detailed review of available information. The goal of the screening process was to use a logical process that produced a list of the best potential sites located within the candidate areas.

The screening process also included consideration of existing site conditions, including whether the site was improved or potentially contained wetlands or floodplains. Aerial screening was used to identify areas within which potential sites were identified. The screening of the potential sites was conducted as an iterative process by applying refined criteria until an appropriate number of potential sites were identified. In addition, the potential sites needed to satisfy PEC's overall business objectives; and offer the ability of constructing and operating future nuclear units to provide PEC customers with reliable, cost-effective electric service.

The screening and evaluation of the Candidate Areas resulted in the identification of the 11 potential sites identified on Table 9.3-1.

Sites outside the ROI were considered only in specific instances. The Savannah River Site (which is outside the PEC service territory and the ROI) was considered as a potential site because the site aggressively pursued a new nuclear plant with PGN, Duke, and SCANA. PEC eliminated the Savannah River Site from further consideration because it is not close to the PEC service territory and because of high transmission costs and an undesirable cooling water source.

The next step in the siting process was to screen the potential sites in order to identify the Candidate Sites. The overall process for screening the 11 potential sites was comprised of the following elements: 1) develop criterion ratings for each site; 2) develop weight factors reflecting the relative importance of each criterion; and 3) develop composite site suitability ratings.

- **Criterion Ratings** — Each site was assigned a rating of 1 to 5 (1 = least suitable, 5 = most suitable) for each of the following site evaluation criteria: cooling water supply, flooding, population, hazardous land uses, ecology, wetlands, railroad access, transmission access, geology/seismic, and land acquisition. Information sources for these evaluations included publicly available data, information available from PEC files and personnel, and large-scale satellite photographs.

- **Weight Factors** — Weight factors reflecting the relative importance of the criteria were synthesized from those developed for previous nuclear power plant siting studies. The weight factors were originally derived using methodology consistent with the modified Delphi process specified in the EPRI Siting Guide. Weight factor used designated 1 as least important to 10 as most important).
- **Composite Suitability Ratings** — Ratings reflecting the overall suitability of each site were developed by multiplying criterion ratings by the criterion weight factors and summing over all criteria for each site.

In summary, the first phase of the site evaluation process involved screening the ROI using the exclusionary criteria identified above. This initial evaluation identified the sites by eliminating areas in which it is not feasible to site a nuclear facility due to regulatory, institutional, facility design impediments, or environmental constraints. Further screening was performed using avoidance criteria to eliminate feasible but less favorable areas, thus reducing the areas remaining under consideration to an adequate and reasonable number of EPRI “candidate sites” for continued screening.

The EPRI potential site list was further screened using refined exclusionary and avoidance criteria to identify optimum areas for a facility. The screening process eliminates many potential unsuitable locations before detailed, expensive, and time-consuming investigations are committed. The more favorable EPRI candidate sites undergo detailed investigations to determine both their basic engineering and environmental feasibility. The EPRI siting criteria used to evaluate candidate sites included the following: cooling water supply, flooding, population, hazardous land uses, terrestrial and aquatic ecology, wetlands, railroad access, transmission access, geology/seismic and land acquisition. resulted in reducing the EPRI candidate site list to a fewer number of alternative sites.

Based on the initial iterative screening approach, the list of 11 EPRI potential sites was reduced to four EPRI candidate sites for further evaluation: the HNP site, located in Wake County, North Carolina; the Brunswick Nuclear Power Plant, located in Brunswick County, North Carolina; and the H.B. Robinson Nuclear Power Plant, located in Darlington County, South Carolina. In addition, a greenfield site was chosen in Marion County, South Carolina.

The use of the EPRI siting criteria in the PEC Siting Study is consistent with the ESRP because PEC selected an existing nuclear site as the ESRP preferred site and identified two other nuclear sites in the ROI as two of the three alternative sites. The evaluation of the ESRP preferred site and three alternative sites in the PEC siting study represent among the best that could reasonably have been found within the ROI as required by the ESRP. The basis for screening out the seven remaining potential sites is discussed below.

Seven EPRI potential sites were evaluated by PEC but eliminated from further consideration. The site southeast of the city of Marion was eliminated because seismic criteria could not be met. The Fayetteville site was eliminated because the tract of land was not of suitable size. The “South River” site was eliminated due to soil liquefaction issues. A grouping of sites evaluated together on the Pee Dee River was eliminated because a new cooling water reservoir would have been required, as well as significant transmission line upgrades. The Savannah River Site (SRS) was eliminated because it lies outside the PEC Service Territory and the ROI. Two sites in eastern North Carolina were eliminated because they are being actively considered for new fossil plants and the location lacked sufficient off-site power voltage to support a nuclear plant. The Marion County site was the eighth non-nuclear site evaluated and was selected as an EPRI candidate site. It was the only non-nuclear site to pass the screening criteria, primarily because of the availability of suitable land and an adequate water supply.

The nuclear sites were chosen for further evaluation because they are owned by PEC (with ready access to the site and other information), are located relatively near the HNP site, and are within the applicant’s candidate areas. Other sites within the North and South Carolina candidate area were not evaluated further because they are not owned by PEC or its partners. Purchase of or access to a competitor’s site would be cost prohibitive and, therefore, would not be viable options for siting of a new reactor by the applicant. The applicant conducted an initial review of all potential sites.

Table 9.3-1 provides a list of the EPRI potential sites identified, results of the analysis of these sites against exclusionary criteria and PEC’s business objectives, and the disposition of each site.

The next component of the site selection process was to further evaluate the four EPRI alternative sites and select a EPRI proposed site (i.e., ESRP preferred site) for the PEC COL. PEC undertook a site-by-site comparison of EPRI alternative sites and the ESRP preferred site in the ER to “determine if there are any alternative sites that are environmentally preferable to the proposed site.” The review process involved the two-part sequential test outlined in NUREG-1555. The first stage of the review uses reconnaissance-level information to determine whether there are environmentally preferable sites among the alternatives. If environmentally preferable sites are identified, the second stage of the review considers economics, technology, and institutional factors for the environmentally preferred sites to determine if any are obviously superior to the proposed site.

PEC used the following two-phase, three-step process for reviewing the candidate sites:

- Step 1 – *Identify the candidate sites*. The proposed site is co-located with an existing nuclear facility (HNP). Therefore, PEC chose other nuclear sites over which it had control in the candidate areas (North and South Carolina), as well as a greenfield site.

- Step 2a – *Consider sites without existing nuclear facilities*. The initial step was to evaluate undeveloped greenfield and brownfield/non-nuclear sites. PEC assumed that the environmental impacts of building on a greenfield site could be greater than those of building at an existing site with a nuclear facility (disturbing land that had not previously been disturbed). PEC identified a greenfield site in Marion County, South Carolina, for evaluation.

- Step 2b – *Consider sites with existing nuclear facilities*. The next step was to evaluate sites with an existing nuclear facility to determine if the sites met the land requirements specified in this ER. If additional land would be required, PEC assumed that the environmental impacts of developing a new nuclear facility would be similar to the impacts for developing a previously undeveloped site, and concluded that the impact would be MODERATE to LARGE. Initially, PEC relied on NUREG-1437 as a basis of defining land requirements for building a new nuclear unit at candidate sites and used these land requirements as one basis for initial review. PEC reviewed land use and other land requirements to identify their initial environmental impacts on the alternatives and the proposed site.

- Step 3 – *Compare alternative sites with HAR for environmental preferability and "obvious superiority."* The environmental impacts of siting a new nuclear unit at alternative sites were compared with the impacts for siting a new unit at the proposed site, using the candidate site criteria identified in NUREG-1555 as the general standard. "Reconnaissance level" information made publicly available and site reviews conducted for other projects were also used to identify site-specific information. The comparisons made using the candidate site criteria and reconnaissance level information did not indicate that the alternative sites were environmentally preferable as noted in Subsection 9.3.2. PEC did not identify any environmentally preferable alternative site in its evaluation process because the effects of the reference plant on the alternative sites was considered greater than or equal to the effects predicted for HAR. As a result, PEC did not compare any alternative sites with the HAR site for "obvious superiority."

General siting criteria used to evaluate the four candidate sites were derived from those presented in the PEC siting study (Reference 9.3-001). The criteria were tailored to reflect issues applicable to, and data available for, the PEC sites.

The overall process for applying the general site criteria to evaluate the four EPRI alternative sites was analogous to that which was used in the evaluation of the 11 ROI sites described earlier. The evaluation process for the four EPRI alternative sites was comprised of the following elements: develop criterion ratings for each site and develop weight factors reflecting the relative importance of each criterion.

- **Criterion Ratings** – Each site was assigned a rating of 1 to 5 (1 = least suitable, 5 = most suitable) for each of the potential site evaluation criteria. Information sources for these evaluations included publicly available data, information available from PEC files and personnel, and U.S. Geological Survey (USGS) topographic maps.

- **Weight Factors** – Weight factors reflecting the relative importance of these criteria were synthesized from those developed for previous nuclear power plant siting studies. The weight factors were originally derived using methodology consistent with the modified Delphi process specified in the EPRI Siting Guide. Weight factors used factors of 1 as least important, through 10 as most important).

From the application of these exclusionary and avoidance features, alternative sites were identified as discrete parcels of land approximately the size of an actual nuclear site, thus eliminating large tracts of land that do not exhibit conditions suitable to a nuclear facility site. The process then becomes one of comparing the small number of alternative sites, and identifying a site that possesses the most favorable set of conditions for siting a nuclear power facility. The evaluation technique to this point ensures that the remaining alternative sites have no fatal flaws that could result in extended licensing delays and increased costs.

The remaining alternative sites were evaluated against suitability criteria, resulting in a transition from the elimination approach to an evaluation approach of the suitable sites. The objective of evaluation against suitability criteria is to rank the small number of alternative sites for determination of the preferred site(s).

The suitability criteria are grouped into four categories: Health and Safety, Environmental, Land Use/Socioeconomics, and Engineering/Cost-related, with features in each category relevant to the specific aspects of facility development that are weighted and scored to provide a relative comparison of the candidate sites. The multiple features of the suitability criteria are combined into one composite value for each of the alternative sites.

Next, the technically acceptable and ranked alternative sites then undergo a final technical evaluation process and a verification process as a second step to ensure compliance and compatibility with PEC's business strategic considerations, transmission deliverability, and population considerations. This analysis allows the decision of site selection to consider tradeoffs in business requirements and identification of a basis for differentiation among sites, thereby ensuring the optimal site is chosen. The components of PEC's business strategic considerations include the following:

- Existing nuclear site advantages: Sharing of existing resources and facilities associated with security, maintenance, training, warehousing, and emergency planning.
- Proximity to load: Location to load center to ensure transmission delivery capabilities and system operations.
- NRC considerations: Preference of existing nuclear facility sites facilitating the COLA review process.
- Local and state government support: Incentives and support associated with infrastructure improvements, rate base impact, emergency planning and employment training.
- Business planning: The selected site must promote assurance of satisfying schedule and budget for COL approval.
- Public support: General public desire for safe and efficient nuclear power generation and avoidance of nonproductive intervention.
- Land utilization: Leverage of PEC land for potential applications of public benefit.

Finally, each of the four EPRI alternative sites were evaluated on transmission deliverability/system direct connect and upgrade costs and on population considerations.

The results of the evaluation of the four EPRI alternative sites concluded that the HAR site is the "preferred site" since it received the highest scoring in the following evaluation areas: Technical Evaluation, PEC Strategic Considerations, and Transmission System Compatibility.

The HAR site was considered the best in regard to technical evaluation criteria which address licensing and design technical requirements to construct and operate a new nuclear plant. The HAR is superior to Robinson regarding the lake cooling water and availability of PEC-owned property. While Brunswick has access to more than adequate river water for cooling, the transmission system upgrades required are significant. The Marion County site had the largest land area, but also the largest percentage of wetland acreage, and less than desirable geotechnical features. The HAR site has the least wetland acreage, and the benefit of being a solid rock site as compared to deep soil of the alternative locations.

In regards to PEC's strategic considerations, the HAR site also ranks the highest. The NRC indicates preference to existing nuclear plant sites based on licensing reviews and detailed site characterization already completed to support the existing nuclear plant, which places the Marion County site at a disadvantage. The existing nuclear plant locations further provide an advantage due to the ability to leverage existing site facilities and resources, such as warehousing, security, and operator training. HAR demonstrated an advantage over Brunswick and Robinson due to larger acreage of PEC-owned property, and the clear ability to accommodate additional future generation capacity.

Transmission deliverability analysis has further concluded the HAR site was best suited to the existing transmission system requirements. The HAR site has minimal transmission impact costs for the installation of an 1100 megawatt (MW) nuclear unit. All other sites evaluated had considerable overloads identified with the addition of a 1100-MW nuclear unit (during various contingency scenarios), and required significant transmission system upgrades as compared to the HAR. Brunswick required the most extensive transmission system upgrades to remedy current overloads, estimated to be more than $300 million in cost.

The HAR site had a higher population than the other three EPRI alternative sites. However, there are a number of beneficial factors associated with the HAR site as compared to other acceptable locations. These include transmission deliverability and proximity to load, available land area, adequate water supply for multiple units and minimal environmental impact.

In summary, the evaluation of the four EPRI alternative sites indicated that all three of the nuclear sites are suitable for a new nuclear power plant; the Marion County site (greenfield site) ranks significantly lower than the existing sites, as a result of high transmission costs and seismic, land acquisition and wetlands issues. Of the existing nuclear sites, HAR rated highest followed by Robinson and Brunswick. Robinson rated somewhat lower, primarily due to potential cooling water supply operational limitations and a lower rating in the geology/seismic category. Brunswick rated lower primarily due to transmission challenges as well as being slightly less favorable with respect to ecology and nearby hazardous land uses. Based on these rating results and other applicable considerations related to PEC’s business plans, HAR was selected as the proposed site for the PEC COL. In addition to its advantages as an existing nuclear power plant site, HAR ranked highest or equal-highest in 26 of the general site criteria and was rated as being more suitable in both the screening-level and general site criteria composite ratings. A summary of the information used to evaluate the EPRI candidate sites and EPRI alternatives that support the selection of the EPRI preferred site (i.e., ESRP proposed site) location are presented in Subsection 9.3.2.

9.3.2 PROPOSED AND ALTERNATIVE SITE EVALUATION

The ESRP alternative sites are those ESRP candidate sites that are specifically compared with the proposed site to determine if there is an obviously superior site for the location of the new nuclear power plant. The ESRP proposed (or EPRI preferred) site is the ESRP alternative site that is submitted to the NRC by the applicant as the proposed location for a nuclear power plant. The remaining ESRP alternative sites chosen from within the ROI are compared with HAR.

The ESRP alternative sites that are compared with the HAR site (the ESRP proposed site) include Brunswick Nuclear Power Plant, located in Brunswick County, North Carolina; the H.B. Robinson Nuclear Power Plant, located in Darlington County, South Carolina; and a greenfield site located in Marion County, South Carolina. According to Regulatory Guide 4.2, the applicant is not expected to conduct detailed environmental studies at alternative sites; only preliminary reconnaissance-type investigations need be conducted. The alternatives sites were compared with HAR based on information about the existing nuclear plants and the surrounding area, as well as existing environmental studies and final environmental impact statements issued by the Atomic Energy Commission (AEC) and/or NRC. In Subsection 9.3.2, PEC's siting study (Reference 9.3-001) was used to determine whether or not any alternative sites are environmentally preferable to the proposed site.

To analyze the effects of building a new nuclear plant at each of the alternative site locations, PEC assumed the construction and operation practices described in ER Chapters 4 and 5 would generally be applied to each site; thereby, allowing for a consistent description of the impacts on each site.

In Subsection 9.3.2, environmental impacts of the alternatives are assessed using the NRC three-level standard of significance: SMALL, MODERATE, or LARGE. This standard of significance was developed using the following Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of Title 10 CFR Part 51, Subpart A, Appendix B:

- **SMALL**. Environmental effects are not detectable or are so minor they will neither destabilize nor noticeably alter any important attribute of the resource.

- **MODERATE**. Environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.

- **LARGE**. Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in the GEIS, NUREG-1437, Volumes 1 and 2.

Based on the conclusion of PEC's siting study (Reference 9.3-001), the ESRP proposed site is co-location of the new reactor units at the existing HNP site. Siting a new reactor at an existing nuclear facility offers a number of benefits. By co-locating nuclear reactors, the total number of nuclear power generating sites is reduced. No additional land acquisitions are necessary, and the applicant can readily obtain control of the property. This reduces both initial costs to the applicant and the degree of effect on the surrounding anthropogenic and ecological communities. Site characteristics, including geologic/seismic suitability, are known, and the site has already undergone substantial review through the NEPA process during the original selection procedure. No new analysis of site appropriateness is necessary, which can reduce start-up costs. In addition, the environmental impacts of constructing and operating the existing unit are known. It can be expected that the effects of a new unit should be comparable to those of the operating nuclear plant. Furthermore, co-located sites can share existing infrastructure, reducing both development costs and environmental effects associated with construction of new access roads, waste disposal areas, and other supporting facilities and structures. Construction of new transmission corridors could be eliminated because of the potential use and/or expansion of existing corridors. Finally, existing nuclear plants have nearby markets, the support of the local community, and the availability of experienced personnel.

A summary of the information contained in the PEC’s siting study (Reference 9.3-001) is presented in the following subsections.

9.3.2.1 The Marion County, South Carolina, Greenfield Site

The greenfield site chosen for analysis is the Marion County site, located between the towns of Florence and Marion, South Carolina. A nuclear power facility could be constructed and operated at this site; however, several significant issues make this location less desirable than co-location. The environmental impacts from constructing and operating a nuclear power plant at this site would range from MODERATE TO LARGE, but would be similar to or greater than those at the preferred site.

9.3.2.1.1 Land Use

The Marion County site is not currently owned by PEC. The site is a greenfield site that is located in a low-lying area surrounded by wetlands and swamps. Previous site investigations indicate that soil is at least 6.1 meters (m) (20 feet [ft.]) deep with groundwater encountered at 2.7 to 4.9 m (9 to 16 ft.) below the existing ground surface .The site is generally low in elevation, with considerable on-site and surrounding swamp land. Site elevations appear to be at or even slightly below that of the 100-year floodplain (a probable maximum flood [PMF] elevation has not been determined, but it is assumed that it would be higher than the 100-year floodplain and site grade could be below PMF). This presents the need to address environmental effects on floodplains as well as the possibility that engineered flood protection features will be required to protect the plant. These factors, combined with the surrounding known swamps and shallow depth to groundwater, also indicate the potential for construction dewatering problems (Reference 9.3-001).

No current or future regulatory land use restrictions were identified that are incompatible with locating nuclear power generation plants on the Marion County site. However, based on the need to acquire and commit land that is currently greenspace to a new nuclear power generating station, coupled with the potential for construction dewatering problems, impacts are anticipated to be MODERATE to LARGE.

9.3.2.1.2 Air Quality

Potential adverse impacts caused by drift from cooling towers on surrounding plants, including crops and ornamental vegetation, natural plant communities, and soils, is expected to be SMALL. This potential impact can be minimized with the use of drift eliminators on the cooling towers.

Based on the new reactor design and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.1.3 Water

The water metric evaluated for the Marion County site is the ability of a primary water source to provide adequate cooling water for a two-unit plant with cooling towers without significant permitting issues or operational restrictions. PEC indicated that the Pee Dee River 7-day and 10-year low flow at the site is 41 cubic meters per second (m^3/s) (1450 cubic feet per second [ft^3/s]) or 650,805 gallons per minute (gpm) (Reference 9.3-001). The closed-cycle cooling system, cooling water supply requirements for the proposed two-unit plant is approximately 2.65 m^3/s (93.58 ft^3/s) or 42,000 gpm. Adequate cooling water is available to support a two-unit plant for any of the designs under consideration. However, there are potential concerns regarding adequate flow during extreme drought conditions because the water source is not on a reservoir or lake. The Marion County site would likely require the construction of a reservoir (size not known at this time), and pumping distances could be longer at that site, depending on reservoir siting (Reference 9.3-001). Based on the concerns associated with the supply of adequate cooling water and the potential commitment of a significant area to a new cooling water reservoir, water resource impacts would likely be LARGE.

9.3.2.1.4 Terrestrial Ecology

Both on and near the Marion County site, there are approximately 518 ha (1280 ac.) of freshwater forested wetlands, forested/shrub wetlands, and freshwater emergent wetlands. Much of this wetland area is semi-permanently flooded, consistent with the low-lying land in this area. These wetlands are jurisdictional wetlands and a permit from USACE would be needed before conducting land disturbance activities. Based on the low-lying nature of the land in this area, dewatering of the site would be necessary, which would most likely affect wetlands (Reference 9.3-001). There are no terrestrial species in the immediate site vicinity that are included on federal or state lists of endangered or threatened species (Reference 9.3-001). Table 9.3-2 presents the rare, threatened, and endangered terrestrial species status list for Marion County, South Carolina. Based on the extensive amount of wetlands on the site, impacts would likely be MODERATE.

9.3.2.1.5 Aquatic Ecology

There are no aquatic species in the immediate site vicinity that are included on federal or state lists of endangered or threatened species (Reference 9.3-001). Table 9.3-3 presents the rare, threatened, and endangered aquatic species status list for Marion County, South Carolina.

