ENVIRONMENTAL REPORT

CHAPTER 9

ALTERNATIVES TO THE PROPOSED ACTION

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9.0 ALTERNATIVES TO THE PROPOSED ACTION

This chapter assesses alternatives to the proposed siting and construction of a new nuclear power plant at the Bell Bend Nuclear Power Plant (BBNPP) site.

Chapter 9 describes the alternatives to construction and operation of a new nuclear unit with closed cycle cooling adjacent to the Susquehanna Steam Electric Station (SSES) Units 1 and 2 location, and alternative plant and transmission systems. The descriptions provide sufficient detail to facilitate evaluation of the impacts of the alternative generation options or plant and transmission systems relative to those of the proposed action. The chapter is divided into four sections:

- “No-Action" Alternative
- Energy Alternatives
- Alternative Sites
- Alternative Plant and Transmission Systems

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9.1 NO-ACTION ALTERNATIVE

The "No-Action" alternative refers to a scenario where a new nuclear power plant, as described in Chapter 2, is not constructed and no other generating station, either nuclear or non nuclear, is constructed and operated.

The most significant effect of the No-Action alternative would be loss of the potential 1,600 MWe additional generating capacity that BBNPP would provide, which could lead to a reduced ability of existing power suppliers to maintain reserve margins and supply lower cost power to customers. Chapter 8 describes a 1.5% annual increase in electricity demand in the eastern part of the PJM Interconnection, LLC (PJM) "classic" region for the merchant BBNPP, over the next 10 years. (PJM, 2008a) Under the No-Action alternative, this increased need for power would need to be met by means that involve no new generating capacity.

Additionally, over the next 10 years, the expected annual increase in the weather normalized average peak demand for electricity in the region of interest (ROI)/primary market area will be approximately 1.6%. As noted in Section 8.2.2, PJM has identified over 9,400 megawatts (MW) of new generation for commercial operation dates of 2006 to 2012, with most of the new generation units proposed to be baseload coal-fired units located in the western part of the PJM area. The BBNPP would provide much needed baseload power (i.e., the quantity of generation that exists continuously during a given period) for the ROI/primary market area that is expected to have average annual peak forecast grow between 1.2% (winter) and 1.6% (summer) per year over the next 10 years (PJM, 2008a).

Under the No-Action alternative, PPL Bell Bend, LLC (PPL), would not be able to satisfy corporate climate change policy objectives that include reducing greenhouse gas emissions while maintaining a strong economy, reducing dependence on foreign energy sources, and providing reliable electricity supply and infrastructure (PPL, 2008).

Although Pennsylvania has not, at this time, established mandatory programs to regulate carbon dioxide and other greenhouse gases, it is observing, though not participating, in the Regional Greenhouse Gas Initiative (RGGI), a cap and trade program among nine northeastern states. As of November 2007, three other states within the ROI/primary market area (New Jersey, Delaware, and Maryland) are members of RGGI (MDE, 2008).

The New Jersey Department of Environmental Protection (NJDEP) proposed regulations in July 2008 to establish a carbon dioxide (CO_2) cap-and-trade program for fossil-fuel-fired electric generators as part of its participation in the RGGI (NJDEP, 2008). The proposed New Jersey rule provides for up to 99% of New Jersey's CO_2 allowances to be sold via auction rather than allocated for free. Certain cogeneration units that qualify as "dispatch agreement facilities" or that meet certain thermal efficiency standards will be eligible to receive allowances for free or at a reduced cost. In addition, the proposed rule allows for up to one percent of New Jersey's annual CO_2 allowances to be set aside and retired to account for the voluntary purchase of qualified renewable energy, such as wind and solar. The proposed rule also exempts electric generating units that sell less than 10% of their electric output to the grid.

In 2008, the state of Delaware became the tenth state to pass legislation ratifying its participation in RGGI. The state's RGGI legislation caps emissions at 2009 levels and reduces them to 10% below 2009 levels by 2019 (DSS, 2008). Under the legislation, Delaware will auction its share of emissions allowances and use the proceeds to fund a variety of emission reduction, conservation, and low income financial assistance programs.

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The Maryland RGGI Rule, Code of Maryland Regulations (COMAR) 26.09, was enacted in 2007 and closely follows the RGGI Model Rule with some reorganization. As part of the RGGI program, Maryland is proposing to auction 100% of the CO_2 budgeted allowances annually allocated to its Consumer Energy Efficiency Account, a strategic energy fund with proceeds to go into the MDE Clean Air Fund (MDE, 2008).

Although a non-RGGI state, Virginia enacted the Virginia Energy Plan in 2007. The Plan aims to increase the state's energy independence, conservation, and efficiency. The primary goals of the Plan are to reduce the rate of growth in energy use by 40%, reduce greenhouse gas emissions 30% by 2025, and increase in-state energy production by 20%. The Plan also recommends consumer energy education, strategic economic development, alternative energy research, and the creation of a Climate Change Commission to assess the level of Virginia's carbon emissions, related consequences, and potential further action. The Plan is to be updated every 5 years. (COV, 2007)

PPL Corporation has conducted an inventory of its carbon dioxide emissions and is continuing to evaluate various options for reducing, avoiding, off setting, or sequestering its carbon dioxide emissions. PPL Corporation believes that the regulation of greenhouse gas emissions may have a material impact on its capital expenditures and operations, but the costs are not now determinable.

As noted in Chapter 8, electric utilities forecast demand to increase over the next 10 years by 19% (141,000 MW) in the U.S. and 13% (9,500 MW) in Canada, but project committed resources to increase by only 6% (57,000 MW) in the United States and by 9% (9,000 MW) in Canada. The following points suggest the continuing benefits of and the need for a new merchant baseload generating facility in the ROI/primary market area: the region's need to diversify sources of energy, the potential to reduce the average cost of electricity to consumers, and the current national policy to reduce dependence on fossil fuels. As discussed in Chapter 8, the BBNPP will help meet the growing demand for new capacity and reduce carbon emissions in the ROI/ primary market area.

The No-Action alternative is not optimal from the standpoint of the cost of operation or the cost of supplied power. Generating capability within this ROI/primary market area could become increasingly dependent on existing fossil fuel generation. If current trends continue, it is expected that older steam units in the east will be replaced by units burning natural gas (PJM, 2008b). The North American Energy Reliability Council (NERC) states:

Available capacity margins are projected to decline over the 2006-2015 period.

Available capacity margins are projected to drop below minimum regional target levels in Electric Reliability Council of Texas (ERCOT), Midwest Reliability Organization (MRO), New England, ReliabilityFirst Corporation (RFC), and the Rocky Mountain and Canada areas of Western Electricity Coordinating Council (WECC) in the next 2 to 3 years, with other portions of the northeastern, southwestern, and western U.S. reaching minimum levels later in the 10-year period. (PPUC, 2007)

Without additional nuclear capacity, the ROI/primary market area would not recognize the role that diversity of generation fuels has in satisfying the overall reliability needs of the PJM Regional Transmission Organization (RTO) power system, as discussed in Section 8.1. For example, the development and installation of many gas-fired plants and recent shortages in gas supply and pipeline capability in some areas of the RTO have highlighted this issue. If PPL took No-Action to meet growth demands, the ability to supply low cost, reliable power to its

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customers and to the RTO would be impaired. In addition, PPL 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 described in Section 10.4, additional benefits of the construction and operation of the BBNNP include economic and tax impacts to the surrounding region that are described in Section 4.4.2, Section 4.4.3, Section 5.8.2.3, and Section 5.8.2.4. Under the No-Action alternative, none of the benefits of the proposed action as described in this Environmental Report (ER) would be realized.

Under the No-Action alternative, the predicted construction- and operation-related impacts from the project would not occur at the site. Those impacts would result primarily from the construction of the facility and would include land use, ecological, socioeconomic, and water related impacts, as summarized in Table 4.6-1. The potential adverse impacts identified from the operation of BBNPP are anticipated to be SMALL for all categories evaluated and are summarized in Table 5.10-1. The benefits of implementing the No-Action alternative would include avoiding the construction and operation impacts, as described in the sections referenced above.

As discussed in Chapter 8, because of transmission constraints with import of electricity from nearby states, purchasing power from other utilities or power generators is not considered economically practicable. Demand-side management is one alternative; however, even using optimistic projections, demand-side management will not meet future demands.

Implementation of the No-Action alternative could result in the future need for other generating sources, including continued reliance on carbon intensive fuels, such as coal and natural gas. Therefore, the predicted impacts, as well as other unidentified impacts, could occur in other areas.

9.1.1 REFERENCES

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9.2 ENERGY ALTERNATIVES

This section discusses the potential environmental impacts associated with electricity generating sources other than a new nuclear unit at the BBNPP site. These alternatives include: purchasing electric power from other sources to replace power that would have been generated by a new unit at the BBNPP site, a combination of new generating capacity and conservation measures, and other generation alternatives that were deemed not to be competitive alternatives to the proposed facility.

Alternatives that do not require new generating capacity were considered, including energy conservation and Demand-Side Management (DSM). Alternatives that would require the construction of new generating capacity, such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, and 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 Section 9.2.1, while alternatives that do require new generating capacity are discussed in Section 9.2.2. Some of the alternatives discussed in Section 9.2.2 were eliminated from further consideration based on their availability in the region, overall feasibility, and environmental consequences. Section 9.2.3, describes the remaining alternatives in further detail relative to specific criteria such as environmental impacts, reliability, and economic costs.

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

The alternative of electric power generating capacity through the combination of purchased power and the reactivation or extended service life of power generating facilities within the primary market area is not feasible due to the insufficient capacity of power available for purchase from other local utilities or power generators, or inability to transport available power to the ROI/primary market area during periods of grid congestion. Also, the lack of inventory of deactivated power generating facilities or the possibility of extending the service life of a facility scheduled for deactivation in the future is also not feasible (PPL, 2006). A description of the power system, factors associated with the power demand and supply, and an assessment of the need for power is provided in Chapter 8.

As noted in Section 8.2.2, although the expected growth rates vary in the individual utilities' geographic zones, many of the highest projected rates of annual growth are in the eastern part of the PJM classic market area. To meet this load, the PJM regional transmission extension plan (RTEP) shows a need for reliance on western generation sources over an already congested transmission system or additional local generation resources to both ensure reliable service to customers and to obtain economical, available electricity supplies. (PJM, 2007)

The electricity needs of the eastern part of the PJM classic market area are supplied by local generation and significant energy transfers from the western portion of the PJM region. A significant portion of these transfers flows through transmission systems of northern West Virginia, northern Virginia, Maryland, eastern Ohio, and central southwestern Pennsylvania. This eastern part of the PJM classic market area's dependence on energy transfers from the western portion of the PJM region has been growing steadily over the past decade (PJM, 2007). This dependence is a result of limitations in the west-to-east transmission of energy across the Allegheny Mountains and the growing demand for baseload power at load centers along the east coast. As noted in Section 8.3, PJM was among the first to seek early designation of two transmission corridors designed to address congestion problems, which have been included in a 2007 DOE study on transmission congestion issues (PJM, 2006). PJM's two proposed corridors

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are the Allegheny Mountain Corridor, extending from the West Virginia panhandle region southeastward and serving population in Baltimore and Washington areas, and the Delaware River Corridor, extending from West Virginia region eastward and serving population centers around Philadelphia, New Jersey, and Delaware. Congestion costs resulting from constraints in the Allegheny Mountain Corridor totaled $747 million in 2005, with another $464 million on the Delaware River Corridor that year.

This section describes the assessment of the economic and technical feasibility of supplying the demand for energy without constructing new generating capacity. Specific alternatives include:

- 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
- A combination of these elements that would be equivalent to the output of the project and therefore eliminate its need.

9.2.1.1 Initiating Conservation Measures

Under the Energy Policy Act of 2005 (PL, 2005) a rebate program was established for homeowners and small business owners who install energy-efficient systems in their buildings. The rebate was set at $3,000, or 25% of the expenses, whichever was less. The Act authorized $150 million in rebates for 2006 and up to $250 million in 2010. This new legislation was enacted in the hope that homeowners and small business owners would become more aware of energy-efficient technologies, lessening energy usage in the future.

Historically, state regulatory bodies have required utilities to institute programs designed to reduce demand for electricity. DSM has shown great potential in reducing peak-load consumption (maximum power requirement of a system at a given time). According to the Department of Energy/Energy Information Administration (DOE/EIA), in 2006, peak load usage was reduced by 27,240 MWe through DSM strategies. This reduction is 6% greater than that of the 25,710 MWe reduction in 2005 (EIA, 2007a). However, DSM costs increased by 6.8% over the same period (EIA, 2007b). Although DSM has shown great potential in reducing peak load usage, it does not satisfy the baseload need of the BBNPP. Additional information regarding energy efficiency and substitutions is provided in Section 8.2.2, and the assessment of need for power is discussed in more detail in Section 8.4.

9.2.1.1.1 Conservation Programs

As noted in Section 8.0 and Section 9.1, parts of Delaware, New Jersey, Maryland, Virginia, and Pennsylvania are included as the ROI/primary market area for the BBNPP. Conservation programs are generally comprehensive and complementary and focus on providing technical and financial assistance to homeowners, businesses, schools, and government organizations.

In 2007, the Governor of the State of Delaware signed "An Act to Amend Title 29 of the Delaware Code to Create a Sustainable Energy Utility in the State of Delaware" (DSS, 2007). The act created the Delaware State Energy Utility (SEU) program that will use competitive markets and leverage private financing to deliver cost-effective end-use energy services to residential, commercial, industrial, and transportation markets. The energy efficiency targets in the act state that by December 31, 2015, the SEU shall have achieved 30% reduction in annual energy

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usage for SEU participants, with a target of one-third of the participating savings occurring for residential clients, based on January 1, 2006, baseline levels.

New Jersey's Clean Energy Program™, administered through the New Jersey Office of Clean Energy, is a signature initiative of the New Jersey Board of Public Utilities (NJBPU), which provides education, information, and financial incentives for renewable energy systems and energy efficiency measures (NJBPU, 2008). New Jersey's Clean Energy Program is a statewide program that targets approximately $180 million each year toward technologies that save electricity and natural gas and increase the amount of electricity generated from clean, renewable resources. The Program establishes a set of objectives and measures to track progress in reducing energy use and increasing the use of renewable energy in New Jersey. The Program promotes increased energy efficiency and the use of clean, renewable sources of energy including solar, wind, geothermal, and sustainable biomass. Each year, the program provides an average of $145 million dollars in financial incentives, programs, and services to residential customers, businesses, schools, and municipalities that install energy efficient and renewable energy technologies, including solar PV systems.

Additionally, the State of New Jersey developed a draft Energy Master Plan to plan for adequate, reliable energy supply of electricity that keeps up with the growth in demand. The five major goals of the draft Plan are: (1) maximize energy conservation and energy efficiency by reducing energy consumption at least 20% by 2020; (2) reduce peak electricity demand by 5,700 MW by 2020; (3) meet 22.5% of the state's electricity needs from renewable sources; (4) develop new low carbon emitting, efficient power plants to help close the gap between the supply and demand of electricity; and (5) invest in innovative clean energy technologies and businesses to stimulate the industry's growth in New Jersey (NJOG, 2008).

In 1991, the Maryland General Assembly (MGA) enacted an energy conservation measure that is codified as Section 7-211 of the Public Utility Companies (PUC) Article (MGA, 1991). This provision requires each gas and electric company to develop and implement programs to encourage energy conservation. In response to this mandate and continuing with preexisting initiatives under its existing authority, the Maryland Public Service Commission (MDPSC) directed each affected utility to develop a comprehensive conservation plan. The MDPSC further directed each utility to engage in a collaborative effort with staff, the Office of People's Counsel (OPC), and other interested parties to develop its conservation plan. The result of these actions was that each utility implemented conservation and energy efficiency programs. (MDPSC, 2007)

The MDPSC requires Maryland electric utilities to implement DSM as a means to conserve energy and to take DSM energy savings into account in long-range planning. Recent legislation passage positions the State of Maryland as one of the leaders in energy efficiency and climate policy. On the energy efficiency side, the state recently launched the EmPOWER Maryland Initiative, which establishes a state goal of achieving a 15% reduction in per capita electricity use and peak demand by the end of 2015. This requires the state's utilities to implement energy efficiency programs and tasks the MDPSC with tracking progress toward that goal. This energy efficiency initiative, unlike energy conservation, which is based on changing behaviors and lifestyles, is technology-based.

As noted in Section 9.1, Virginia enacted the Virginia Energy Plan in 2007. The Plan aims to increase the state's energy independence, conservation, and efficiency. The primary goals of the Plan are to reduce the rate of growth in energy use by 40%, reduce greenhouse gas emissions 30% by 2025, and increase in-state energy production by 20%. To achieve these goals, the Plan sets fuel-specific goals to reduce electricity use by 10% by 2022, to reduce

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natural gas consumption by more than 7%, to reduce non-transportation petroleum use by 10%, and to reduce transportation energy use by 5% (COV, 2007).

Pennsylvania has implemented the Alternative Energy Portfolio Standards (AEPS) Act that includes provisions for market-based DSM measures to reduce electricity demand within the commonwealth. Prior to implementing the AEPS Act, Pennsylvania had developed, through individual settlements with the commonwealth's major distribution companies, a comprehensive program to promote and advance DSM in the retail electric market. The Pennsylvania Sustainable Energy Board (PSEB) worked in partnership with regional sustainable energy boards, other Commonwealth agencies, electric utilities, business organizations, and environmental organizations to develop and implement "tools" to save energy. Five settlement agreements were established as separate and independent sustainable energy funds to promote: (1) the development and use of renewable energy and clean energy technologies, (2) energy conservation and energy efficiency, (3) renewable energy business initiatives, and (4) projects which improve the environment in the companies' service territories, related to the transmission and distribution facilities. PPL Electric Utilities Corporation (PPL EU) DSM offerings under this program included energy efficiency programs, education programs, renewable energy projects, and clean energy projects (PSEB, 2004). It is expected that projected energy efficiencies would be anticipated by the market.

PPL EU is an industry leader in establishing programs to help customers save energy, promote energy efficiency, and understand how they can reduce their electricity use and cost. PPL EU has offered customer electric use DSM and financial assistance programs for a quarter of a century, and PPL EU plans to continue to increase the number and financial support for these programs. In the past, PPL EU offered large industrial customers a DSM program that allowed them to curtail their electric load during heavy system peak use. The companies were financially rewarded with a lower price per kilowatt hour (kWh) for allowing PPL EU this control over their demand. PPL EU also has had a pilot DSM program for residential customers for the last 6 years. That program is focused on on-peak and off-peak time of use rates in trying to get customers to reduce demand and their cost during these peak energy use times on weekdays. As the energy landscape is changing, PPL EU is developing more programs and tolls to help customers understand how they use energy, and learn what they can do to save energy and money on their bills (PPL Susquehanna, LLC, 2008).

The following provides additional information on these and other customer energy savings programs:

- Customer Daily Electricity Use: In 2004, PPL EU completed installation of automated meters for all its customers, making it one of the first electric utilities in the country to install advanced electric meters that can be read automatically by the company, saving the energy previously required from manual reading operations. PPL EU can use the capability of these advanced electric meters to provide customers with their monthly and daily energy usage and show customers trends in their monthly electricity use on their bills. By 2009, customers will be able to see their hourly electricity use. All this information will enable customers to evaluate the effectiveness of their energy efficiency actions, and make even more informed decisions about their electricity use (PPL Susquehanna, LLC, 2008).

- Expansion of Existing Pilot Program: Since 2002, PPL EU has operated a residential customer pilot program for time of use electricity pricing during the summer months. Approximately 300 residential customers currently participate in the program. PPL EU is expanding the program in 2008. The expanded program will provide about 600

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participating customers an opportunity to lower their bills by conserving energy during "on peak" hours, when the cost of wholesale electric generation supply is greatest. The participants in the expanded pilot program will be able to track their hourly electric use using the company's Energy Analyzer. In addition, the company is planning a year round time of use pilot program that could begin in late 2008 (PPL Susquehanna, LLC, 2008).

- Energy Analyzer Website: In June 2007, PPL EU launched a new website with an online Energy Analyzer tool that helps customers understand and manage their electricity use, and identify actions they can take to use energy wisely. The Energy Analyzer had more than 165,000 individual users in its first 9 months.

  The website includes an Energy Learning Center where a customer can calculate the energy use of various appliances and learn about potential savings by switching to more energy efficient appliances. The energy library offers the customer detailed information about everything from compact fluorescent lights to attic insulation. The website also has a bill analyzer tool that allows customers to take a closer look at why one bill was higher than another and understand how much weather or changes in the home may have affected the bill (PPL Susquehanna, LLC, 2008).

- Compact Fluorescent Light Bulb Initiative: In fall 2007, PPL EU delivered more than 150,000 energy efficient compact fluorescent light bulbs (CFLs) to customers who completed profiles on the Energy Analyzer to find ways they could save energy in their homes and businesses. Those light bulbs could save customers more than $8 million and 77 million kWh of electricity before they burn out. PPL EU also delivered special CFL recycling containers to more than 160 municipalities as part of an Earth Day initiative to encourage safe disposal of these bulbs (PPL Susquehanna, LLC, 2008).