The Marion County site was evaluated with respect to potential for entrainment and impingement impacts on the closed-cycle cooling water system. Proposed facilities at the site would likely include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. Proper design of the water intake structure would also minimize potential adverse impacts. With cooling towers and appropriate intake design, potential adverse impacts from entrainment or impingement of aquatic organism would be minor and would not significantly disrupt existing populations. Assuming a two-unit closed-cycle plant at the site, and 100 percent of the local plankton passing through the plant, there would be no discernible effect on the plankton population in the Pee Dee River at the site because of the very small volume of water used by the plant compared with the total volume in the river. Because of the low-flow velocities of a closed-cycle plant at the site, impingement of adult fish would be expected to be minimal. Use of a deepwater intake would have a minimal effect on entrainment of larval fish. Impacts on aquatic species from the construction of a reservoir include loss of habitat, temporary displacement, temporary turbidity, and water quality impacts during construction. Because of the potential to disrupt aquatic species associated with wetland, impacts are expected to be SMALL to MODERATE.

9.3.2.1.6 Socioeconomics

Marion County has a 2006 population estimate of 34,684, which is a 2.2 percent decrease from the 2000 population (Reference 9.3-002). The median household income is $26,593 per year. Approximately 22.5 percent of the county's population lives below the poverty level. The mean value of owner-occupied housing units was $63,500. There were 1898 firms doing business in the county in 2002 (Reference 9.3-002). The largest towns near the proposed greenfield site are the towns of Marion (7042) and Florence (30,248) (Reference 9.3-001).

The impact on area employment from construction and operation of the two new units would be low because Marion County is in close proximity to two population centers with high population density (Darlington and Florence counties) (Reference 9.3-001). It is expected that the impact on housing and community services would be negligible. The site appears to have sufficient population centers within commuting distance such that its public services sector would be able to absorb the population in-migration associated with plant construction and operation with minimal impact. Therefore, the effect of the proposed facility on the population and demographics of Marion County, South Carolina, is expected to be SMALL.

9.3.2.1.7 Transportation

The proposed Marion County site is located on the east side of the Great Pee Dee River. No limiting climate or terrain conditions were identified (Reference 9.3-001). The Marion County site is served by several primary access roads; however, site access will need to be constructed. About 1.6 to 3.2 km (1 to 2 mi.) of additional access roads will be needed to develop the Marion County site (Reference 9.3-001).

There are several airports nearby including the Florence City-County airport, the Marion County Airport the Dillon County Airport, and a landing strip in Latta, South Carolina. The proposed site is in the vicinity of the existing Seaboard rail line. (Reference 9.3-001).

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan before construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered. Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. Use of shared (e.g., carpooling) and multi-person transportation (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility. Transportation impacts are expected to be MODERATE based on the cost of supplying to necessary rail line infrastructure.

9.3.2.1.8 Historic, Cultural, and Archeological Resources

Potentially significant cultural resources on the Marion County site that could be affected by the proposed project include a confederate naval yard and Pee Dee Indian Town. These cultural resources along with mapped archaeological sites connected with a large graveyard might limit use of certain areas of the site (Reference 9.3-001). Investigation would be required before siting a new reactor at this location. Consultation with the State Historic Preservation Officer (SHPO) would occur if any significant historic, cultural, or archeological resources were identified and any appropriate mitigation measures put in place before construction and operation. Even with the implementation of mitigation measures, the historical context and original location of historic, cultural or archaeological resources would be lost. Therefore, impacts are thought to be MODERATE to LARGE.

9.3.2.1.9 Environmental Justice

Table 9.3-4 presents demographic information for several counties surrounding the proposed Marion County site: Marion, Florence, Dillon, and Darlington counties. Given that no significant impacts on any human populations are expected to occur at the proposed Marion County site, there would not be significant disproportionate impacts on 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. In addition, if no significant health and safety impacts from construction and operation of the proposed project are identified, there would be no environmental justice concerns, regardless of the percentage of minority or low income populations found within the surrounding communities. Therefore, it is anticipated that environmental justice impacts would be SMALL.

9.3.2.1.10 Transmission Corridors

Transmission system upgrades would be required at the Marion County site to construct and operate the proposed nuclear facility. Transmission system upgrades for the addition of an 1100-megawatt electric (MWe) power generating unit would result in environmental impacts related to clearing and construction of the new lines (Reference 9.3-001). Impacts would be LARGE based on the commitment of land, construction impacts on ecological resources associated with clearing, and the permanent commitment of land.

9.3.2.2 Existing Nuclear Facilities for Comparison

Co-locating the new reactor is preferable to the greenfield alternative because the new reactor will be able to take advantage of the infrastructure that serves the existing reactor(s). Co-location negates the need for many of the preliminary analyses required for a Greenfield site because these analyses have already been performed for the existing site license. Preliminary analyses of site suitability; appropriate seismicity and geological setting; federal, state, and local regulatory restrictions; and other significant issues have already been conducted for the existing unit(s). This further reduces uncertainties associated with construction and operation of the new units. Discussion of resource commitments for HAR can be found in ER Sections 10.1, 10.2, and 10.3. The resource commitments needed for construction and operation of the new facility would be similar regardless of where the unit is co-located. Therefore, the information in Chapter 10 applies to the candidate sites described below.

9.3.2.2.1 HAR Site: The Preferred Location

HAR is the preferred site for locating the new nuclear reactors. The HAR site is in Wake County, North Carolina. The HAR site and its surroundings, as well as the impacts of its construction and operation, is further described in ER Chapters 2, 4, and 5, and summarized below.

9.3.2.2.1.1 Land Use

The HAR site is to be located on land that is already owned by PEC and is already zoned for uses that are compatible with the development of new reactor units. The existing units are integrated into the surrounding land use patterns.

No surface faulting or deformation has been identified at the site. No areas of volcanic activity, subsidence caused by withdrawal of subsurface fluids, potential unstable slope, potential collapse, mined areas, or areas subject to seismic or other induced water waves or floods occur at the site.

Because of the 30-m (100-ft.) difference in elevation between the site and the Cape Fear River, and distance to HNP, flooding from the river is not a concern because flood protection features are currently in place to protect safety-related structures on the existing nuclear facility.

To meet the new facilities' water needs during operation of the plant, the Harris Reservoir volume will need to be increased (Subsection 9.3.2.2.1.3). The inundation of the reservoir will require replacement or relocation of existing infrastructure. Long-term land use impacts are expected to be insignificant because the relocation and/or rebuilding of structures with similar infrastructure in non-affected areas nearby will occur before or after inundation. The effect of these mitigation efforts would be no net loss in resource area or associated functional value.

Land use impacts are expected to be SMALL to MODERATE based on the fact that the HNP was initially planned to be a multiple-unit facility with a larger reservoir (Subsection 9.3.2.2.1.3).

9.3.2.2.1.2 Air Quality

Potential adverse impacts caused by drift from cooling towers on surrounding plants, including crops and ornamental vegetation, natural plant communities, and soils, are expected to be minor. These potential impacts can be minimized with the use of drift eliminators on the cooling towers.

Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.1.3 Water

The water metric evaluated for this site is the ability of a primary water source to provide adequate cooling water for a two-unit plant with cooling towers without significant permitting issues or operational restrictions. The water supply is Harris Lake, consisting of the Harris Reservoir on Buckhorn Creek, and the Auxiliary Reservoir located on Tom Jack Creek. The average reservoir level is at 66.8 m (219.4 ft.) NGVD29 for a one-unit operation. Buckhorn Creek has its headwaters near Holly Springs and Apex, North Carolina, and flows on a southwesterly course to its confluence with the Cape Fear River. Buckhorn Creek has five tributaries above the main dam. The conceptual design of the original reservoir system was intended to support multiple nuclear units at full development of the site with a higher lake elevation at 76.2 m (250 ft.) NGVD29. The existing nuclear facility contains one 900-MWe unit with closed-cycle cooling. At full development, the reservoir was to be recharged by pumping from the Cape Fear River in addition to the natural recharge from the watershed. Previous modeling efforts showed that for a two-unit plant, the Harris Reservoir water level would fluctuate from a minimum water level of 66.3 m (217.7 ft.) NGVD29 to a maximum level of 67.6 m (221.9 ft.) NGVD29. Analysis of a 100-year drought in both Buckhorn Creek and Cape Fear River, in connection with a hypothetical 4-unit operation at 100-percent load factor, resulted in the lowest reservoir level of 62.7 m (205.7 ft.) NGVD29 (at which point, the plant would shut down – 62.7 m [205.7 ft.] NGVD29 is the minimum operating level). During licensing of the HNP, NRC concluded that the water supply was adequate for a two-unit plant operation, including the Cape Fear River makeup system, and is also adequate in the event of a severe drought for both a one- and two-unit operation (Reference 9.3-001).

The closed-cycle cooling system, cooling water supply requirements for the proposed two-unit facility is approximately 2.65 m^3/s (93.58 ft^3/s) or 42,000 gpm (Reference 9.3-001). Adequate cooling water from the reservoir could support a two-unit plant for any of the designs under consideration. Because the HNP site is located on a large reservoir system, which would likely provide sufficient heat rejection capacity for the new units, plant operation should not have significant thermal impacts on aquatic or marine ecology and water quality. Impacts from constructing and operating the new reactor units would be SMALL as a result of adequate water supply and building the plant on an existing reservoir.

9.3.2.2.1.4 Terrestrial Ecology

There are two potentially occurring endangered or threatened species near the HAR site: the red-cockaded woodpecker (*Picoides borealis*) (federally listed as endangered) and an experimental population of Michaux's sumac (*Rhus michauxii*) (federally and state-listed as endangered) (Reference 9.3-001). PEC has procedures in place to protect endangered or threatened species if they are encountered on-site (or along the transmission corridors), and provides training for employees on these procedures (Reference 9.3-001) (see Table 4.3-2 for listed species in Wake and Chatham counties).

The forested and wetland habitats at the HAR site support a variety of wildlife species of birds, mammals, amphibians, and reptiles typically found in the Piedmont region of North Carolina. According to Subsection 5.2.1.1, approximately 164 ha (404 ac.) of wetlands exist along the perimeter of the reservoir and near the dam. These wetland areas were created or modified during the construction of the HNP. These wetlands will be inundated because of the increased water level of the reservoir. However, this inundation will also create new wetlands.

No impacts on the terrestrial ecosystems would be expected when construction of the new reactor is complete. Therefore, the impacts of construction might be MODERATE; however, the impacts of operation would be SMALL.

9.3.2.2.1.5 Aquatic Ecology

There are no aquatic species in the HAR site that are included on federal or state lists of endangered or threatened species (Reference 9.3-001) (see Table 4.3-3 for listed species in Wake and Chatham counties).

As discussed in Subsection 5.2.1, water from the Cape Fear River, in addition to the existing Harris Reservoir drainage area, will be required to fill and maintain the required pool level for normal operations. The normal rate of 2.35 m^3/s (84 ft^3/s) or 37,248 gpm, for operation and water quality control, is approximately 3.6 percent (2.35 m^3/s / 65 m^3/s = 3.6 percent) of the average daily flow reported at the USGS gauge at Lillington (USGS02102500). The rate at which water is withdrawn would be based on a set of operational rules designed to meet the target flows at Lillington as defined by the 1992 Water Control Manual for B. Everett Jordan Lake.

The HAR site was evaluated with respect to relative potential for entrainment and impingement effects to aquatic organisms for the closed-cycle cooling water system. Proposed facilities at the site will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. Through the use of cooling towers with an appropriate intake design, it is anticipated that potential adverse effects from entrainment or impingement of aquatic organism would be minor and would not significantly disrupt existing populations of aquatic organisms (Reference 9.3-001). Because of the low-flow velocities of a closed-cycle plant at the site, it is expected that aquatic effects would be SMALL.

9.3.2.2.1.6 Socioeconomics

Wake County has a 2006 population estimate of 786,522, which is a 25.3 percent increase from the 2000 population (Reference 9.3-003). The median household income is $57,846 per year. Approximately 9.2 percent of the county's population lives below the poverty level. The mean value of owner-occupied housing units was $162,900. There were 61,908 firms doing business in the county in 2002 (Reference 9.3-003). The towns with the highest population near the HAR site are the town of Cary (94,536), located 21 km (13 mi.) from the proposed site, and the City of Raleigh (276,093), located approximately 34.9 km (21.7 mi.) from the proposed site (Reference 9.3-001).

The HAR site had a higher population than the other three alternative sites. However, there are a number of beneficial factors associated with the HAR site as compared to other acceptable locations. These include transmission deliverability and proximity to load, available land area, adequate water supply for multiple units and minimal environmental impact.

The general population level is anticipated to be sufficiently large that the impact on area employment from construction and operation of the two new units would be low. It is expected that the impact on housing and community services would be negligible. The site area appears to have sufficient population centers within commuting distance such that its public services sector would be able to absorb the population in-migration associated with plant construction and operation with minimal impact. Therefore, the effect of the proposed facility on the population and demographics of Wake County, North Carolina, is expected to be SMALL.

9.3.2.2.1.7 Transportation

The HAR site is located on the northern side of the Harris Reservoir. U.S. Highway 1 is located immediately north of the site and provides access to the Raleigh, North Carolina area (northeast of the site) and Interstate 40. The proposed site will not need significant, if any, highway construction to accommodate construction or operation of a new plant. The location of the site in relation to the Harris Reservoir prevents direct egress to the south. No other limiting climate or terrain conditions were identified (Reference 9.3-001). The proposed HAR site is located near the HNP. On-site railroad access is already provided in the immediate vicinity of the proposed HAR site from the Seaboard rail line. It is anticipated that approximately 0.3 km (0.2 mi.) of rail would need to be constructed to link the proposed HAR site to the existing rail line. The cost of constructing this rail line is approximately $600,000 (Reference 9.3-001).

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan before construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered. Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. Use of shared (e.g., carpooling) and multi-person transportation (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.2.1.8 Historic, Cultural, and Archeological Resources

As discussed in Sections 4.4 and 5.8, PEC is coordinating with the North Carolina SHPO to comply with Section 106 of the National Historic Preservation Act to construct and operate a new facility at the HNP site. Investigations will be conducted to identify the full extent of historic properties and cultural resources in the area of potential effects (APE). The APE includes all areas of direct impact for the two new reactor units, the areas of direct impact for the 5.6-km- (3.5-mi.-)

long makeup water line and pumphouse, and all lands between the existing normal pool elevation of Harris Reservoir and the proposed 100-year flood elevation. Areas where potential historic properties could be affected by plant operation include the land between the existing normal pool elevation of Harris Reservoir and the proposed 100-year flood elevation and the three new transmission lines. As a result of consultation with SHPO, it is expected that the impacts of constructing and operating an additional reactor(s) at this site would be SMALL.

9.3.2.2.1.9 Environmental Justice

Table 9.3-5 presents demographic information for several counties surrounding the HAR site: Chatham, Harnett, Durham, Orange, and Wake counties. Given that no significant impacts to any human populations are expected to occur at the HAR site, there would not be significant disproportionate impacts on minority or low income populations; and based on actual employment experience, positive economic benefits have been shown to be available to all members of the population regardless of income or ethnicity. In addition, if no significant health and safety impacts are identified from reactor construction and operation, there would be no environmental justice concerns regardless of the percentage of minority or low income populations found within the surrounding communities. Furthermore, this site has been operating as a power-generating facility for many years. Therefore, it is anticipated that environmental justice impacts would be SMALL.

9.3.2.2.1.10 Transmission Corridors

The HAR site is located near the HNP. As such, transmission lines are located in the immediate vicinity of the proposed site. Transmission system upgrades are estimated to be less than $1 million for the addition of each 1100-MWe power-generating unit (Reference 9.3-001).

As stated in Subsection 3.7.1.1, three new transmission lines will be needed to connect the HAR 3 switchyard to the PEC grid. The proposed routing of the new lines for HAR 3 are being evaluated for placement adjacent to or within the existing maintained transmission corridors rights-of-way (ROWs) for the HNP. The new corridors for HAR 3 are conservatively estimated to require an additional 100 ft. of width. The corridor areas are mostly remote and pass through land that is primarily agricultural and forest land with low population densities. It is anticipated that farmlands that have corridors passing through them will generally continue to be used as farmland. Also, the longer transmission lines cross numerous state and United States highways. Use of existing corridors and ROWs would avoid critical or sensitive habitats/species as much as possible. If transmission towers that are to be inundated will pose either a permanent threat to boaters or a threat during low water events, permanent buoys and warning signs will be placed in appropriate locations. Specific monitoring requirements for new transmission lines and associated switchyards will be designed to meet conditions of permits, to minimize adverse environmental impacts, and to ensure that organisms are protected against transmission line alterations. Therefore, environmental effects from expansion efforts are anticipated to be SMALL and the effect of these corridors on land usage is expected to be minimal.

9.3.2.2.2 Brunswick Nuclear Power Plant Site

The Brunswick Nuclear Power Plant (Brunswick) site is located in Brunswick County, North Carolina.

9.3.2.2.2.1 Land Use

The Brunswick Nuclear Power Plant site is located on the Cape Fear River on the North Carolina coast at 6.1 to 7.6 m (20 to 25 ft.) NGVD29 (nominal plant grade is 6.1 m [20 ft.] NGVD29). The nominal plant grade of 6.1 m (20 ft.) NGVD29 results in 0.6 m (2 ft.) of water depth surrounding the plant during the maximum surge conditions. All safety-related structures at the current plant are waterproofed to 6.7 m (22 ft.) NGVD29 (Reference 9.3-001). The Brunswick Nuclear Power Plant site is on land already owned by PEC and is already zoned for uses compatible with the development of new units. The existing facility is integrated into the surrounding land use patterns. The impacts on land use at this site would be expected to be SMALL because the new reactor would be placed near existing nuclear facilities in an area that is currently zoned appropriately for power generation.

9.3.2.2.2.2 Air Quality

Potential adverse impacts caused by drift from cooling towers on 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.

Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.2.3 Water

The Brunswick Nuclear Power Plant site is located on the Cape Fear River on the North Carolina coast. The site is 6.1 to 7.6 m (20 to 25 ft.) NGVD29. During a probable maximum hurricane, storm surge levels at the site would be 6.7 m (22 ft.) NGVD29 and the peak storm elevation of the Cape Fear River would be 7.1 m (23.3 ft.) NGVD29. In the intake canal, the stillwater level in this situation could reach 6.7 m (22 ft.) NGVD29. The nominal plant grade of 6.1 m (20 ft.) NGVD29 would result in 0.6 m (2 ft.) of water surrounding the plant during these hypothetical maximum surge conditions. However, this peak tide would not reach the site because all safety-related structures are waterproofed to an elevation 6.7 m (22 ft.) NGVD29 (Reference 9.3-001).

Because of the intake design and proximity of the site to the Atlantic Ocean, there are no flow constraints. The drainage area of Cape Fear River is 23,670 square kilometers (km^2) (9140 mi^2). In this drainage area, stream flow from about 15,540 km^2 (6000 mi^2) is continuously gauged by the USGS. The average daily freshwater discharge rate of Cape Fear River at its mouth is estimated to be 229 m^3/s to 283 m^3/s (8100 ft^3/s and 10,000 ft^3/s) or 3,629,724 gpm and 4,485,641 gpm (Reference 9.3-001). Water impacts are expected to be SMALL.

9.3.2.2.2.4 Terrestrial Ecology

According to the NRC's NUREG-1437, Supplement 25, terrestrial species that are listed as threatened or endangered by the U.S. Fish and Wildlife Service (USFWS) and have potential to occur in the vicinity of the Brunswick Nuclear Power Facility site or along the transmission line ROWs are presented in Table 9.3-6. Terrestrial species listed by the State of North Carolina in the vicinity of the Brunswick Nuclear Power Facility site or along the transmission line ROWs are presented in Table 9.3-7. NRC staff conducted a review and concluded that the impacts on terrestrial endangered, threatened, proposed, or candidate species of an additional 20 years of operation and maintenance of the Brunswick Nuclear Power Plant site would be SMALL, and no additional mitigation was needed. The operation of additional units at this site would not be expected to adversely affect any federally listed terrestrial species (Reference 9.3-001).

Approximately 162.01 ha (400.33 ac.) of wetlands are known to occur in the 2428 ha (6000 ac.) site area. Of these wetlands, 33 ha (81 ac.) were found in the 162 ha (400 ac.) power block area, which would be affected by construction of the proposed facility (Reference 9.3-001). Terrestrial ecology impacts are expected to be MODERATE to LARGE.

9.3.2.2.2.5 Aquatic Ecology

According to the NRC's NUREG-1437, Supplement 25, aquatic species that are listed as threatened or endangered by the USFWS or the State of North Carolina and have potential to occur in the vicinity of the Brunswick Nuclear Power Facility are presented in Table 9.3-8. During the Brunswick Nuclear Power Plant re-licensing process, it was concluded that 1) continued operation of the plant and maintenance of the associated transmission line ROWs during the license renewal term was unlikely to adversely affect any federally listed aquatic species, and 2) any effect on threatened and endangered species during the additional 20 years of operation would be SMALL; therefore, no additional mitigation was warranted. Based on this information, it is reasonable to assume that operation of additional reactors at the Brunswick Nuclear Power Plant site would not adversely affect any federally listed aquatic species (Reference 9.3-001).

The Brunswick Nuclear Power Plant site was evaluated with respect to relative potential for entrainment and impingement impacts on the closed-cycle cooling water system. Proposed facilities at each site will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. In addition, proper design of the water intake structure would minimize the potential adverse impacts. In NUREG-1437, NRC concludes that, with cooling towers and appropriate intake design, potential adverse impacts from entrainment or impingement of aquatic organism are minor and do not significantly disrupt existing populations. Assuming that there would be a two-unit closed-cycle plant at the site, there would be no discernible adverse effect on aquatic organisms because of the very small volume of water used by the plant compared with the total volume of available water at the site. Because of the low flow velocities of a closed-cycle plant at the site, impingement of adult fish is expected to be minimal. Use of a deep-water intake would have a minimal effect on entrainment of larval fish (Reference 9.3-001).