- Onsite Energy Generation: In addition to helping customers reduce energy demand from PPL supplied electricity, PPL EU has developed and installed a significant number and variety of on site customer energy projects to help them control their electric demand. These include onsite natural gas, biogas and solar energy customer installations. PPL EU plans to invest more than $100 million over the next 5 years in renewable energy projects. One of PPL EU's 2007 customer renewable energy projects was selected as a "Project of the Year" by the U.S. Environmental Protection Agency (USEPA). (PPL Susquehanna, LLC, 2008)

- ENERGY STAR: PPL EU is a partner in the federal government's ENERGY STAR® program to promote energy efficiency and the wise use of electricity. With the help of ENERGY STAR, Americans saved an estimated $14 billion on their utility bills in 2006 (PPL Susquehanna, LLC, 2008).

- Customer Energy Education: Each issue of PPL EU's Connect newsletter, which accompanies PPL EU's 1.4 million customer bills each month, includes a focus on energy saving tips. PPL EU has also begun a new Speakers Bureau, delivering presentations on energy efficiency to community groups throughout PPL EU's service area (PPL Susquehanna, LLC, 2008).

As a practical matter, it would be impossible to increase the energy savings identified above by an additional 1,600 MWe to replace the BBNPP generating capability. For these reasons, PPL does not consider energy conservation to represent a reasonable alternative to the BBNPP.

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9.2.1.2 Reactivating or Extending Service Life of Existing Plants

Retired fossil fuel power generating facilities and fossil fuel power generating facilities slated for retirement may not be economically viable, particularly in meeting today's restrictions on air contaminant emissions. Because of increasingly stringent environmental restrictions, delaying retirement or reactivating power generating facilities in order to compensate for the closure of a large baseloaded facility would require major construction to upgrade or replace facility components. There are a number of planned retirements in the PJM service area. These known retirements are listed in Table 8.3-8, including PPL Corporation's two, Martins Creek coal units in September 2007 (totaling 280 MWe). None of these retired power generating facilities would be able to supply the necessary 1,600 MWe of baseload capacity and, in accordance with the Federal Energy Regulatory Commission (FERC) order, PJM cannot compel the owners of units proposed for retirement to remain in service. Such retirements may take effect upon 90 days prior notice. Therefore, reactivating or extending the service life of existing baseload plants is not a feasible alternative to the BBNPP.

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

In PJM, market participants wishing to buy and sell energy have multiple options. Market participants decide whether to meet their energy needs through self-supply, bilateral purchases from generation owners or market intermediaries, through the day-ahead market or the real-time balancing (that is, spot) market. Energy purchases can be made over any timeframe from instantaneous real-time balancing market purchases to long-term, multi-year bilateral contracts. Purchases may be made from generation located within or outside the PJM RTO region. Market participants also decide whether and how to sell the output of their generation assets. Generation owners can sell their output within the PJM RTO region or outside the region and can use generation to meet their own loads, to sell into the spot market or to sell bilaterally. Generation owners can sell their output over any timeframe from the real-time spot market to multi-year bilateral arrangements. Market participants can use increment and decrement bids in the day-ahead market to hedge positions or to arbitrage expected price differences between markets (PJM, 2008b). In addition, each RTO has a commitment to control its generation in a manner so as not to burden the interconnected systems. Failure to provide adequate control can result in deviations in frequency and inadvertent power flow, stability issues, or transmission constraints.

The policy of PJM is to maintain, at all times, the integrity of the PJM RTO transmission systems and the Eastern Interconnection, and to give maximum reasonable assistance to adjacent systems when a disturbance that is external to the PJM RTO region occurs. Power system disturbances are most likely to occur as the result of loss of generating equipment, transmission facilities, or as the result of unexpected load changes. These disturbances may be of, or develop into, a magnitude sufficient to affect the reliable operation of the PJM RTO region and/or the Eastern Interconnection. These events demand timely, decisive action to prevent further propagation of the disturbance. At these times, PJM must either purchase energy from outside the PJM RTO region, as needed, or sell energy to other RTOs as requested during disturbance condition. When the purchasing of energy is needed, PJM uses its best efforts to acquire the lowest priced energy available at the time. (PJM, 2008c)

Under the purchased power alternative, therefore, environmental impacts would still occur, but they would originate from a baseload power generating facility located elsewhere in the region.

Because of existing constraints on west-to-east power transfers within PJM, the purchased power alternative would likely necessitate additional high voltage (that is, 345 or 500 kV)

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transmission lines to route power from the remote locations in the PJM region to the intended primary market area. PPL anticipates that most of the transmission lines could be routed along existing rights-of-way. In such cases, the environmental impacts of transmission line construction would be moderate to large. Otherwise, impacts would be large for new line construction. Since baseload generating capacity available for purchase in western PJM is typically fossil-fired, the environmental impacts of emissions due to operation of this fossil-fired capacity for purchased power to replace the BBNPP would be large. Purchasing power from other utilities or power generators has been identified as inconsistent with the objectives of the BBNPP; therefore, it is not described in more detail.

Because of transmission constraints with import of electricity from nearby areas, purchasing power from other utilities or power generators is not considered economically practicable.

9.2.2 ALTERNATIVES THAT REQUIRE NEW GENERATING CAPACITY

Although many methods are available for generating electricity and many combinations or mixes can be assimilated to meet system needs, such expansive consideration would be too unwieldy to reasonably examine in depth given the purposes of this alternatives analysis. The alternative energy sources considered are as follows:

- Wind
- Geothermal
- Hydropower
- Solar power
    - Concentrating solar power systems
    - Photovoltaic (PV) cells
- Wood waste
- Municipal solid waste
- Energy crops
- Petroleum liquids (oil)
- Fuel cells
- Coal
- Natural gas
- Integrated gasification combined cycle (IGCC)

Based on the installed capacity of 1,600 MWe that BBNPP would produce, not all of the above-listed alternative sources are competitive or viable. Each of the alternatives is discussed in more detail in later sections, with an emphasis on coal, solar, natural gas, and wind energy. As a renewable resource, solar and wind energies have gained increasing popularity over the years, in part because of concern over greenhouse gas emissions. Air emissions from solar and wind

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facilities are much smaller than fossil fuel air emissions. Although the use of coal and natural gas has undergone a slight decrease in popularity, they remain two of the most widely used fuels for producing electricity.

This section identifies alternatives that PPL has determined are not viable and the basis for this determination. This Combined License (COL) Application is premised on the installation of a facility that would serve as a merchant baseload resource and that any feasible alternative would need to be able to generate equivalent baseload power. In performing this evaluation, PPL has utilized information from the NRC Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants (NRC, 1996).

The GEIS is useful for the analysis of alternative sources because NRC has determined that the technologies of these alternatives will enable 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 set of reasonable alternatives that are considered in the GEIS, common generation technologies were included and various state energy plans were consulted to identify the alternative generation sources typically being considered by state authorities across the country.

From this review, a reasonable set of alternatives to be examined was identified. These alternatives included 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. These alternatives were considered pursuant to the statutory responsibilities imposed under the National Environmental Policy Act of 1969 (NEPA) (NEPA, 1982).

Although the GEIS is provided for license renewal, the alternatives analysis in the GEIS can be compared to the proposed action to determine if the alternative represents a reasonable alternative to the proposed action.

Each of the alternatives is discussed in the subsequent sections relative to the following criteria:

- The alternative energy conversion technology is developed, proven, and available in the relevant region within the life of the COL.
- The alternative energy source provides baseload generating capacity equivalent to the capacity needed and to the same level as the proposed nuclear plant.
- The alternative energy source does not create more environmental impacts than a nuclear plant would, and the costs of an alternative energy source do not make it economically impractical.

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

9.2.2.1 Wind

In general, areas identified by the National Renewable Energy Laboratory (NREL) as wind resource Class 4 and above are regarded as potentially economical for wind energy production

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with current technology. Class 4 wind resources are defined as having mean wind speeds between 15.7 and 16.8 mph (25.3 to 27.0 kph) at 50 m elevation. (AWEA, 2008)

As a result of advances in technology and the current level of financial incentive support, a number of additional areas with slightly lower wind resources (Class 3+) may also be suitable for large-scale wind development. These would, however, operate at an even lower annual capacity factor and output than used by NREL for Class 4 sites.

Wind turbines must be sufficiently spaced to maximize capture of the available wind energy. If the turbines are too close together, one turbine can impact the efficiency of another turbine. A 2 MWe turbine requires approximately 0.25 ac (0.1 ha) of dedicated land for placement of the wind turbine, leaving landowners with the ability to utilize the remaining acreage for some other uses that do not impact the turbine, such as agricultural use. (AE, 2008)

Even if there was enough land area to develop wind turbines, the majority of land area throughout the primary market area is characterized as a Class 1 site with scattered areas of Class 2 and Class 3 sites; therefore, it would not be practicable to construct a wind power generating facility at the site or within the primary market area/ROI (Energy Efficiency and Renewable Energy [EERE], 2003).

Although wind technology is considered mature, technological advances may make wind a more economic choice than other renewable sources for developers (CEC, 2003). Technological improvements in wind turbines have helped reduce capital and operating costs. In 2000, wind power was produced at a cost between $0.03 and $0.06/kWh, depending on wind speeds. By 2020, wind power production costs are projected to decrease to between $0.03 and $0.04/kWh (ELPC, 2001). The following contains information about the viability of the wind resource.

- In 1995, the EIA estimated the cost of building a 115 kV line to be $130,000 per mile, excluding rights-of-way costs (EIA, 2003b). Besides construction, operating, and maintenance costs for wind farms, there are also costs for connection to the transmission grid. 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 connection for a 115 kV transmission line with a substation was estimated to be $360,000. 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. (EIA, 1995)

- A 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 would be required to connect the wind farm to the distribution system. Existing transmission infrastructure may 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 may be limited by land use regulations and the ability to obtain the required permits from local, regional, and national authorities.

- Additional considerations on the integration of wind capacity into the electric utility system are the limitations of wind energy generation. Wind power generating facilities must be located at sites with specific characteristics to maximize the amount of wind energy captured and electricity generated (ELPC, 2001). Additionally, for transmission

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purposes, wind generation is not considered "dispatchable," meaning the generator can control output to match load and economic requirements. Because the resource is intermittent (or not available all of the time), wind by itself, even with an attached storage system to store energy captured at any time for later use, 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 BBNPP; however, wind can be used in combination with other resources. This is discussed further in Section 9.2.3.3.

In addition to the land requirements posed by large facilities, wind power generating facilities have the following potential environmental impacts:

- Some people consider large scale commercial wind farms to be an aesthetic problem. Local residents near the wind farms may lose what they consider their pristine scenic viewshed of the area.
- High speed wind turbine blades can be noisy.
- Wind power generating facilities can expect to have higher bird fatality rates than those expected if the facility were not there.

Although Wind Powering America indicates that Pennsylvania has wind resources consistent with utility-scale production in a few areas of the state, near Lake Erie and on ridge crests in the southwestern part of the state, and southwest and southeast of Altoona, they are classified as fair winds (Class 3) at a maximum (EERE, 2008a).

Wind Powering America indicates that Delaware has wind resources consistent with utility-scale production. The good to excellent wind resource is located along the coasts of Delaware Bay and the Atlantic Ocean, especially from Cape Henlopen to the Maryland border. In addition, small wind turbines may have applications in some areas (EERE, 2008b).

Wind Powering America indicates that the highest resources areas in New Jersey are found along the Atlantic Ocean and Delaware Bay coastal areas, and on the ridges of western and northwestern New Jersey. In addition, small wind turbines may have applications in some areas (EERE, 2008c).

Wind Powering America indicates that Maryland has wind resources consistent with utility-scale production. Several areas are estimated to have good to excellent wind resources. These are the barrier islands along the Atlantic coast, the southeastern shore of Chesapeake Bay, and ridge crests in the western part of the state, west of Cumberland. In addition, small wind turbines may have applications in some areas (EERE, 2008d).

Wind Powering America indicates that Virginia has wind resources consistent with utility-scale production. Several areas of the state are estimated to have good to excellent wind resource. In addition, small wind turbines may have applications in some areas (EERE, 2008e).

Many renewable resources, like wind, are intermittent. Storing energy from renewable resources allows supply to match demand. For example, a storage system attached to a renewable resource, such as a wind turbine, could store energy captured at any time, and then utilize that energy during higher-priced midday usage. (NREL, 2006)

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With the inability of wind energy to generate baseload power; the lack of available Class 3 and Class 4 sites; the cost factors in construction, operation, and transmission connections; and the environmental impacts associated with development, a wind power generating facility alone is not a feasible alternative to the BBNPP and, therefore, is not carried forward for further analysis.

9.2.2.2 Geothermal

As illustrated by Figure 8.4 in the GEIS (NRC, 1996), geothermal plants might be located in the western continental U.S., Alaska, and Hawaii, where hydrothermal reservoirs are prevalent; however, suitable geothermal resources do not exist in the ROI/primary market area. (NRC, 1996)

Based on the hottest known geothermal regions of the U.S., the ROI/primary market area is not a candidate for geothermal energy and could not produce the proposed 1,600 MWe of baseload energy (GEO, 2000). Delaware and Maryland have vast low-temperature resources suitable for geothermal heat pumps. However, neither state has sufficient resources to use other geothermal technologies (EERE, 2008b) (EERE, 2008d). Pennsylvania, New Jersey, and Virginia have low to moderate temperature resources that can be tapped for direct heat or for geothermal heat pumps (EERE, 2008a) (EERE, 2008c) (EERE, 2008e) but they are not adequate for the baseload power requirements. Therefore, a geothermal energy source is not adequate in the ROI/primary market area, and a geothermal power generating facility is not a feasible alternative. As a result, this energy source is not carried forward for further analysis.

9.2.2.3 Hydropower

The GEIS (NRC, 1996) estimates land use of 1,600 mi^2 (4,144 km^2) per 1,000 MWe generated by hydropower. Based on this estimate, hydropower would require flooding more than 2,600 mi^2 (6,734 km^2) to produce a baseload capacity of 1,600 MWe, resulting in a large impact on land use.

Environmental considerations associated with hydropower dams include alteration of aquatic habitats above and below the dam, which would affect existing aquatic species, and the constraint the dam puts on migrating fish species in the area. Another consideration is the potential displacement of communities by flooding the new reservoir, or local communities' loss of use of the current river system for recreational activities.

Pennsylvania has 104 hydropower sites with the potential for 2,217.3 MWe of electricity. Sixty-seven of the sites have been developed with an impoundment or diversion structure, but are currently without power generation capability. These have a potential for 309.8 MWe of electricity. Thirty-two of the sites are undeveloped (no impoundment or diversion structure and no power generation capability) with a potential for 1,700.6 MWe of electricity. Five of the sites have been developed with power generation capability and have the potential for 206.9 MWe of additional capacity. In order to produce the 1,600 MWe of baseload capacity required by the BBNPP, numerous hydropower generating facilities would need to be developed and in operation (INEEL, 1997). Virginia has a total of 88 hydropower facilities with the potential for generating 1,250 MWe (INEEL, 1997a). Pennsylvania, Delaware, New Jersey, and Maryland have low hydropower resource as a percentage of the state's electricity generation (EERE, 2008a; EERE, 2008b; EERE, 2008c; EERE, 2008d). Virginia has moderate hydropower resource as a percentage of the state's electricity generation (EERE, 2008e).

Because hydropower is not a feasible alternative due to substantial land use requirements, this energy source is not carried forward for further analysis.

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9.2.2.4 Solar Power

Solar energy depends on the availability and strength of sunlight (strength is measured as kWh/m^2), and solar power is considered an intermittent source of energy. Solar facilities would have equivalent or greater environmental impacts than a new nuclear facility at the BBNPP site. Such facilities would also have higher costs than a new nuclear facility.

The 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, land requirements are high: 35,000 ac (14,000 ha) per 1,000 MWe for PV cells and approximately 14,000 ac (6,000 ha) per 1,000 MWe for solar thermal systems (NRC, 1996). This would require a footprint of approximately 56,000 ac (22,700 ha) for PV cells and 22,400 ac (9,100 ha) for solar thermal systems to produce a 1,600 MWe baseload capacity. Both of these alternatives would increase environmental impacts by constructing on a much larger footprint area.

In the ROI, two types of collectors for solar resources were 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 the ROI/primary market area, approximately 3,000 to 3,500 watt hours per square meter per day ($W(hr)/m^2/day$) can be collected using concentrating collectors (EERE, 2008f). 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 the ROI/primary market area, approximately 4,000 to 4,500 $W(hr)/m^2/day$ can be collected using flat-plate collectors (EERE, 2008f). For flat-plate collectors, Pennsylvania has a useful resource across the state. For concentrating collectors, Pennsylvania resource is relatively poor (EERE, 2008a). For flat-plate collectors, Delaware has a useful resource throughout the state. For concentrating collectors, Delaware has a marginal resource (EERE, 2008b). For flat-plate collectors, New Jersey has a useful resource; southern New Jersey has the best resource. For concentrating collectors, New Jersey has a marginal resource (EERE, 2008c). For flat-plate collectors, Maryland has a good, useful solar resource throughout the state. For concentrating collectors, Maryland has a marginal resource (EERE, 2008d). For flat-plate collectors, Virginia has good, useful solar resource throughout most of the state. For concentrating collectors, Virginia could pursue some types of technologies in the south central region of the state (EERE, 2008e). The footprint needed to produce a 1,600 MWe baseload capacity is much too large to construct at the proposed plant site.

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

- 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 to the land used by a new nuclear plant.
- Depending on the solar technology used, there may be thermal discharge impacts. These impacts are anticipated to be small. During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.
- PV technology creates environmental impacts related to manufacture and disposal. Chemicals used in the manufacture of PV cells include cadmium and lead. Potential human health risks also arise from the manufacture and deployment of PV systems because there is a risk of exposure to heavy metals such as selenium and cadmium

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during use and disposal (CEC, 2004). 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. The impact of these lead batteries is lessening; however, as batteries become more recyclable, batteries of improved quality are produced and better quality solar systems that enhance battery lifetimes are created. (REW, 2001)

Based on the large facility footprint needed to produce a 1,600 MWe baseload capacity, as well as the early stage of development of the technology, solar power systems are not considered competitive to the proposed project and are not carried forward for further analysis.

9.2.2.4.1 Concentrating Solar Power Systems

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

Concentrating solar power systems can be sized for "village" power (10 kWe) or grid connected applications (up to 100 MWe). Some systems use thermal energy storage (TES), setting aside heat transfer fluid in its hot phase during cloudy periods or at night. These attributes, along with solar-to-electric conversion efficiencies, make concentrating solar power an attractive renewable energy option in the southwest part of the U.S. and other Sunbelt regions worldwide (EERE, 2006b). Others can be combined with natural gas. This type of combination is discussed in Section 9.2.3.3.

There are three kinds of concentrating solar power systems-troughs, dish/engines, and power towers - classified by how they collect solar energy (EERE, 2006b).

Concentrating solar power technologies utilize many of the same technologies and equipment used by conventional power plants, simply substituting the concentrated power of the sun for the combustion of fossil fuels to provide the energy for conversion into electricity. This "evolutionary" aspect - as distinguished from "revolutionary" or "disruptive" - allows for easy integration into the transmission grid. It also makes concentrating solar power technologies the most cost-effective solar option for the production of large-scale electricity generation (10 MWe and above).

In 2005, concentrating solar power systems had a benchmark cost of $0.12 to $0.14/kWh with a target cost of $0.035 to $0.06/kWh by 2025 (EERE, 2006a). However, concentrating solar power generating facilities are still in the demonstration phase of development, are not currently competitive with nuclear based technologies, and are not carried forward for further analysis.

9.2.2.4.2 "Flat-Plate" Photovoltaic Cells

The second common 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 cm (4 in) on a side. A cell can produce about 1 watt of power-more than enough to power a watch, but not enough to run a radio.

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When more power is needed, some 40 PV cells can be connected to form a "module." A typical module is powerful enough to light a small light bulb. For larger power needs, about 10 such modules are mounted in PV arrays, which can measure up to several meters on a side. The amount of electricity generated by an array increases as more modules are added.

"Flat-plate" PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture more sunlight over the course of a day. Ten to 20 PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system (NREL, 2007). The land requirement for this technology is approximately 14 hectares (35 acres) per MWe (NRC, 1996). In order to produce the 1,600 MWe baseload capacity as BBNPP 22,660 hectares (55,993 acres) would be required for construction of the photovoltaic modules.

Some PV cells are designed to operate with concentrated sunlight, and a lens is used to focus the sunlight onto the cells. This approach has both advantages and disadvantages compared with flat-plate PV arrays. Economics of this design turn on the use of as little of the expensive semi-conducting PV material as possible, while collecting as much sunlight as possible. The lenses cannot use diffuse sunlight, but must be pointed directly at the sun and moved to provide optimum efficiency. Therefore, the use of concentrating collectors is limited to the west and southwest areas of the U.S.

Currently, PV solar power is not competitive with other methods of producing electricity for the open wholesale electricity market. When calculating 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. It is important to remember that all systems are unique in their quality and size, making it difficult to make broad generalizations about price. The average price for modules (dollars per peak watt) increased 9%, from $3.42 in 2001 to $3.74 in 2002. For cells, the average price decreased 14%, from $2.46 in 2001 to $2.12 in 2002 (EIA, 2003a). The module price, however, does not include the design costs, land, support structure, batteries, an inverter, wiring, and lights/appliances.

Costs of PV cells in the future may decrease with improvements in technology and increased production. By 2020, costs of grid-connected PV systems could drop to $2,275 per kWe and to $0.15 to $0.20 per kWh by 2020 (ELPC, 2001). These costs would still be substantially in excess of the costs of power from a new nuclear plant. Therefore, PV cells are non competitive with a new nuclear plant at the BBNPP site and are not carried forward for further analysis.

9.2.2.5 Wood Waste and Other Biomass

The use of wood waste and other biomass to generate electricity is largely limited to 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. This would not meet the proposed 1,600 MWe baseload capacity.

Nearly all of the wood-energy-using electricity generation facilities in the U.S. 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 feedstock.

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As indicated in the GEIS, construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant. Like coal-fired plants, wood waste plants require large areas for fuel storage, processing, and waste (i.e., ash) disposal. Additionally, the operation of wood-fired plants creates environmental impacts, including impacts on the aquatic environment and air (NRC, 1996).

The availability of biomass resources in Pennsylvania are as follows in thousand metric tons/year (thousand tons/year): Crop residues: 735 (810); switchgrass on CRP lands: 610 (672); forest residues: 1,523 (1,679); methane from landfills: 582 (642); methane from manure management: 21 (23); primary mill: 1,231 (1,358); secondary mill: 115 (127); urban wood: 1,123 (1,238); and methane from domestic wastewater: 18 (20). This totals approximately 5,959 thousand metric tons/year (6,569 thousand tons/year)) total biomass availability in the Commonwealth of Pennsylvania (NREL, 2005).

Studies indicate that Delaware has good biomass resource potential. According to a technical report (NREL, 2005), the availability of biomass resources in Delaware are as follows in thousand metric tons/year (thousand tons/year): Crop residues: 222 (245); switchgrass on CRP lands: 20 (22); forest residues: 47 (51); methane from landfills: 53 (58); methane from manure management: 0.5 (0.5); primary mill: 0.05 (0.05); secondary mill: 7 (8); urban wood: 77 (85); and methane from domestic wastewater: 0.9 (1). This totals approximately 437 thousand metric tons/year [482 thousand tons/year]) total biomass availability in the State of Delaware (NREL, 2005).

Data in the NREL report shows the availability of biomass resources in New Jersey are as follows in thousand metric tons/year (thousand tons/year): Crop residues: 83 (91); switchgrass on CRP lands: 10 (11); forest residues: 26 (29); methane from landfills: 451 (497); methane from manure management: 0.3 (0.3); primary mill: 15 (17); secondary mill: 811 (894); urban wood: 566 (624); and methane from domestic wastewater: 13 (14). This totals approximately 1,462 thousand metric tons/year (1,612 thousand tons/year)) total biomass availability in the State of New Jersey (NREL, 2005).

The availability of biomass resources in Maryland are as follows in thousand metric tons/year (thousand tons/year): Crop residues: 530 (584); switchgrass on CRP lands: 246 (271); forest residues: 239 (263); methane from landfills: 185 (204); methane from manure management: 5.4 (6); primary mill: 125 (138); secondary mill: 30 (33); urban wood: 566 (624); and methane from domestic wastewater: 8.2 (9). This totals approximately 1,933 thousand metric tons/year (2,131 thousand tons/year)) total biomass availability in the State of Maryland (NREL, 2005).

According to a technical report (NREL, 2005), the availability of biomass resources in Virginia are as follows in thousand metric tons/year (thousand tons/year): Crop residues: 455 (502); switchgrass on CRP lands: 269 (297); forest residues: 2,180 (2,403); methane from landfills: 249 (275); methane from manure management: 21 (23); primary mill: 1,948 (2,147); secondary mill: 56 (62); urban wood: 738 (813); and methane from domestic wastewater: 11 (12). This totals approximately 5,928 thousand metric tons/year (6,535 thousand tons/year)) total biomass availability in the Commonwealth of Virginia (NREL, 2005).

Biomass fuel can be used to co-fire with a coal-powered generating facility, decreasing cost from $0.023 to $0.021 per 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 per kWh (EERE, 2007), which is significantly higher than the costs associated with a nuclear power plant ($0.031 to $0.046 per kWh) (DOE, 2002). Because of the environmental impacts and costs of a biomass-fired plant, biomass is non-competitive within

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the ROI with a new nuclear unit and this energy source is not carried forward for further analysis.

9.2.2.6 Municipal Solid Waste

The initial capital costs for municipal solid waste (MSW) plants are greater than for comparable steam turbine technology at wood-waste facilities (NRC, 1996). This is because of the need for specialized waste separation and handling equipment.

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 may limit the growth in MSW power generation. Chief among them are environmental regulations and public opposition to siting MSW facilities.

Estimates suggest that the overall level of construction impacts from a waste-fired plant should be approximately the same as those for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal) (NRC, 1996). Some of these impacts would be moderate, but still larger than the proposed action.

As an MSW reduction method, incineration can be implemented, generating energy and reducing the amount of waste by up to 90% in volume and 75% in weight (USEPA, 2006b).

As of March 2008, generation of other renewable electricity, which includes MSW, accounted for the following percentages of total generation in the ROI: 1.2% in Pennsylvania, 1.6% in Delaware, 1.3% in Maryland, and 1.6% in New Jersey (EIA, 2008c).

The U.S. has about 89 operational MSW-fired power generation plants, generating approximately 2,500 MWe, or about 0.3% of total national power generation. However, economic factors have limited new construction. This comes to approximately 28 MWe per MSW-fired power generation plant, and would not meet the proposed 1,600 MWe baseload capacity. Burning MSW produces nitrogen oxides and sulfur dioxide as well as trace amounts of toxic pollutants, such as mercury compounds and dioxins. MSW power 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 (USEPA, 2006a).

The cost of power for MSW fired power generation plants would be partially offset by savings in waste disposal fees. However, MSW fired power generation remains significantly more costly than nuclear power, even when disposal fee savings are included into the cost of power. A study performed for a proposed MSW fired power facility in 2002 found that cost of power varied from $0.096 to $0.119 per kWh in the case with low MSW disposal fees, and from $0.037 to $0.055 per KWh in the case with high MSW disposal fees (APT, 2004). These costs, accounting for the disposal fees, are significantly higher than the costs associated with a nuclear power plant ($0.031 to $0.046 per kWh) (DOE, 2002). Therefore, MSW is non-competitive with a new nuclear unit at the BBNPP site because the energy source cannot provide the baseload electricity needs compared to a new nuclear unit and this energy source is not carried forward for further analysis.

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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 plant capacity of 1,600 MWe.

Estimates suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as those for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air) (NRC, 1996). In addition, these systems have large 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 3.0 mi^2 (7.69 km^2) of corn are needed to produce 1 million gallons of ethanol and in 2002, Pennsylvania produced approximately 2,073 mi^2 (5,369 km^2) of corn. Currently in Pennsylvania, more corn is used for grain products than any other purpose. Pennsylvania produces more than 50% of the corn grown in the ROI. If ethanol were to be proposed as an energy crop, Pennsylvania would have to supplement its corn production from nearby states (USDA, 2004). Surrounding states within the ROI also use corn for grain products and do not have the resources to supplement ethanol based fuel facilities.

The energy cost per KWh for energy crops is estimated to be similar to, or higher than, other biomass energy sources (EIA, 2004). A DOE forecast concluded that the use of biomass for power generation is not projected to increase substantially in the next ten years because of the cost of biomass relative to the costs of other fuels and the higher capital costs relative to those for coal- or natural-gas-fired capacity (EIA, 2002). Therefore, energy crops are non-competitive with a new nuclear unit at the BBNPP site and this energy source is not carried forward for further analysis.

9.2.2.8 Petroleum Liquids (Oil)

From 2002 to 2005, petroleum costs almost doubled, increasing by 92.8%, and the period from 2004 to 2005 alone produced an average petroleum increase of 50.1% (EIA, 2006). Between January 2006 and January 2008, petroleum costs tripled, increasing by approximately 195 percent (EIA, 2007c) (EIA, 2008b). In spite of the increase in the cost of petroleum, Pennsylvania experienced an increase in production of electricity by power generating facilities fueled by oil. However, from 2005 to 2006, net generation of electricity from petroleum liquids dropped by about 84% in Maryland (EIA, 2007d). As of March 2008, generation of petroleum fired electricity accounted for only a small percentage of total generation in the ROI: 0.4% in Pennsylvania, 3.5% in Delaware, 0.4% in Maryland, and 0.8% in New Jersey. Between January 2007 and January 2008, net generation from petroleum liquids increased by 82% (EIA, 2008a). In the GEIS, NRC staff estimated that construction of a 1,000 MWe oil power generating facility would require approximately 120 ac (50 ha) of land (NRC, 1996).

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. Oil fired plants also have one of the largest carbon footprints of all the electricity generation systems analyzed. Conventional oil-fired plants result in emissions of greater than 650 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 130 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Future

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developments such as carbon capture and storage and co-firing with biomass have the potential to reduce the carbon footprint of oil-fired electricity generation (POST, 2006).

Apart from fuel price, the economics of oil fired power generation are similar to those for 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 type of combined cycle system a less competitive alternative when natural gas is available. Oil fired power generation experienced a significant decline in the early 1970s. Increases in world oil prices have forced utilities to use less expensive fuels; however, oil fired generation is still an important source of power in certain regions of the U.S. (NRC, 1996).

On these bases, an oil-fired generation plant is non-competitive with a new nuclear unit at the BBNPP site and this energy source is not carried forward for further analysis.

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 $4,500 per kWh of installed capacity.

By contrast, a diesel generator costs $800 to $1,500 per kWh of installed capacity, and a natural gas turbine may cost even less. DOE has launched an initiative - the Solid State Energy Conversion Alliance - to bring about dramatic reductions in fuel cell cost. The 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. (DOE, 2006)

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 1,600 MW(e) baseload capacity. At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation and the fuel cell alternative is non-competitive with a new nuclear unit at the BBNPP site. As a result, this energy source is not carried forward for further analysis.

9.2.2.10 Coal

Coal-fired steam electric plants provide the majority of electric generating capacity in the U.S., accounting for about 52% of the electric utility industry's total generation, including co-generation, in 2000 (EIA, 2001). Conventional coal-fired plants generally include two or more generating units and have total capacities ranging from 100 MWe to more than 2,000 MWe. Coal is likely to continue to be a reliable energy source well into the future, assuming environmental constraints do not cause the gradual substitution of other fuels (EIA, 1993).

The U.S. has abundant low-cost coal reserves, and the price of coal for electric 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 (NRC, 1996).

The environmental impacts of constructing a typical coal-fired steam plant are well known because coal is the most prevalent type of central generating technology in the U.S. The impacts of constructing a 1,000 MWe coal plant at a greenfield site can be substantial, particularly if it is sited in a rural area with considerable natural habitat. An estimated 1,050

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acres (425 ha) or 1.64 mi^2 (4.25 km^2) would be needed at the BBNPP for a new 1,600 MWe coal-fired facility, including power block, coal storage, and waste management, resulting in the loss of the same amount of natural habitat and/or agricultural land for the plant site alone, excluding land required for mining and other fuel cycle impacts (NRC, 2008).

As of March 2008, generation of coal-fired electricity accounted for the following percentages of total generation in the ROI: 57.2% in Pennsylvania, 76.5% in Delaware, 62.1% in Maryland, and 17.1% in New Jersey (EIA, 2008c). An existing 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 (EERE, 2007).

The operating impacts of new coal plants would be substantial for several resources. Concerns over adverse human health effects from coal combustion have led to important federal legislation in recent years, such as the Clean Air Act and Amendments (CAAA). Although new technology has improved emissions quality from coal-fired facilities, health concerns remain. Air quality would be degraded by the release of additional carbon dioxide, regulated pollutants, and radionuclides.

Carbon dioxide has been identified as a leading cause of global warming. Sulfur dioxide and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. However, the positive socioeconomic benefits can be considerable for surrounding communities in the form of several hundred new jobs, substantial tax revenues, and plant spending.

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a coal gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.11 Natural Gas

As of March 2008, generation of natural gas-fired electricity accounted for the following percentages of total generation in the ROI: 7.0% in Pennsylvania, 8.3% in Delaware, 2.2% in Maryland, and 32.9% in New Jersey (EIA, 2008c).

Most of the environmental impacts of constructing natural gas-fired plants are similar to those of other large central generating stations. Land-use requirements for gas-fired plants are small, at 0.17 mi^2 (0.45 km^2) for a 1,000 MWe plant, so land-dependent ecological, aesthetic, erosion, and cultural impacts should be small. Siting at a greenfield location would require new transmission lines and increased land-related impacts, whereas collocating 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 facilities, take much less time to construct than other plants (NRC, 1996).

Additionally, land use requirements for the BBNPP site would be approximately 160 ac (65 ha) or 0.25 mi^2 (0.65 km^2) for a new 1,600 MWe gas-fired plant to be located at the BBNPP site. Another 12 ac (4.9 ha) or 0.02 mi^2 (0.05 km^2) would be required to build a pipeline to connect to an existing pipeline corridor (NRC, 2008).

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Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a natural gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.12 Integrated Gasification Combined Cycle (IGCC)

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 prior to 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, a black, glassy, sand-like material that is potentially a marketable byproduct. Slag production is a function of ash content. The other large-volume byproduct produced by IGCC plants is sulfur, 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.

At present, IGCC technology has insufficient operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But the 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 U.S. Experience has been gained with the chemical processes of gasification, coal properties and their impact on IGCC design, efficiency, economics, etc.

However, system reliability is still relatively lower than conventional pulverized coal-fired power plants. There are problems with the integration between gasification and power production, as well. For example, if there is a problem with gas cleaning, uncleaned gas can cause various damages to the gas turbine. (PU, 2005)

Overall, IGCC plants are estimated to be about 15% to 20% more expensive than comparably sized pulverized coal plants, due in part to the coal gasifier and other specialized equipment. Recent estimates indicate that overall capital costs for coal-fired IGCC power plants range from $1,400 to $1,800/kilowatt (kW) (EIA, 2005). The production cost of the electricity from a coal-based IGCC power plant is estimated to be about $0.033 to $0.045/kWh. The projected cost associated with operating a new nuclear facility similar to BBNPP is in the range of $0.031 to $0.046/kWh.

In 2004, the DOE commissioned Booz Allen Hamilton to conduct a study on the various ways to increase IGCC's market penetration potential in the future. The study considered only coal as the feedstock. Booz Allen Hamilton concluded that it is feasible for IGCC to assume a more prominent role in energy production only after extensive research is conducted to lower the production costs. Additionally, Booz Allen Hamilton depicted three challenges that IGCC must overcome before becoming a prominent source of energy, including: overcoming the financial burden relative to competing technologies, mitigating siting risks, and managing uncertainty. Booz Allen Hamilton lays out a series of recommendations for the DOE to take to begin to overcome these challenges. Many of these recommendations include conducting further studies and research tests (BAH, 2004).

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Because IGCC technology currently requires further research to achieve an acceptable level of reliability, an IGCC facility is not a competitive alternative to BBNPP and is not carried forward for further analysis.

9.2.3 ASSESSMENT OF REASONABLE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

For the viable alternative energy source options identified in Section 9.2.2, the issues associated with these options were characterized based on the significance of impacts, with the impacts characterized as being either SMALL, MODERATE, or LARGE. This characterization is consistent with the criteria that NRC established in 10 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. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

- MODERATE - Environmental 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 (NRC, 2001).

Table 9.2-1 provides a comparison of the alternatives regarding environmental categories.

9.2.3.1 Coal-Fire Generation

The environmental impacts from coal-fired generation alternatives were evaluated in the GEIS (NRC, 1996), draft GEIS for license renewal (NRC, 2008), and SSES Units 1 and 2 License Renewal Application (NRC, 2006). It was concluded that construction impacts for coal-fired generation could be substantial, in part because of the large land area required (for the plant site alone; 1,050 ac (425 ha) or 1.64 mi^2 (4.25 km^2) would be needed at the BBNPP for a new 1,600 MWe coal-fired facility, including power block, coal storage, and waste management (NRC, 2008), which would be in addition to the land resource required for mining and other fuel cycle impacts. These construction impacts would be decreased to some degree by siting a new coal-fired plant where an existing nuclear plant is located.

9.2.3.1.1 Air Quality

The air quality impacts of coal-fired generation are considerably different from those of nuclear power. A coal-fired plant would emit sulfur dioxide (SO2, as SOx surrogate), oxides of nitrogen (NOx), 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 generation facility based on the emission factors contained in USEPA document, AP-42 (USEPA, 1995). The emissions from this facility are based on a power generation capacity of 1,600 MWe. The coal-fired generation facility assumes the use of bituminous coal-fired in a circulating fluidized bed combustor (FBC). The sulfur content of the coal was assumed to be 2% 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 NOx emissions and a baghouse to control PM. Table 9.2-2 summarizes the air emissions produced by a 1,600 MWe coal-fired facility.

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Operating impacts of a new coal plant include concerns over adverse human health effects, such as increased cancer and emphysema. Air quality would be impacted by the release of CO_2, regulated pollutants, and radionuclides. CO_2 has been identified as a leading cause of global warming, and SO_2 and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be also be produced and would require constant management. Losses of aquatic biota due to cooling water withdrawals and discharges would also occur.

As described in Section 9.1, Pennsylvania has not, at this time, established mandatory programs to regulate carbon dioxide and other greenhouse gases and is observing, though not participating in, the RGGI. As of November 2007, three other states within the ROI/primary market area (New Jersey, Delaware, and Maryland) are members of RGGI (MDE, 2008). A description of the RGGI and implementation within the ROI/primary market area is provided in Section 9.1.

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 1,000 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 200 times higher than the carbon footprint of a nuclear power generation facility (approximately 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 not as widespread as proven combustion technologies. Future developments such as carbon capture and storage (CCS) and co-firing with biomass have the potential to reduce the carbon footprint of coal-fired electricity generation. (POST, 2006)

The NRC indicates that air emission impacts from fossil fuel generation are greater than nuclear power generating facility air emission impacts (NRC, 1996) (NRC, 2006) (NRC, 2008). The NRC notes that human health effects from coal combustion are also greater based on the health effects from air emissions (NRC, 2008). Based on the emissions generated by a coal-fired facility, air impacts would be MODERATE.

9.2.3.1.2 Waste Management

Substantial solid waste, especially fly ash and scrubber sludge, would be produced during plant operation and would require constant management (NRC, 2008). Approximately 360 ac (145.7 ha) would be required over a 40-year period of a coal-fired facility at the BBNPP for waste disposal. (NRC, 2008)

With proper placement of the facility, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources. There would also need to be an estimated 34.4 mi^2 (89 km^2) for mining the coal and disposing of the waste to support a coal plant during its operational life (NRC, 1996).

As a result of the above mentioned factors, waste management impacts would be MODERATE. Impacts from construction wastes, such as debris from land clearing and solid wastes would be SMALL.

9.2.3.1.3 Economic Comparison

DOE has estimated the cost of generating electricity from a coal facility to be approximately $0.049 per kWh. The projected cost associated with operating a new nuclear facility similar to the BBNPP is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004).

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Although coal-fired generation is considered a competitive alternative to nuclear power generation, coal-fired generation is not considered to be environmentally preferable to the proposed action. Therefore, as allowed in NUREG-1555, ESRP 9.2.3 (NRC, 2007), additional cost data, e.g., decommissioning costs, and fuel cost estimates, are not provided for alternatives that are not deemed to be environmentally preferable to the proposed action.

9.2.3.1.4 Other Impacts

Construction of the power block and coal storage area would disturb approximately 690 ac (279 ha) or 1.1 mi^2 (2.8 km^2) of land and associated terrestrial habitat and 360 ac (146 ha) or 0.6 mi^2 (1.5 km^2) for waste management (NRC, 2008). As a result, land use impacts would be MODERATE during construction and operation.

Impacts to aquatic resources and surface water quality would be minimized but could be characterized as SMALL due to the coal power generating facility's use of a new cooling water system. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. Impacts from construction activities to surficial groundwater would be localized and SMALL. The groundwater would be expected to recover during operations mode, therefore, impact to groundwater would be SMALL (PPL, 2006) (NRC, 2008). Impacts to surface water bodies would be MODERATE during construction primarily due to loss of wetlands and wetland buffers. Although coal pile runoff could affect surface water quality, impacts to water resources and quality would be SMALL due to the coal power generating facility's use of a new cooling water system. (NRC, 2008)

The BBNPP site is already aesthetically altered by the presence of the existing SSES Units 1 and 2 structures. The power plant buildings would be up to 200 ft (61 m) tall and may be visible in the daylight hours and the exhaust stacks would be up to 600 ft (183 m) tall. Current SSES cooling towers are approximately 540 ft (165 m) tall. The visual impact of the towers could be mitigated through landscaping and light paint color. The aesthetic impact, therefore, would be SMALL during operation (NRC, 2008). Noise impacts during operation would be SMALL to MODERATE (NRC, 2006). Construction activities would not be visible to the public because of highways bordered by vegetation; therefore, impacts would be SMALL to MODERATE (NRC, 2008).

The BBNPP site development would use terrestrial forest, wetland habitat, and land previously disturbed by agriculture near SSES. Permanent and/or temporary impacts to wetlands and/or streams would occur within the project footprint during construction. BMPs would be used to minimize wetlands impacts and wetland construction on PPL-owned or other property would mitigate loss of wetland habitat. Because wetland habitat loss would require mitigation, ecological resource impacts would be MODERATE. Terrestrial habitat loss during construction would be small in comparative acreage to the region but may be locally significant. No important aquatic species are present on site. Impacts from construction activity to terrestrial habitat and the totality of the aquatic ecosystems would be limited and temporary; therefore, impacts during construction would be SMALL. Recovery of some species during operations is anticipated and impacts would be SMALL. (Ecology, 2007b) (NRC, 2008)

No known state or federal rare, threatened, or endangered plant species have been observed on the BBNPP site. Ten threatened and endangered species and species of special concern are known to have distribution in the area. Four important habitats, including wetlands will be impacted. (PDCNR, 2008a) (PDCNR, 2008b) (PPL, 2006) (Ecology, 1995) (Ecology, 2007a) Impact to wetlands and wetland buffer would require mitigation. Impacts would be MODERATE.