Thermal effluent from the Brunswick Nuclear Power Plant site discharges through two 4-m- (13-ft.-) diameter, 610 m (2000 ft.) long submerged pipes that extend into the Atlantic Ocean. Water depth at the point of discharge is approximately 3 m (10 ft.). The ocean floor near the discharge pipes is sandy, with no hard bottom outcroppings or attached vegetation that might attract fish. There is a strong westerly tidal and longshore flow in this region. Most aquatic organisms in the area, such as fish and shellfish, are highly mobile and can avoid the discharge area. Although aquatic species might use the nearshore area around the discharge location, the slight increase in temperature above ambient ocean temperature is not enough to cause heat shock (Reference 9.3-001).

The National Pollutant Discharge Elimination System (NPDES) permit for the Brunswick Nuclear Power Plant site includes a semi-annual monitoring requirement of water temperatures at the discharge location. The plant is currently able to operate at or near full power while still meeting state water temperature standards. Temperature monitoring is conducted when both reactor power levels are 85 percent or greater (Reference 9.3-001).

A newly abundant *Gracilaria spp*. species in the sounds of southeastern North Carolina has become a problem for commercial fishing and industries drawing water from the lower Cape Fear River. DNA sequence analyses have shown that this species is *Gracilaria vermiculophylla*, a taxon originally identified as native to East Asian countries. This species has wider temperature and salinity tolerance range than native species of *Gracilaria spp.* It is also presumed to not have many predators since it is an invasive species. *Gracilaria vermiculophylla* has been identified as a major fouling organism on the Brunswick Nuclear Power Plant's cooling water diversion and intake screens. Heavy accumulations of the macroalgae have been documented in the shallow waters north of the intake canal.

Operation under the NPDES permit should result in the maintenance of a balanced, indigenous population of fish, shellfish, and other aquatic organisms, both in the Cape Fear Estuary and Atlantic Ocean near the discharge structure. Based on a review of the available information regarding potential impacts of the cooling water intake system on the entrainment of fish and shellfish in early life stages and on the effectiveness of the mitigation measures already in place at the Brunswick Nuclear Power Plant site, the potential impacts are SMALL, and no additional mitigation is warranted. In addition, based on a review of the available information regarding potential impacts of the cooling water intake system on the impingement of fish and shellfish, and on the effectiveness of mitigation measures already in place at the Brunswick Nuclear Power Plant site that reduce impingement and mortality caused by impingement, the potential impacts are SMALL, and no additional mitigation is warranted (Reference 9.3-001).

9.3.2.2.2.6 Socioeconomics

Brunswick County, North Carolina, has a 2006 population estimate of approximately 94,945, which is a 29.8 percent increase from the 2000 population (Reference 9.3-004). The median household income is $39,379 per year. Approximately 13.2 percent of the county's population lives below the poverty level. The mean value of owner-occupied housing units was $127,400. There were 8009 firms doing business in the county in 2002 (Reference 9.3-004). The largest town near the proposed site is the town of Wilmington, North Carolina (75,838), located 25.7 km (16 mi.) from the proposed site (Reference 9.3-001).

Based on the population near the plant, it is expected that most construction workers would come from within the region surrounding the site. Should a higher than expected number of construction workers come from outside the region, there could be a noticeable increase in population, but it would not be excessive. The population level is anticipated to be sufficiently high that the impact on area employment from construction and operation of the two new units would be low. It is expected that the impact on housing and community services would be negligible. The site area has sufficient population centers within commuting distance such that its public services sector would be able to absorb the population in-migration associated with plant construction and operation with minimal impact. Therefore, the effect of the proposed facility on the population and demographics of Brunswick County, North Carolina, is expected to be SMALL.

9.3.2.2.2.7 Transportation

The proposed Brunswick Nuclear Power Plant site is located near the city of Southport, North Carolina. The site is accessed by local roads. U.S. State Highways 87, 133, and 211 provide access to the Southport area, and feed into U.S. Highway 17 (Ocean Highway East). The Atlantic Ocean and Cape Fear River prevent egress to the east and the south (Reference 9.3-001). The proposed site will not need significant, if any, highway construction to accommodate construction or operation of a plant.

On-site railroad access is already provided in the immediate vicinity of the proposed site; however, an additional 0.16 km (0.1 mi.) of rail would be needed to connect to the existing rail (Reference 9.3-001). The existing units at the site are integrated into the surrounding land use patterns. The land that would be used for the new units is already owned by PEC and is currently zoned for uses compatible with the development of the new units.

Facilities within 8 km (5 mi.) of the site include Brunswick County Airport (6.4 km [4 mi.]), Cape Fear River/barge traffic (ocean-going vessels), and Sunny Point Army Terminal. The site area is generally industrial, and the closest industries are an Archer Daniels Midland (ADM) industrial plant (principal product is citric acid) and a Co-Gentrix Plant (steam and fossil fuel electricity). There is also a natural gas pipeline adjacent to the proposed site (Reference 9.3-001).

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan before construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered. Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. Use of shared (e.g., carpooling) and multi-person transportation (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impacts during operation of the facility.

9.3.2.2.2.8 Historic, Cultural, and Archeological Resources

Because no historic sites are known to occur at the existing Brunswick Nuclear Power Plant site, impacts on historic, cultural, and archeological resources from construction and operation of an additional reactor unit at this site would be SMALL. Investigation would be required before siting a new reactor at this location. Consultation with SHPO would occur if any significant historic, cultural, or archeological resources were identified and appropriate mitigation measures would be put in place before construction and operation. Therefore, it is expected that the impacts from constructing and operating an additional reactor at this site would be SMALL.

9.3.2.2.2.9 Environmental Justice

Table 9.3-9 presents demographic information for four counties surrounding the proposed Brunswick site: Brunswick, Columbus, New Hanover, Pender counties. Because no significant impacts on any human populations are expected to occur at the proposed Brunswick Nuclear Power Plant site, there would not be significant disproportionate impacts on minority or low income populations; and based on actual employment experience, positive economic benefits have been shown to be available to all members of the population regardless of income or ethnicity. In addition, if no significant health and safety impacts are identified from reactor construction and operation, there would be no environmental justice concerns, regardless of the percentage of minority or low income populations found within the surrounding communities. Furthermore, this site has been operating as a power generating facility for a number of years. Therefore, environmental justice impacts would be SMALL.

9.3.2.2.2.10 Transmission Corridors

The proposed site is located near the existing Brunswick Nuclear Power Plant. Required transmission system upgrades are estimated to require the significant installation of new infrastructure for the addition of an 1100-MWe generating unit (Reference 9.3-001). Additional infrastructure will be needed for a two-unit facility. However, efficiencies can be gained by using existing and proposed switchyards and corridors. If additional transmission corridors and towers are needed, they would be situated (if possible) in existing ROWs to avoid critical or sensitive habitats/species as much as possible. Specific monitoring requirements for new transmission lines and corridors, and associated switchyards will be designed to meet conditions of applicable federal, state, and local permits, to minimize adverse environmental impacts, and to ensure that organisms are protected against transmission line alterations. Transmission corridor impacts would be LARGE due to the commitment of land and construction impacts associated with the installation of new infrastructure on ecological resources. Utilization of existing transmission corridor ROWs could present opportunities to minimize impacts.

9.3.2.2.3 H.B. Robinson Nuclear Power Plant Site

The H.B. Robinson Nuclear Power Plant (Robinson) site is located in Darlington County, South Carolina. The site has an existing 710 MWe nuclear, 174 MW fossil and 15 MWe combustion turbine (Reference 9.3-001).

9.3.2.2.3.1 Land Use

The Robinson site is located on approximately 2435 ha (6020 ac.) of property in northwestern Darlington and southwestern Chesterfield counties, including the 911-ha (2250-ac.) Lake Robinson (Reference 9.3-001). The site area is rural, with light development. Facilities within 8 km (5 mi.) of the site include the Darlington County Internal Combustion Electric Plant (1.6 km [1 mi.]), Robinson Unit 1 coal-fired power plant, and the gas pipeline at Hartsville Municipal Airport (4 km [2.5 mi.]). Railroad Specialty Steel plant (Talley Metals) adjacent to the existing plant Lee County Airport lies within 24 km (15 mi.) of the site (Reference 9.3-001). Land to be used for new units is already owned by PEC and is already zoned for uses compatible with development of a new unit. The existing units are integrated into the surrounding land use patterns. Land use impacts are expected to be SMALL.

9.3.2.2.3.2 Air Quality

Potential adverse impacts caused by drift from cooling towers on 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.

Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.2.3.3 Water

Lake Robinson, a 911-ha (2250-ac.) impoundment on Black Creek is the cooling water source for the H.B. Robinson Nuclear Power Plant. Currently, water to cool the nuclear unit is pumped at a rate of approximately 31.92 m^3/s (1127.37 ft^3/s) or 506,000 gpm and returned to the lake through the discharge canal. The site currently contains a 710-MWe nuclear, a 174-MWe fossil, and a 15-MWe combustion turbine. Based on operation of the existing unit, there have been some restrictions based on water availability and thermal effects (Reference 9.3-001).

Because Black Creek was impounded to provide cooling water to the H.B Robinson Nuclear Power plant, NRC considers the lake a “cooling pond” by definition. Units 1 and 2 share the cooling water discharge canal that extends approximately 6.4 km (4 mi.) to the north of the plant along the western edge of the lake. The canal was designed to allow the discharge water to cool before entering the lake. There are impacts from the thermal effluent on Lake Robinson near the discharge area; however, the impacts are limited and do not threaten the continued existence of a balanced and indigenous community of fish and wildlife in and around the lake. The NRC staff concluded that the potential heat shock impacts from operation of the plant’s cooling water discharge system on the aquatic environment on- or near the site are SMALL, and mitigation is not warranted (Reference 9.3-001).

The proposed site is located on a 911-ha (2250-ac.) lake at an elevation of 69 m (225 ft.) NGVD29. Modeling of the PMF based on probable maximum precipitation (PMP) of 50.8 centimeters [cm] (20 inches [in.]) in 48 hours from a postulated hurricane showed a resulting flow of 850 m^3/s (30,000 ft^3/s). However, the proposed site would still be above flood elevation in this scenario. In addition, the spillway is designed to pass a flow of 1133 m^3/s (40,000 ft^3/s), which would result in a lake level of 67.57 m (221.67 ft.) NGVD29 (Reference 9.3-001).

The site appears to be challenged for water supply. In addition, operation of the coal unit at the Robinson site has historically been curtailed to avoid exceeding thermal limits for the lake (Reference 9.3-001). Therefore, SMALL to MODERATE impacts are expected based on concerns about operational limitations associated with water supply and thermal issues in Lake Robinson.

9.3.2.2.3.4 Terrestrial Ecology

According to NRC's NUREG-1437, Supplement 13, terrestrial species that are listed as threatened or endangered by the USFWS or the State of South Carolina and have potential to occur in the region surrounding the H.B. Robinson Nuclear Power Plant are presented in Table 9.3-10. No rare, threatened, or endangered species are known to occur in the immediate vicinity of the site (Reference 9.3-001).

Approximately 20.1 ha (49.7 ac.) of wetlands are located in the 162 ha (400 ac.) power block area and approximately 42.8 ha (105.8 ac.) of wetlands were found in the 2428 ha (6000 ac.) site area (Reference 9.3-001). Terrestrial ecology impacts are expected to be SMALL.

9.3.2.2.3.5 Aquatic Ecology

According to NRC's NUREG-1437, Supplement 13, aquatic species that are listed as threatened or endangered by the USFWS or the State of South Carolina and have potential to occur in the region surrounding the H.B. Robinson Nuclear Power Plant are presented in Table 9.3-11. However, none of these species are considered to exist on or near the site (Reference 9.3-001).

The Robinson site was evaluated for potential for entrainment and impingement impacts on the closed-cycle cooling water system. Proposed facilities at each site will include cooling towers that will reduce the amount of cooling water withdrawal required for plant operation. In addition, proper design of the water intake structure would minimize the potential adverse impacts. In NUREG-1437, NRC concludes that, with cooling towers and appropriate intake design, potential adverse impacts from entrainment or impingement of aquatic organism are minor and do not significantly disrupt existing populations.

Based on the results of entrainment studies and operating history of the Robinson intake, the NRC staff has reviewed the available information (in support of recent re-licensing) and concludes that the potential impacts of the cooling water intake system's entrainment on fish and shellfish in the early life stages are SMALL and, therefore, no additional mitigation is warranted. Furthermore, the H.B. Robinson Nuclear Power Plant operations will be required to comply with any future requirements imposed in its NPDES permit to ensure that entrainment impacts at the site will continue to be SMALL (Reference 9.3-001).

Based on the results of impingement studies and operating history of the Robinson intake, the NRC staff has reviewed the available information regarding potential impacts of the cooling water intake on the impingement of fish and shellfish and, based on this data, concludes that the potential impacts are SMALL, and no additional mitigation is warranted. Furthermore, the H.B. Robinson Nuclear Power Plant operations will be required to comply with any future requirements imposed in its NPDES permit to ensure that impingement impacts at the site will continue to be SMALL (Reference 9.3-001). Overall, aquatic ecology impacts are expected to be SMALL.

9.3.2.2.3.6 Socioeconomics

Darlington County, South Carolina, has a 2006 population estimate of approximately 67,551, which is a 0.2-percent increase from the 2000 population (Reference 9.3-005). The median household income is $31,982 per year. Approximately 19.9 percent of the county's population lives below the poverty level. The mean value of owner-occupied housing units was $74,100. There were 4112 firms doing business in the county in 2002 (Reference 9.3-005). The largest town near the proposed site is the town of Hartsville (7556); located 6.4 km (4 mi.) from the proposed site (Reference 9.3-001).

Based on the population near the plant, it is expected that most construction workers would come from within the region surrounding the site. Should a higher than expected number of construction workers come from outside the region, there could be a noticeable increase in population, but it would not be excessive. The population level is anticipated to be sufficiently high that the impact on area employment from construction and operation of the two new units would be low. It is expected that the impact on housing and community services would be negligible. The site area has sufficient population centers within commuting distance such that its public services sector would be able to absorb the population in-migration associated with plant construction and operation with minimal impact. Therefore, the effect of the proposed facility on the population and demographics of Darlington County, South Carolina, is expected to be SMALL.

9.3.2.2.3.7 Transportation

The proposed Robinson site is located on the southwestern side of Lake Robinson, near the town of Pine Ridge, South Carolina. State Highway 151 provides access to the area and serves as a link to U.S. Highway 1 (northwest) or U.S. Highway 15 (southeast). The location of the site in relation to Lake Robinson prevents direct egress to the east. No other limiting climate or terrain conditions were identified (Reference 9.3-001). The proposed site would not require any highway construction to accommodate construction or operation of a plant.

On-site railroad access is already provided near the proposed site. However, an additional 0.32 km (0.2 mi.) of rail line would be needed to connect to the existing rail. (Reference 9.3-001)

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan before construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered. Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. Use of shared (e.g., carpooling) and multi-person transportation (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impacts during operation of the facility.

9.3.2.2.3.8 Historic, Cultural, and Archeological Resources

Because no historic sites are known to occur at the existing Robinson plant, impacts on historic, cultural, and archeological resources from construction and operation of an additional reactor unit at this site would be SMALL. Investigation would be required before siting a new reactor at this location. Consultation with SHPO would occur if any significant historic, cultural, or archeological resources were identified and any appropriate mitigation measures would be put in place before construction and operation.

9.3.2.2.3.9 Environmental Justice

Table 9.3-12 presents demographic information for several counties surrounding the proposed Robinson site: Darlington, Chesterfield, Lee, Kershaw, and Sumter counties. Because no significant impacts on any human populations are expected to occur at the proposed site, there would not be significant disproportionate impacts on minority or low income populations; and based on actual employment experience, positive economic benefits have been shown to be available to all members of the population regardless of income or ethnicity. In addition, if no significant health and safety impacts are identified from reactor construction and operation, there would be no environmental justice concerns, regardless of the percentage of minority or low income populations found within the surrounding communities. Furthermore, this site has been operating as a power generating facility for a number of years. Therefore, environmental justice impacts would be SMALL.

9.3.2.2.3.10 Transmission Corridors

Transmission systems are estimated to require significant additional infrastructure for the addition of an 1100-MWe generating unit (Reference 9.3-001). Additional infrastructure will be needed for a two-unit facility. However, efficiencies can be gained by using existing and proposed switchyards and corridors. If additional transmission corridors and towers are needed, they would be situated (if possible) in existing ROWs to avoid critical or sensitive habitats/species as much as possible. Environmental impacts are anticipated during the expansion of existing lines and/or the construction of new lines. Specific monitoring requirements for new transmission lines and corridors and associated switchyards will be designed to meet conditions of applicable federal, state, and local permits to minimize adverse environmental impacts and to ensure that organisms are protected against transmission line alterations. Transmission corridor impacts are expected to be LARGE based on anticipated environmental impacts on ecological resources associated with the installation of the necessary transmission corridor infrastructure.

9.3.2.3 Evaluation of Population Density for Alternative Sites

The NRC Standard Review Plan, NUREG-0800, section 2.1.3, III. 5, notes that if the population density of the proposed site exceeds, but is not well in excess of, 500 people per square mile (ppsm) over a radial distance out to 32 km (20 mi.), then the analysis of alternative sites should evaluate alternative sites having lower population density. The underlying regulation for this guidance is 10 CFR 100.21(h), which states:

> Reactor sites should be located away from very densely populated centers. Areas of low population density are, generally, preferred. However, in determining the acceptability of a particular site located away from a very densely populated center but not in an area of low density, consideration will be given to safety, environmental, economic, or other factors, which may result in the site being found acceptable[3].

Footnote 3 states:

> Examples of these factors include, but are not limited to, such factors as the higher population density site having superior seismic characteristics, better access to skilled labor for construction, better rail and highway access, shorter transmission line requirements, or less environmental impact on undeveloped areas, wetlands or endangered species, etc. Some of these factors are included in, or impact, the other criteria included in this section.

For the HAR site, the current population (year 2000) density for the 0 to 32 km (0 to 20 mi.) radius is 383 ppsm, which is below the 500 ppsm guidance. Projections estimate a population density of 511 ppsm in 2010 and 574 in 2015 for the 0 to 32 km (0 to 20 mi.) radii. The population densities identified in the PEC Siting Study are slightly lower than the more current numbers presented above. For the purpose of this analysis, the numbers are equivalent to the "approximately 500" ppsm in the PEC Siting Study. The population density projected for the HAR site at the time of initial site approval and 5 years thereafter is expected to exceed, but not be well in excess of, 500 ppsm in 2015. (Reference 9.3-001)

The largest portion of the population that contributes to the relatively high population density is associated with the City of Raleigh, which is located beyond the 16-km (10-mi.) radius of the HAR Emergency Planning Zone (EPZ). Projections estimate a population density of 340 ppsm in 2010 and 384 in 2015 for the 0 to 16 km (0 to 10 mi.) radii.

The HAR site has a higher population density than the other three alternative sites considered. County population information for the locations of the four sites considered is provided in ER Table 10.4-1. However, a number of beneficial factors are associated with the HAR site, compared with the other acceptable locations, which include transmission deliverability and proximity to load, available land area, adequate water supply for multiple units, minimal environmental impact, and safety considerations.

From a safety perspective, HAR 2 and HAR 3 are advanced reactors with passive safety systems. The probabilistic analysis in ER Chapter 7 demonstrates that, even with HAR 2 and HAR 3 located in a relatively high population density area, the consequences of postulated accidents meet the NRC safety goals by a significant margin (Table 7.2-6). Also, site-specific off-site exposures during the spectrum of design basis accidents is significantly below the NRC's guideline limits (Table 7.1-2). While projected doses at the alternative sites would similarly benefit from the advantages of the AP1000 design, the significant margin provided diminishes the relevance of the 500 ppsm guidance.

The siting analysis conducted for this project indicated that the HAR site was the best location when compared with the other three alternative sites. The other three alternative sites included a Marion County greenfield site, the Brunswick site, and the Robinson site. Overall, the HAR is superior to Robinson with regards to the lake cooling water and availability of PEC-owned property. While Brunswick has access to more than adequate river water for cooling, the transmission system upgrades required are significant. The Marion County site had the largest land area, but also the largest percentage of wetland acreage and less than preferable geotechnical features.

The HAR site has the least environmental impact and the best characteristics for seismic safety as compared with the other alternative sites. Of the existing nuclear sites considered as alternatives (Brunswick and Robinson), HAR has the lowest evaluated peak ground acceleration. The Marion County site is expected to have similar seismic characteristics to Robinson and has seismic concerns due to its proximity to Charleston, South Carolina, an area with significant historic seismic activity.

Environmental factors that make the HAR site preferable include a smaller number of listed, threatened, or endangered species and critical habitat; no spawning grounds for any state or federal threatened or endangered species are present as is the case at the Brunswick site; and no postulated effluent discharge beyond the limits of existing NPDES permits or regulations. Potential impacts of a new nuclear facility on terrestrial or aquatic environments at the HAR site would not be greater than at the other alternative sites; and the siting of the new units at the HAR site would not require significant land use changes for construction in the area designated for the new units when compared to the other three alternative sites. Additionally, impacts to cultural resources at HAR are anticipated to be small in comparison to Marion County, where there is potential to impact a confederate naval yard, Pee Dee Indian Town, and a large graveyard.

The existing nuclear plant locations provide an advantage due to the ability to leverage existing site facilities and resources, such as warehousing, security, and operator training. HAR demonstrated an advantage over Brunswick and Robinson due to larger acreage of PEC-owned property and the clear ability to accommodate additional future generation capacity. HNP was originally planned for multiple units.

Co-location of the new units at the HAR site will allow some shared use of existing infrastructure, reducing both developmental costs and environmental effects associated with construction of new access roads, waste disposal areas, and other supporting facilities and structures. Construction impacts associated with new transmission lines can be minimized at the HAR site because of the potential use and/or expansion of existing corridors.

The HNP was originally designed as a four reactor site. Although only one reactor was built, certain infrastructure was built to support the four reactors, which can be used to support HAR 2 and HAR 3. The infrastructure includes transmission line corridors, a switchyard currently sized for two units, and a lake that can be increased in water level to support multiple units. The lake is currently filled to a level required for one reactor; however, the dam was designed and constructed to accommodate the four reactors and can be increased in level to support HAR 2 and HAR 3 with spillway modifications. In contrast, the Robinson site has limited water availability, the Marion County site would require a new impoundment, and the Brunswick site would use saltwater for cooling that could pose cooling tower salt drift concerns.

Transmission deliverability analysis has further concluded the HAR site was best suited to the existing transmission system requirements. The HAR site has minimal transmission impact of costs for the installation of a 1100-megawatt (MW) nuclear unit. Existing transmission lines and corridors would be used for HAR 2, and existing transmission corridors would be expanded for HAR 3. Only three new lines would need to be developed for the HAR site in the existing corridors. In contrast, the Robinson and Marion County sites are not located near major load centers, and new transmission corridors and switchyards would need to be developed. The Brunswick site is near the Wilmington, NC load center, but new transmission corridors and switchyards would need to be developed to serve other load centers on the PEC system. Transmission system upgrades at the other alternative sites were estimated to total $300 million for Brunswick, $286 million for Robinson, and $410 million for the Marion County site. In comparison, estimated costs of transmission upgrades for the HAR site were evaluated as negligible.

The HAR site, with its higher population density, also offers greater availability to skilled workers than the alternatives. The HAR site has significantly more-developed infrastructure than the other alternative sites, with major highways including Interstate Highways 40 and 440, interconnections with Interstate 85 at Durham, North Carolina, and U.S. Highway 1. None of the other alternative sites are in close proximity to Interstate or major United States highways.

Construction of new rail lines also favor using an existing nuclear plant location. Railroad improvement costs at the three existing facilities are as follows: approximately $600,000 for HAR; approximately $300,000 for Brunswick; and approximately $600,000 for Robinson. The cost of railroad improvements at the proposed Marion County greenfield site is approximately $3.42 million.

The siting analysis indicated that all three of the existing nuclear sites are suitable for a new nuclear power plant; the Marion County site (greenfield site) ranks significantly lower than the existing sites, as a result of high transmission costs and seismic, land acquisition, and wetlands issues. Of the existing nuclear sites, HAR rated highest, followed by Robinson and Brunswick. Robinson rated somewhat lower, primarily due to potential cooling water supply operational limitations and a lower rating in the geology/seismic category. Brunswick rated lower primarily due to transmission challenges, as well as being slightly less favorable with respect to ecology and nearby hazardous land uses. Based on these environmental factors and other applicable considerations related to PEC's business plans, HAR was selected as the proposed site for the PEC COLA. In addition to its advantages as an existing nuclear power plant site, HAR ranged highest or equal-highest in 26 of the general siting criteria composite ratings. (Reference 9.3-001)

As stated above, the NRC Standard Review Plan, NUREG-0800, section 2.1.3, III. 5, notes that if the projected population density of the proposed site exceeds, but is not well in excess of, 500 ppsm over a radial distance out to 32 km (20 mi.), then the analysis of other alternative sites should evaluate other alternative sites having lower population density. However, "consideration will be given to safety, environmental, economic, or other factors, which may result in the site being found acceptable." Population projections currently estimate a population density of 511 ppsm in 2010 and 574 in 2015 for the 0 to 32 km (0 to 20 mi.) radii, which is not well in excess of the criteria. As demonstrated in the siting analysis described in this chapter, the HAR site is acceptable based on consideration of factors considered in 10 CFR 100.21(h).

Seven EPRI potential sites were evaluated by PEC as potential sites with low population densities, but these sites were eliminated from further consideration. The site southeast of the city of Marion was eliminated because seismic criteria could not be met. The Fayetteville site was eliminated because the tract of land was not of suitable size. The "South River" site was eliminated due to soil liquefaction issues. A grouping of sites evaluated together on the Pee Dee River was eliminated because a new cooling water reservoir would have been required, as well as significant transmission line upgrades. The SRS was eliminated because it lies outside the PEC Service Territory and the ROI. Two sites in eastern North Carolina were eliminated because they are being considered for new fossil plants and the location lacked sufficient off-site voltage to support a nuclear unit. Although these seven sites had lower population densities, other siting criteria (e.g., hydrology, environmental) resulted in the sites being eliminated during the screening process. (Reference 9.3-001)

9.3.3 SUMMARY AND CONCLUSIONS

The advantages of the HAR site over the other alternative sites are summarized as follows:

- The postulated consumptive use of water by a new unit at the HNP site would not be greater than water use at the other alternative sites.
- A smaller number of listed, threatened, or endangered species and critical habitat has been identified at the HAR site than at the other alternative sites. Through consultation with the appropriate state and federal agencies and/or potential mitigation measures, it is expected that impacts of development of a new unit at the proposed site on endangered species would not be greater than impacts postulated for the other alternative sites.
- The HAR site does not contain spawning grounds for any state or federal threatened or endangered species. Thus, the impacts on spawning areas would not be greater than impacts at the other alternative sites.
- The HAR site impact review does not postulate effluent discharge beyond the limits of existing NPDES permits or regulations. Based on the information available for the other alternative sites, the impacts from effluent discharge at the proposed site would not be greater than impacts at the other alternative sites.
- The siting of a new unit at the HNP site would not require pre-emption or land use changes for construction. Therefore, construction land use impacts at the proposed site would not be greater than the impacts at the other alternative sites.
- The potential impacts of a new nuclear facility on terrestrial and aquatic environments at the HNP site would not be greater than the impacts at the other alternative sites.
- There are a number of beneficial factors associated with the HAR site as compared to other acceptable locations. These include transmission deliverability and proximity to load, available land area, adequate water supply for multiple units, and minimal environmental impact.
- The need for transmission and rail line upgrades is significantly less for the HAR site than for the other alternative sites.

As summarized in Table 9.3-13, no other alternative sites are environmentally preferable and, therefore, cannot be considered obviously superior to the HAR site. Development of a greenfield site would offer no advantages and would increase both the cost of the new facility and the severity of impacts. Co-location of the new reactor unit at an existing site would allow existing infrastructure and transmission lines and corridors to be used. Alternative nuclear sites offer no environmental advantages over the preferred site. The existing facility currently operates under an NRC license, and the proposed location has already been found acceptable under the requirements for that license. Further, operational experience at HAR has shown that the environmental impacts are SMALL, and operation of a new unit at the site should have essentially the same environmental impacts.

9.3.4 REFERENCES

9.3-001 Progress Energy Carolinas, Inc., “Progress Energy: New Nuclear Baseload Generation Addition, Evaluation of Carolina Sites,” January 2006 (Proprietary Reference).

9.3-002 U.S. Census Bureau, “Marion County Quickfacts,” Website, www.quickfacts.census.gov/qfd/states/45/45067.html, accessed June 26, 2007.

9.3-003 U.S. Census Bureau, “Wake County Quickfacts,” Website, www.quickfacts.census.gov/qfd/states/37/37183.html, accessed June 26, 2007.

9.3-004 U.S. Census Bureau, “Brunswick County Quickfacts,” Website, www.quickfacts.census.gov/qfd/states/37/37019.html, accessed June 26, 2007.

9.3-005 U.S. Census Bureau, “Darlington County Quickfacts,” Website, www.quickfacts.census.gov/qfd/states/45/45031.html, accessed August 15, 2007.

Table 9.3-1 (Sheet 1 of 2)
Carolinas Site Identification and Analysis Status

#	Site Description and Location	Identified By	Evaluation	Status
Carolinas locations identified as candidate sites for further consideration:				
1	Harris Nuclear site	Nuclear Generation Group (NGG) existing site	Existing nuclear power plant site; no issues to preclude consideration for COL site. This site was originally developed to accommodate much more electrical capacity and has much of the infrastructure to support units already in place.	Carried forward as candidate site.
2	Brunswick Nuclear site	NGG existing site	Existing nuclear power plant site; no issues to preclude consideration for COL site.	Carried forward as candidate site.
3	Robinson Nuclear site	NGG existing site	Existing nuclear power plant site; no issues to preclude consideration for COL site. This site is challenged from thermal limits on the lake, based on existing operating experience.	Carried forward as candidate site.
4	Marion County, SC Site	Identified by Emerson Gower	Site identified as being available for acquisition, with adequate land area and water supply from the Pee Dee River.	Carried forward as candidate site.
Carolina Sites eliminated from further consideration:				
5	SC site	Identified by Emerson Gower	Site identified as being available for acquisition, with adequate land and water. Initial evaluation of the site indicated a high likelihood that it would not meet seismic requirements for existing and planned certified reactor designs.	Eliminated from further consideration.
6	NC site	Proposed by the Mayor	Preliminary analysis indicates that there is no block of suitable land of sufficient size in a low population zone without wetlands. The area is also generally too flat for development of the large lake that would be required for a cooling water reservoir, and the site would require considerable expense to make it viable from an engineering perspective.	Eliminated from further consideration.

Table 9.3-1 (Sheet 2 of 2)
Carolinas Site Identification and Analysis Status

#	Site Description and Location	Evaluation	Status
7	NC site	This site was previously considered by PEC for a potential nuclear plant. Soil liquefaction issues have been identified that could make the site unsuitable for a certified plant design, and cooling tower makeup water sources are not adequate. The site also appears to be environmentally sensitive.	Eliminated from further consideration.
8	Three sites near the NC/SC border	This site grouping was identified based on current ownership of the hydro plant and previous Progress Energy site selection studies. The site would require major transmission upgrades and a new cooling water reservoir would likely be needed to deal with periodic low river flows on the Pee Dee at this location.	Eliminated from further consideration.
9	SC site	This site (which is outside the PEC service territory) was identified because Savannah River Site (SRS) has aggressively pursued a new nuclear plant on the reservation with PGN, Duke, and SCANA. The site is not close to the PEC service territory and therefore would have high transmission costs. In addition, SRS controls the on-site cooling water loop from which cooling water would be drawn; the need for operational water arrangements with SRS to obtain cooling water was not desirable.	Eliminated from further consideration.
10	NC site	The site is available, has been identified in previous PEC siting studies, and is actively being considered for a future approximately 800-MW fossil plant. This location also did not have sufficient off-site power voltage to support a nuclear unit.	Eliminated from further consideration.
11	NC site	The site is available, has been identified in previous PEC siting studies, and is actively being considered for a future approximately 800 MW fossil plant. This location also did not have sufficient off-site power voltage to support a nuclear unit.	Eliminated from further consideration.

Source: Reference 9.3-001

Table 9.3-2
South Carolina Rare, Threatened, & Endangered Species Inventory Species Found in Marion County — Terrestrial

Scientific Name	Common Name	Federal Status	State Status
Corynorhinus Rafinesquii	Rafinesque’s Big-Eared Bat	--	Endangered
Haliaeetus Leucocephalus	Bald Eagle	Delisted (August 2007)	Endangered
Heterodon Simus	Southern Hognose Snake	--	Species of Concern
Pituophis Melanoleucus	Pine or Gopher Snake	--	Species of Concern

Source: Information taken from the South Carolina Department of Natural Resources.

Table 9.3-3

South Carolina Rare, Threatened, & Endangered Species Inventory Species Found in Marion County — Aquatic

Scientific Name	Common Name	Federal Status	State Status
Ilex Amelanchier	Sarvis Holly	--	Species of Concern
Isoetes Riparia	River Bank Quillwort	--	Species of Concern
Lampsilis Cariosa	Yellow Lampmussel	--	Species of Concern
Thalia Dealbata	Powdery Thalia	--	Species of Concern

Source: Information taken from the South Carolina Department of Natural Resources.

Table 9.3-4
Marion Site Minority and Low Income Population/Percentages

County	Population (2000)	White (%)	Black (%)	Hispanic (%)	Low Income (%)
Marion	35,466	41.7 (14,787)	56.3	1.8	23.2 (8228)
Florence	125,761	58.7 (73,760)	39.3	1.1	16.4 (20,625)
Dillon	31,289	50.4 (15,481)	45.3	1.8	24.2 (7572)
Darlington	67,394	57.0 (38,402)	41.7	1.0	20.3 (13,680)
Total	259,910	54.6 (141,910)	45.4% minority (118,000)		19.3 (50,105)

Source: Reference 9.3-002

Table 9.3-5
HAR Site Minority and Low Income Population/Percentages

County	Population (2000)	White (%)	Black (%)	Hispanic (%)	Low Income (%)
Chatham	49,329	74.9 (36,969)	17.1	9.5	9.7 (4785)
Harnett	91,025	71.1 (64,744)	22.5	5.9	14.9 (13,560)
Durham	223,314	50.9 (113,698)	39.5	7.6	13.4 (29,920)
Orange	118,227	78.0 (92,272)	13.8	4.5	14.1 (16,670)
Wake	627,846	72.4 (454,544)	19.7	5.4	7.8 (48,970)
Total	1,109,741	68.7% (762,392)	32.3% minority (358,446)		10.3 (113,905)

Source: Reference 9.3-003

Table 9.3-6

Federally Listed Terrestrial Species Potentially Occurring in the Vicinity of the Brunswick Site

Scientific Name	Common Name	Federal Status	State Status
	Reptiles		
Alligator mississippiensis	American alligator	Threatened (Similarity of Appearance	Threatened
	Mammals		
Puma concolor cougar	eastern cougar	Endangered	Endangered
	Birds		
Charadrius melodus	piping plover	Threatened	Threatened
Haliaeetus leucocephalus	bald eagle[(a)]	Threatened	Threatened
Mycteria americana	wood stork	Endangered	Endangered
Picoides borealis	red cockaded woodpecker	Endangered	Endangered
	Invertebrates		
Neonympha mitchellii francisci	Saint Francis' satyr butterfly	Endangered	State Rare
	Plants		
Amaranthus pumilus	seabeach amaranth	Threatened	Threatened
Carex lutea	golden sedge	Endangered	Endangered
Dichanthelium hirstii	Hirst's panic grass	Candidate for listing	Endangered
Isotria medeoloides	small whorled pogonia	Threatened	Endangered
Lindera melissifolia	pondberry or southern spicebush	Endangered	Endangered
Lysimachia asperulifolia	rough-leaf loosestrife	Endangered	Endangered
Rhus michauxii	Michaux's sumac	Endangered	Endangered
Schwalbea americana	chaffseed	Endangered	Endangered
Thalictrum cooleyi	Cooley's meadowrue	Endangered	Endangered

Notes:
a) Since the publication of this reference, the bald eagle has been delisted from its "Threatened" status.

Source: Information taken from the NRC's NUREG-1437, Supplement 25.

Table 9.3-7 (Sheet 1 of 2)
North Carolina State-Listed Terrestrial Species Potentially Occurring in the Vicinity of the Brunswick Site

Scientific Name	Common Name	Federal Status	State Status
Mammals			
Corynorhinus rafinesquii	Rafinesque's big-eared bat	Species of Concern	Threatened
Neotoma floridana	eastern wood rat	---	Threatened
Birds			
Falco peregrinus	peregrine falcon	---	Endangered
Sterna nilotica	gull-billed tern	---	Threatened
Reptiles			
Crotalus adamanteus	eastern diamondback rattlesnake	---	Endangered
Micrurus fluvius	eastern coral snake	---	Endangered
Amphibians			
Ambystoma tigrinum	eastern tiger salamander	---	Threatened
Rana capito	Carolina gopher frog	Species of Concern	Threatened
Plants			
Adiantum capillus-veneris	Venus hair fern	---	Endangered
Amorpha georgiana var confusa	savanna indigo-bush	Species of Concern	Threatened
Amorpha georgiana var georgiana	Georgia indigo-bush	Species of Concern	Endangered
Asplenium heteroresiliens	Carolina spleenwort	Species of Concern	Endangered
Astragalus michauxii	Sandhills milk-vetch	Species of Concern	Threatened
Calopogon multiflorus	many-flowered grass-pink	Species of Concern	Endangered
Carex exilis	coastal sedge	---	Threatened
Carya myristiciformis	nutmeg hickory	---	Endangered
Chrysoma pauciflosculosa	woody goldenrod	---	Endangered
Cystopteris tennesseensis	Tennessee bladder-fern	---	Endangered
Eupatorium resinosum	resinous boneset	---	Threatened

Table 9.3-7 (Sheet 2 of 2)
North Carolina State-Listed Terrestrial Species Potentially Occurring in the Vicinity of the Brunswick Site

Scientific Name	Common Name	Federal Status	State Status
Fimbristylis perpusilla	Harper's fimbry	Species of Concern	Threatened
Helenium brevifolium	littleleaf sneezeweed	—	Endangered
Helenium vernale	spring sneezeweed	—	Endangered
Lilaeopsis carolinensis	Carolina grasswort	—	Threatened
Lilium pyrophilum	Sandhills lily	—	Endangered
Lindera subcoriacea	bog spicebush	Species of Concern	Threatened
Lobelia boykinii	Boykin's lobelia	Species of Concern	Threatened
Lophiola aurea	golden crest	—	Endangered
Macbridea caroliniana	Carolina bogmint	Species of Concern	Threatened
Muhlenbergia torreyana	pinebarren smokegrass	—	Endangered
Myriophyllum laxum	loose watermilfoil	Species of Concern	Threatened
Parnassia caroliniana	Carolina grass-of- parnassas	—	Endangered
Parnassia grandiflora	large-leaved grass- of-parnassus	Species of Concern	Threatened
Plantago sparsiflora	pineland plantain	Species of Concern	Endangered
Platanthera integra	yellow fringeless orchid	—	Threatened
Platanthera nivea	snowy orchid	—	Threatened
Pteroglossaspis ecristata	spiked medusa	Species of Concern	Endangered
Pyxidanthera barbulata var brevifolia	Sandhills pixie-moss	Species of Concern	Endangered
Rhexia aristosa	awned meadow-beauty	Species of Concern	Threatened
Rhynchospora macra	southern white beaksedge	—	Endangered
Rhynchospora thornei	Thorne's beaksedge	Species of Concern	Endangered
Sabatia kennedyana	Plymouth gentian	—	Threatened
Solidago pulchra	Carolina goldenrod	—	Endangered
Solidago villosicarpa	coastal goldenrod	—	Endangered
Sporobolus teretifolius	wireleaf dropseed	Species of Concern	Threatened
Stylisma pickeringii var pickeringii	Pickering's dawnflower	Species of Concern	Endangered
Trillium pusillum var pusillum	Carolina least trillium	Species of Concern	Endangered
Utricularia olivacea	dwarf bladderwort	—	Threatened

Source: Information taken from the NRC's NUREG-1437, Supplement 25.

Table 9.3-8 (Sheet 1 of 2)
Federally Listed and State-Listed Aquatic Species Potentially Occurring in the Vicinity of the Brunswick Site

Scientific Name	Common Name	Federal Status	State Status
	Reptiles		
Caretta caretta	loggerhead turtle	Threatened	Threatened
Chelonia mydas	green turtle	Threatened	Threatened
Dermochelys coriacea	leatherback turtle	Endangered	Endangered
Eretmochelys imbricata	hawksbill turtle	Endangered	Endangered
Lepidochelys kempii	Kemp's [Atlantic] ridley turtle	Endangered	Endangered
	Mammals		
Balaenoptera borealis	sei whale	Endangered	---
Balaenoptera musculus	blue whale	Endangered	---
Balaenoptera physalus	fin whale	Endangered	---
Eubalaena glacialis	right whale	Endangered	---
Megaptera novaeangliae	humpback whale	Endangered	---
Physeter macrocephalus	sperm whale	Endangered	---
Trichechus manatus	West Indian manatee	Endangered	Endangered
	Fish		
Acipenser brevirostrum	shortnose sturgeon	Endangered	Endangered
Acipenser oxyrhynchus	Atlantic sturgeon	Species of Concern	Special Concern
Carcharhinus obscurus	dusky shark	Species of Concern	---
Carcharhinus signatus	night shark	Species of Concern	---
Elassoma boehlkei	Carolina pygmy sunfish	Species of Concern	Threatened
Eleotris pisonis	spinycheek sleeper	—	Significantly Rare
Epinephelus drummondhayi	speckled hind	Species of Concern	---
Epinephelus nigritus	Warsaw grouper	Species of Concern	---
Etheostoma perlongum	Waccamaw darter	Species of Concern	Threatened
Evorthodus lyricus	lyre goby	—	Significantly Rare
Fundulus luciae	spotfin killifish	—	Significantly Rare
Fundulus waccamensis	Waccamaw killifish	Species of Concern	Special Concern
Gobionellus stigmaticus	marked goby	—	Significantly Rare
Heterandria formosa	least killifish	—	Special Concern

Table 9.3-8 (Sheet 2 of 2)
Federally Listed and State-Listed Aquatic Species Potentially Occurring in the Vicinity of the Brunswick Site

Scientific Name	Common Name	Federal Status	State Status
Hypsoblennius ionthas	freckled blenny	—	Significantly Rare
Menidia extensa	Waccamaw silverside	Threatened	Threatened
Microphis brachyurus	opossum pipefish	—	Significantly Rare
Noturus sp.	broadtail madtom	—	Special Concern
Odontaspis taurus	sand tiger shark	Species of Concern	---
Poecilia latipinna	sailfin molly	—	Significantly Rare
	Mollusks		
Anodonta couperiana	barrel floater	—	Endangered
Elliptio folliculata	pod lance	—	Special Concern
Elliptio marsupiobesa	Cape Fear spike	—	Threatened
Elliptio roanokensis	Roanoke slabshell	—	Threatened
Elliptio sp.	Waccamaw lance pearlymussel	Species of Concern	---
Elliptio waccamewensis	Waccamaw spike	Species of Concern	Threatened
Fusconaia masoni	Atlantic pigtoe	Species of Concern	Endangered
Helisoma eucosmium = Taphius eucosmius eucosmius	greenfield ramshorn	Species of Concern	Endangered
Lampsilis cariosa	yellow lampmussel	Species of Concern	Endangered
Lampsilis fullerkati	Waccamaw fatmucket	Species of Concern	Threatened
Ligumia nasuta	Eastern pondmussel	—	Threatened
Planorbella magnifica	magnificent ramshorn	Species of Concern	Endangered
Toxolasma pullus	Savannah lilliput	Species of Concern	Endangered
Triodopsis soelneri	Cape Fear threetooth	Species of Concern	Threatened
Villosa delumbis	Eastern creekshell	—	Significantly Rare

Source: Information taken from the NRC’s NUREG-1437, Supplement 25.