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Based on a Phase Ia cultural and resource assessment and data base review at SSES, no confirmed listings of historical sites were identified. Therefore, adverse impacts are unlikely to this previously disturbed site. Impacts from construction and operations would be SMALL. (PHMC/BHP, 2001)

Construction employment impacts would be MODERATE (NRC, 2008), socioeconomic benefits from several hundred mining and construction and operation jobs as well as additional tax revenues would be associated with the coal mining (NRC, 1996). As a result, socioeconomic impacts would be MODERATE and beneficial.

As a result of increased safety technologies, accident impacts would be SMALL. Mining safety is not considered within this impact category.

As previously described, as a result of increased air emissions and public health risks, such as cancer and emphysema associated with those emissions, human health impacts during operation would be MODERATE and SMALL during construction due to best management practices to curb fugitive dust emissions. (NRC, 2008)

Demographic characteristics of the area surrounding the BBNPP demonstrate that there are no significant numbers of minority or low-income populations represented in the vicinity; therefore, the environmental justice impact would be SMALL. (NRC, 2008)

9.2.3.1.5 Summary

The impacts for the operation of the coal-fired alternative would be SMALL, SMALL to MODERATE, and MODERATE. Water use and quality, terrestrial and aquatic ecology including wetlands, threatened and endangered species, cultural and historic resources, safety, and environmental justice impacts would be SMALL. Impacts to aesthetics would be SMALL to MODERATE and impacts to land use, air quality, waste management, human health, and socioeconomics would be MODERATE. Based of these impacts, the coal power generating facility would not be environmentally preferable to the BBNPP.

9.2.3.2 Natural Gas Generation

Most environmental impacts related to constructing natural gas-fired plants should be approximately the same for steam, gas-turbine, and combined-cycle plants. These impacts, in turn, generally will be similar to those of other large central generating stations. The environmental impacts of operating gas-fired plants are generally less than those of other fossil fuel technologies of equal capacity.

The environmental impacts from natural gas generation alternatives were evaluated in the GEIS (NRC, 1996), draft GEIS for license renewal (NRC, 2008), and SSES Units 1 and 2 License Renewal Application (NRC, 2006).

As identified in Table 9.2-1, construction impacts from this alternative would be SMALL to MODERATE. SMALL impacts would be anticipated for the impact categories of air quality, water use and quality, land use, terrestrial and aquatic ecology, waste management, human health, historic and cultural resources, enviromental justice, aesthetics, and safety. MODERATE impacts during construction would be anticipated in the categoies of socioeconomics, and threatened and endangered resources due to impacts to wetlands.

Impacts from operations would be SMALL to MODERATE overall. Impacts would be SMALL for air quality, water use and quality, ecology, waste management, socioeconomics, historic and

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cultural resources, environmental justice, aesthetics, and accidents. MODERATE impacts are anticipated for human health. Adverse off-site environmental impacts from natural gas wellfields were not included within the impact comparisons.

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% vs. 33% 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 NOx emissions.

Human health effects are not as large as from coal-fired generation, and based on decreased air quality impacts are determined to be SMALL. Natural gas technologies produce fewer pollutants than other fossil technologies, and SO_2, a contributor to acid rain, is not emitted at all (NRC, 1996). Air emissions were estimated for a natural gas-fired generation facility based on the emission factors contained in USEPA document, AP-42 (USEPA, 1995). Emissions from the facility were based on a power generation capacity of 1,600 MWe.

Current gas powered electricity generation has a carbon footprint around half that of coal (approximately 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 (approximately 5 gCO_2eq/kWh). Like coal-fired plants, gas plants could co-fire biomass to reduce carbon emissions in the future (POST, 2006).

The natural gas-fired generation facility assumes the use of a combined cycle gas turbine generator (GTG). Water injection is used to control nitrogen oxides emissions. Table 9.2-2 summarizes the air emissions produced by a 1,600 MWe natural gas-fired facility. Based on the emissions generated from a natural gas-fired facility, air impacts would be MODERATE.

9.2.3.2.2 Waste Management

Construction wastes (land clearing and solid wastes) would be minimal and would be subject to regulatory control. Therefore, the impact of construction waste management would be SMALL (NRC, 2008).

Gas-fired generation would result in almost no waste generation, producing minor (if any) impacts. Approximately 1,500 cubic ft of spent selective catalytic reduction (SCR) catalyst would be generated per year for a 2,400 MWe plant and would be less for a 1,600 MWe plant. This waste would be shipped offsite for disposal. As a result, waste management impacts would be SMALL.

9.2.3.2.3 Economic Comparison

DOE has estimated the cost of generating electricity from a gas-fired facility to be $0.047 per kWh. The projected cost associated with operating a new nuclear facility similar to BBNPP is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004).

Although natural gas-fired generation is considered a competitive alternative to nuclear power generation, natural gas-fired generation is not considered to be environmentally preferable to the proposed action, as described in the following section. Therefore, as allowed in NUREG-1555, ESRP 9.2.3 (NRC, 2007), additional cost data, e.g., decommissioning costs, and fuel cost estimates, are not provided for alternatives that are not deemed to be environmentally preferable to the proposed action.

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9.2.3.2.4 Other Impacts

Construction of a 1,600 MWe natural gas power generating facility could affect approximately 160 ac (65 ha) or 0.25 mi^2 (0.65 km^2) would be required for the facility and 12 ac (4.9 ha) or 0.02 mi^2 (0.05 km^2) for a pipeline that would be needed to connect to an existing line (PPL, 2006). Acreage does not include the gas well field (NRC, 2008). As a result, land use impacts would be SMALL during construction and operation of this type of facility.

According to the GEIS, consumptive water use is about the same for natural gas power generating facilities as for alternate power generating facilities. Water consumption is likely to be less for gas turbine power generating facilities (NRC, 1996). Potential impacts to aquatic biota through impingement and entrainment and increased water temperatures in receiving water bodies and water quality would be minimized but could be characterized as SMALL due to the natural gas power generating facility's use of a new cooling water system, dependent upon the cooling system's design. Impacts from construction activities to surficial groundwater would be localized and SMALL. The groundwater would be expected to recover during operation; therefore, impacts to groundwater would be SMALL (PPL, 2006) (NRC, 2008). Impacts to surface water bodies are MODERATE during construction primarily due to loss of wetlands and wetland buffers. (NRC, 2008)

The BBNPP site is already aesthetically altered by the presence of the existing SSES Units 1 and 2 structures, and the gas-fired plant structures are smaller that the existing SSES structures. Gas-fired units would be about 100 ft tall, while the exhaust stacks would be at least 174 ft (53 m) tall as opposed to the current units' height of 540 ft (165 m) tall. A new Turbine Building and exhaust stacks would need to be constructed. Noise would be detectable offsite, but it is likely that the level would not be any greater than the existing plant noise; a closed cycle cooling alternative could also introduce plumes. As a result, aesthetic impacts would be SMALL. (NRC, 2006) (NRC, 2008)

The BBNPP site would use a previously disturbed area near the SSES Units 1 and 2. Although permanent and/or temporary impacts during construction to wetlands and/or streams within the project footprint may occur, mitigation could be used to minimize impacts (NRC, 2006). Ecological resource impacts would, therefore, be SMALL. Terrestrial habitat loss during construction is small in comparative acreage to the region but may be locally significant. No important aquatic species are present onsite. Impacts from construction activity to terrestrial habitat and aquatic ecosystems would be limited and temporary; therefore, impacts during construction would be SMALL. Recovery of some species during operation is anticipated and impacts would be SMALL. (Ecology, 2007b) (NRC, 2008)

No known state or federal rare, threatened, or endangered plant species have been observed on the BBNPP site. Ten threatened and endangered species and species of special concern are known to have distribution in the area. Four important habitats, including wetlands will be impacted (PDCNR, 2008a) (PDCNR, 2008b) (PPL Susquehanna, LLC, 2006) (Ecology III, Inc.,1995) (Ecology III, Inc., 2007a). Impact to wetlands and wetland buffer would require mitigation. Impacts would be MODERATE.

Based on a Phase Ia cultural and resource assessment and database review at SSES, no confirmed listings of historical sites were identified. Therefore, adverse impacts are unlikely to this previously disturbed site. Therefore, impacts from construction and operations would be SMALL. (PHMC/BHP, 2001)

Construction employment impacts would be MODERATE (NRC, 2008). Socioeconomic benefits from approximately 88 construction and operations jobs, as well as additional tax revenues,

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would be associated with this alternative (PPL Susquehanna, LLC, 2006). As a result, socioeconomic impacts would be SMALL.

Due to increased safety technologies, accident impacts would be SMALL.

As previously mentioned because of increased air emissions and public health risks, human health impacts would be MODERATE (PPL Susquehanna, LLC, 2006) and SMALL during construction due to best management practices to curb fugitive dust emissions (NRC, 2008).

Demographic characteristics of the area surrounding the BBNPP demonstrate that there are no significant numbers of minority or low-income populations represented in the vicinity; therefore, the environmental justice impact would be SMALL. (NRC, 2008)

9.2.3.2.5 Summary

The majority of operations impacts for the natural gas-fired generator would be SMALL: land use, ecology, water use and quality, waste management, historic and cultural resources, environmental justice, aesthetics, socioeconomics, and safety. Categories with MODERATE impacts include air quality, human health and threatened and endangered resources due to impacts to wetlands. Because of these impacts, the natural gas power generating facility would not be environmentally preferable to the BBNPP.

9.2.3.3 Combination of Alternatives

BBNPP will have a baseload capacity of approximately 1,600 MWe. Any alternative or combination of alternatives would be required to generate the same baseload capacity.

Because of the intermittent nature of the resources and the lack of cost-effective technologies, wind and solar energies are not sufficient on their own to generate the equivalent baseload capacity or output of BBNPP, as discussed in Section 9.2.2.1 and Section 9.2.2.4. As noted in Section 9.2.3.1 and Section 9.2.3.2, fossil fuel fired technology generates baseload capacity, but the associated environmental impacts are greater than for a nuclear facility.

A combination of alternatives may be possible, but should be sufficiently complete, competitive, and viable to provide NRC with appropriate comparisons to the proposed nuclear plant.

9.2.3.3.1 Determination of Alternatives

Many possible combinations of alternative power generation sources could be used to satisfy the baseload capacity requirements of the BBNPP facility. Some of these combinations include renewable sources, such as wind and solar, although wind and solar do not, by themselves, provide a reasonable alternative energy source to the baseload power to be produced by the BBNPP facility. In combination with fossil fuel fired power generation; however, wind and solar may be a reasonable alternative to nuclear energy produced by the BBNPP facility.

As described in Section 8.3 and throughout Section 9.2.3, the ROI/primary market area utilizes a diversity of fuel sources for baseload power generation, including the alternatives identified in this section as a combination alternative to the baseload power to be provided by the BBNPP. A generation portfolio of diverse fuel sources reduces the risk to system reliability from the availability of individual fuels, the transportation of individual fuels, and the impact of fuel price variations and consequent generation loading patterns.

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The BBNPP will operate as a baseload, merchant independent power producer. The power produced will be sold on the wholesale market without specific consideration to supplying a traditional service area or satisfying a reserve margin objective. The ability to generate baseload power in a consistent, predictable manner meets the business objectives for the BBNPP. Therefore, when examining combinations of alternatives, the ability to consistently generate baseload power must be a determining factor when analyzing the suitability of the combination. This section reviews the ability of the combination alternative to have the capacity to generate baseload power equivalent to BBNPP.

When examining a combination of alternatives that would meet business objectives similar to that for the BBNPP, any combination that includes a renewable power source (either all or part of the capacity of the BBNPP) must be combined with a fossil-fueled facility equivalent to the generating capacity of the BBNPP. 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 provided by some amount of wind generation and that resource became available, then the output of the fossil fueled generation portion of the combination alternative could be lowered to offset the increased generation from the renewable portion. This facility, or facilities, would satisfy business objectives of the BBNPP facility in that it would be capable of providing the requisite baseload power regardless of the availability of the renewable power source.

Coal and natural gas power generating facilities have been determined to have environmental impacts that are equivalent to or greater than the impacts of the BBNPP. Based on the comparative impacts of these two technologies, as shown in Table 9.2-1 (USEPA, 1995), it can be concluded that a natural gas power generating facility would have less of an environmental impact than a comparably sized coal power generating facility. In addition, the operating characteristics of natural gas power generation are more amenable to the kind of load changes that may result from inclusion of renewable generation, such that the baseload generation output of 1,600 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 NOx, SOx, and particulate emissions; however, the environmental impacts from burning coal using these technologies, if proven, will still be greater than the impacts from natural gas (NETL, 2001). Therefore, for the purpose of examining the impacts from a combination of alternatives to the BBNPP, a natural gas power baseload generating facility equivalent to the BBNPP was used in the environmental analysis of combination alternatives.

The analysis accounts for the reduction in environmental impacts from a gas-fired facility when generation from the facility is displaced by the renewable resource. Additionally, the impact associated with the combined-cycle natural gas-fired unit is based on the gas fired generation impact assumptions discussed in Section 9.2.3.2. 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 BBNPP when such resources were available.

This combination of renewable energy and natural gas fired generation represents a potentially viable mix of non nuclear alternative energy sources. Many types of alternatives can be used to supplement wind energy, notably solar power. PV cells are another source of solar power that would complement wind power by using the sun during the day to produce energy while wind turbines use windy and stormy conditions to generate power. Wind and solar facilities in

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combination with fossil fuel facilities (coal, petroleum) could also be used to generate baseload power.

However, wind and solar facilities in combination with fossil fuel facilities would have equivalent or greater environmental impacts relative to a new nuclear facility at the BBNPP site. Similarly, wind and solar facilities in combination with fossil fuel facilities would have costs higher than a new nuclear facility at the BBNPP site. Therefore, wind and solar facilities in combination with fossil fuel facilities are non-competitive with a new nuclear unit at the BBNPP site.

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 BBNPP have already been described in previous sections. Depending on the level of potential renewable output included in the combination alternative, the level of impact of the gas-fired portion would be comparably lower during periods that the renewable resource is available. If the renewable portion of the combination alternative were not enough to displace all of the power produced by the natural gas power generation, then there would be some level of impact associated with the natural gas power generating facility. Alternately, if the renewable portion of the combination alternative were enough to fully displace the output of the natural gas portion, then when the renewable resource is available, the output of the natural gas power generating facility could be removed, thereby eliminating its operational impacts.

The environmental impacts associated with solar and wind power generating facilities are discussed in Section 9.2.2.1 and Section 9.2.2.4. Whereas the natural gas plant and solar arrays could potentially be built on the BBNPP site, the level of wind, as previously discussed, is not sufficient for this technology. The wind facility, therefore, would need to be located offsite but within the ROI. If this technology combination were deemed to be feasible, then potential locations within the ROI could be evaluated. In comparing the environmental impacts of the combinations, existing information was used for the previously determined gas-fired generation in conjunction with available data for solar and wind technologies. Because a location within the ROI has not been selected, information regarding many of the impact categories could not be determined. Categories of impacts which would be SMALL include waste management and accidents, and categories of impacts which would be MODERATE include air quality, water use and quality, socioeconomics, human health, and environmental justice. Categories with SMALL to LARGE impacts include land use, ecology, historic and cultural resources, and threatened and endangered resources. It should be noted, however, that the natural gas power generating facility alone has larger impacts than the BBNPP. The greater the potential output of the renewable portion of the combination alternative, the closer the impacts would approach the level of impacts associated with the BBNPP.

The combination of wind and/or solar power generating facilities with a natural gas power generating facility would have environmental impacts equal to or greater than the BBNPP. When the renewable resource is not available, the environmental impacts would be greater than the BBNPP. Therefore, the most favorable combination of energy alternatives is not environmentally preferable to the BBNPP.

9.2.3.3.3 Economic Comparison

As noted earlier, the combination alternative must generate power equivalent to the capacity of the BBNPP. DOE has estimated the cost of generating electricity from a gas-fired facility ($0.047 per kWh), a wind facility ($0.057 per kWh), and a solar facility ($0.04 to $0.05 per kWh)

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(DOE, 2002). The cost for a natural gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource.

As a result, the capital costs and fixed operating costs of the natural gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with operating a new nuclear facility similar to the BBNPP is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004). The projected costs associated with forms of generation other than from a nuclear unit would be higher. Therefore, the cost associated with the operation of the combination alternative would be non-competitive with the BBNPP.

9.2.3.3.4 Summary

Because the combination alternative is not considered to be a competitive alternative to nuclear power generation, this combination is not considered to be environmentally preferable to the proposed action as described in the following section. Therefore, as allowed in NUREG-1555, ESRP 9.2.3 (NRC, 2007), additional cost data, e.g., decommissioning costs, and fuel cost estimates, are not provided for alternatives that are not deemed to be environmentally preferable to the proposed action.

Wind and/or solar power generating facilities in combination with a natural gas power generating facility could be used to generate baseload power and would serve the purpose of the BBNPP. This combination, however, would have equivalent or greater environmental impacts than a nuclear power generating facility at the BBNPP site, and land requirements would be substantially larger. Therefore, wind and/or solar facilities in combination with a natural gas power generating facility are not an environmentally preferable alternative to the BBNPP.

9.2.3.4 Conclusion

PPL has determined that neither a power generating facility fueled by coal, nor one fueled by natural gas, nor a combination of alternatives, including wind and/or solar power generating facilities, would provide an appreciable reduction in overall environmental impacts relative to the BBNPP. 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 power generating facility. To achieve a SMALL air quality impact in the combination alternative by using larger amounts of wind or solar generation, a MODERATE to LARGE impact on land use would result. Therefore, PPL concludes that neither a power generating facility fueled by coal, nor one fueled by natural gas, nor a combination of alternatives, would be environmentally preferable to a nuclear power generating facility at the BBNPP site. Furthermore, these alternatives would have higher economic costs, and therefore, would also not be economically preferable to a nuclear power generating facility.

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Table 9.2-1—Impacts Comparison Table
(Page 1 of 7)

Impact Category	Proposed Action (BBNPP)	Coal-Fired Generation	Gas Fired Generation	Combinations (wind and solar with natural gas)
Land Use	BBNPP and supporting facilities will consist of approximately 424 ac (172 ha). Site land use will not change as a result of construction or operations. Federal, state, and local requirements will be followed to limit impact. Therefore, the impact will be SMALL during both the construction and operation phases of the proposed project.	This alternative would require approximately 690 ac (279 ha) for the power block and coal storage and 360 ac (146 ha) for waste management (NRC, 2008). Therefore, land use impact would be MODERATE.	Approximately 160 ac (65 ha) would be required for the facility and 12 ac (4.9 ha) for a pipeline that would be needed to connect to an existing line (PPL Susquehanna, LLC, 2006). Land use impact would be SMALL.	Wind facilities would require about 200 ac (81 ha) for 1,600 MWe (about 0.25 acres for each 2 MWe wind (AE, 2008). Solar facilities require 56,000 acres (22,662 ha) per 1,600 MWe generation for photovoltaic and 22,400 ac (9,065 ha) per 1,600 MWe for solar thermal systems (NRC, 1996). Impacts from wind and solar facilities would be SMALL to LARGE. Approximately 160 ac (65 ha) for a gas-fired generation facility and 12 ac (4.9 ha) for pipelines would be needed. A new gas pipeline would be needed to connect to the existing line (PPL Susquehanna, LLC, 2006). Land use impact for a gas-fired facility would be SMALL.
Air Quality	During construction, limited air emissions from temporary sources such as diesel generators and boilers and fugitive dust and particulate matter would be generated. Impacts would be mitigated and impacts would be SMALL to MODERATE. During operations of the SSES Units 1 and 2 cooling towers, no impact observed from salt drift. This would be similar to the BBNPP. Operations air emission sources would be managed in accordance with federal, state, and local laws and regulations. Therefore, impacts to air quality during operations are SMALL. (NRC, 2008)	Similar construction activities as proposed action for construction, therefore, impacts would be SMALL. Based on the air emissions data provided in Table 9.2-2, during operations, impacts would be MODERATE.	Similar construction activities as proposed action for construction, therefore, impacts would be SMALL. Based on the air emissions data provided in Table 9.2-2, during operations, impacts would be MODERATE.	Similar construction activities as proposed action for construction, therefore, impacts would be SMALL. No air emissions would results from wind or solar facilities during operations. If natural gas is used in this combination, calculated estimates of SO_2 19 tons/yr NO_2 729 tons/yr CO 168 tons/yr PM 37 tons/yr PM-less than 10 microns 26 tons/yr CO_2 equivalent 622,791 tons/yr (USEPA, 1995) during operations impacts would be MODERATE.