Table 9.3-9
Brunswick Site Minority and Low Income Population/Percentages

County	Population (2000)	White (%)	Black (%)	Hispanic (%)	Low Income (%)
Brunswick	73,143	82.3 (60,200)	14.4	2.7	12.6 (9216)
Columbus	54,749	63.4 (34,737)	30.9	2.3	22.7 (12,430)
New Hanover	160,307	79.9 (128,098)	17	2.0	13.1 (21,000)
Pender	41,082	72.7 (29,882)	23.6	3.6	13.6 (5587)
Total	329,281	76.8 (252,887)	23.2 minority (76,393)		14.6 (48,233)

Source: Reference 9.3-004

Table 9.3-10
Federally Listed and State-Listed Terrestrial Species Potentially Occurring in the Vicinity of the H.B. Robinson Site

Scientific Name	Common Name	Federal Status	State Status
	Birds		
Haliaeetus leucocephalus	bald eagle[(a)]	Threatened	Endangered
Picoides borealis	red-cockaded woodpecker	Endangered	Endangered
	Mammals		
Corynorhinus rafinesquii	Rafinesque’s big-eared bat	—	Endangered
	Amphibians		
Hyla andersonii	pine barrens treefrog	—	Threatened
	Plants		
Schwalbea americana	chaffseed	Endangered	Endangered
Lysimachia asperulifolia	rough-leaved loosestrife	Endangered	Endangered
Oxypolis canbyi	Canby’s dropwort	Endangered	Endangered

Notes:
a) Since the publication of this reference, the bald eagle has been delisted from its “Threatened” status.

Source: Information taken from the NRC’s NUREG-1437, Supplement 25.

Table 9.3-11
Federally Listed and State-Listed Aquatic Species Potentially Occurring in the Vicinity of the H.B. Robinson Site

Scientific Name	Common Name	Federal Status	State Status
		Fish	
Acipenser brevirostrum	shortnose sturgeon	Endangered	Endangered
Acipenser oxyrinchus	Atlantic sturgeon	Candidate for listing	—
Etheostoma flabellare	fantail darter	—	Species of Concern
Notropis chiliticus	redlip shiner	—	Species of Concern
Semotilus lumbee	sandhills chub	—	Species of Concern
		Mollusks	
Elliptio congaraea	Carolina slabshell	—	Species of Concern
Elliptio lanceolata	yellow lance	—	Species of Concern
Lasmigona decorata	Carolina heelsplitter	Endangered	Endangered
Pyganodon cataracta	Eastern floater	—	Species of Concern
Villosa constricta	notched rainbow	—	Species of Concern
Villosa delumbis	Eastern creekshell	—	Species of Concern

Source: Information taken from the NRC’s NUREG-1437, Supplement 25.

Table 9.3-12
H.B. Robinson Site Minority and Low Income Population/Percentages

County	Population (2000)	White (%)	Black (%)	Hispanic (%)	Low Income (%) (population)
Darlington	67,394	57.0 (38,402)	41.7	1.0	20.3 (13,680)
Chesterfield	42,768	64.3 (27,500)	33.2	2.3	20.3 (8682)
Lee	20,119	35 (7048)	63.6	1.3	21.8 (4386)
Kershaw	52,647	71.6 (37,701)	26.3	1.7	12.8 (6739)
Sumter	104,646	50.1 (52,462)	46.7	1.8	16.2 (16,953)
Total	287,574	56.7 (163,305)	43.3 minority (124,520)		17.5 (50,440)

Source: Reference 9.3-005

Table 9.3-13
Comparison of Candidate and Potential Sites

Location	HAR Site	Marion County (Greenfield) Site	Brunswick Nuclear Power Plant Site	H.B. Robinson Nuclear Power Plant Site
Land Use	SMALL to MODERATE	MODERATE to LARGE	SMALL	SMALL
Air Quality	SMALL	SMALL	SMALL	SMALL
Water	SMALL	LARGE	SMALL	SMALL to MODERATE
Terrestrial Ecology	SMALL to MODERATE	MODERATE	MODERATE to LARGE	SMALL
Aquatic Ecology	SMALL	SMALL to MODERATE	SMALL	SMALL
Socioeconomics	SMALL	SMALL	SMALL	SMALL
Historic, Cultural, and Archeological Resources	SMALL	MODERATE to LARGE	SMALL	SMALL
Environmental Justice	SMALL	SMALL	SMALL	SMALL
Transmission Corridors	SMALL	LARGE	LARGE	LARGE
Transportation	SMALL to MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Is this Site a Candidate Site (Yes or No)	Yes	Yes	Yes	Yes
Is this Candidate Site a good Alternative Site to the Proposed Site	Yes	Yes	Yes	Yes
Is the Site Environmentally Preferable?	Preferred alternative	No	No	No
Is the Site Obviously Superior?	Preferred alternative	Not Evaluated	Not Evaluated	Not Evaluated

9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

In accordance with NUREG-1555, Section 9.4, this section describes the evaluation of the alternative plant and transmission systems for heat dissipation, circulating water, and power transmission at the HAR. PEC proposes to build and operate two Westinghouse AP1000 units, a certified nuclear plant design under 10 CFR 52, Subpart B.

Throughout this chapter, environmental impacts of the alternatives are assessed using the NRC's three-level standard of significance – SMALL, MODERATE, or LARGE. This standard of significance was developed using the Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Subpart A, Appendix B:

- **SMALL**. Environmental effects are not detectable or are so minor they will neither destabilize nor noticeably alter any important attribute of the resource.
- **MODERATE**. Environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.
- **LARGE**. Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2.

Some clearing and other development will be required for the construction and operation of the HAR units, as discussed in ER Chapters 4 and 5. Potential SMALL to MODERATE adverse impacts were noted for the selected heat dissipation and cooling water systems from the installation of the Cape Fear River intake structures and the associated pipelines for the makeup water. Additionally, SMALL impacts are anticipated from the placement of the transmission lines since existing corridors and existing PEC-owned or other ROW are expected to be utilized. Subsection 9.4.1 discusses alternative heat dissipation systems; Subsection 9.4.2 discusses alternative circulating water systems; and Subsection 9.4.3 reviews transmission systems.

9.4.1 HEAT DISSIPATION SYSTEMS

Generally, heat dissipation systems are dependent on the availability of water resources at the particular site. The potential sources of cooling water at HAR sites could be from freshwater cooling ponds, lake water, or wet cooling towers.

The purpose of the plant cooling system is to dissipate energy to the environment. The condenser creates the low pressure required to draw steam through and increase the efficiency of the turbines. The lower the pressure of the exhaust steam leaving the low-pressure turbine, the more efficiency is gained. The limiting factor is the temperature of the cooling water.

The various heat dissipation system options differ in how the energy transfer takes place and, therefore, have different environmental impacts. Potential alternatives considered were those generally included in the broad categories of “once-through” and “closed-cycle” systems. The once-through method involves the use of large quantity of cooling water, withdrawn from and returned to a large water source following its circulation through the main condenser. Closed-cycle cooling systems involve substantially less water usage, since the water performing the cooling is continually re-circulated through the main condenser 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 purpose of blowdown is to control solids in the water that accumulate due to evaporation, which helps protect surfaces from scaling or corrosion problems. Drift is liquid water that escapes from the heat dissipation system in the form of unevaporated droplets during operation.

For the HAR, the waste heat would be dissipated by a cooling tower(s), which draws cooling water makeup via a new intake structure from Harris Reservoir. Additional water would be pumped from the Cape Fear River via a new intake structure and associated pipeline to maintain the desired operating level for Harris Reservoir. As discussed in ER Section 3.3, the AP1000 reactor will be used for the HAR. The AP1000 is designed to effectively remove or enable removal of heat from the reactor during all modes of operation, including shutdown and accident conditions.

According to guidance provided in NUREG-1555 Environmental Standard Review Plan (ESRP) 9.4.1, this subsection discusses alternatives to the proposed heat dissipation system that was described in Section 3.4. The information provided in this subsection is based on a report generated by the applicant, *Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle* (Reference 9.4-001). A summary of the environmental impacts of the heat dissipation system alternatives is provided in Table 9.4-1. As indicated in Table 9.4-2 (single hot year weather), indicates that the generation benefits partially offset the high initial cost of the two natural draft towers. The generation benefits analysis is repeated in Table 9.4-3 for the average weather year.

Heat dissipation systems are generally included in the broad categories of “once-through” and “closed-loop” systems. The once-through method involves the use of a large quantity of cooling water, withdrawn from a water source and returned to that source (receiving body of water) following its circulation through the normal heat sink (i.e., main condenser). Closed-loop cooling systems use substantially less water because the water performing the cooling is continually recirculated through the normal heat sink (i.e., the main condenser), and only makeup water for evaporative losses and blowdown is required. In closed-loop systems, two pumping stations are usually required — a makeup water system and a cooling water system. Closed-loop systems include cooling towers and a cooling pond or a spray pond. As a result of the evaporation process, the concentration of chemicals in the water will increase. To maintain acceptable water chemistry, water must be discharged at a small rate (blowdown) and compensated by a makeup water source.

Heat dissipation systems are categorized as wet or dry, and the use of either system depends on the site characteristics. Both wet and dry cooling systems would use water as the heat exchange medium. A wet cooling tower cools water circulated through the tower. Heat from the water is dissipated by direct contact with air circulating through the tower. The heat transfer takes place primarily by evaporation of some of the water into the air stream (latent heat transfer). Generally, a relatively minor amount of sensible heat transfer (heating of the air and cooling of the water) also occurs. During very cold weather, the amount of sensible heat transfer can be fairly substantial. On the other hand, during a warm, dry summer day, the amount of sensible heat transfer might be nil or even negative (when negative, the air discharged from the tower is cooler than the ambient dry bulb). This does not adversely affect the cold-water performance of mechanical draft towers but does affect evaporation rate. The wet cooling tower is used widely in the industry and is considered a mature technology.

Because wet cooling towers provide direct contact between the cooling water and the air passing through the tower, some of the liquid water could be entrained in the air stream and be carried out of the tower as "drift" droplets. The magnitude of drift loss is influenced by the number and size of the droplets produced within the cooling tower. The droplets, in turn, are influenced by the fill design, the air and water patterns, and other interrelated factors. Tower maintenance and operation levels can influence the formation of drift droplets. For example, excessive water flow, excessive air flow, and water bypassing the tower drift eliminators can promote and/or increase drift emission. To reduce the drift from cooling towers, drift eliminators usually are incorporated into the tower design to remove as many droplets as practical from the air stream before exiting the tower. The drift eliminators rely on inertial separation of the droplets, caused by direction changes, while passing through the eliminators. Types of configurations for drift eliminators include herringbone, wave form, and cellular (or honeycomb) designs. The cellular units are generally the most efficient. Drift eliminators include various materials, such as ceramics, fiber-reinforced cement, fiberglass, metal, plastic, and wood installed or formed into closely spaced slats, sheets, honeycomb assemblies, or tiles. The materials might include other features, such as corrugations and water removal channels that enhance the drift removal further (Reference 9.4-002).

9.4.1.1 Screening of Alternative Heat Dissipation Systems

PEC performed a heat rejection system optimization study for the HAR 2 and HAR 3 AP1000 pressurized water reactor, and the alternatives evaluated were those generally included in the broad category of "closed-loop" systems (Reference 9.4-001).

The result of the evaluation identified two additional natural draft cooling towers, one per AP1000 unit, as the preferred heat dissipation system for HAR 2 and HAR 3. The proposed cooling towers will be hyperbolic natural draft cooling towers with counterflow.

Heat dissipation system alternatives were evaluated by the applicant and the alternatives considered were those generally included in the broad categories of "once-through" and "closed-loop" systems. Other heat dissipation systems such as dry cooling systems, hybrid wet/dry cooling systems, and once-through cooling were considered but rejected early in the process. These alternatives were eliminated from further consideration because it was determined that these systems were not environmentally preferred alternatives, given the location of the plant and existing infrastructure at the HNP. A summary of the environmental impacts of the heat dissipation system alternatives is provided in Table 9.4-1.The closed-loop category includes the following types of heat dissipation systems:

- Wet cooling systems (closed-loop cooling system):
  - Single natural draft hyperbolic cooling tower per one AP1000 unit.
  - Two natural draft hyperbolic cooling towers per one AP1000 unit.
  - Three round mechanical draft cooling towers per one AP1000 unit.
- Dry cooling tower systems.
- Hybrid wet/dry cooling tower system.
- Once-through cooling system.

An initial evaluation of the closed-loop alternative and the once-through cooling alternative designs was performed to eliminate systems that are unsuitable for use in the HAR.

Harris Reservoir was originally designed to provide cooling water for four reactor units and to remove the design heat load from the cooling tower blowdown water associated with those units. During construction activities for all units, a decision was made to reduce the number of units to one; therefore, only the HNP was completed. Given the existing cooling water capacity potential, construction of an additional cooling pond was considered unnecessary and not practicable for HAR.

The spray pond alternative is similar to cooling ponds because it involves the creation of new bodies of surface water. Spray modules are included to promote evaporative cooling in the ponds, which reduces the land requirements. However, this advantage is offset by higher operating and maintenance costs for the spray modules. This alternative is considered unsuitable for the HAR site for the same reasons that cooling ponds are unsuitable.

9.4.1.1.1 Dry Cooling Tower Systems

Dry cooling is an alternative cooling method in which heat is dissipated directly to the atmosphere using a tower without the evaporative loss of water. This tower transfers the heat to the air by conduction and convection rather than by evaporation. The condenser coolant is enclosed within a piping network with no direct air to water interface. Heat transfer is then based on the dry bulb temperature of the air and the thermal transport properties of the piping material. Both natural and mechanical draft can be used to move the air. While water loss is less for dry cooling towers than wet cooling towers, some makeup water is typically required.

There are two types of dry cooling systems for power plant applications: direct dry cooling and indirect dry cooling. Direct dry cooling systems utilize air to directly condense steam, while indirect dry cooling systems utilize a closed-cycle water cooling system to condense steam, and the heated water is then air cooled. Indirect dry cooling generally applies to retrofit situations at existing power plants because a water-cooled condenser would already be in place for a once-through or recirculated cooling system (Reference 9.4-003).

Because there is no evaporative or drift losses in this type of system, many of the problems of conventional cooling systems are eliminated. For example, there are no problems with blowdown disposal, water availability, chemical treatment, fogging or icing when dry cooling towers are utilized. Although the elimination of such problems is beneficial, the dry towers have associated technical obstacles such as high turbine backpressure, and possible freezing in cooling coils during periods of light load and startup.

This is an inherently less efficient process and required an extensive heat transfer surface area of metal fin tubing within the tower, which could be either mechanical or natural draft. In this system, the temperature of the water leaving the tower could only approach the dry-bulb temperature of air which was invariably higher than the wet-bulb temperature approached by the wet towers.

PEC concluded that this alternative is not suitable for the reasons discussed in the USEPA preamble to the final rule addressing cooling water intake structures for new facilities (Reference 9.4-004). Dry cooling carries not only high capital but operating and maintenance costs that are sufficient to pose a barrier to entry to the marketplace for some facilities. In addition, dry cooling has a detrimental effect on electricity production by reducing the efficiency of steam turbines. Dry cooling requires the facility to use more energy than would be required with wet cooling towers to produce the same amount of electricity. This energy penalty is most significant in warmer southern regions during summer months when the demand for electricity is at its peak. The energy penalty would result in an increase in environmental impacts, because replacement of the generating capacity would be needed to offset the loss in efficiency from dry cooling. USEPA concluded that dry cooling is appropriate in areas with limited supplies of water available for cooling or where the source of cooling water is associated with extremely sensitive biological resources (e.g., endangered species and specially protected areas). The conditions at the HAR site do not warrant further consideration of dry cooling. A summary of the environmental impacts of the dry cooling tower heat dissipation system alternative is provided in Table 9.4-1.

Additionally, the thermal performance of the dry cooling tower is only dependent on the dry-bulb temperature of the entering air, therefore the cold water temperature attainable could be 20 degrees Fahrenheit (°F) to 30°F higher than would be expected from a normal evaporative-type cooling tower. This warmer circulating water temperature would result in maximum turbine backpressures that are higher than AP1000 standard turbine trip set point of 7.4 inches of mercury (absolute).

9.4.1.1.2 Hybrid Wet/Dry Cooling Tower System

Hybrid wet/dry cooling tower systems are used primarily in areas where plume abatement is necessary for aesthetic reasons or to minimize fogging and icing produced by the tower plume. Dry/wet cooling towers use approximately one-third to one-half less water than wet cooling towers (Reference 9.4-003). Additionally, somewhat more land is required for the dry/wet cooling tower due to the additional equipment (fans and cooling coils) required in the tower assembly. The same disadvantages described above for dry cooling towers would apply to the dry cooling portion of the dry/wet cooling tower. The dry cooling process is not as efficient as the wet cooling process because it requires the movement of a large amount of air through the heat exchanger to achieve the necessary cooling. This results in less net electrical power for distribution. Consequently, an increase would occur in environmental impacts because replacement generating capacity would be needed to offset the loss in efficiency from dry cooling. Therefore, this alternative is not considered to be environmentally preferable to the proposed natural draft wet cooling towers. A summary of the environmental impacts of a hybrid wet/dry cooling tower heat dissipation system alternative is provided in Table 9.4-1.

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. In the dry section, the fans are located above the wet level in front of the heat exchangers. The hyperbolic shell achieves a natural draft effect that helps reduce power consumption.

9.4.1.1.3 Once-Through Cooling System

In a once-through cooling system, water is withdrawn from a body of water, passes through the heat exchanger, and is discharged back to the same source. The discharged water temperature is higher than the intake water due to the warmth gained when passing through the heat exchanger.

Based on the current Harris Reservoir configuration and size, the once-through cooling alternative would not support the cooling requirements for the proposed units. Additionally the once-through design could have a LARGE environmental impact by discharging high-temperature water (delta t of more than 13.9°C [delta t of 25°F] higher than intake) at 31.55 m^3/s (1114.01 ft^3/s) or 500,000 gpm per unit. Therefore, the temperature rise after mixing could not meet the criteria a sufficient amount of time to justify the once-through cooling system.

Once-through cooling would pose risks of thermal effects and damage to aquatic organisms. USEPA regulations (40 CFR Part 125) governing cooling water intake structures under Section 316(b) of the Clean Water Act (CWA) make the use of once-through cooling systems difficult for steam electricity-generating plants (Reference 9.4-004). For these reasons, impacts from once-through cooling systems were considered LARGE and, therefore, eliminated from further consideration. A summary of the environmental impacts of the once-through cooling heat dissipation system alternative is provided in Table 9.4-1.

Only mechanical draft and natural draft cooling towers are considered suitable heat dissipation systems for the HAR site and were evaluated in detail. Because natural draft cooling towers were selected as the preferred heat dissipation system for the HAR 2 and HAR 3 (see ER Section 5.3), the two natural draft cooling towers, one per AP1000 unit, are evaluated further in Subsection 9.4.1.2. In accordance with NUREG-1555, the heat dissipation alternatives were evaluated for land use, water use, and other environmental requirements (Table 9.4-1).