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Table 9.2-1—Impacts Comparison Table
(Page 2 of 7)

Impact Category	Proposed Action (BBNPP)	Coal-Fired Generation	Gas Fired Generation	Combinations (wind and solar with natural gas)
Water Use and Quality	Impact would be SMALL to surficial groundwater from construction activities. These impacts would be localized and water use and quality would be expected to recover during the operations mode. (PPL Susquehanna, LLC, 2006) (NRC, 2008) Impacts to surface water bodies are MODERATE during construction and operation primarily due to loss of wetlands and wetland buffers and the re-routing of the east fork of Walker Run. Increased surface water use during operations would be SMALL. (NRC, 2008)	Impact would be SMALL to surficial groundwater from construction activities. These impacts would be localized and water use and quality would be expected to recover during the operations mode. (PPL Susquehanna, LLC, 2006) (NRC, 2008) Impacts to surface water bodies are MODERATE during construction primarily due to loss of wetlands and wetland buffers. Although coal pile runoff could affect surface water quality, impacts to water resources and quality would be minimized due to the coal power generating facility's use of a new cooling water system would be SMALL. As groundwater will not be used during operations, impact to groundwater would be SMALL. (NRC, 2008)	Impact would be SMALL to surficial groundwater from construction activities. These impacts would be localized and water use and quality would be expected to recover during the operations mode. (PPL Susquehanna, LLC, 2006) (NRC, 2008) Impacts to surface water bodies are MODERATE during construction primarily due to loss of wetlands and wetland buffers. Water consumption is likely to be less for gas turbine power generating facilities during operations (NRC, 1996) (PPL Susquehanna, LLC, 2006). As a result, water quality impacts would be SMALL.	Impacts of solar and wind facilities on water quality during construction and operation is assumed to be SMALL. If natural gas is used in conjunction with solar and wind, impact would be SMALL to surficial groundwater from construction activities. These impacts would be localized and water use and quality would be expected to recover during the operations mode. (PPL Susquehanna, LLC, 2006) (NRC, 2008) Impacts to surface water bodies are MODERATE during construction primarily due to loss of wetlands and wetland buffers. Water consumption is likely to be less for gas turbine power generating facilities during operations (NRC, 1996) (PPL Susquehanna, LLC, 2006). As a result, water quality impacts would be SMALL.

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Table 9.2-1—Impacts Comparison Table
(Page 3 of 7)

Impact Category	Proposed Action (BBNPP)	Coal-Fired Generation	Gas Fired Generation	Combinations (wind and solar with natural gas)
Ecology	Proposed plant site would use previously disturbed area. Terrestrial habitat loss during construction is small in comparative acreage to the region but may be locally significant. No important aquatic species are present on site. Impacts from construction activity to terrestrial habitat and aquatic ecosystems, except wetlands, would be limited and temporary; therefore, impacts during construction are anticipated to be SMALL. Recovery of some species during operations is anticipated and impacts would be SMALL. Aquatic ecology impacts during construction would be MODERATE because there would be wetlands disturbances. Aquatic ecology impacts during operation would be SMALL. (Ecology III, Inc., 2007b) (NRC, 2008)	Proposed plant site would use previously disturbed area. Terrestrial habitat loss during construction is small in comparative acreage to the region but may be locally significant. No important aquatic species are present on site. Impacts from construction activity to terrestrial habitat and aquatic ecosystems, except wetlands, would be limited and temporary; therefore, impacts during construction are anticipated to be SMALL. Recovery of some species during operations is anticipated and impacts would be SMALL. (Ecology III, Inc., 2007b) (NRC, 2008) Habitat loss in coal-mining areas (NRC, 2008). MODERATE impact.	Proposed plant site would use previously disturbed area. Terrestrial habitat loss during construction is small in comparative acreage to the region but may be locally significant. No important aquatic species are present on site. Impacts from construction activity to terrestrial habitat and aquatic ecosystems, except wetlands, would be limited and temporary; therefore, impacts during construction are anticipated to be SMALL. Recovery of some species during operations is anticipated and impacts would be SMALL. (Ecology III, Inc., 2007b) (NRC, 2008)	Proposed plant site would use previously disturbed area. Terrestrial habitat loss during construction is small in comparative acreage to the region but may be locally significant. No important aquatic species are present on site. Impacts from construction activity to terrestrial habitat and aquatic ecosystems, except wetlands, would be limited and temporary; therefore, impacts during construction are anticipated to be SMALL. Recovery of some species during operations is anticipated and impacts would be SMALL. (Ecology III, Inc., 2007b) (NRC, 2008) Construction impact of the wind facility within the ROI could potentially be MODERATE to LARGE. Operations impact is assumed to be SMALL.
Waste Management	Construction (land clearing and solid wastes) and operational wastes would be minimal because of regulatory control and the small quantities generated (PPL Susquehanna, LLC, 2006). Relatively small quantities of mixed waste would be generated. This waste would be stored temporarily onsite and then shipped to an offsite facility for treatment (NRC, 1996). Therefore, impact will be SMALL.	Construction wastes (land clearing and solid wastes) would be minimal because of regulatory control and the small quantities generated. Therefore, impact will be SMALL. (PPL Susquehanna, LLC, 2006) (NRC, 2008) Approximately 73,000 tons of coal ash and 808,000 tons of scrubber sludge would be generated annually from operations and would require 193 acres onsite over a 20-year renewal term (PPL Susquehanna, LLC, 2006). These impacts would, therefore, be MODERATE.	Construction wastes (land clearing and solid wastes) would be minimal because of regulatory control and the small quantities generated. Therefore, impact will be SMALL. (PPL Susquehanna, LLC, 2006) (NRC, 2008) Approximately 1,500 cubic ft spent SCR catalyst per year for a 2,400 MWe plant (PPL Susquehanna, LLC, 2006). Assumption that this waste volume would be less for a 1,600 MWe plant. Therefore, waste management impacts would be SMALL.	Because they are renewable energy sources, it is assumed that the impact from waste generated during the construction and operation of the solar and wind facilities would be SMALL. Approximately 1,500 cubic ft spent SCR catalyst is expected to be generated per year for a 2,400 MWe gas-fired plant (PPL Susquehanna, LLC, 2006). Assumption that this waste volume would be less for a 1,600 MWe plant. Therefore, waste management impacts would be SMALL.

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Table 9.2-1—Impacts Comparison Table
(Page 4 of 7)

Impact Category	Proposed Action (BBNPP)	Coal-Fired Generation	Gas Fired Generation	Combinations (wind and solar with natural gas)
Socioeconomics	Cumulative beneficial and adverse impacts due to construction would be SMALL to MODERATE. During operation, beneficial impacts would be SMALL to LARGE and adverse impacts would be SMALL. (NRC, 2008)	Construction and operation employment impacts would be MODERATE. Several hundred mining and construction and operation jobs as well as additional tax revenues would be associated with the coal mining. (NRC, 2008)	Construction employment impacts would be MODERATE. Operations employment would decrease and these impacts would be SMALL. (NRC, 1996) (NRC, 2008)	Construction employment impacts would be MODERATE. Operations employment would decrease and these impacts would be SMALL. (NRC, 1996) (NRC, 2008).
Human Health	Impacts to the public from thermophilic microorganisms associated with fresh water, noise, and air emissions from operations would be SMALL. (NRC, 2008)	During construction, impacts to human health would be SMALL. As a result of increased air emissions and associated public health risks, human health impacts during operations would be MODERATE. (PPL Susquehanna, LLC, 2006)	During construction, impacts to human health would be SMALL. As a result of increased air emissions and associated public health risks, human health impacts during operations would be MODERATE. (PPL Susquehanna, LLC, 2006)	It is assumed that construction and operational impacts from solar and wind technologies would be SMALL. During construction, impacts to human health would be SMALL. As a result of increased air emissions and associated public health risks from gas-fired facilities, human health impacts during operations would be MODERATE. (PPL Susquehanna, LLC, 2006)
Historic and Cultural Resources	Based on a Phase Ia cultural and resource assessment and data base review, no confirmed listings of historical sites were identified. Therefore, adverse impacts are unlikely to this previously disturbed site and impacts will be SMALL during construction and operation. (PHMC/BHP, 2001)	Based on a Phase Ia cultural and resource assessment and data base review, no confirmed listings of historical sites were identified. Therefore, adverse impacts are unlikely to this previously disturbed site and impacts during construction and operation will be SMALL. (PHMC/BHP, 2001)	Based on a Phase Ia cultural and resource assessment and data base review, no confirmed listings of historical sites were identified. Therefore, adverse impacts are unlikely to this previously disturbed site and impacts during construction and operation will be SMALL. (PHMC/BHP, 2001)	Based on a Phase Ia cultural and resource assessment and data base review, no confirmed listings of historical sites were identified. Therefore, adverse impacts are unlikely to this previously disturbed site and impacts during construction and operation will be SMALL. (PHMC/BHP, 2001) The wind facility would be located offsite but in the ROI, therefore, impacts to historic and cultural resources could be SMALL to LARGE.

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Table 9.2-1—Impacts Comparison Table
(Page 5 of 7)

Impact Category	Proposed Action (BBNPP)	Coal-Fired Generation	Gas Fired Generation	Combinations (wind and solar with natural gas)
Environmental Justice	Demographic characteristics of the area surrounding BBNPP determined that no significant numbers of minority or low-income populations are represented in the vicinity; therefore, the environmental justice impact is SMALL during construction and operation. (Section 9.3) (NRC, 2008)	Demographic characteristics of the area surrounding BBNPP determined that no significant numbers of minority or low-income populations are represented in the vicinity; therefore, the environmental justice impact is SMALL during construction and operation. (Section 9.3) (NRC, 2008)	Demographic characteristics of the area surrounding BBNPP determined that no significant numbers of minority or low-income populations are represented in the vicinity; therefore, the environmental justice impact during construction and operation is SMALL. (NRC, 2008)	For the gas-fired facility, demographic characteristics of the area surrounding BBNPP determined that no significant numbers of minority or low-income populations are represented in the vicinity; therefore, the environmental justice impact during construction and operation is SMALL. (NRC, 2008) A wind facility located within the ROI (but not at the BBNPP) could have environmental justice impacts that range from SMALL to MODERATE.
Aesthetics	Because the BBNPP site is already aesthetically altered by the presence of the existing SSES Units 1 and 2 structures, the visual impact of the cooling towers and plumes associated with the BBNPP is expected to be SMALL. (NRC, 2006)	Because the BBNPP site is already aesthetically altered by the presence of the existing SSES Units 1 and 2 structures, the visual impact of the cooling towers and plumes from a coal-fired facility is expected to be SMALL during construction and SMALL to MODERATE during plant operation. Noise impacts during construction would be SMALL and during operations would be MODERATE (NRC, 2006)	The BBNPP site is already aesthetically altered by the presence of the existing SSES Units 1 and 2 structures. However, these gas-fired plant structures are smaller than the existing SSES Units 1 and 2 structures. Impacts during construction and operation would be SMALL. Noise would be limited and impacts during construction and operation would be SMALL. (NRC, 2006) (NRC, 2008)	Because of their size and visual impact, solar arrays and wind turbines constructed at other locations within the ROI would have aesthetics impacts that are MODERATE to LARGE. For the gas-fired facility, the BBNPP site is already aesthetically altered by the presence of the existing SSES Units 1 and 2 structures. However, these gas-fired plant structures are smaller than the existing SSES Units 1 and 2 structures. Noise would be limited during construction and operation and resulting impacts would be SMALL. (NRC, 2006) (NRC, 2008)

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Table 9.2-1—Impacts Comparison Table
(Page 6 of 7)

Impact Category	Proposed Action (BBNPP)	Coal-Fired Generation	Gas Fired Generation	Combinations (wind and solar with natural gas)
Threatened and Endangered Resources	No known state or federal rare, threatened, or endangered plant species have been observed occur on the BBNPP site. Ten threatened and endangered species and species of special concern are known to have distribution in the area. Four important habitats, including wetlands will be impacted (PDCNR, 2008a) (PDCNR, 2008b) (PPL, 2006) (Ecology III, Inc., 1995) (Ecology III, Inc., 2007a). Some mitigation may be possible. Impact to wetlands and wetland buffer would require mitigation. Impacts will be MODERATE.	No known state or federal rare, threatened, or endangered plant species have been observed occur on the BBNPP site. Ten threatened and endangered species and species of special concern are known to have distribution in the area. Impacts to terrestrial and aquatic ecology would be SMALL during both construction and operation. Four important habitats, including wetlands will be impacted (PDCNR, 2008a) (PDCNR, 2008b) (PPL, 2006) (Ecology III, Inc., 1995) (Ecology III, Inc., 2007a). Impact to wetlands and wetland buffer would require mitigation. Impacts will be MODERATE.	No known state or federal rare, threatened, or endangered plant species have been observed occur on the BBNPP site. Ten threatened and endangered species and species of special concern are known to have distribution in the area. Impacts to terrestrial and aquatic ecology would be SMALL during both construction and operation. Four important habitats, including wetlands will be impacted (PDCNR, 2008a) (PDCNR, 2008b) (PPL, 2006) (Ecology III, Inc., 1995) (Ecology III, Inc., 2007a). Impact to wetlands and wetland buffer would require mitigation. Impacts will be MODERATE.	No known state or federal rare, threatened, or endangered plant species have been observed occur on the BBNPP site. Ten threatened and endangered species and species of special concern are known to have distribution in the area. Impacts to terrestrial and aquatic ecology would be SMALL during both construction and operation. Four important habitats, including wetlands will be impacted (PDCNR, 2008a) (PDCNR, 2008b) (PPL, 2006) (Ecology III, Inc., 1995) (Ecology III, Inc., 2007a). Impact to wetlands and wetland buffer would require mitigation. Impacts will be MODERATE. Impact to threatened and endangered species for the wind facility within the ROI can not be determined, therefore, construction and operational impacts range from SMALL to LARGE.
Accidents	As a result of increased safety technologies, accident impacts would be SMALL. (Section 7.2) (NRC, 2008)	As a result of increased safety technologies, accident impacts would be SMALL.	As a result of increased safety technologies, accident impacts would be SMALL.	As a result of increased safety technologies, accident impacts would be SMALL.

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Table 9.2-1—Impacts Comparison Table
(Page 7 of 7)

Impact Category	Proposed Action (BBNPP)	Coal-Fired Generation	Gas Fired Generation	Combinations (wind and solar with natural gas)
Facility Footprint	265 acres per 1,000 MWe generation (424 acres for 1,600 MWe generation)	1,700 acres per 1,000 MWe generation	110 acres per 1,000 MWe generation (excludes well fields)	Wind facility footprint would be approximately 125 acres for 1,000 MWe (about 0.25 acres for each 2 MWe wind. (AE, 2008) Solar facility footprint would be approximately 35,000 acres per 1,000 MWe generation for photovoltaic and 14,000 acres per 1,000 MWe for solar thermal systems (NRC, 1996). Gas-fired facility footprint would be 110 acres per 1,000 MWe generation (excludes well fields)
Costs	The projected cost associated with operating a new nuclear facility similar to the BBNPP is in the range of $0.031 to $0.046/kWh. (DOE, 2002)	The estimated cost of generating electricity from a coal facility to be approximately $0.049/kWh. (DOE, 2002)	The estimated cost of generating electricity from a gas fired facility to be $0.047/kWh. (DOE, 2002)	In 2000, wind power was produced at a cost between $0.03/kWh and $0.06/kWh, depending on wind speeds. By 2020, production costs are projected to be between $0.03/kWh and $0.04/kWh. In 2005, concentrating solar power systems had a benchmark cost of $0.12/kWh to $0.14/kWh with a target cost of $0.035/kWh to $0.06/kWh by 2025 (EERE, 2006). The estimated cost of generating electricity from a gas fired facility to be $0.047/kWh (DOE, 2002).

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Table 9.2-2—Air Emissions from Alternative Power Generation Facilities

Fuel	Bituminous Coal	Natural Gas
Combustion Facility	Circulating FBC	Combined Cycle GTG
Generation Capacity	1,600 MWe	1,600 MWe
Air Pollutant Emissions - metric tons (tons) per year		
Sulfur Dioxide (SO_2)	415 (457)	17 (19)
Nitrogen Dioxide (NO_2)	734 (809)	661 (729)
Carbon Monoxide (CO)	4,402 (4,852)	152 (168)
Particulate Matter (PM)	21 (23)	34 (37)
PM less than 10µm (PM_{10})	15 (17)	24 (26)
Carbon Dioxide, equiv. (CO_2e)	1,731,000 (1,908,000)	565,000 (623,000)

Notes:
CO_2e = CO_2 equivalent
FBC = fluidized bed combustor
GTG = gas turbine generator

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9.3 ALTERNATIVE SITES

This section identifies and evaluates a set of alternative site locations to the Bell Bend Nuclear Power Plant (BBNPP) site. The object of this evaluation is to verify that there are no "obviously superior" sites to build and operate the BBNPP facility.

Siting new units at existing nuclear sites has provided another option to the way alternatives are reviewed and selected. Existing sites offer decades of environmental and operational information about the impact of a nuclear plant on the environment. Because these sites are licensed nuclear facilities, the Nuclear Regulatory Commission (NRC) has already found them to be acceptable relative to other undeveloped sites in the region of interest. The NRC recognizes in NUREG-1555, (NRC, 2007), ER Section 9.3, that proposed sites may not be selected as a result of a systematic review:

> Recognize that there will be special cases in which the proposed site was not selected based on 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 NEPA review and/or demonstrated to be environmentally satisfactorily on the basis of operating experience. 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. The site selection process is the same for this case except for the fact that the proposed site is not selected from among the candidate sites based on a site-by-site comparison.

The information provided in this section is consistent with the special case noted in NUREG-1555, (NRC, 2007), Section 9.3. This section identifies and discusses the evaluation of a set of alternative locations for the proposed plant and compares the suitability of these alternative sites with the suitability of the proposed site. The objective of this assessment is to verify that no site is "environmentally preferable" (and thus, no site is "obviously superior") for the siting of a new nuclear plant exists. This section evaluates the characteristics of existing nuclear generation stations, existing power generating stations, greenfield sites that are located adjacent to existing nuclear and power generating stations and brownfields. The sites were evaluated based on building and operating a merchant U.S. Evolutionary Power Reactor (EPR). This provides a realistic, consistent basis for evaluating environmental site conditions against site requirements for a nuclear power generating station design.

9.3.1 SITE SELECTION PROCESS

The site 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 preferred site is chosen from within the candidate sites, and then compared with the remaining candidate sites to demonstrate that none are "environmentally preferable." The basic constraints and limitations applicable to 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.

9.3.1.1 Region of Interest and Candidate Areas

The first step in the siting process was to define and identify the ROI. As defined in Environmental Standard Review Plan (ESRP) 9.3 (NRC, 2007), the ROI is the largest area

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considered and is the geographic area within which sites suitable for the size and type of nuclear power generating facility 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 facility. The site selection process contains a description of the ROI, including the following elements:

- Major centers of population
- Areas predicted to be deficient in power
- Available bodies of water (for cooling)
- Railroads, highways, and waterways (existing and planned)
- Topographic features
- Major land use classifications (for example, residential and agricultural) and areas reserved for specific uses
- Location and description of existing and planned primary electrical generating facilities
- Existing and planned transmission network
- Transmission interconnections with other utilities
- Natural and man made features (for example, zones of seismic activity, unusual geologic features, and military installations) constituting potential hazards to construction or operation of a nuclear power generating facility

As discussed in Chapter 8, the BBNPP would be developed as a merchant facility, owned by PPL. A merchant facility is one that sells or conveys its capacity and electricity in competitive markets. As a merchant facility, the primary market area is based on PPL's fundamental business decisions on the economic viability of a nuclear power generating facility, the market for the facility's output, and the general geographic area where the facility should be deployed to serve the market.

The geographic scope or primary market area for the BBNPP is generally defined as the eastern part of the Pennsylvania-New Jersey-Maryland Interconnection, LLC (PJM) classic market area. This area is closely approximated by the service territories for the electric delivery companies identified and depicted on Figure 9.3-1. The PJM classic market area is a sub-set of the entire PJM area. The primary market area and the ROI are one in the same.

For PPL Corporation and its marketing entity, PPL Energy Plus, the key drivers for selection of this defined ROI/primary market area include:

- Fit with the marketing plan: Assets and locations in the primary PJM east area fit will with the PPL Energy Plus marketing plan.
- Regulatory environment: A thorough understanding of state regulatory issues is one of the most important considerations in development of a new generating facility. States within the ROI, and particularly Pennsylvania, are well understood from a regulatory perspective.

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- Market operations (RTO, ISO): PJM is a mature, well-functioning market that can readily fulfill PPL Corporation's marketing objectives.

- Electric transmission concerns: The eastern part of the PJM classic market area provides access to several key market areas and is not subject to some of the problems other areas have historically experienced in moving power to these markets.

- Probability of success/competitive advantages: Assets for which competition is expected to be less and where PPL has a competitive advantage rank highest. The eastern part of the PJM classic market area, particularly where PPL Corporation already has assets, scores high in these considerations.

Reflecting historical power flows and constraints on the PJM transmission system, the ROI extends slightly west of the regulated service territory boundaries shown on Figure 9.3-1. This recognizes the advantages of situating the proposed facility east of PJM's Western Interface, which is often a point of constraint to the delivery of energy from western areas of PJM to eastern Pennsylvania, New Jersey, the Delmarva Peninsula, and the Washington/Baltimore metropolitan area. Such placement would allow PJM to dispatch more cost-effective generation located east of this interface to meet load demands, including periods when such constraints are experienced. (PJM, 2008)

Since the deregulation of electric utilities in Pennsylvania, the Commonwealth of Pennsylvania is not mandated to develop a comprehensive need-for-power analysis. In addition, the Commonwealth does not have a State Siting Board, State Power Planning board, or similar process. The Commonealth does provide strategic direction and policy guidance for the electric power industry, but does not currently have an integrated plan for existing and future facilities to address the need for power.