9.4.1.1.4 Mechanical Draft Cooling Tower

A mechanical draft water-cooling tower induces or forces air through the tower by one or more fans built into the tower. Mechanical draft towers are divided into two basic designs: forced draft or induced draft. Mechanical draft cooling towers consist of forced draft towers, which contain side fans that force the air through the system, and induced draft cooling towers, which contain overhead fans that pull the air through the system. Mechanical draft cooling towers are often used in smaller cooling tower systems. Mechanical draft cooling towers may also employ a crossflow or counterflow design. Round mechanical draft towers consists of shared fans that are clustered in the center of the tower (crossflow [XF] towers) or uniformly spaced on the fan deck (counterflow [CF] towers). An XF tower is designed so that the air and water are mixed at a 90-degree angle. A CF cooling tower design allows vertically falling water to mix with vertically rising, cooling air at an angle of 180 degrees. Generally XF and CF cooling towers have similar drift loss. Water to be cooled is pumped to a hot water distribution system above the fill and falls over the fill to the cold water basin. Air is drawn through the falling water by a fan, which results in the transfer of heat from the water to the air, and the evaporation of some of the water. The fill serves to increase the air-water contact surface and contact time, thereby promoting heat transfer. A mechanical draft cooling tower employs large fans to either force or induce a draft that increases the contact time between the water and the air maximizing the heat transfer. A forced draft tower has the fan mounted at the base, forcing air in at the bottom and discharging air at low velocity through the top. An induced draft tower uses fans to create a draft that pulls air through the cooling tower fill. A typical mechanical draft cooling tower has a loading capacity of 1.4 to 4.1 liters per second per square meter (l/[s/m^2]) (2 to 6 gpm per square foot [gpm/ft^2]) (Reference 9.4-005). Additionally, a rectangular mechanical draft cooling tower consists of a continuous row of rectangular cells in a side-by-side arrangement sharing a common cold water basin.

Most mechanical draft towers are wood-framed structures based on cost considerations. Wood towers generally are constructed of treated redwood or treated Douglas fir. Redwood is a better material but has become increasingly expensive in recent decades and now is seldom used for new construction. In addition, such wood has to be treated for outdoor use with copper arsenate (CCA) or similar compounds. Concerns over leaching chromium, copper, and arsenic compounds into the environment have resulted in decreased usage of treated lumber and has spurred research into alternative wood preservation methods. Wooden structures are not considered to be a preferable option. Wood towers offer the shortest life expectancy, leach the preservative chemicals (chromated copper arsenate [CCA] or acid copper chromate [ACC]) with which they are treated into your blowdown and tower sediment, and require a pH balance below 8.5, but they are relatively inexpensive to build and repair. A summary of the environmental impacts of round mechanical draft cooling tower heat dissipation system alternative is provided in Table 9.4-1.

Other materials commonly used for mechanical draft towers are ceramic, fiberglass, steel, or concrete. Although ceramic cooling towers offer aesthetic advantages over other cooling towers constructed of other materials, they are typically more expensive. Due to their resistance to severe weather, fiberglass cooling towers are considered to be useful in harsher environmental conditions. Additionally, these cooling towers also provide good corrosion resistance, which remains advantageous in applications when the tower is exposed to chemicals, such as in water treatment. Fiberglass is considered to be stronger than Douglas fir and redwood, and because it is available in long lengths, it allows a cooling tower to be designed and built with a minimum number of airflow obstructions. Concrete towers will last the longest, but are the most expensive to build.

The use of mechanical draft towers would require three round towers with thirty-six- 250 BHP motors. The mechanical draft tower was dropped from further consideration based on space requirements, added house load and added maintenance requirements (Reference 9.4-006).

9.4.1.2 Analysis of the Preferred Alternative Natural Draft Hyperbolic Cooling Tower

A cooling tower relies on the latent heat of water evaporation to exchange heat between the process and the air passing through the tower. In a cooling tower, warmer water is brought into direct contact with the cooler air. When air enters the cooling tower, its moisture content is generally less than saturation. When the air exits, it emerges at a higher temperature and with moisture content at or near saturation. Even at saturation, cooling can take place because a temperature increase results in an increase in heat capacity, which allows better absorption of sensible heat. A natural draft cooling tower induces the air flow by generating warm moist air that is less dense than the ambient air, which results in a convection flowing up the tower. This air convection cools the water on contact. Because of the tremendous size of these towers (typically 152.4 m [500 ft.] high, and 121.9 m [400 ft.] in diameter at the base), they are generally used for flow rates above 12,620 l/s (200,000 gpm), generally the flow rates used in utility power stations in the United States (Reference 9.4-005). They are generally loaded at about 1.4 to 2.5 $l/s/m^2$ (2 to 4 gpm/ft^2). Natural draft towers are however, infrequently used for installation in the United States (Reference 9.4-003).

The preferred heat dissipation system for HAR 2 and HAR 3 is the addition of two natural draft cooling towers (one per unit) with makeup water from Harris Reservoir as the best closed-loop option for circulating water system in the heat dissipation system. As discussed in Chapter 3, the heat dissipation system could have a height of up to 327 m (523 ft.) and would slightly alter the visual aesthetics of the site. Any visual effects from the visible plumes from the facility would be similar to those associated with the other nuclear power plants and that of the present cooling tower for HNP.

An additional visible plume potentially could result from the heat dissipation system. As discussed in Subsection 9.4.1, the proposed cooling towers will be hyperbolic natural draft cooling towers with counterflow. As this type of cooling tower operates without fans, the substantial amount of electric power otherwise required for large cooling tower systems is not needed. The required cooling air is conveyed through the tower by natural draft; therefore, neither fan nor fan power is required.

The proposed cooling towers will be very similar to the existing tower, consequently, lack of adverse observations relating to this tower are the most indicative evidence of the limited potential for adverse effects from the proposed cooling towers. Several important terrestrial species exist within the vicinity of the proposed cooling tower (see ER Sections 2.4 and 4.3). Operation of the heat dissipation system is not expected to have an adverse effect on any terrestrial species due to the height of plume release, minimal amounts of solids deposition, and the historical existence of a cooling tower; therefore, no mitigation is warranted.

The evaporation rate for the proposed cooling towers is estimated to be 1.82 m^3/s (64.30 ft^3/s) or 28,860 gpm during normal operations (Reference 9.4-007). The combination of three cooling towers (one existing and two proposed) creates the possibility of a mixed-plume larger than the single visible plume from the existing cooling tower. The greatest frequency of visible plumes is expected to occur during the winter and fall months due to increasing ambient moisture contents and decreasing temperatures. The greatest frequency of plumes is expected to the north of the plant and the longest plumes are expected to the southwest of the plant. Due to the release elevation and plume rise, the additional water and heat released to the atmosphere by the cooling tower plumes will have a SMALL effect. Mitigation is not required.

Water droplets from the cooling tower will contain the same concentration of dissolved and suspended solids as the water within the cooling tower basin. The dissolved and suspended solid concentrations in the cooling tower basins will be controlled via use of the makeup and blowdown water lines from and to Harris Reservoir. The effect from solids deposition will be SMALL and will not require mitigation. Additionally, cloud shadowing, localized increases to precipitation, and increased ground level humidity is possible when a visible plume occurs. However, the increases are expected to be SMALL and mitigation is not warranted.

As discussed in ER Chapter 4, construction of the HAR 3 cooling tower will result in filling an approximate 1-ha (2-ac.) man-made pond. This pond was created during construction of the first reactor as a source of water for fire control until Harris Reservoir filled. There are no industrial, municipal, commercial, or agricultural users of this pond, which has not been used since the reservoir was filled.

Potential impacts to land use from cooling towers are primarily related to salt drift. New cooling towers would be assumed to produce salt concentrations similar to cooling towers at existing nuclear power plants. In addition, fogging, icing, or drift damage potentially could result from a cooling tower plume. While the potential exists for minor salt drift, fogging, and icing to occur, it is expected to be of such SMALL magnitude that no land use changes would result.

Adverse effects on any terrestrial species are not expected to be caused by operation of the heat dissipation system, by the height of the plume released, or by minimal amounts of solids deposition. The historical existence of a cooling tower supports this position; thus, no mitigation is warranted. Salt drift, vapor plumes, localized precipitation modifications, and noise might have a small effect on the terrestrial ecosystem but will not warrant mitigation. Impacts to bird species from collisions with the proposed cooling towers and from shoreline vegetation changes are expected to be SMALL and will not warrant mitigation.

9.4.1.3 Summary of Alternative Heat Dissipation Evaluation

The information provided in this subsection about the evaluation conducted for the heat rejection system optimization study is from a report generated by the applicant (Reference 9.4-001).The evaluation assumed that if the predicted differences in net economic benefit were small, then other considerations might be given higher consideration. Other considerations include aesthetics, corporate preferences related to operations and maintenance issues, first cost, risk associated with tower technology or vendor capability, and associated site work for arrangement and fit of cooling water piping fit up to tower.

In addition to the above evaluation, a review of cooling of tower blowdown in hot months was performed. Sizing the main towers to maintain tower blowdown to temperatures below expected environmental constraints was not practical. Therefore, blowdown cooling options were reviewed and a recommended option was selected. A summary of the environmental impacts of the three cooling tower alternatives (single natural draft hyperbolic, two natural draft hyperbolic, and three round mechanical draft) are provided in Table 9.4-1.

Each of the cooling tower options was evaluated at three different circulating water flow rates-31.55 m^3/s (1114.01 ft^3/s) or 500,000 gpm, 37.85 m3/s (1336.81 ft^3/s) or 600,000 gpm, and 39.75 m^3/s (1403.65 ft^3/s) or 630,000 gpm using two different weather profiles (the representative ‘hot’ year and the ‘average’ year). In addition, two energy rates were applied to the net production differences between the base case and each option (Reference 9.4-001). For this evaluation, ‘net’ power referred to gross production less the circulating water pump and tower fan power consumed for each option. Auxiliary power serving the power block was common to all options and therefore was not considered for the evaluation. For the base case, a single natural draft hyperbolic tower with 37.85 m^3/s (1336.81 ft^3/s) or 600,000 gpm circulating water flow was used.

It was determined that the environmental impacts of the three cooling tower alternative evaluated were SMALL to MODERATE. Therefore in considering the comparison of the various cooling tower options, three main costs/benefits were considered:

- Production — Calculated the detailed net present value for production benefits for an average and the hot single year of plant operation for each cooling tower option.

- Initial Cost — Initial ‘overnight’ cooling tower cost was based on vendor input and expected cost differences associated with procurement, support systems, and general contractor items to integrate the towers into the site.

- Maintenance — Inspection and maintenance (replacement parts) cost differences were considered over the anticipated 60 years of the plant life.

Because the evaluation was performed at different circulating water flows, temperatures, and condenser heatloads, a separate evaluation was performed to determine the condenser backpressure at these operating conditions. The methodology used in the evaluation allowed for condenser backpressure to be determined for a given steam loading, condenser surface area, circulating water temperature and flow rate, condenser cleanliness, tube material, and other plant specific parameters. The condensing temperatures then are computed based on this input. The condenser backpressure is then the saturation pressure at the condensing temperature.

The evaluation used weather data for Raleigh, North Carolina, from 1961 to 1990 to develop a hottest and an average year based on hourly wet bulb temperatures (Reference 9.4-001). The average year weather data were developed from the 30 years of the meteorological data by averaging the hourly wet bulb temperatures and relative humidities to generate a single year of average weather.

In addition to the differences in the initial cost of construction for each of the cooling tower options, some differences exist in the expected maintenance cost that were included in the overall economic evaluation. These include the following:

- Inspection and replacement of the cooling tower fill.
- Inspection and replacement of the distribution piping/nozzle.
- Inspection and maintenance of mechanical components.
- Replacement of mechanical components.

Blowdown from the towers, whether of natural or mechanical draft design, is required to maintain tower water chemistry within design limits. Blowdown will be regulated by environmental permit. Although a maximum blowdown temperature was not identified, the evaluation assumed that the blowdown would be limited to a maximum temperature of 32.8°C (91°F); however, this temperature will be established as a part of the final NPDES permitting process. The current regulations for new generation do not refer to a maximum blowdown temperature, but do refer to the temperature mixing zone. The measurement of mixing zone temperatures and averaging periods currently might not be defined.

With expected extreme wet-bulb temperatures in the range of 25.6 to 27.2°C (78 to 81°F), and expected approach temperatures for aged towers to be in the range of 8.3 to 11.1°C (15 to 20°F), it might not be prudent to expect that blowdown temperatures and associated mixing zone temperature will comply with environmental regulations (Reference 9.4-001). A forced downpower to address periodically high blowdown temperatures might not be economical. As a result, the following options were considered to address high blowdown temperatures:

- Blowdown Tower — A dedicated (small) cooling tower for blowdown could be included in the design. However, in addition to operating and maintenance expense, such a tower would have the same difficulty in achieving the close-approach temperature needed to meet the environmental limit (as would the main tower). With the complexity and cost of a separate tower that would be used only a small fraction of operating hours; this alternative is not practical or cost effective.

- Cooling Blowdown using Makeup — For this option, blowdown is cooled, as necessary, by makeup using a plate-and-frame heat exchanger. Large units such as these are equipped with titanium or stainless steel plates for freshwater duty. These units are capable of very close approach temperatures (approaches in the range of 1.9 to 2.8°C [3.5 to 5.0°F] are economically achievable). A single unit is capable of flow in excess of 0.95 m^3/s (33.42 ft^3/s) or 15,000 gpm, and likely could accomplish the total blowdown cooling duty for two units (Reference 9.4-001).

  Because blowdown and makeup are operated simultaneously, the design will essentially always have a cooling medium. Further, the design is passive without requirements for power-actuated valves or devices. Blowdown is either gravity fed or pump driven, depending on plant layout. The plate-and-frame heat exchanger would not impact this aspect of the blowdown system design.

  Because heating of the makeup adds to the tower heat load and costs some plant efficiency, a bypass is included in the design such that cooling would be effected only when required by permit. This flow balancing through and around the heat exchanger likely could be performed as a seasonal activity (without the need for automated valves and associated instrumentation). Flow balancing would assist in improvement of the heat rate without the associated capital, operating, and maintenance costs of automated equipment

  Because the heat exchanger is passive and has high anticipated reliability, and it is expected that it will only occasionally require cleaning, there is no required redundancy for this equipment. The unit can simply be bypassed during the short time frame associated with disassembly for cleaning.

  A makeup/blowdown system designed to cool blowdown (as necessary) using makeup in a plate-and-frame heat exchanger could be a cost-effective alternative to reliably maintain blowdown and mixing zone temperatures within environmental limits. This approach would eliminate constraints on main tower performance and avoid unit downpowers (for this issue). Because a cost-effective alternative to address the environmental permitting issue associated with blowdown heat load is available and common to all alternatives, the need for and cost of this supplemental cooling option was not evaluated further.

To prevent any undesirable impact of the hot makeup water on the service water system (makeup system is planned to be common for service water and circulating water) the plate-and-frame heat exchanger should be installed only on the circulating water leg of the makeup system.

The cooling tower performance evaluation demonstrated that the two natural draft cooling towers, one per AP1000 unit, design resulted in the largest yearly gross generation revenue for all cases considered. However, this is also the cooling tower alternative with the highest initial cost. The simplified economic evaluation shown in Table 9.4-2 incorporates the initial tower cost and maintenance differences along with the generation revenue differences for the expected 60-year life of the plant for the cases with an assumed 37.85 m^3/s (1336.81 ft^3/s) or 600,000 gpm of circulating water flow (Reference 9.4-001).

The generation benefits shown in Table 9.4-2 (single hot year weather) indicate that partially offset of the high initial cost of the two natural draft towers, one per AP1000 unit. For the high (2005 year) energy rate, the mechanical draft tower has the lowest overall cost (net present value) The single natural draft tower was next in cost (-$9,616,000) and the two natural draft towers cost the most (-$13,439,000). Costs are per one AP1000 unit.

For the average (2004 year) energy rate, the mechanical draft tower has the lowest overall cost (net present value) with the single natural draft tower next (-$8,019,000) and the two natural draft towers with the highest costing the most (-$19,970,000) per one AP1000 unit (Reference 9.4-001).

The summary shown in Table 9.4-3 (single average year weather) indicates that the generation benefits partially offset the high initial cost of the two natural draft towers, one per AP1000 unit. For the high (2005 year) energy rate, the mechanical draft tower has the lowest overall cost, with the single natural draft tower next (-$3,772,000) and the two natural draft towers costing the most (-$13,835,000) per one AP1000 unit.

For the average (2004 year) energy rate the mechanical draft tower has the lowest overall cost with the single natural draft tower next (-$3,708,000) and the two natural draft towers costing the most (-$20,213,000) per one AP1000 unit (Reference 9.4-001).

These differences in impacts are SMALL for the HAR site. These alternatives for heat dissipation systems are considered environmentally equivalent.

9.4.2 CIRCULATING WATER SYSTEM

In accordance with NUREG-1555 ESRP 9.4.2, this subsection presents a discussion of alternatives to the following components of the circulating water system (CWS) for the HAR: intake systems, discharge systems, water supply, and water treatment processes.

As stipulated in NUREG-1555 ESRP 9.4.2, this subsection should present only those alternatives that are:

- Applicable at the HAR site.

- Compatible with the proposed heat dissipation system.
- Feasible for construction and operation at the proposed site.
- Not prohibited by federal, state, regional, or local regulations nor affected by Native American tribal agreements.
- Consistent with any of the NPDES or the Federal Water Pollution Control Act (FWPCA), commonly referred to as the CWA findings.
- Can be judged as practicable from a technical standpoint with respect to the proposed dates of plant construction and operation.

The CWS is an integral part of the heat dissipation system. It provides the interface between (1) the normal heat sink, main steam turbine condenser (heat exchanger), where waste heat is discharged from the steam cycle and is removed by the circulating water, and (2) the heat dissipation system where the heat energy is then dissipated or transferred to the environment.

Essentially, two CWS are available for removing this waste heat, once-through (open-loop) and recycle (closed-loop) systems. In once-through cooling systems, water is withdrawn from a cooling source, passed through the condenser, and then returned to the source (receiving body of water). In the recycle (closed-loop) cooling system, heat picked up from the condenser by the circulating water is dissipated through auxiliary cooling facilities, after which the cooled water is recirculated to the condenser.

As discussed in Chapter 4, the HAR site will use surface water from Harris Reservoir for domestic, process, and cooling tower makeup water. No groundwater is used at the HAR site. Water from the Cape Fear River would be used to increase the water level of Harris Reservoir approximately 6 m (20 ft.) to provide adequate cooling tower makeup water for HAR 2 and HAR 3. As discussed in Subsection 9.4.1, the CWS for HAR 2 and HAR 3 would be a closed-loop system, including concrete-volute pumps and piping, a water retention basin, and two concrete natural draft hyperbolic cooling towers. Freshwater from the CWS would be pumped from the cooling tower basin through the main steam turbine condensers and turbine plant auxiliary heat exchangers, where heat transferred to the cooling water in the condenser would be dissipated to the atmosphere by evaporation, cooling the water before its return to the condenser. The water from the cooling system lost to the atmosphere through evaporation must be replaced. In addition, this evaporation would increase the level of solids in the circulating water. To control solids, a portion of the recirculated water must be removed (generating blowdown) and replaced with clean water. In addition to the blowdown and evaporative losses, a small percentage of water in the form of droplets (drift) would be lost from the cooling tower. Water pumped from the Harris Reservoir (see Subsection 9.4.2.1) intake structure would be used as the source for makeup water to replace water lost by evaporation, drift, and blowdown from the cooling tower. Blowdown water would be returned to Harris Reservoir via the existing discharge flume structure (see Subsection 9.4.2.1).

9.4.2.1 Intake and Discharge Systems

This subsection provides a discussion of the intake and discharge alternatives reviewed by PEC for HAR.

For both once-through and closed-loop cooling systems, the water intake and discharge structures can be of various configurations to accommodate the source body of water and to minimize impacts to the aquatic ecosystem. The intake structures generally are located along the shoreline of the body of water and are equipped with fish protection devices. The discharge structures are generally of the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Biocides and other chemicals used for corrosion control and for other water treatment purposes can be mixed with the condenser cooling water and discharged from the system. Only biocides or chemical additives that are approved by USEPA and North Carolina as safe for humans and the constituent discharged to the environment will satisfy requirements established in the NPDES permit.

Cooling water intake structures (CWIS) are typically regulated under Section 316(b) of the federal CWA (Reference 9.4-008) and under Section 15A of the North Carolina Administrative Code (NCAC) 2H.0100, which sets the procedure used to apply for, develop, and issue wastewater discharge permits (Reference 9.4-009). However, a federal court decision in January 2007 changed that regulatory process. The regulations that implemented Section 316(b) were suspended, and USEPA recommended that all permits formerly under Section 316(b) for Phase II facilities should include conditions developed on a best professional judgment basis (Reference 9.4-010).

According to the North Carolina NPDES, a mixing zone could be established in the area of a discharge to provide reasonable opportunity for the mixture of the discharge with the receiving waters. Water quality standards will not apply within regions defined as mixing zones. The limits of such mixing zones will be defined by the North Carolina Division of Water Quality (DWQ) on a case-by-case basis after consideration of the magnitude and character of the discharge and the size and character of the receiving waters. For the discharge of heated wastewater, compliance with federal rules and regulations pursuant to Section 316(a) of the CWA, as amended, shall constitute compliance with Subparagraph (b) of this Rule (Reference 9.4-011). Thermal wastewater discharges in North Carolina are subject to effluent limitations under Section 15A NCAC 02B.0211 (3) (j). This rule limits thermal discharges to 2.8°C (5.04°F) above the natural water temperature and includes further restrictions based on geographic regions of the state. Exceptions to these limits are allowed under the temperature variance provisions of the CWA, Section 316(a). Under this provision, permittees must demonstrate that the variance for the thermal component of the discharge ensures the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in the receiving water.

Intake and discharge structures will be required for operation of the HAR. No long-term physical changes in land use are anticipated from construction of the water intake structure, the pumphouse, and the makeup-water pipeline corridor. Construction activities will cause only temporary effects to streams and wetlands.