In 1999, the State of Maryland restructured the manner in which it regulated the state's utilities by allowing for customer choice of electricity suppliers and by deregulating the price of electric supply. With the restructuring of the electric power industry in Maryland, generation of electricity is now provided in competitive marketplace (transmission and distribution remain regulated monopolies). Prices for power supply are determined by a competitive electric power supply market rather than by the Maryland Public Service Commission (MPSC) in a regulated environment. Despite the deregulation of the price of electric supply and generation in Maryland, electric power generators must obtain a "Certificate of Public Convenience and Necessity" (CPCN) from MPSC to build or modify power facilities and transmission lines in the state. The CPCN is a single, comprehensive licensing process for the State. The CPCN encompasses the requirements of the Clean Air Act (CAA), including the Prevention of Significant Deterioration (PSD) approval, which MPSC, on behalf of Maryland, has been authorized by the U.S. Environmental Protection Agency (USEPA) to issue to power developers.

In 1999, the Delaware General Assembly passed legislation restructuring the electricity industry in Delaware. Prior to restructuring, the generation, transmission, and distribution of electric power by investor-owned utilities was fully regulated by the Delaware Public Service Commission (DPSC). With restructuring, the generation of electric power became deregulated, leaving only distribution services under the regulatory control of DPSC. In 2006, faced with significantly increased energy costs, the Delaware General Assembly passed a revision to the restructuring legislation entitled "The Electric Utilities Retail Supply Act of 2006." The Act provides that all electric distribution companies subject to the jurisdiction of DPSC would be designated as the standard offer service supplier and returning customer service supplier in their respective territories. The Act provided further opportunity for distribution companies to

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enter into long- and short-term supply contracts, own and operate generation facilities, build generation and transmission facilities , make investments in demand-side resources, and take any other DPSC-approved action to diversify their retail load supply. Additionally, generation companies are required to conduct Integrated Resource Planning (IRP) for a forward-looking 10-year timeframe and to file such plans with DPSC, the state Controller General, the state Director of the Office of Management and Budget, and the Energy Office every 2 years starting with December 1, 2006.

In 1999, the New Jersey Board of Public Utilities (NJBPU), the governing body for electric, oil, and natural gas services in New Jersey, introduced a bill to deregulate the state's energy industry for residential customers. The goal of the Electric Discount and Energy Competition Act (EDECA) was to enable New Jersey energy consumers to shop around and choose the energy provider that best suited their budget and service requirements. The free-market rationale hinged on the prediction that enough healthy competition between generation companies would likely keep prices down, while offering better service and reliability to customers. Under the auspices of the federal U.S. Department of Energy (DOE), New Jersey took measures to safeguard free market competition for electricity and gas, including the requirement for NJBPU to "unplug" power facilities with higher costs than other available energy sources.

The task of evaluating the region's power supply lies with the PJM RTO and the regional electric reliability organization RFC. PJM has projected continuing load growth in the primary PJM east area. The DOE has identified New Jersey, Delaware, eastern Pennsylvania, and eastern Maryland as a Critical Congestion Area. PJM expects expanded exports of power into New York, further exacerbating the situation. Limitations in the east-west transmission of energy across the Allegheny Mountains and the growing demand for baseload power at load centers along the east coast were factors in selecting the eastern part of PJM's primary market area as the ROI.

One of PJM's objectives is to provide a transmission system that can accommodate power needs in all areas while maintaining a reliable network. The existing PJM high-voltage backbone transmission network provides lines appropriate for use by an EPR facility (500-kV or 345-kV). In June 2007, PJM authorized a new 500-kV line connecting the existing Susquehanna 500-kV substation with the Roseland substation in northern New Jersey. This Susquehanna-Roseland line is being added independent of the proposals to construct BBNPP or other generating facilities. Planned to be in service by 2012, this will become part of the "existing" transmission network for the BBNPP.

The Susquehanna-Roseland project addresses numerous overloads projected to occur on critical 230-kV circuits across eastern Pennsylvania and northern New Jersey, with multiple lines projected to exceed their conductor rating as early as 2013. (PJM, 2008) PJM regularly reviews performance issues associated with specific transmission facility overloads and outages as experienced in actual operations. This new circuit was justified on the basis of reliability as identified by reliability criteria violation tests in PJM's RTEP process deliverability studies. From an economic perspective, the line was not proposed to facilitate access of specific new generation proposals, even though this additional backbone capability can present economic opportunities for them. The ability of each generation request to interconnect safely and reliably is addressed in specific RTEP interconnection process studies.

PJM also documents the retirement of numerous older generating facilities in the PJM east area. As stated in ER Section 8.4, reserve margins of 15% in the RFC are expected to remain adequate through 2010. Assuming no new capacity additions are made and a projected reduction of 1,000 MW of existing capacity occurs, existing generation would be sufficient to maintain a

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15% reserve margin through 2009. Since there are more than 3,000 MW of new capacity planned for completion by 2010, it is unlikely that the reserve margins will drop below 15% before 2011. The amount of new capacity needed to satisfy a 15% reserve margin through 2010 is about 500 MW. If all forecasted new capacity goes in service as projected and the exisiting energy-only and uncommitted capacity are available to supply regional demand, then the reserve margins will remain greater than a 15% benchmark through 2012. Excluding energy-only and uncommitted capacity, and assuming no new capacity addition, there will be sufficient capacity to maintain a 15% reserve margin through 2009. Based on existing resources, projected retirements and capability changes through summer 2016, the reserve margins based on the summer peak net internal demand (NID) are projected to decline from a high of 18.8% in 2008, to a low of 5.1% in 2016. The projected reserve margins for the summer peak NID based on existing and planned capacity plus existing uncommitted and energy-only resources decline over the period from 22.4% in 2008 (compared with 23.3% in 2007) to 9.6% in 2016. (RFC, 2007) As a result, there is a need for power from the BBNPP and other new generating capacity.

The ROI covers approximately 31,296 mi^2 (81,296 km^2) and encompasses the major population centers of the cities of Wilmington, Delaware; Allentown/Bethlehem/Easton, Pennsylvania; Harrisburg, Pennsylvania; Scranton/Wilkes Barre, Pennsylvania; Philadelphia, Pennsylvania; Baltimore, Maryland; and Newark, New Jersey (Figure 9.3-1). The ROI is large enough (encompassing portions of four states) to have sufficient environmental diversity. Bodies of water available as sources of cooling water for the proposed nuclear facility include Susquehanna River, Juniata River, Lehigh River, Patuxent River, Delaware River, Chesapeake Bay, Barnegat Bay, Lake Wallenpaupack, and the Atlantic Ocean. Major interstate highways include I-70, I-76, I-78, I-80, I-81, I-83, I-95, I-270, I-278, I-280, I-287, I-476, and I-695. Railroads in Maryland include Amtrak, Maryland and Delaware Railroad, and the Maryland Midland Railway. Railroads in New Jersey include Amtrak; Black River and Western Railroad; and the New York, Susquehanna and Western Railway. Railroads in Pennsylvania include Amtrak; Juniata Valley Railroad; New York, Susquehanna and Western Railway; North Shore Railroad; and Canadian Pacific Railroad. Topographic features in the ROI range from flat floodplains along the rivers and coastal plains along the bays to steep hills, deep ravines, and mountain ranges. Topography in Maryland includes coastal plains, the Piedmont Plateau, the Appalachian Mountains, Backbone Mountain, and land features such as Cunningham Falls and Calvert Cliffs. Topography in New Jersey includes coastal plains, the Piedmont Plateau, the Appalachian Mountains, and land features, such as High Point State Park. Topography in Pennsylvania includes coastal plains, the Piedmont Plateau, Pocono Plateau, and the Appalachian Mountains. Major land use designations can be found throughout the ROI and include Residential, Rural, Agricultural, Industrial, Commercial, Public Facilities, Parks, Open Space, Preserves, Reserves, Natural Areas, Transportation, Communications and Utilities, Government Special Designation, and Education. There are several military installations throughout the ROI, including the U.S. Naval Academy located in Annapolis, Maryland.

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. Screening of the ROI was performed at a high level with the purpose of quickly identifying areas within the ROI that would not be suitable for the siting of a nuclear power generating station.

The criteria used in the screening of the ROI are listed below and are consistent with those identified in ESRP 9.3 (NRC, 2007) and the Electric Power Research Institute (EPRI) siting guide (EPRI, 2002):

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- Distance from major population centers (that is, identifying sites that are located within 20 mi (32 km) of an area with less than 300 persons per square mile (ppsm)).

- Proximity to adequate transmission lines (that is, identifying sites that are located within approximately 30 mi (48.3 km) of 345 kV or 500 kV transmission lines). In accordance with the EPR standard grid connection design, 345 kV or 500 kV transmission lines are needed.

- Proximity to a suitable source for cooling water (that is, identifying sites that are located within 15 mi (24.1 km) of an adequate source for cooling water).

- Non-dedicated land (that is, identifying sites that are not located within areas such as national and state parks, historic sites, and tribal lands).

The exclusionary criterion pertaining to population density used in this siting evaluation is more specific and more conservative than what is presented in 10 CFR 100. The information presented in 10 CFR 100 does not specify a permissible population density or total population within this zone because the situation may vary from case to case.

NRC Regulatory Guide 4.7, Rev. 2 (NRC, 1998) contains the same information as presented in 10 CFR 100, but adds the following specific criterion:

> *Preferably a reactor would be located so that, at the time of initial site approval and within about 5 years thereafter, the population density, including weighted transient population, averaged over any radial distance out to 20 mi (32 km) (cumulative population at a distance divided by the circular area at that distance), does not exceed 500 persons per square mile (ppsm). A reactor should not be located at a site whose population density is well in excess of the above value.*

The EPRI siting guide contains the most conservative criterion with regard to population density and recommends that a new reactor not be located in an area with greater than or equal to 300 ppsm (300 persons per 2.6 km^2) (EPRI, 2002). Consistent with the current industry guidance as detailed in the EPRI document, this siting evaluation used the conservative population criterion (300 ppsm) as an exclusionary criterion in identifying candidate areas.

Figure 9.3-2 identifies the areas eliminated during screening of the ROI because they did not satisfy the exclusionary criteria. (It should be noted some of the identified excluded areas overlap.)

Information gathered from the initial screening was used to identify areas that satisfied the exclusionary screening criteria. The results of screening the ROI for areas that satisfied the exclusionary screening criteria yielded those candidate areas identified on Figure 9.3-3.

9.3.1.2 Candidate Sites

The next step in the site selection process was to screen and evaluate the candidate areas using refined discretionary criteria in order to identify 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 publically held images, publicly held information on geographic information system (GIS) databases that generally included electric power producing plants and brownfield sites, topographic maps showing roads, urban areas, wetlands, parks, and other dedicated lands. Information on electric power plants within the ROI (Delaware, Maryland, New Jersey, and Pennsylvania) was obtained from the DOE, Energy

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Information Administration (EIA) (EIA, 2008a) (EIA, 2008b) (EIA, 2008c) (EIA, 2008d). Information on brownfield sites within the ROI was obtained from the State of Delaware Department of Natural Resources Environmental Control (DNERC, 2008); the State of Maryland Department of the Environment (MDE), Maryland Brownfield, Voluntary Cleanup Program and State Remediation Sites database (MDE, 2008); the State of New Jersey Brownfield SiteMart (NJSiteMart, 2008); and the State of Pennsylvania Brownfield PA Site Search (PASiteSearch, 2008). Compiling the information resulted in more than several thousand brownfield sites, 6 hydroelectric sites, 47 natural gas sites, 59 other power generating stations (for example, coal, wood, and oil), 8 nuclear sites, and federal (DOE and Department of Defense) sites being considered for redevelopment within the ROI candidate areas that needed to be screened.

The screening process used to identify the potential sites considered discretionary criteria consistent with those identified in ESRP 9.3 (NRC, 2007) and which was used in the process of identifying the candidate areas (that is, distance of a site from population centers, proximity of transmission lines, proximity to suitable source of cooling water). However, identifying potential sites required a more detailed review of available information. The criteria used in screening the candidate areas to identify potential sites include:

- Proximity of a site to either existing 345 kV or 500 kV transmission lines. The closer a site can be located to existing transmission system infrastructure, the less environmental impacts are associated with constructing transmission corridors that join the new nuclear facility with the existing transmission system.
- Identifying sites that are located within 20 mi (32 km) of an area with less than less than 300 ppsm.
- Proximity of a site to an existing nuclear power generating facility infrastructure.
- Identification of sites near suitable water supply sources (rivers, lakes, and coastal areas)
- Avoidance of areas that contained land use restrictions
- Ownership and/or availability of adequate land area

The screening process also included a 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. 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.

As identified in Figure 9.3-4, the results of the candidate area screening identified potential sites within the ROI that included existing nuclear facilities, PPL Corporation owned properties (such as coal, gas/oil fired, hydroelectric plants, and greenfield buffer lands), and suitable brownfield/ industrial development sites.

It is noted that an identified potential site (Sandy Bend brownfield site (Mifflin County, Pennsylvania)) lies within the defined ROI, but falls just outside the electric delivery company service territories shown on Figure 9.3-1. Because of its location for access to the existing transmission system, the site meets the definition for inclusion in the ROI.

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Identification of the candidate sites was performed by conducting a technical evaluation of the potential sites using a two step process. The first step of the process involved identifying criteria to evaluate each of the potential sites. The criteria used to evaluate the potential sites were selected to be appropriate: (1) to the ROI, (2) to the status of the proposed applicant's nuclear power generating facility being a merchant nuclear power generating facility, and (3) to the technology involved with constructing and operating the proposed nuclear facility.

ESRP 9.3 provides the following information about candidate site qualification criteria (NRC, 2007):

- Consumptive use of water should not cause significant adverse effects on other users.
- The proposed action should not jeopardize Federal, State, and affected Native American tribal listed threatened, endangered, or candidates species or result in the destruction or adverse modification of critical habitat.
- There should not be any potential significant impacts to spawning grounds or nursery areas of populations of important aquatic species on Federal, State, 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 should be no preemption of or adverse impacts 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.
- There are no other significant issues that preclude the use of the site.

The following criteria were used to evaluate and score the potential sites identified in Figure 9.3-3:

- Available land, 420 ac (170 ha): This is an exclusionary criterion based on the availability of the identified site and adjoining available area to support an EPR footprint (240 ac (97 ha)) plus approximately 180 ac (73 ha) of additional land needed for ancillary structures, construction buildings, construction laydown areas and parking areas.
- Distance to cooling water supply was scored based on the distance in miles from the potential site to its closest cooling water supply.
- Flooding data were gathered from Federal Emergency Management Agency (FEMA) maps (FEMA, 2008) and scored based on the site's proximity to 100 year or 500 year floodplains.
- Distance to population centers was scored based on the site's proximity to a population center (defined as a census tract (CT) with more than 300 ppsm (300 persons per 2.6 km^2). The regional population density analysis was based on the population density within a 10 mi (16.1 km) radius of the site, based on data for CTs.

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- Wetland data were gathered from National Wetland Inventory (NWI) wetland maps. Each site was evaluated based on the presence or absence of wetlands at or surrounding the site. Site area was defined as an approximate 0.5 mi (0.8 km) radius around site.

- Railroad access was evaluated according to each site's proximity (within 5 mi (8 km)) to an active rail line.

- Transmission access was evaluated according to each site's proximity (within 15 mi (24.1 km)) to a 500 kV transmission line, and the existing transmission corridor was scored based on whether the site has access to any existing transmission connection, including 230 kV, 345 kV, and 500 kV lines. It is noted that the distance to transmission access and existing transmission corridor criteria only refer to direct grid access requirements.

- Ecological evaluations of the sites were based upon the number of state-listed rare, threatened, and endangered species in the county (aquatic and terrestrial). The site was characterized by its location (county) and was then scored according to the county species data (from 0 to over 100 species).

- The need for additional land acquisition also was evaluated for each site. This criterion was based on whether or not additional surrounding land (other than the minimum land needed for the EPR footprint) would be needed and likely could be acquired for construction laydown areas and the appurtenant structures of the proposed nuclear power generating station. Scoring of this criterion was evaluated based on whether additional land acquisition would be required. The rating was broken down further by characterizing the readily available land surrounding the site as low density or high density development.

- An expansion potential criterion was based on the site's availability of additional land to accommodate the potential for the expansion of the plant for a second unit. This criterion was measured by evaluating the amount of land potentially available adjacent to the potential site up to 840 ac (340 ha). This evaluation was conducted by assessing the site and the surrounding land using a radius of approximately 0.9 to 1 mi (1.4 to 1.6 km). A score of 5 indicated that the site and surrounding land was sufficient for expansion potential. A score of 3 indicated that the site's surrounding land was expected to be readily available for sale/purchase such as land described as low density development (rural, few residences within the 840 ac (340 ha)). A score of 1 indicated that the land would not be readily available for sale/purchase based on the other uses of the land, such as industrial, commercial, major transportation corridors, or high density developments (residential).

- An ownership criterion was based on the site's ownership status. A score of 5 was assigned to any properties currently owned by PPL Corporation or its subsidiaries. A score of 3 was assigned to privately owned properties, such as landfills or other companies not within the power sector. A score of 1 was assigned to competitor owned properties. A competitor was defined as any company within the power sector (coal, nuclear, hydroelectric) that could be a direct competitor to PPL.

- Environmental remediation was evaluated based upon the site's need for environmental remediation or cleanup of hazardous materials. The purpose of this criterion was to identify remediation that might be necessary at a site so as to preclude

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the site from being considered for development of a nuclear facility. The sites were characterized based upon their land use and then scored based on if the site would need remediation performed and the type and amount of remediation (for example, landfill - cleanup required; coal/oil or other brownfields - unknown if cleanup is necessary; nuclear or hydroelectric plants - no anticipated cleanup necessary).

The second step of the potential site evaluation involved scoring and ranking each potential site. A team was developed based on their knowledge, skills, and specific areas of expertise to conduct the evaluation, scoring, and ranking of the potential sites. For the evaluation, the team used readily available reconnaissance level information sources, which included publicly available data and images, information available from PPL, files and personnel. Each discretionary criterion was scored based on a point scale of suitability. GIS analysis was performed for the majority of the discretionary criteria, with the exception of ecology (threatened and endangered species), additional land acquisition, and environmental remediation. A preliminary score with amplifying remarks reflecting the overall suitability of each potential site was assigned based on the information collected by the evaluation team members. The scores and remarks developed by the evaluation team were subsequently challenged and adjusted in a collaborative fashion where necessary. The potential sites were ranked according to their raw scores and average scores. The raw score was based on the sum of all the scores for the site, while the average score was based upon the sum of the scores divided by the number of discretionary criteria available.

The potential site evaluation scoring process was performed as follows: the exclusionary criterion for site size (420 ac (170 ha)) was applied to the list of potential sites and those sites that failed to meet this criterion were not considered for further evaluation. Next, discretionary criteria were applied to the remaining potential sites and the sites were scored and ranked accordingly.

The highest scoring potential sites were:

- Bell Bend greenfield site (BBNPP Site) adjacent to SSES, Luzerne County, Pennsylvania
- Montour greenfield site adjacent to Montour Coal Power Plant (Montour site), Montour County, Pennsylvania
- Martins Creek greenfield site (Martins Creek site), Warren County, New Jersey
- Sandy Bend brownfield site (Sandy Bend site), Mifflin County, Pennsylvania

Based on having the highest scores, these four sites were chosen as candidate sites and are identified on Figure 9.3-5.

The next highest scoring sites consisted of a nuclear power station and brownfield sites. The nuclear site was not considered for further evaluation because the site is owned and operated by a direct competitor to PPL in the energy market. The brownfield sites were not carried forward as candidate sites for further review because the sites were located a distance from a suitable cooling water supply, a transmission corridor was not located on or near the site, the sites were located in areas that have population centers, and the sites do not have suitable acreage for expansion potential.

The four identified candidate sites were among the best sites that could reasonably be found for the siting of a nuclear power station. As identified in ESRP 9.3, an adequate number of

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candidate sites include at least three to five alternative sites in addition to the proposed site (NRC, 2007). The selected candidate sites were chosen in order of having the least environmental impacts, while satisfying the requirements of an EPR nuclear plant site. Finally, the candidate sites are expected to be licensable (that is, able to obtain applicable NRC licenses and state and local permits).

After the candidate sites were identified, the next step in the siting process was a screening and evaluation that involved a two part sequential test to determine if any candidate site could be judged as environmentally preferable, and obviously superior, to the proposed site. For this site selection process, the alternative sites are those candidate sites that remain after the proposed site is selected (that is, (candidate sites) minus (proposed site) equals (alternative sites)). This identification matches the guidance provided in ESRP 9.3 (NRC, 2007).

The first stage of the test determines whether there are environmentally preferred sites among the alternative sites. During this first stage, 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 led to the applicant's selection of the proposed site

Evaluation factors used in comparing the proposed site to the alternative sites to determine if there are environmentally preferred sites among the alternative sites are presented below and are consistent with those identified in ESRP 9.3 (NRC, 2007):

- Environmental: Aesthetics, demography, ecological, geology, hydrology, socioeconomics, archeological and historic preservation, environmental justice, and transportation access
- Land use
- Water use: Accessibility, availability, and quality
- Institutional: Federal, state, local, regional, and tribal restrictions
- Construction workforce availability and accessibility, and workforce housing
- Cost: Construction costs
- Transmission: Access to existing network and new corridors

The second stage of the test considers economics, technology, and institutional factors among the environmentally preferred site(s) to determine if any are obviously superior to the proposed site. As indicated in ESRP 9.3 (NRC, 2007):

> The criterion for making this determination is that one or more important aspects, either singly or in combination, of a reasonably available alternative site are obviously superior to the corresponding aspects of the applicant's proposed site, and the alternative site does not have offsetting deficiencies.

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If there is no environmentally preferred or obviously superior site(s), the proposed site prevails and becomes the candidate site that is submitted to the NRC by the applicant as the proposed location for a nuclear power station. If an alternative site is determined to be obviously superior to the applicant's proposed site, the application may be denied.

Readily available reconnaissance level information sources were used for the candidate site evaluation so as to be consistent with Regulatory Guide 4.2, Rev. 2 (NRC, 1976) which states:

> *The applicant is not expected to conduct detailed environmental studies at alternative sites; only preliminary reconnaissance type investigations need be conducted.*

The information sources included publicly available data and images, information available from PPL files and personnel, and the Environmental Data Resources, Inc. (EDR) database in order to evaluate, score, and rank the candidate sites. Additional information and clarification of map and literature data were supplemented with site investigations as needed.

9.3.2 PROPOSED AND ALTERNATIVE SITE EVALUATION

As noted in Section 9.3.1.2, an evaluation was conducted to compare the alternative sites to the proposed site and determine if any of the alternative sites were environmentally preferable to the proposed site for the location of a nuclear power generating facility. The siting process discussed in Section 9.3.1 was used to conduct the evaluation of the proposed site and alternative sites.

The evaluation consisted of assessing the environmental impacts of constructing and operating a nuclear power generating facility at the proposed site and alternative sites using the NRC three level standard of significance: SMALL, MODERATE, or LARGE. This standard of significance is defined in Section 9.2.3.

To assess and analyze the environmental impacts of constructing and operating a nuclear power generating facility at each of the alternative sites and at the proposed site, it was assumed the construction and operation practices described in Chapters 4 and 5 will generally be applied to each site, thereby allowing for a consistent description of the impacts on each site.

A summary of the evaluation of environmental impacts on the proposed site and alternative sites is presented in the following sections.

9.3.2.1 Bell Bend Nuclear Power Plant

The BBNPP site is located directly adjacent to an existing nuclear facility: the Susquehanna Steam Electric Station (SSES). The proposed site is located in Luzerne County, Pennsylvania, approximately 4 mi (6.4 km) south of Shickshinny, Pennsylvania, and 5 mi (8 km) northeast of Berwick, Pennsylvania. Figure 9.3-6 contains a vicinity map showing the 6 mi (9.7 km) radius surrounding the BBNPP site. Because the aspects listed below have been discussed in detail in previous chapters of the Environmental Report, the discussions consist of summary statement(s) with predicted impact levels and references to the section(s) containing the basis for these impacts.

9.3.2.1.1 Land Use

Land use impacts associated with the construction and operation of the BBNPP are discussed in Section 4.1.1 and Section 5.1.1, respectively. Overall land use impacts are anticipated to be SMALL for both construction and operation activities.

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9.3.2.1.2 Air Quality

Air quality impacts associated with the construction and operation of the BBNPP are discussed in Section 4.4.1 and Section 5.8.1, respectively. Air quality impacts are anticipated to be SMALL for both construction and operation activities.

9.3.2.1.3 Water

BBNPP water use impacts from construction and operation activities and associated mitigation measures are discussed in Section 4.2.1, Section 4.2.2, Section 5.2.1 and Section 5.2.2, respectively. Water use impacts associated with construction activities would be MODERATE due to the re-routing of the east fork of Walker Run, while impacts associated with operation activities would be SMALL.

9.3.2.1.4 Terrestrial Ecology and Sensitive Species

Terrestrial ecology impacts at the BBNPP site from the construction and operation and associated mitigation measures are discussed in Section 4.3.1, Section 5.3.3.2, and Section 5.6.1. Terrestrial ecology impacts associated with construction and operation activities would be SMALL.

9.3.2.1.5 Aquatic Ecology and Sensitive Species

Aquatic ecology impacts at the BBNPP site from construction and operation activities and associated mitigation measures are discussed in Section 4.3.2, Section 5.3.1.2, Section 5.3.2.2, and Section 5.6.2. Aquatic ecology impacts associated with construction and operation activities would be SMALL.

9.3.2.1.6 Socioeconomics

Socioeconomic beneficial and adverse impacts associated with the construction and operation of the BBNPP and associated mitigation measures are discussed in Section 4.4 and Section 5.8, respectively. Socioeconomic adverse and beneficial impacts associated with construction activities would be SMALL to MODERATE. Adverse impacts associated with operation activities would be SMALL. Beneficial impacts associated with operation activities would be SMALL to LARGE.

9.3.2.1.7 Transportation

The impacts on transportation from the construction and operation of the BBNPP and associated mitigation measures are discussed in Section 4.4.1 and Section 5.8.1, respectively. Transportation impacts are anticipated to be MODERATE during construction activities and SMALL during operation of the proposed nuclear station.

9.3.2.1.8 Historic, Cultural, and Archeological Resources

A discussion of potential impacts to historic, cultural, and archeological resources from the construction and operation of the BBNPP and associated mitigation measures are provided in Section 4.1.3 and Section 5.1.3, respectively. Historic, cultural, and archeological resources impacts associated with construction and operation activities would be SMALL.

9.3.2.1.9 Environmental Justice

Environmental justice impacts from the construction and operation of the BBNPP and associated mitigation measures are discussed in Section 4.4.3 and Section 5.8.3, respectively. Environmental justice adverse impacts associated with construction would be SMALL.

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Beneficial impacts associated with construction would be SMALL to MODERATE. Environmental justice adverse and beneficial impacts associated with operation activities would be SMALL.

9.3.2.1.10 Transmission Corridors

Transmission system environmental impacts from the construction and operation of the BBNPP and associated mitigation measures are discussed in Section 4.1.2 and Section 5.6, respectively. Transmission system impacts associated with construction and operation activities would be SMALL.

9.3.2.2 Montour Site

The Montour site is a greenfield site that is located directly adjacent to the existing Montour coal-fired power plant in Derry Township, approximately 2 mi (3.2 km) northeast of the borough of Washingtonville, Montour County, Pennsylvania. State Route (SR) 54 and SR 254 are located to the west and south, respectively. Figure 9.3-7 contains a vicinity map showing the 6 mi (9.7 km) radius surrounding the Montour site.

9.3.2.2.1 Land Use

Surrounding land use consists of agricultural/open land and forested areas. The coal-fired facility and adjoining lands in Montour County consist of approximately 5,400 ac (2,185 ha) of land that is owned either by PPL Generation, LLC or its operating subsidiary, PPL Montour, LLC. The prospective facility site would be located on this property on land just north of the coal-fired facility. North of the prospective facility site, the company property includes the Montour Preserve (a recreational lake with boating and fishing, picnic areas, wildlife refuge, educational areas, hiking, hunting, etc.) and other areas that are largely undeveloped. A new gas pipeline has recently been installed north of the Preserve. Industrial facilities (greenhouses) are located northwest of the coal-fired facility. A new gypsum/wallboard plant southeast of the coal plant uses byproducts from the newly installed scrubber. A small residential area (Strawberry Ridge) is located east of the coal-fired facility, and a larger area (Washingtonville) is located to the southwest. It is anticipated that the Montour facility would take advantage of existing rail infrastructure from the Montour Power Plant. Other land uses surrounding the Montour site are primarily agriculture and low density residential. Overall land use impacts from construction and operation of a new nuclear power generating facility are anticipated to be SMALL.

9.3.2.2.2 Air Quality

Construction activities at the Montour site have the potential to temporarily impact ambient air quality in the immediate vicinity of the existing coal-fired facility, and to a lesser extent, air quality in the vicinity of the transmission corridors, pipeline corridor, and appurtenant structures due to emissions from onsite construction equipment. These emissions are expected to be consistent with emissions from other construction projects of this magnitude. It is anticipated that there should be no significant impacts on air quality at offsite locations during the construction period due to the relatively long distance from the center of the site (where most construction and equipment laydown would occur) to the site boundaries. Overall air quality impacts to the surrounding area attributable to the construction of the proposed facility would be SMALL.

With the exception of some relatively small diesel fueled emergency power generating equipment and fire pumps, operation of the proposed facility would not have significant sources of emissions attributable to the combustion of fossil or other fuels. The proposed

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facility will contain cooling towers that will emit water vapor and particulate matter (PM) to the atmosphere. Because of the low level of emissions, operation activities are not expected to cause or contribute to a violation of state or federal ambient air quality standards. There would be a small increase in regional and local air emissions as a result of increased vehicular traffic associated with workforce employed for facility operations. It is anticipated that overall air quality impacts associated with operation of the proposed facility would be SMALL.

9.3.2.2.3 Water

Hydrologic impacts associated with construction activities include alteration of the existing watershed surface; disturbance of the ground surface for stockpiles, material storage, and construction of temporary access roads; construction of water intake and discharge structures; construction of cofferdams and storm sewers; construction of structures that might alter shoreline processes; dredging operations; temporary dewatering activities; construction activities contributing to sediment runoff; changes in surface water drainage characteristics; decreases in surface water infiltration (increases of impervious surfaces); increased erosion and sedimentation; changes in groundwater levels related to temporary dewatering activities; and possible subsidence resulting from groundwater withdrawals. Water will be used for construction activities, and the required quantity of water is anticipated to be similar to the quantity described in Section 4.2.2. Proper mitigation and management methods implemented during construction will limit the potential water quantity and quality effects to surface water and groundwater.

Construction related water use impacts will be minimized by implementing BMPs, including erosion, grading, and sediment control measures; stormwater control measures; spill prevention plan; and observance of federal, state, regional, tribal, and local regulations pertaining to nonpoint source discharges. Overall construction related water impacts would be SMALL.

The main source of water for the proposed new unit at the Montour site would be from the West Branch of the Susquehanna River. Water use and withdrawal would be similar to that discussed in Section 5.2 and Section 5.3. Ensuring permitted limits for water withdrawal and discharge are met through operational controls and monitoring will minimize the potential for adverse impacts to water availability and water quality. It is anticipated that there would be a site-specific water treatment system or the use of a municipal system, if available. Overall water use impacts from operation activities would be SMALL.

9.3.2.2.4 Terrestrial Ecology and Sensitive Species

Impacts on the terrestrial ecosystem associated with construction of the proposed facility include noise, clearing and grading, and potential collisions of birds with new structures. Construction of the proposed facility will result in direct mortality for certain wildlife and will reduce the available habitat area but will not adversely affect local or regional populations of wildlife species. Native habitats on the property have been significantly altered through agricultural and existing coal-fired facility operations, and listed species that are mobile are likely to preferentially use less disturbed habitats on adjacent conservation lands. The terrestrial ecology impacts from construction of the water pipeline (approximate 12 mi (19.3 km) long) and upgrade of transmission line corridors (transmission corridors expanded to accommodate 500 kV line for approximately 30 mi (48.2 km)) are anticipated to be MODERATE due to the commitment of land and construction impacts on ecological resources. In order to lessen the impacts, wetland impacts will be mitigated, threatened and endangered species will be considered and protected and BMPs will be used to prevent impacts to watercourses.

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Table 9.3-1 (PNHP, 2008) provides a list of federal-listed and state-listed threatened and endangered terrestrial species located within Montour County, Pennsylvania. A search of the EDR database indicated that the Indiana bat (Myotis sodalis) is a federal endangered species that is located in the county but not found on site (EDR, 2008a). Therefore, potential construction impacts to threatened or endangered species at the Montour site would be SMALL.

It is anticipated that terrestrial ecology impacts from operation of the proposed EPR nuclear station would be similar to those described in Section 5.3.3. Therefore, impacts to terrestrial ecology from the operation of the proposed site would be SMALL.

9.3.2.2.5 Aquatic Ecology and Sensitive Species

Construction related impacts to the aquatic ecology would be similar to those described in Section 4.3 and include loss of wetlands and temporary loss of habitat and short term degradation of water quality in isolated areas due to in water and shoreline construction of the Circulating Water System (CWS) Makeup Water Intake Structure. According to the EDR database, there are wetlands located within 0.5 mi (0.8 km) of the site.

It is anticipated that, while much of the supporting structure will be located onshore, the CWIS will extend a short distance into the waterway and will likely involve the dredging of sediment to allow for the construction of the concrete structure on the bottom of the river. The dredging of sediment during construction of the CWS Makeup Water Intake Structure will result in the temporary suspension and re-deposition of the sediment, as well as the removal of those benthic organisms living in or on the removed sediment. It is anticipated that the suspended sediment will quickly redeposit in the immediate area. For a short time, the suspended sediment will create increased turbidity in the immediate area of the construction. Fish and motile crustaceans present in the area during construction of the CWS Makeup Water Intake Structure will avoid the area during active construction or will actively feed on suspended organisms during dredging operations, and are unlikely to be adversely affected by the construction activities.

No construction effluents are anticipated from the CWS Makeup Water Intake Structure construction area. BMPs will be used to minimize runoff volumes and impacts. The use of a cofferdam to facilitate construction of the in water portions of the CWS Makeup Water Intake Structure will minimize releases of sediment. Prior to commencement of dredging, sediment in those areas proposed to be dredged will be sampled and analyzed to obtain detailed chemical characterizations according to the requirements of dredging permits; special sediment handling requirements suggested by the sediment sampling results and required by the dredging permit will be followed.

CWS Makeup Water Intake Structure construction related impacts on aquatic species are anticipated to be minor because the area of impacts is limited to the immediate vicinity of the construction activities. Because the potential impacts will be localized and given the short term nature of the construction activities and the relatively short term recovery periods for disturbed benthic species within and near the dredged area, no long term effects on important species and their habitats are anticipated to occur. Therefore, the adverse aquatic ecology impacts associated with construction of the CWS Makeup Water Intake Structure are anticipated to be SMALL.

An approximate 12 mi (19.3 km) long makeup and blowdown water pipeline would need to be constructed to connect the Montour site to the West Branch of the Susquehanna River. It is anticipated that the makeup and blowdown water system pipelines would extend along

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existing rights-of-way, if feasible, to reduce potential impacts. It is anticipated that approximately 30 mi (48 km) of transmission corridor would need to be upgraded to the necessary 500 kV transmission system. In addition, according to NWI mapping, palustrine wetlands could be present on the site (EDR, 2008a). Impacts to wetlands would need to be coordinated through the U.S. Army Corps of Engineers (USACE) and the state prior to construction activities. Therefore, it is anticipated that construction activities would have a MODERATE impact on aquatic ecology based on the commitment of land and on construction impacts associated with pipeline and transmission system corridors.

It is anticipated that aquatic ecology impacts from operation of the proposed EPR nuclear station would be similar to those described in Section 5.3.3. Therefore, impacts to aquatic ecology from the operation of the proposed site would be SMALL.

Table 9.3-1 (PNHP, 2008) provides a list of federal-listed and state-listed threatened and endangered aquatic species located within Montour County, Pennsylvania. According to the EDR database, no federally-listed or state-listed threatened or endangered species are located on site (EDR, 2008a). There is the potential for construction-related impacts to threatened or endangered species along the pipeline and upgraded transmission corridors. However, conditions of applicable federal, state, and local permits would be met to minimize adverse environmental impacts, and to ensure that organisms are protected against potential construction related impacts.

9.3.2.2.6 Socioeconomics

The Montour site is located within Census Block 3025, Block Group 3, Census Tract 9501, within Montour County, Pennsylvania. A census tract is a particular community defined for the purpose of taking a census by the U.S. Census Bureau. Usually these coincide with the limits of cities, towns, or other administrative areas. Several tracts commonly exist within a county. Census tracts are subdivided into block groups and census blocks. A census block group is a geographical unit between the census tract and census block. The census block group is the smallest geographical unit for which the U.S. Census Bureau publishes sample data, that is, data which is only collected from a fraction of all households. A census block is the smallest geographic unit used by the U.S. Census Bureau for tabulation of 100% data (data collected from all houses, rather than a sample of houses). Several blocks make up block groups which again make up census tracts. There are on average about 39 blocks per block group, but there are variations. Blocks typically have a four-digit number where the first number indicates which block group the block is in; for example, Block 3019 would be in Block Group 3.

In 2007, Montour County had a population of approximately 17,817, a 2% decrease from 2000. In 2000, the population within Census Tract 9501 was 3,808 with eight people residing in Census Block 3025. The population density of Montour County is 139.5 ppsm. Census tract data were reviewed to determine the average population density within a 20 mi (32 km) radius of the Montour site. Based on these data, 176 ppsm, including seasonal transient population, are within this area (USCB, 2000). Montour County is estimated to continue to decrease in population by 5.1% from 2000 to 2010, and by 1.6% from 2010 to 2020 (PSDC, 2008).

There are approximately 17 hospitals located within a 50 mi (80 km) radius of the Montour site, with Geisinger, Danville State, and Shamokin State hospitals located within Montour County. (ESRI, 2006)

The Montour County, Pennsylvania Fire Services consists of six fire departments, one of which is a volunteer fire department (Montour County, 2008).

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There are approximately 343 public and private schools, including elementary, middle, and high school, colleges, and universities, located within a 50 mi (80 km) radius of the Montour site, and there are 13 schools located in Montour County. (ESRI, 2006)

There are approximately 53 public and private airports located within a 50 mi (80 km) radius of the Montour site. This does not include airstrips, airfields, or heliports. Based on 2006 data, no airports are located in Montour County. (ESRI, 2006)

There are approximately 91 parks, which include gardens, game lands, some playgrounds and athletic fields, located within a 50 mi (80 km) radius of the Montour site, with two parks located in Montour County. (ESRI, 2006)

Employment projections within the area indicate a general upward trend in the availability of various construction jobs (COP, 2008). An increase of available jobs indicates additional competition in acquiring a workforce for construction of the proposed facility.

Data from the 2006 American Survey were not available for Montour County; therefore, an analysis was conducted of the most recent data for the area, including the Bloomsburg Berwick Metropolitan Statistical Area, which includes Montour and Columbia counties. According to 2000 Census data, approximately 542 housing units currently are vacant in the county. According to 2006 survey data, 3,862 units are available in the Bloomsburg Berwick Metropolitan Statistical Area (USCB, 2006). Based on 2000 census data, approximately 41,967 housing units are vacant, representing 11% of the total housing within a 50 mi (80 km) radius of the site. It is assumed that many of the direct and indirect jobs created by the proposed facility would require a largely migrating workforce.

The plume from the facility would likely be visible at a considerable distance; however, it would represent a limited alteration of the aesthetics due to the proximity to the existing Montour Power Plant.

The impact of the proposed facility on the population and demographics of Montour County is expected to be SMALL. The construction and operation of the new nuclear station would have a MODERATE to LARGE beneficial economic impact to the surrounding area and region.

9.3.2.2.7 Transportation

The Montour site has access from SR 54 and SR 254, both of which are two lane state highways located near the site. The anticipated area of construction is currently undeveloped and would likely require the construction of new roads to access the site. There is existing infrastructure for the Montour Power Plant to support the current operations, and these could, in part, be used to support the proposed facility.

The site is located more than 5 mi (8 km) from the nearest water source and has no barge access. There is an existing rail line and spur leading to the existing coal-fired facility. It is likely, however, that extensions and/or upgrades to the existing rail spur (less than 1 mi (1.6 km)) would be required.

It is anticipated that there will be traffic impacts on local roads during construction and operation activities. The development of a traffic management plan prior to construction would aid in identifying and mitigating potential traffic impacts. The following mitigation measures will be considered in the traffic management plan:

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- Workforce shift changes and delivery options: Scheduling shift changes and the delivery of large items during off peak hours could reduce potential impacts on local roads.

- Carpooling: The use of carpooling and providing transit services (buses) during construction and operation of the facility could be considered.

- Coordination with local planning authorities: If necessary, the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered.

The impacts on transportation are anticipated to be MODERATE during construction activities, and SMALL during operation of the proposed facility.

9.3.2.2.8 Historic, Cultural, and Archeological Resources

Pennsylvania was inhabited by a number of Native American tribes before the arrival of the Europeans (Kindred Trails, 2004). Because archeological sites are often found along watercourses, the area bordering Chillisquaque Creek and its tributaries is considered an archeologically sensitive area (USGS, 2008a).

Of the seven sites in Montour County that are listed in the National Register of Historic Places (NRHP), only Keefers Bridge No. 7 is located in the same township as the Montour site (PHMC, 2008). The bridge is located several miles from the Montour site; therefore, direct impacts from construction and operation of the proposed facility are not anticipated. A review of the EDR database indicated that no historic properties are located within 1 mi (1.8 km) of the site (EDR, 2008a). Aside from potential viewshed impacts, impacts to historical, cultural, and archeological resources would be SMALL, but consultation with SHPO would be required regarding appropriate investigations prior to commencing the project.

9.3.2.2.9 Environmental Justice

The demographic characteristics of the areas surrounding the Montour site were evaluated to determine the potential for environmental justice claims based on disproportionate impacts to minorities or low income population near the site.

Demographics of the Census tract and block groups around the site were examined and compared with the demographics of Montour County and the Commonwealth of Pennsylvania. Census block group data represent the smallest reported census area surrounding the Montour site. Table 9.3-2 (USCB, 2000) provides a summary of the demographic characteristics of the area. Figure 9.3-8 presents the census tract and block groups that fall within a 6 mi (10 km) radius of the site. In addition, the figure also presents the minority populations and percentages that fall within the census tract and block groups within the 6 mi (10 km) radius (USCB, 2000).

The demographics of the census tract and block groups surrounding the Montour site consist of minority population percentages that are generally similar to those found at the county and state levels. A higher percentage of Asian population is present at the block level.

The median household income for Montour County was $38,075, compared to an average of $40,106 for Pennsylvania (USCB, 2000). Eleven percent of the Census tract was below the poverty level.