Long-term changes in land use from operation of the HAR 2 and HAR 3 will be associated primarily with the roads, cooling/heat dissipation systems, makeup water pipeline, intake structure, and pumphouse, as well as with the increase in the water level in the Main Reservoir. The long-term impacts on land use are expected to be moderate, caused primarily by the increased water level of approximately 6 m (20 ft.) in Harris Reservoir.

Short-term changes in land use from operation of the HAR 2 and HAR 3 will be associated primarily with impacts resulting from the increase in the water level of Harris Reservoir. Short-term changes in land use would be minor and would include recreational areas, roads, HAR facilities, municipal facilities, and ecological issues.

During HAR construction activities, the potential main effect to water use will be short term, consisting of temporary increases in the suspended solids concentrations of water drawn into the existing water systems at HNP. Long-term effects are less significant, consisting of temporary increases in the sediment loading to the Main Reservoir and the loss of capacity in the reservoir with associated ecological and cooling water storage issues.

As discussed in Subsection 2.4.2.2, a significant amount of wetlands exist within the 67.1-m to 73.2-m (220- to 240-ft.) NVGD29 contours. These wetlands will be delineated according to USACE guidelines and mitigation measures will be implemented prior to construction. Potential mitigation strategies include the creation of wetlands along the new perimeter of Harris Reservoir, particularly in areas with gradual slopes and suitable underlying soils. Other possibilities for mitigation include creating wetlands in areas already undergoing earthmoving activities or the acquisition of additional land that would support wetland mitigation. Mitigation activities will require careful planning and close coordination with the NCDENR to determine if the North Carolina Ecosystem Enhancement Plan is an appropriate mitigation strategy.

Measures such as accepted best management practices (BMPs) will be taken during construction to minimize effects to ground and surface waters. Construction will be conducted when conditions in streams are low flow or dry. All relevant federal, state, and local permits and regulations will be followed during construction activities. Adhering to the conditions specified in the permits and regulations should minimize temporary effects. Specific erosion control measures will be implemented to minimize effects to Harris Reservoir (i.e., the Main Reservoir and the Auxiliary Reservoir) and existing HNP operations. In addition, HAR site preparation and construction activities will comply not only with BMPs but also with federal, state, and local regulations to prevent adverse aquatic ecological effects along the perimeter of Harris Reservoir. PEC is committed to conducting a Phase 1 cultural resource assessment for the HAR site to determine the potential to affect cultural resources (such as archaeological, historical, or architectural resources).

During HAR site preparation, construction activities such as clearing and grading activities will have localized noise and air quality effects. Construction noise will occur during construction activities and while installing equipment (such as turbines, generators, pumps, transformers, and switchyard equipment). As a result, background noise levels will increase in the short term. To minimize the increased ambient noise, mitigation measures will be implemented. Additionally, controls will be implemented to mitigate potential air emissions from construction sources. Slight but negligible increases in emissions of particulate matter and combustion by-products might occur during HAR site preparation and construction activities. Construction-related dust and air emissions from equipment, which are expected to be minimal, would be controlled by implementing mitigation measures.

HAR site preparation and construction activities could result in some temporary visual aesthetic disturbance. Because these impacts will be temporary, no long-term indirect or cumulative impacts to visual aesthetics are expected.

9.4.2.1.1 Intake System

HNP collects cooling tower makeup water at the cooling tower makeup water intake structure located on the Thomas Creek branch of Harris Reservoir east of the HNP site. After cooling, the blowdown water will be discharged into Harris Reservoir through a pipeline at a location north of the Main Dam.

The Cape Fear makeup water intake structure is too be located in the cove adjacent to the Buckhorn Dam, routing of the makeup water pipeline north from the intake connecting with the PEC transmission line, and continued pipe routing along the PEC transmission line to the west bank upstream from the HNP cooling tower blowdown line discharge point.

HAR 2 and HAR 3 will collect cooling tower makeup water at the HAR raw water pumphouse structure located on the Thomas Creek branch of the Harris Reservoir east of the HAR site. It was determined that the number of intake bays in the existing HNP CWIS were inadequate to accommodate the additional volume of makeup water needed for the proposed HAR 2 and HAR 3. Placement of the new CWIS near the existing CWIS would result in SMALL impacts to the perimeter of Harris Reservoir and the bottom sediments because of the existing infrastructure in the area. The existing conventional intermittent traveling screens technology that is used at the existing CWIS is proposed for the new CWIS. Under normal operations, the low-speed drive for the traveling screens is expected to minimize wear and tear on the screens. During periods of high debris loading, it is expected that the traveling water screens will operate at high speeds. The intent is to meet the through-screen velocity required under Section 316(b) of the NPDES permit program.

As discussed in above and in ER Chapter 4, makeup water would be obtained from Cape Fear River to maintain the proposed operating water level of 73.2 m (240 ft.) NVGD29 in the Harris Reservoir. The Harris Reservoir makeup water system has been designed to maintain the required water level at Harris Reservoir and to minimize buildup of tritium in the Harris Reservoir. This system includes the Intake Channel in the Cape Fear River, the Harris Reservoir makeup water system intake structure and pumphouse, the Harris Reservoir makeup water system pipeline from the Cape Fear River to the Harris Reservoir, and the HAR Reservoir makeup water discharge structure on the Harris Reservoir. A conceptual description of the intake design is provided in ER Section 3.4. Three alternatives were assessed for the location of the makeup water pumphouse on the Cape Fear River. Alternative 1 was the location of the original makeup pumphouse design which has good access to major roads and no land ownership concerns. The location for Alternative 2 was on the CP&L transmission line corridor, but was a wetland site with little or no direct access to major roadways. New access road construction would be required along the CP&L transmission corridor or from an existing roadway that might result in multiple waterway crossings including a large forested wetland area. The location of Alternative 3 was directly adjacent to a public boat launch where the Cape Fear River and the Dixie Gas pipeline intersect. This site had good access, but had many disadvantages including: land ownership issues, recreational boat hazards or obstructions from the newly constructed pipeline, potential for site vandalism, and safety concerns during construction.

The increase in the water level of the reservoir will be relatively slow. Therefore, the fish and invertebrate communities in Harris Reservoir will be able to relocate to and colonize at suitable depths and habitats as the reservoir water level rises. No adverse effects to fish and invertebrate species in Harris Reservoir, beyond displacement and relocation to favorable habitats, are expected.

Generally, the makeup water pipeline corridor primarily will follow the existing Fayetteville transmission line ROW. An alternative route for the makeup water pipeline was the Dixie pipeline corridor. It was determined that this route was not adequate for staging and construction. Additional issues related to land ownership, access /permission to cross land and roadways, close proximity of water line to gas pipeline in Dixie pipeline corridor ROW. The remaining portion of the makeup water pipeline corridor will run along Buckhorn Road, an existing access road, and through forested land adjacent to the proposed intake structure and pumphouse at the Cape Fear River. Impacts from construction to existing land use in the ROW are expected to be SMALL and short-term. Operational impacts of the makeup pipeline will be SMALL. The design being considered for the intake system on the Cape Fear River to support HAR 2 and HAR 3 is consistent with the original design for the four-unit HNP site. Impacts will be limited to maintenance of access roads and vegetation, as required for maintenance and repair of the pipeline. Maintenance activities will take place on pre-existing road and transmission line ROW and are not expected to cause any significant impacts.

As noted above, the makeup water pipeline discharge structure would be built at the terminating end of the makeup water pipeline on Harris Reservoir at the fourth estuary from the west end of the Main Dam. This location will provide makeup water upstream of the cooling tower blowdown pipeline discharge.

The amount of shoreline and bottom that would be disturbed is an insignificant percentage of the total for the supply lake. As stated in Section 3.4, the approximate intake dimension of 30.5-m (100-ft.) wide by 45.7-m (150-ft.) deep (shore- to lake-dimension) has been estimated based on intake velocity and flow rate. During construction of the proposed intake structure for HAR 2 and HAR 3, the HNP intake structure will be protected to prevent suspended sediment from entering the cooling system. Special construction techniques (such as watertight sheet piling with dewatering of submerged areas to expose the construction zone) will be implemented, where necessary, to prevent migration of suspended solids. Water collected from dewatering operations will be settled or filtered before returning it to the reservoir system.

No federal, state, or regional land use plans apply to the area where the intake structure and pumphouse will be located. Due to the use of existing ROW, no restrictions, changes, or variances to current land use ordinances will be required for the operation of the makeup water pipeline and discharge structure.

As discussed in Section 4.3, dredging will be required in the channel of the Cape Fear River and the inlet at the confluence with the discharge channel. Disposition of this dredged material will require sediment analysis and identification of an acceptable disposal location. As needed, measures will be taken to eliminate the development of disease vectors (for example, mosquitoes) in dredge-spoil ponds. The overall short- and long-term effects of construction at the proposed location of the Harris Reservoir makeup water system intake structure and pumphouse, should be SMALL due to the small footprint and the existence of other water-related infrastructure in the area.

As stated previously, Section 316(b) of the federal CWA requires USEPA to ensure that the location, design, construction, and capacity of CWIS reflect the best available technology (BAT) for minimizing adverse environmental impact (Reference 9.4-004). The objective of any CWIS design is to have adequate flow sweeping past the screens to achieve entrainment and impingement-reduction goals established under the 316(b) requirements. In addition to the impingement and entrainment losses associated with CWIS, are the cumulative effects of multiple intakes and re-siting or modification of the CWIS contributing to environmental impacts at the ecosystem level. These impacts include disturbances to threatened and endangered species, to keystone species, to the thermal stratification of bodies of water, and to the overall structure of the aquatic system food web.

Consequently, in addition to evaluating alternative screen operations and screening technologies, such as fine-mesh traveling water screens or wedge-wire screens, other means of reducing impingement, such as curtain walls, fish return systems, or other physical barriers, also must be assessed. A number of different alternatives exist for reducing impingement and entrainment impacts, including changes in intake structure operation, fish handling, and external structure design; however, no single operational or technological change will have the same effects or benefits at all facilities. Therefore, site-specific studies and evaluations are critical to be successful, cost-effective reductions of CWIS impacts.

9.4.2.1.2 Discharge System

The cooling tower blowdown water from HAR 2 and HAR 3 will be discharged into Harris Reservoir through a new blowdown discharge pipeline installed adjacent to the existing blowdown discharge pipeline for the HNP. A conceptual description of the intake design is provided in Section 3.4. The design being considered for the discharge system into Harris Reservoir to support HAR 2 and HAR 3 is consistent with the original design for the four-unit HNP site.

The final plant discharge consists of cooling tower blowdown from both the CWS cooling towers and site wastewater streams, including the domestic water treatment and circulation water treatment systems. As noted in Section 9.4.2.1, only biocides or chemical additives that are approved by USEPA and North Carolina as safe for humans and the constituent discharged to the environment will satisfy requirements established in the NPDES permit.

Prior to the startup of HAR, PEC will acquire an NPDES permit. This permit will specify threshold concentrations of Free Available Chlorine (when chlorine is used) and Free Available Oxidants (when bromine or a combination of bromine and chlorine is used) in cooling tower blowdown when the dechlorination system is not in use. Lower discharge limits would apply to effluent from the dechlorination system when in use. The effluent would be released into Harris Reservoir. Cooling-tower blowdown and other wastewater resulting from electric power generation typically will be monitored for flow, pH, total residual chlorine, free available chlorine, total chromium, total zinc, priority pollutants, temperature, and 7-day chronic toxicity; however, monitoring requirements will be stipulated in the new NPDES permit for HAR 2 and HAR 3 or the revised combined permit for HNP and HAR 2 and HAR 3. Chromium and zinc are widely used in the United States as corrosion inhibitors in cooling towers. The existing number of permitted waste streams will be reduced because the AP1000 design consolidates several facility liquid-waste streams from facility operations into a single discharge point that will discharge to Harris Reservoir through one NPDES-permitted outfall. Chemicals that are added to cooling water for treatment are effective at low concentrations and are mostly consumed or broken down in application. Bioassay testing required by the NPDES permit will assess the potential toxicity of the discharge and provide for corrective action, if necessary. Little, if any, fouling in the plant heat exchangers is expected. The pH of the circulating water is controlled by the addition of sulphuric acid or sodium hydroxide, as needed. Discharge will be permitted by NCDENR and will comply with applicable state water quality regulations. Impacts to aquatic biota from chemicals added to the cooling water are expected to be SMALL and will not warrant mitigation.

Because the HNP is located on a large reservoir system that likely would provide sufficient heat-rejection capacity for a new unit (appropriately located, using a closed cooling water system), plant operation should not have significant thermal impacts to aquatic/marine ecology and water quality. No information was discovered during the evaluation that revealed any concerns with significant thermal impacts at the candidate site locations.

PEC will continue to employ a closed-loop, cooling-tower-based, heat dissipation system rather than a once-through system. Therefore, the issue of heat shock should not be a factor in Harris Reservoir. Additionally, all discharges in the small mixing zone of the reservoir are required to meet the state NPDES permit requirements. Because most of the water column is unaffected by the blowdown, even under extreme (worst-case) conditions, the thermal plume is not expected to create a barrier to upstream or downstream movement of important fish species, including black crappie, bluegill, largemouth bass, redear sunfish, common carp, white perch, and gizzard shad. No thermal impacts exist beyond some thermally sensitive species that would possibly avoid the immediate area of the discharge opening. Impacts to aquatic communities will be SMALL and will not warrant mitigation.

As stated in Section 3.3, cooling tower blowdown is estimated at 0.83 m^3/s (29.41 ft^3/s) or 13,200 gpm (screen wash water, and strainer backwash are returned to Harris Reservoir) (Table 3.3-3 and Figure 3.3-3). The net consumptive use of Harris Reservoir water is estimated to be 1.77 m^3/s (62.66 ft^3/s) or 28,122 gpm (i.e., cooling tower makeup water + raw water use + service water tower makeup water + demineralizer makeup water – sanitary discharge – demineralizer water discharge – cooling tower blowdown – service tower blowdown – based on two AP1000 units) assuming all secondary services of the cooling tower makeup pumps are required simultaneously.

Either a new discharge flume will be constructed or an existing discharge flume will be modified to accommodate discharges from the HAR. The only modification to the existing discharge flume will be to connect discharge pipes from the HAR to the discharge flume. Chapter 3 of the ER provides additional detail on the discharge of cooling tower blowdown.

Assuming the degree/extent of bottom scouring associated with operation of the new discharge is similar to that associated with operation of the existing discharge, an area of several hundred square feet could be rendered unsuitable for benthic organisms. The benthic community in the area of the discharge point could exhibit reduced organism abundance and/or decreased numbers of species (i.e., reduced-species diversity). This reduction, if any, in organism abundance or diversity could be a reflection of increased temperature, substrate scouring, or a combination of both factors. This reduction, however, is expected to occur in only a limited area of the reservoir located in the immediate vicinity of the discharge point, and should not affect the general community structure or ecology of the benthic macroinvertebrates inhabiting undisturbed areas of the reservoir.

The discharge is expected to have a limited impact on the fish community. The area involved is SMALL in comparison to the rest of the reservoir; therefore, even those fish species not able to tolerate these temperatures should be able to avoid the small portion of the mixing zone that has elevated temperatures.

Other than a localized reduction in numbers of benthic organisms, no impacts should occur to macrobenthos or fish. No important aquatic species or its habitat will be affected. Physical impacts to aquatic communities, therefore, are expected to be SMALL and will not warrant mitigation.

9.4.2.2 Water Supply (Makeup Water System)

The HAR facility would need continuous makeup water for the heat dissipation system and the CWS. As described in Subsection 9.4.2, a nonsafety-related freshwater makeup water system using freshwater from Harris Reservoir as the makeup water source would be the best option for the closed-loop natural draft hyperbolic cooling tower system. Additional water would be pumped from the Cape Fear River via a new intake structure and associated pipeline to maintain the desired operating level for Harris Reservoir. The new intake structure on the Cape Fear River likely would be located at the cove at Buckhorn Dam and would use the existing Carolina Power & Light Company (CP&L) transmission line corridor to route the makeup water pipeline to the discharge location at the fourth embayment or “finger” on the west side of the Harris Reservoir. This location resolves the issue of the mixing zone for the water in the Harris Reservoir and provides a location for the discharge of the makeup water that is well upstream of the existing (and probable new) cooling tower blowdown pipe discharge (Reference 9.4-012).

As noted in Chapters 4 and 5, the preferred water supply alternative (freshwater from Harris Reservoir) would have SMALL construction impacts and MODERATE to LARGE operational impacts. The increased reservoir level also will inundate infrastructure along the shores of Harris Reservoir. The most serious impacts will be to county roads, North Carolina game lands, transmission lines, boat ramps, emergency siren towers, Harris Lake County Park, the Wake County sheriff firing range, and several PEC facilities. These impacts will be mitigated through the re-location of the boat launch and parking facilities to an area above the proposed water level. Additionally, PEC is committed to relocating the Harris County Park services affected by the increased level of the reservoir. Park facilities might be removed and/or relocated during the construction phase and prior to the water level increase. PEC could conduct a study of the usage of existing park facilities to evaluate future relocation. PEC will find an alternate location for the impacted portions of the park, as close to the original location as possible and composed as close to the USGS land use designations that are very similar to the current location.

The rise in lake elevation will require enhancements to the existing roads and could entail the purchase of additional ROW. In-use roadways, along with associated infrastructure (bridges and culverts), will be reconstructed in their current locations to accommodate the rise in the water level in the reservoir.

9.4.2.2.1 Summary of Makeup Water Alternatives

The operation of HAR will require a consistent source of fresh makeup water for cooling purposes. HAR will not withdraw any groundwater for use at the site. Harris Reservoir was originally designed to provide cooling water for four (4) reactor units and to remove the design heat load from the cooling tower blowdown water associated with those units and will therefore serve as the cooling tower makeup water source for the closed-loop natural draft hyperbolic cooling tower.

No restrictions on withdrawal volume are anticipated with this water source. The environmental impact of the use of this water supply is SMALL to MODERATE. No alternative source is identified that is environmentally equivalent or superior.

Groundwater was evaluated and not considered a viable water source alternative, as the groundwater would not be able to support the large CWS makeup water requirement necessary for each unit.

9.4.2.3 Water Treatment

The HAR 2 and HAR 3 will require water treatment measures for the influent and effluent water streams for the heat dissipation system and the CWS. Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases the scaling tendencies of the water. The circulating water system for the new units would be operated so that the concentration of solids in the circulating water would be approximately four times the concentration in the makeup water (i.e., four cycles of concentration). The concentration ratio would be sustained through blowdown of the circulating water from the cooling towers to the Harris Reservoir and the addition of makeup water.

The wetted materials in the primary system of the AP1000 unit typically will be primarily austenitic stainless steel, inconel alloys, and Zircaloy cladding. Reactor water chemistry limits will be established to provide an environment favorable to these materials. Design limits will be placed on conductivity and chloride concentrations. Operationally, the conductivity will be limited because it can be measured continuously and reliably. In addition, conductivity measurements will provide an indication of abnormal conditions and the presence of unusual materials in the coolant. Chloride limits will be specified to prevent stress corrosion cracking of stainless steel.

The service water chemical injection system, demineralized water treatment system, and potable water-processing system operate the same in all plant operational modes (i.e., no difference exists in how the systems operate during full power plant operations, plant shutdown/refueling, and plant startup).

Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increase scaling tendencies of the water. A water treatment system would be required at the HAR to minimize bio-fouling, prevent or minimize growth of bacteria (especially *Legionella*, in the case of cooling towers), and inhibit scale on system heat transfer surfaces. Water treatment will be required for both influent and effluent water streams. Considering that water sources for the new plant are the same as those for the existing plant, treatment methodologies for the two plants will be similar.

The circulating water treatment system provides treated water for the CWS and consists of three phases: makeup treatment, internal circulating water treatment, and blowdown treatment. Makeup treatment will consist of a biocide (for example, Towerbrom 960) injected into bay water influent during spring, summer, and fall months to minimize marine growth and to control fouling on surfaces of the heat exchangers. Treatment will improve the quality makeup water and will allow increased cycles of concentration in the cooling tower. Similar to the existing plant, an environmental permit to operate this treatment system will be obtained from the state. For prevention of *Legionella*, treatment for internal circulating water components (i.e., piping between the new intake structure and condensers) will include existing power-industry control techniques that consist of hyperchlorination (chlorine shock) in combination with intermittent chlorination at lower levels, biocide (for example, bromine), and scale-sludge inhibitor. Blowdown treatment will depend on water chemistry but is anticipated to include application of an acid, biocide, and scale inhibitor to control pH, biogrowth, and scaling, respectively.

As discussed in Subsection 3.3.1.5, potable water used throughout the plant typically will be processed through a reverse osmosis (RO) filtration system and, if necessary, will be treated with an antibacterial inhibitor (such as chlorine). The drinking water treatment system, which supplies water for the potable and sanitary distribution system, will treat the raw water so that it meets the North Carolina potable (drinking) water program and USEPA bacteriological and chemical standards for drinking water quality under the National Primary Drinking Water Regulation and National Secondary Drinking Water Regulation. The system will be designed to function during normal operation and outages (i.e., shutdown).

The system to demineralize water prior to its use in various applications at HAR 2 and HAR 3 typically will consist of an RO system. During demineralization or regeneration, chemicals such as sulphuric acid and caustic soda typically are used to adjust the pH to between 6 and 9 for release to the wastewater stream outfall that discharges to Harris Reservoir.

All nuclear power plants are required to obtain an NPDES permit to discharge effluents. These permits are renewed every 5 years by the regulatory agency, either EPA or, more commonly, the state's water quality permitting agency. The periodic NPDES permit renewals provide the opportunity to require modification of power plant discharges or to alter discharge monitoring in response to water quality concerns.

Discharges to outfalls from processing of demineralized and potable water typically will include coagulation, filtration, disinfection, and ion exchange. Wastes from treatment could include filter backwash and demineralizer regeneration wastes. The spent filters from the RO system are disposed in accordance with applicable industrial solid-waste regulations.

The demineralized water transfer and storage system receives water from the demineralized water treatment system and provides a reservoir of demineralized water to supply the condensate storage tank and for distribution throughout the plant. Demineralized water is processed in the demineralized water transfer and storage system to remove dissolved oxygen. In addition to supplying water for makeup of systems that require pure water, the demineralized water is used to sluice spent radioactive resins from the ion exchange vessels in the chemical and volume control system, from the spent fuel pool cooling system, and from the liquid radwaste system to the solid radwaste system.

Liquid wastes generated by the plant during all modes of operation will be managed by the liquid waste storage and processing systems. The liquid waste storage system collects and segregates incoming waste streams, provides initial chemical treatment of those wastes, and delivers them to one of the processing systems. The liquid waste processing system separates wastewaters from radioactive and chemical contaminants. The treated water is returned to the liquid waste storage system for monitoring and eventual release. Chemicals used to treat wastewater for both systems include sulphuric acid for reducing pH, sodium hydroxide for raising pH, and an antifoaming agent for promoting settling of precipitates.

The existing system will be used to treat sewage for the new plant. This treatment system removes and processes raw sewage so that discharged effluent conforms to applicable local and state health and safety codes, and environmental regulations. Sodium hypochlorite (chlorination) is used to disinfect the effluent by destroying bacteria and viruses, and sodium thiosulfate (de-chlorination) reduces chlorine concentration to a specified level before final discharge. Soda ash (sodium bicarbonate) is used for pH control. Alum and polymer are used to precipitate and settle phosphorus and suspended solids in the alum clarifier; polymer also is used to aid flocculation.

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. No substitutions are proposed for the current treatment amounts or methods. The environmental impact on the use of this water treatment is SMALL. No alternative treatment is identified that is environmentally equivalent or superior.

9.4.3 TRANSMISSION SYSTEMS

As specified in the guidelines in NUREG-1555, Section 9.4.3, the preparation of the summary discussion identifies the feasible and legislatively compliant alternative transmission systems. As discussed in Section 3.7, the existing HNP is connected to the PEC transmission grid by seven 230-kilovolt (kV) transmission lines. Five circuits share a common ROW. In that common corridor, the lines are spaced sufficiently far apart to preclude the possibility of the failure of one line causing the failure of more than one other line. These seven lines radiating in different directions from the plant, connect to strong and diverse parts of the PEC system. For the greater part of their lengths, these lines are on separate ROW. The probability is extremely high that a transmission grid would be available to supply off-site power to HNP and the HAR facility.

PEC is a vertically integrated investor-owned company regulated by the State of North Carolina and the Federal Energy Regulatory Commission (FERC). Although PEC will bear the ultimate responsibility for defining the nature and extent of system improvements, as well as the design and routing of connecting transmission lines, separate agencies and reports are required to obtain licenses for the new transmission lines (Reference 9.4-013). Three new transmission lines would be constructed only if the HAR 3 is constructed and were required to distribute generated electricity. If the decision is made not to install the new unit, any plans for new transmission lines also would be abandoned. A Regional Transmission Organization (RTO) or the owner, both regulated by FERC and the Southeastern Electric Reliability Council (SERC), will bear the ultimate responsibility for the following:

- Defining the nature and extent of system improvements.
- Designing and routing connecting transmission.
- Addressing the impacts of such improvements.

Therefore, the construction described in this subsection is based on the existing infrastructure, PEC system design preferences, and best transmission practices. The guiding assumptions for transmission route design are that:

- The new construction will follow in parallel with some of the transmission corridors serving the HNP.

- Reaching the nearest substation to provide connection to the greater area grid is the only requirement.

The HAR facility will be located on the transitional zone between the North Carolina coastal plain and piedmont physiographic regions. Therefore, the new transmission lines will traverse both regions. The coastal plain ranges from nearly flat to very gently rolling. The piedmont region is gently rolling with most steep slopes occurring around drainage ways. The terrain associated with the new transmission lines is not considered rugged. Slopes are no greater than 45 percent, and most areas are gently rolling with no prominent hills. The terrain is mostly broken near large streams where elevation differences range from 15.24 to 30.48 m (50 to 100 ft.) between the highest and lowest elevations. Consequently, no safety-related problems result from the terrain and no unusual features require special design plans. Therefore, the new transmission lines will be constructed using standard designs and routine engineering guidelines that have been proven safe and reliable through experience.

Once the transmission system owner/operator received an interconnection request, the owner/operator would conduct a study to determine the impacts of the generation or transmission service on the existing system. Then, the necessary system improvements would be identified. System improvement needs generally are based on two types of studies, power flow studies to determine the thermal capacity necessary to accommodate the power flows and system stability studies to determine the effects the generation will have on system stability under steady-state and transient conditions, given various system contingencies. The transmission system owner/operator would prepare these studies and additional impact studies under FERC and SERC regulations and guidance.

The output from the HAR is expected to be approximately 2000 megawatt electric (MWe). Although the existing switchyard and transmission corridor system was sized for the transmission capability of the HNP plus one additional unit, the existing system (i.e., the switchyard and lines) may not be able to carry the new generation from HAR 2 and HAR 3. Therefore, a new switchyard and three new lines will be required to accommodate the output from HAR.

As discussed in Subsection 2.2.2, seven 230-kV lines currently connect the HNP to the transmission system. Three new lines will be installed for HAR 3. Three new lines will connect the 230-kV HAR 3 switchyard to the PEC electric grid. These new lines will be connected to the existing Fort Bragg, Erwin, and Wake transmission corridors. The proposed routing of the new lines for HAR 3 are being evaluated to be adjacent to or within existing maintained transmission corridors from the HNP. Use of existing transmission corridors will result in impacts from expansion of the transmission system to be SMALL.

As stated in Subsection 3.7.1.1, the three new lines will connect the new HAR 3 switchyard to the PEC grid. The proposed routing of the new lines for HAR 3 is being evaluated for location adjacent to or within the existing maintained transmission corridors for the HNP. Most transmission corridor ROWs are typically about 30.5 m (100 ft.) wide with 15.2 m (50 ft.) easements on either side. However, they vary depending on the specific location. It is anticipated that the existing transmission corridors will need to be widened approximately 30 m (100 ft.) to accommodate the three new lines; activities for clearing vegetation would involve logging existing forested land along the ROW.

The corridor areas are mostly remote and pass through land that is primarily agricultural and forest land with low population densities. It is anticipated that farmlands that have corridors passing through them will generally continue to be used as farmland. Although noticeable, this effect is not expected to be significant or to noticeably alter significant existing land uses because of the use of existing transmission corridors. The ROW also traverses land in active agricultural production. Minimal plots of land would be removed from agricultural production where new transmission towers might be sited. Land-clearing or construction activities in the ROW would follow BMPs and would be mitigated to the extent possible. The longer transmission lines cross numerous state and United States highways. Therefore, environmental impacts from expansion efforts are anticipated to be SMALL and the effect of these corridors on land usage is expected to be SMALL. No alternative tower designs, tower heights, conductor-to-ground clearances, conductor designs, or ROW widths are necessary (Section 3.7). Auxiliary transmission facilities do not require alternative locations.

The effects of constructing and maintaining new transmission lines are evaluated further in Chapters 4 and 5, therefore no mitigation is required. The measures and controls to limit adverse transmission system impacts that were developed as a result of this environmental review are described in Sections 4.6 and 5.10. No alternative construction methods are indicated to mitigate effects from vegetation, erosion control, access roads, towers, conductors, equipment, or timing.

The startup and shutdown power will be derived from the grid via a new 230-kV transmission system. The new 230-kV lines connecting the HAR to the PEC system will be constructed on PEC standard structures. Through the years, these structures have been very reliable. Experience with similar 230-kV lines on the PEC system has shown availability of power to be virtually 100 percent. Most power companies have an engineering standard and preferred design that consists of wood pole H-frame support structures. Pole heights are typically 24 to 30 m (80 to 100 ft.) with 183- to 213-m (600- to 700-ft.) spans between poles. The poles are typically direct buried, with engineered foundations as needed. Single steel poles with concrete footings will be used, as appropriate. The typical line clearances above ground level will be 9 m (29 ft.) at 15.6°C (60°F) conductor temperature. However, a more typical design for a double circuit line would use steel structures, either lattice tower or monopole construction.

The transmission structures typically will carry a double circuit line consisting of six phases of two- or three-bundle conductors of 1272 thousand circular mils (kcmil) aluminum conductor steel reinforced (ACSR) and two shield wires. Final conductor size will be determined by the transmission system owner based on several factors, including operating voltage, loads to be carried, both initially and in the future, thermal capacity, cost of the conductor, support structures, foundations, ROWs, the present value of the energy losses associated with the conductor size and expected loading, and electric and magnetic field strengths, which depend on operating line voltage, conductor currents, and conductor configuration and spacing.

9.4.4 REFERENCES

9.4-001 Progress Energy Carolinas, Inc. and Sargent & Lundy, LLC, "Engineering and Economic Evaluation of the Integrated Heat Rejection Cycle, Harris Location-Proposed Two Unit AP1000, Final Issue, Not Safety Related," Report HAG-G2-GER-001, Rev. 1, March 2007.

9.4-002 U. S. Environmental Protection Agency, AP 42, Fifth Edition, Compilation of Air Pollutant Emission Factors, "Volume I: Stationary Point and Area Sources, Chapter 13: Miscellaneous Sources" Office of Air Quality Planning and Standards, Office of Air and Radiation, Research Triangle Park, North Carolina, 27711, pp. 13.4-1 and -2, January 1995, Website, www.epa.gov/ttn/chief/ap42/ch13/final/c13s04.pdf

9.4-003 U.S. Environmental Protection Agency, "Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities, Chapter 4–Dry Cooling," Office of Science and Technology, Engineering and Analysis Division, Washington, DC, 20460, Technical Report Number EPA 821-R-01-036, November 2001. Website, www.epa.gov/waterscience/316b/phase1/technical/index.html

9.4-004 U.S. Environmental Protection Agency, "National Pollutant Discharge Elimination System — Amendment of Final Regulations Addressing Cooling Water Intake Structures for New Facilities," Federal Register: December 26, 2002 (Volume 67, Number 248), Pages 78947-78955.

9.4-005 Young, Barry and Ellia Ciammaichella, "Cooling Towers," In the Bay Area Air Quality Management District Air Permit Program Handbook, Source Specific Guidance, Miscellaneous Operations, 4. Cooling Towers, July 17, 2000.

9.4-006 WorleyParsons, "Conceptual Design and Calculations for Harris Raw Water and Circulating Water Systems for Harris Advanced Reactors Units 2 & 3," Report No. HAG-CWS-GER-001, Revision 0, January 5, 2007.

9.4-007 WorleyParsons, "SPX Cooling Technologies, Final Water Usage, Progress Energy," Worley Parsons Design Information Transmittal (DIT) No. WP-007, March 8, 2007.

9.4-008 U.S. Environmental Protection Agency, “National Pollutant Discharge Elimination System--Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities,” *Federal Register*, July 9, 2004 (Volume 69, Number 131), Pages 41575-41624.

9.4-009 North Carolina Administrative Code, North Carolina Division of Water Quality, NPDES: Regulations, 15A NCAC 2H.0100 - Wastewater Discharges to Surface Waters, 2007, Website, h2o.enr.state.nc.us/NPDES/Regulations.html#2h1.

9.4-010 U.S. Environmental Protection Agency, “Implementation of the Decision in Riverkeeper, Inc. v. EPA, Remanding the Cooling Water Intake Structures Phase II Regulation Memorandum,” March 20, 2007.

9.4-011 North Carolina Administrative Code, Standards For Toxic Substances And Temperature, 15A NCAC 02B.0208. May 1, 2007, Website, www.reports.oah.state.nc.us/ncac/title%2015a%20-%20environment%20and%20natural%20resources/chapter%2002%20-%20environmental%20management/subchapter%20b/15a%20ncac%2002b%20.0208.html.

9.4-012 Sargent & Lundy, LLC, “Recommendation for the Conceptual Design of the Harris Lake Makeup Water Intake,” S&L Letter No. SLPEC-2006-005, June 26, 2006.

9.4-013 North Carolina General Assembly, “North Carolina General Statute 62-110.1. Certificate for Construction of Generating Facility; Analysis of Long-Range Needs for Expansion of Facilities,” Website, www.ncga.s3ta3t8e.8n8c.4us/gascripts/statutes/Statutes.asp, accessed March 8, 2007.

.

Table 9.4-1 (Sheet 1 of 4)
Comparison of Heat Dissipation Systems Evaluation Criteria

Factors Affecting System Selection	Dry Tower Cooling System	Hybrid Wet/Dry Cooling Tower System	Once –Through Cooling System	Single Natural Draft Hyperbolic Cooling Tower	Two Natural Draft Hyperbolic Cooling Towers	Three Round Mechanical Draft Cooling Towers
Land Use: On-site Land Requirements	Impacts would be SMALL.	Impacts would be SMALL.	N/A Rejected from range of alternatives before land use evaluated. Impacts would be SMALL.	Impacts would be SMALL.	Impacts would be SMALL to MODERATE.	Impacts would be MODERATE.
Land-Use: Terrain Considerations	Terrain features of the HAR site are suitable for a dry tower cooling system. Impacts would be SMALL.	Terrain features of the HAR site are suitable for a hybrid wet/dry cooling tower system. Impacts would be SMALL.	N/A Rejected from range of alternatives before land use evaluated. Impacts would be SMALL.	Terrain features of the HAR are suitable. Impacts would be SMALL.	Terrain features of the HAR are suitable. Impacts would be SMALL.	Terrain features of the HAR are suitable. Impacts would be SMALL.
Water Use	No makeup water needed for use of a dry tower cooling system. No significant impacts to aquatic biota. Impacts would be SMALL.	Potential for SMALL impacts to aquatic biota. Impacts would be SMALL.	Significant volume of makeup water needed. Potential for significant impacts to aquatic biota. Impacts would be LARGE.	Potential for SMALL to MODERATE impacts to aquatic biota. Impacts would be SMALL to MODERATE.	Potential for SMALL to MODERATE impacts to aquatic biota. Impacts would be SMALL to MODERATE.	Potential for SMALL to MODERATE impacts to aquatic biota. Impacts would be SMALL to MODERATE.
Atmospheric Effects	No visible plume associated with a dry tower cooling system. Impacts would be SMALL.	Short average visible plume. Presents minor potential for fogging and salt deposition. Impacts would be SMALL.	Some plume associated with discharge canal. Impacts would be SMALL to MODERATE.	Visible plume. Presents greater potential for fogging and salt deposition. Impacts would be SMALL.	Visible plume. Presents greater potential for fogging and salt deposition. Impacts would be SMALL.	Short average and median visible plume. Impacts would be SMALL.

Table 9.4-1 (Sheet 2 of 4)
Comparison of Heat Dissipation Systems Evaluation Criteria

Factors Affecting System Selection	Dry Tower Cooling System	Hybrid Wet/Dry Cooling Tower System	Once –Through Cooling System	Single Natural Draft Hyperbolic Cooling Tower	Two Natural Draft Hyperbolic Cooling Towers	Three Round Mechanical Draft Cooling Towers
Thermal and Physical Effects	Minor to no discharges associated with a dry tower cooling system would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Harris Reservoir. Impacts would be SMALL.	Discharges would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be SMALL.	Enormous size of the intake and discharge structures and offshore pipes are needed. Thermal discharges associated with the once-through cooling system would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Thermal discharge study needed to identify environmental impacts on Harris Reservoir. Impacts would be LARGE.	Discharges would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be SMALL.	Discharges would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be SMALL.	Discharges would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be SMALL to MODERATE.
Noise Levels	Would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be SMALL.	Would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be SMALL.	N/A Rejected from range of alternatives before noise evaluated.	Would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be SMALL.	Would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be SMALL.	Would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be SMALL to MODERATE.

Table 9.4-1 (Sheet 3 of 4)
Comparison of Heat Dissipation Systems Evaluation Criteria

Factors Affecting System Selection	Dry Tower Cooling System	Hybrid Wet/Dry Cooling Tower System	Once –Through Cooling System	Single Natural Draft Hyperbolic Cooling Tower	Two Natural Draft Hyperbolic Cooling Towers	Three Round Mechanical Draft Cooling Towers
Aesthetic and Recreational Benefits	No visible plume with the use of a dry tower air-cooled system. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Harris Reservoir is expected. Impacts would be SMALL.	Plumes resemble clouds and would not disrupt the viewscape. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Harris Reservoir is expected. Impacts would be SMALL.	N/A Rejected from range of alternatives before aesthetic and recreational benefits.	Plumes resemble clouds and would not disrupt the viewscape. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Harris Reservoir is expected. Impacts would be SMALL.	Plumes resemble clouds and would not disrupt the viewscape. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Harris Reservoir is expected. Impacts would be SMALL.	Plumes resemble clouds and would not disrupt the viewscape. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Harris Reservoir is expected. Impacts would be SMALL.

Table 9.4-1 (Sheet 4 of 4) Comparison of Heat Dissipation Systems Evaluation Criteria

Factors Affecting System Selection	Dry Tower Cooling System	Hybrid Wet/Dry Cooling Tower System	Once –Through Cooling System	Single Natural Draft Hyperbolic Cooling Tower	Two Natural Draft Hyperbolic Cooling Towers	Three Round Mechanical Draft Cooling Towers
Legislative Restrictions	Potential compliance issues with the requirements for emissions under the federal Clean Air Act. These regulatory restrictions would not negatively affect implementation of this heat dissipation system, but they may impact overall operational cost.	An intake structure would meet Section 316(b) of the CWA and the implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address the additional thermal load from blowdown back into Harris Reservoir. These regulatory restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be SMALL to MODERATE.	Potential compliance issues with Section 316(b) of the CWA. Also, potential significant NPDES thermal discharge issues surrounding discharges back into Harris Reservoir. Impacts would be LARGE.	An intake structure would meet Section 316(b) of the CWA and the implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address the additional thermal load from blowdown back into Harris Reservoir. These regulatory restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be SMALL to MODERATE.	An intake structure would meet Section 316(b) of the CWA and the implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address the additional thermal load from blowdown back into Harris Reservoir. These regulatory restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be SMALL.	An intake structure would meet Section 316(b) of the CWA and the implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address the additional thermal load from blowdown back into Harris Reservoir. These regulatory restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be SMALL.
Environmental impacts	SMALL.	SMALL to MODERATE.	LARGE.	SMALL to MODERATE.	SMALL to MODERATE.	SMALL to MODERATE.
Is this a suitable alternative heat dissipation system?	No (see discussion in Subsection 9.4.1.1)	No	No	No	Yes	No

Table 9.4-2
Life Cycle Cost Benefit for Tower Options (Hot Weather, 600,000 gpm)

	Hot Year				
Type of Cooling Tower	**Single Tower - Natural Draft**	**Two Towers - Natural Draft**	**Round Mechanical Draft**	**Two Towers - Natural Draft**	**Round Mechanical Draft**
Circulating Water flowrate (gpm)	600,000	600,000	600,000	600,000	600,000
Energy Rate	High	High	High	Average	Average
CT Initial Cost ($\$10^3$)[(a)]	71,249	93,093	67,219	93,093	67,219
Contractor+Eng.+Manag,+Owner+Cont. ($\$10^3$)	42,393	55,390	39,996	55,390	39,996
Construction Cost ($\$10^3$) [(a)]	113,642	148,483	107,215	148,483	107,215
Total Present Value of CT Cost Including Maintenance Differences ($\$10^3$)	113,642	148,483	109,394	148,483	109,394
Total Present Value of CT Cost Including Production Difference Benefits ($\$10^3$)	113,642	117,465	104,026	125,593	105,623

Notes:
a) The presented cost excludes common items such as circulating water pumps, makeup and blowdown systems, and tower fill replacement.

Source: Reference 9.4-001

Table 9.4-3
Life Cycle Cost Benefit for Tower Options (Average Weather, 600,000 gpm)

	Average Year				
Type of Cooling Tower	**Single Tower - Natural Draft**	**Two Towers - Natural Draft**	**Round Mechanical Draft**	**Two Towers - Natural Draft**	**Round Mechanical Draft**
Circulating Water flowrate (gpm)	600,000	600,000	600,000	600,000	600,000
Energy Rate	High	High	High	Average	Average
CT Initial Cost ($\$10^3$)[(a)]	71,249	93,093	67,219	93,093	67,219
Contractor+Eng.+Manag,+Owner+Cont. ($\$10^3$)	42,393	55,390	39,996	55,390	39,996
Construction Cost ($\$10^3$)[(a)]	113,642	148,483	107,215	148,483	107,215
Total Present Value of CT Cost Including Maintenance Differences ($\$10^3$)	113,642	148,483	109,394	148,483	109,394
Total Present Value of CT Cost Including Production Difference Benefits ($\$10^3$)	113,642	123,705	109,870	130,147	109,394

Notes:
a) The presented cost excludes common items such as Circulating Water pumps, makeup and blowdown systems, and tower fill replacement.

Source: Reference 9.4-001