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Based on the data presented in Table 9.3-2, no significant numbers of minorities or low income people are represented in the vicinity of the Montour site. Therefore, it is unlikely that more than one necessary condition for demonstrating the validity of a discriminatory effect complaint against the permitting of the project could be fulfilled. Overall environmental justice impacts are anticipated to be SMALL.

9.3.2.2.10 Transmission Corridors

The Montour site has access to an existing switchyard (Montour Power Plant); however, it is anticipated that upgrades to the power transmission system infrastructure would be needed for the proposed facility. Approximately 30 mi (48 km) of existing 230 kV transmission line would require upgrading to access the 500 kV transmission system at the existing Susquehanna 500 kV switchyard. Alternatively, approximately 13 mi (21 km) of transmission corridor would have to be constructed to access the 500 kV transmission system at its closest approach to the Montour site. Most transmission corridors would pass through land that is primarily agricultural and forest land. The areas are mostly rural and remote with low population densities. The lines would cross numerous state and U.S. highways. The effect of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

Impacts to transmission corridors would be MODERATE due to the commitment of land and construction impacts associated with the transmission system upgrades on ecological resources. Utilization of existing transmission corridor rights-of-way could present opportunities to minimize adverse impacts. Specific monitoring requirements for upgrades to transmission lines and corridors would 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 potential construction related impacts.

Operational activities within the transmission corridors might include visual inspection and appropriate maintenance of transmission line rights-of-way. Maintenance activities could include reclearing vegetation, tree trimming/removal, and encroachment licensing/removal. For maintenance purposes, wooded sections of the rights-of-way would be recleared to the full width through mechanical clearing, hand cutting, or herbicide application. Operation impacts are anticipated to be SMALL.

9.3.2.3 Martins Creek Site

The Martins Creek site is a greenfield site that is located in a rural area on the Delaware River, approximately 2.5 mi (4 km) south of the town of Belvidere, Warren County, New Jersey. The site is located directly east, approximately 0.5 mi (0.8 km) across the Delaware River from the existing PPL-owned Martins Creek Power Plant located in Bangor, Pennsylvania. Figure 9.3-9 contains a vicinity map showing the 6 mi (10 km) radius surrounding the Martins Creek site.

9.3.2.3.1 Land Use

The site consists of an approximately 500 ac (202 ha) of agricultural lands with some areas of undeveloped forest land. The site does not currently contain any development such as paved roads or buildings. The site does contain an existing 230 kV high transmission line that travels north-south across the property. The site is part of the Industrial Zone as defined by the Warren County Strategic Growth Plan (Warren County, 2005). Lands to the north are a mix industrial lands, agricultural fields, and residential subdivisions. Land to the east is dominated by undeveloped forest land, while land to the south is mostly agricultural. To the west, the property is bordered by South Foul Rift Road and the Delaware River. There are no population centers, parks, large airports, or other major destinations located in the vicinity.

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It is noted that the proposed site is located across the Delaware River, east of an existing PPL-owned Martins Creek oil/gas industrial facility (located in Bangor, Pennsylvania). There is a risk of locating a nuclear power generating facility in proximity to an existing industrial facility in case there are accidents at the industrial facility. Regulatory Guide 4.7 (NRC, 1998) identities these risks as described below:

Accidents at present or projected nearby industrial, military, and transportation facilities, such as chemical plants, refineries, mining and quarrying operations, oil or gas wells, or gas and petroleum product storage installations may produce missiles, shock waves, flammable vapor clouds, toxic chemicals, or incendiary fragments. These may affect the facility itself or the facility operators in a way that jeopardizes the safety of the facility.

An accident during the transport of hazardous materials (for example, by air, waterway, railroad, highway, or pipeline) near a nuclear power generating facility may generate shock waves, missiles, and toxic or corrosive gases that can affect the safe operation of the facility. The consequences of the accident will depend on the proximity of the transportation facility to the site, the nature and maximum quantity of the hazardous material per shipment, and the layout of the nuclear power generating facility. Potential hazards associated with nearby transportation routes, industrial and military facilities must be evaluated and site parameters established such that potential hazards from such routes and facilities will pose no undue risk to the type of facility proposed to be located at the site (NRC, 2005).

Overall land use impacts are expected to be SMALL based on the discussion above and due to the rural location and nature of the site and the presence of an industrial facility (PPL Martins Creek oil/gas plant) directly west of the site across the Delaware River.

9.3.2.3.2 Air Quality

The Martins Creek site is located in Warren County, New Jersey. Warren County is designated as nonattainment for ozone (8-hour standard) and nonattainment for the primary and secondary standards for SO_2 (USEPA, 2008). All other criteria pollutants are presently in attainment of the national ambient air quality standards (NAAQS). It is also understood that the area may become nonattainment for the new $PM_{2.5}$ standard.

Air emissions during construction can be expected to be typical of other large construction projects, with emissions being generated by construction activity on the site. The quantity and nature of these emissions will depend on the time of day, atmospheric conditions (wind, humidity, rainfall), and the intensity of the construction activity. There will be some fugitive dust emissions that will be primarily limited to the site area, and these emissions will be limited by implementing BMPs for construction activities and a fugitive dust control plan. Site activities will be monitored and specific measures, including site watering where necessary, will be undertaken to limit dust generation. There will also be a small amount of combustion related emissions (NOx, VOC, CO, PM_{10}, and SO_2) associated with the operation of diesel-powered and gasoline-powered construction equipment on the site. However, the magnitude of these emissions would be small, and there is not expected to be a significant or discernible impact local or regional air quality as a result of the construction activities.

The air quality impacts attributable to the construction of the proposed facility in Warren County are therefore expected to be SMALL.

Any air emissions that will occur as a result of the operation of the proposed new facility are expected to be low enough that they will not cause or contribute to a significant change in local or regional air quality levels at any location, nor will they contribute to a degradation of

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ozone or SO_2 levels at any location. While the ozone and SO_2 nonattainment status of Warren County will be a consideration for the siting of the facility, it is not expected to be a significant issue in terms of the ability to obtain the necessary air quality permits to construct and operate. The anticipated air emissions from the facility will be almost entirely attributable to the periodic testing of standby diesel powered generators and fire pump engines, which can be expected to have low annual fuel usage and air emissions.

Therefore, the air quality impacts attributable to the operation of the proposed facility in Warren County are therefore expected to be SMALL.

9.3.2.3.3 Water

Construction related hydrologic and water use impacts and associated migration measures are similar to those described in Section 9.3.2.2.3. Therefore, it is anticipated that overall construction related water impacts are considered to be SMALL.

The main source of water for the proposed new unit at the Martins Creek site would be from the mainstem of the Delaware River. Water impacts to hydrology and consumptive water use attributed to operation of the proposed EPR nuclear facility will be associated with water withdrawal from the mainstem of the Delaware River. The low flow value for the period of record (85 years) for the river at the nearest USGS gage (01446500 near Belvidere, New Jersey) is approximately 577 million gpd (892 cfs) (USGS, 2008b). The consumptive water usage of the proposed nuclear facility is estimated to be 24.6 million gpd (38 cfs) (Section 5.2.2); therefore, the water usage would be approximately 4.3% of the lowest recorded value in 85 years. During periods of extreme low river flow, the consumptive use could be as high as 4.3% of the river flow. The estimated consumptive water use of 24.6 million gpd (38 cfs) is approximately 1% of the mean flow for the Delaware River of 2,440 million gpd (3,770 cfs). The Delaware River near the site is currently on the list of impairments for metals, as well as dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenyldichloroethylene (DDE). Additionally, the river upstream of the location is also listed for total dissolved solids (DRBC, 2004).

Overall operations related water use impacts are anticipated to be SMALL during periods of normal to high flow because of the relatively small percentage of flow that would be consumed. Even under periods of extreme low flow, the operations related water use impacts are anticipated to be SMALL due to the consumptive water use being approximately 4.3% of the flow.

9.3.2.3.4 Terrestrial Ecology and Sensitive Species

Impacts to the terrestrial ecosystem associated with construction activities could include noise, clearing, and grading. Construction activities can result in direct mortality for certain wildlife and will reduce the available habitat area but will not adversely affect local or regional populations of wildlife species. Native habitats on the property have been significantly altered through agricultural operations. Listed species that are mobile are likely to prefer to use less disturbed habitats on adjacent conservation lands. Less than 0.5 mi (0.8 km) of water pipeline will need to be constructed between the CWS Makeup Water Intake Structure and the Martins Creek site property.

The relative suitability of the Martins Creek site with respect to potential impacts to terrestrial ecology (rare, threatened, and endangered terrestrial species, and critical habitat) and wetlands was evaluated. There are limited areas of wetlands along the Delaware River within the Martins Creek site area that would likely be avoided by any construction activities. A limited amount of

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wetlands would likely be disturbed related to the CWS Makeup Water Intake Structure intake and related structures (WCNJEC, 2008).

Table 9.3-3 (WCNJEC, 2008) provides a list of the federal-listed and state-listed protected terrestrial species that have the potential to occur in Warren County, New Jersey. A review of the EDR database indicated that no federally-listed or state-listed endangered species occurs on the site (EDR, 2008b).

Based on the amount of wetlands and threatened and endangered terrestrial species on the site, anticipated construction related impacts onsite would be SMALL. Transmission system upgrades (circuits, towers, lines, corridors) would be needed to connect the Martins Creek site to the nearest 500 kV line. The terrestrial ecology impacts from the expansion of the transmission system in order to connect to the nearest 500 kV line are anticipated to be MODERATE to LARGE due to the commitment of land and the construction impacts to ecological resources. Conditions of applicable federal, state, and local permits would be met to minimize adverse environmental impacts, and to ensure that organisms are protected against potential construction related impacts

For the reasons stated in Section 4.3.1, impacts to terrestrial ecology from the operation of the nuclear power generating facility would be SMALL.

9.3.2.3.5 Aquatic Ecology and Sensitive Species

Construction-related impacts to the aquatic ecology are similar to those described in Section 9.3.2.2.5 and include loss of wetlands and temporary loss of habitat and short-term degradation of water quality in isolated areas due to in-water and shoreline construction of the CWS Makeup Water Intake Structure, makeup water pipeline, and cooling system blowdown discharge pipelines less than 0.5 mi (0.8 km) of pipeline will be needed to convey water from the river to the proposed site. Therefore, the adverse aquatic ecology impacts associated with construction activities are anticipated to be SMALL. A review of the EDR database indicated that no federally-listed or state-listed endangered species occurs on the site (EDR, 2008b). The aquatic ecology impacts from the expansion of the transmission system in order to connect to the nearest 500 kV line include loss of habitat and loss of wetlands and are therefore anticipated to be MODERATE.

Impacts due to operation of the proposed project (consumptive makeup water use and blowdown discharge) could include changes to the aquatic habitat immediately adjacent to the blowdown discharge related to changes to water chemistry and thermal profile. An approved and compliant NPDES permit should minimize these impacts. Impacts of the CWS Makeup Water Intake Structure could include impingement and entrainment of aquatic organisms. These impacts should be minimized by compliance with the appropriate Section 316(b) rule. However, there is one federal-listed threatened or endangered aquatic invertebrate species, the dwarf wedgemussel (*Alasmidonta heterodon*), in Warren County. While the probability of the glochidia becoming entrained in the CWS makeup water is very low due to the relatively large volume of water in the Delaware River, there is a possibility of impact due to known populations existing in Warren County. Therefore, operations impacts are considered to be SMALL to MODERATE due to the presence and potential entrainment of the federal-listed endangered species, the dwarf wedgemussel (*Alasmidonta heterodon*).

9.3.2.3.6 Socioeconomics

The Martins Creek site is located within Census Tract 316.01, Block Group 3, Warren County, New Jersey. In 2007, Warren County had a population of approximately 109,737, a 6.7%

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increase from 2000. In 2000, the population within the entire Census Tract 316.01 was 4,245, and Block Group 3 was 2,021. The population density of Warren County in 2000 and 2005 was 282 ppsm and 305 ppsm, respectively. The 2005 and 2007 population data are estimated projections.

Census tract data from 2000 were reviewed to determine the average population density within a 20 mi (32 km) radius of the Martins Creek site. Based on these data, there are 378 ppsm within this area, including seasonal transient populations (USCB, 2000). When using population data from the year 2000 as a baseline, Warren County is estimated to experience a population increase of 13.3% by 2010, 17.5% by 2015, and 24.4% by 2020 (WCNJEC, 2008).

There are approximately 34 hospitals located within a 50 mi (80 km) radius of the Martins Creek site. Based on 2006 data, no hospitals are located within Warren County. (ESRI, 2006)

The Warren County, New Jersey Fire Services consists of 18 fire departments, 9 of which are volunteer fire departments (WCFD, 2008).

There are approximately 1,024 public and private schools, which include elementary, middle, and high schools, colleges, and universities, located within a 50 mi (80 km) radius of the Martins Creek site, with 19 schools in Warren County. (ESRI, 2006)

There are approximately 134 public and private airports located within a 50 mi (80 km) radius of the Martins Creek site. This does not include airstrips, airfields, or heliports. Twenty airports are located in Warren County. (ESRI, 2006)

There are approximately 265 parks, which include gardens, game lands, some playgrounds, and athletic fields, located within a 50 mi (80 km) radius of the Martin Creek site, and there are four parks in Warren County. (ESRI, 2006)

Employment projections within Warren County from 2004 to 2014 indicate a 13.5% increase in construction industry jobs. From 2004 to 2005, the number of persons filing for unemployment compensation in Warren County decreased by 4%. Unemployment insurance claimants, however, in the construction industry increased by 5.6%.

Based on 2006 census data, approximately 3,608 housing units are currently vacant, representing 8% of the total housing units within the county (USCB, 2006). Based on 2000 census data, approximately 113,839 housing units are vacant representing 7% of the total housing within a 50 mi (80 km) radius of the site. Adequate housing units appear to be available to address the influx of both temporary and permanent workforce required to support a nuclear power generating facility at this location. In addition, an infrastructure is in place for the existing nearby Martins Creek oil/gas plant.

The cooling tower plume from the proposed nuclear power generating facility would likely be visible at a considerable distance; however, it would represent a limited alteration of the aesthetics in the area due to the existing Martins Creek oil/gas plant cooling towers located west of the proposed site, across the Delaware River.

Based on the above information, the construction and operation of a new nuclear power generating facility at this site would have a SMALL impact on the population of Warren County, New Jersey. The construction and operation of the new nuclear station would have a SMALL to LARGE beneficial economic impact to the surrounding area and region.

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9.3.2.3.7 Transportation

The site is bordered by South Foul Rift Road on the west and County Road 519/Phillipsburg-Belvidere Road on the east. The site is bordered on the north by Foul Rift Road that provides east-west access in the vicinity. County Road 519 is approximately 88 mi (142 km) in length extending from Daniel Bray Highway (Route 29) in Delaware Township to the New York state line in Wantage Township. There are a number of unimproved dirt roads on the site used for agricultural purposes. The closest airport is the Lehigh Valley International Airport located approximately 20 mi (32 km) southwest of the site near Bethlehem, Pennsylvania. There is a small grass airstrip (Matthews Airport) located less than 1 mi (1.6 km) east of the site off Matthews Lane. The site does not have barge access or barge facilities. The site is located less than 0.5 mi (0.8 km) from the nearest active rail line.

Traffic impacts and associated mitigation measures would be similar to those discussed in Section 9.3.2.2.7. It is expected that there would be MODERATE impact on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.3.8 Historic, Cultural, and Archeological Resources

Archeological sites are common throughout New Jersey. The distribution of known sites reflects areas that have been surveyed and do not necessarily reflect the actual distribution or patterns of past settlement and use. Historic archeological sites occur in conjunction with historic districts, buildings, and structures, including industrial and commercial buildings, such as mills and warehouses. These sites may remain after aboveground portions of the properties no longer exist.

There are 13 districts and individual properties listed on the NRHP in Knowlton Township. Most are historic structures; however, one (28-WA-290, ID 4432) is a Native American site. Two sites are related to Camp Weygadt, Delaware Water Gap National Recreation Area (28-WA-610-ID 2926 and 28-Wa-619 ID 2765). Two sites include Historic District portions of the Delaware, Lackawanna, and Western Railroad (ID 3454 and 3525). The Delaware Water Gap Slate Co. Quarry and Building Sites comprise a Historic District in Knowlton Township (ID 3659). Bridges and viaducts considered historic sites are the Delaware River Viaduct (ID 4693), the Paulins Kill Viaduct (ID 4694), and the Washington Stone Bridge (ID 2729). Other sites include the Delaware Presbyterian Church (ID 63), the Fairview Schoolhouse (ID 2767), and Ramsayburg Homestead (ID 3744) (NRHP, 2008). A review of the EDR database indicated that there are no historic properties located within 1 mi (1.6 km) of the site (EDR, 2008b). Impacts to historical, cultural, and archeological resources would be SMALL, but consultation with SHPO would be required regarding appropriate investigations prior to commencing the project.

9.3.2.3.9 Environmental Justice

The demographic characteristics surrounding the proposed site were evaluated to determine the potential for environmental justice issues based on disproportionately high and adverse impacts to minority or low income population. Demographic information used for this study was obtained from the 2000 U.S. Census.

Demographics of the census tract around the site and the site block group were examined and compared with the demographics of Warren County and the State of New Jersey. Table 9.3-4 (USCB, 2000) presents this demographic information. Figure 9.3-10 presents the census tract and block groups that fall within a 6 mi (10 km) radius of the site. In addition, the figure also presents the minority populations and percentages that fall within the census tract and block groups within that 6 mi (10 km) radius (USCB, 2000).

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The demographics of the census tract and block group surrounding the proposed site consist of minority population percentages that are less than those found at the county and state levels.

In 2000, the median household income for Warren County was $25,728, compared to an average of $27,006 for the State of New Jersey. Five percent of Census Tract 316.01 was below the poverty level. Four percent of Census Tract 316.01 Block Group 2 was below the poverty level. (USCB, 2000)

Based on the data presented in Table 9.3-4, no disproportionately high percentage of minority or low-income residents would be directly impacted by construction and operation of the proposed nuclear power generating facility. Any adverse human health and environmental consequences from the proposed nuclear power generating facility would not be borne disproportionately by minority or low-income groups. Therefore, it is anticipated that environmental justice impacts from implementation of the proposed nuclear facility would be SMALL.

9.3.2.3.10 Transmission Corridors

The Martins Creek site is less than 1 mi (1.6 km) to the PPL Martins Creek Power Plant (across the Delaware River in Bangor, Pennsylvania), which has a 230 kV switchyard and transmission lines. A 230 kV transmission line and transmission corridor rights-of-way crosses through the center of the Martins Creek site. The nearest 500 kV substation is approximately 23 mi (37 km) away near Spring Pond, Pennsylvania, and about 39 mi (63 km) away near Branchburg, New Jersey. Transmission system upgrades have been planned along the Branchburg circuit corridor (in New Jersey) for 2008 and 2009, but it is unknown if they will be constructed (PJM, 2008). A 500-kV circuit is proposed from Susquehanna-Roseland and planned for completion in 2012. The location of the proposed 500-kV circuit would be within several miles of the Martins Creek site (PJM, 2008).

Transmission system upgrades (circuits, towers, lines, corridors) would be needed to connect the Martins Creek site to the nearest 500 kV line. Most transmission corridors would pass through land that is primarily agricultural and forest land. The areas are mostly rural and remote with low population densities. The lines would cross numerous state and U.S. highways. The effect of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

Impacts to transmission corridors would be MODERATE due to the commitment of land and construction impacts associated with the transmission system upgrades on ecological resources. Utilization of existing transmission corridor rights-of-way could present opportunities to minimize adverse impacts. Specific monitoring requirements for upgrades to transmission lines and corridors would 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 potential construction-related impacts

Impacts associated with operation activities on the transmission system (corridors, lines, structures) are similar to those identified in Section 9.3.2.2.10. Operation impacts are anticipated to be SMALL.

9.3.2.4 Sandy Bend Site

The Sandy Bend site is a brownfield site located in Mifflin County, Pennsylvania. The site is located on the Juniata River, approximately 2.5 mi (4 km) northeast of McVeytown,

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Pennsylvania, and 6 mi (9.7 km) south of Belleville, Pennsylvania. Figure 9.3-11 contains a vicinity map showing the 6 mi (10 km) radius surrounding the Sandy Bend site.

9.3.2.4.1 Land Use

The Sandy Bend site is undeveloped and was formerly used for a sand washing operation. Land uses surrounding the site include agriculture, residential, forestry, recreation, and mining. The site is bordered by the Juniata River to the north. Land to the west of the site consists of forested lands, agricultural uses, and some dispersed residential development. Land to the south consists mostly of forested lands, but it also contains land used for agricultural, residential, and mining purposes. To the east, lands are generally used for agriculture and residential development. There are not constraints to development of this land. Therefore, land use impacts are anticipated to be SMALL.

9.3.2.4.2 Air Quality

Construction-related and operations-related impacts to air quality would be similar to those identified in Section 9.3.2.2.2. For the reasons stated in Section 9.3.2.2.2, overall air quality impacts attributable to the construction and operation of the proposed facility would be SMALL.

9.3.2.4.3 Water

Construction-related hydrologic and water use impacts and associated mitigation measures are similar to those discussed in Section 4.4.2 and Section 9.3.2.2.3. Overall construction related water impacts would be SMALL.

The main source of water for the proposed new unit at the Sandy Bend site would be from the Juniata River. The impacts associated with operating the proposed nuclear power generating station's CWS and intake and discharge systems would be similar to those impacts identified in Section 5.2 and Section 5.3. Ensuring permitted limits for water withdrawal, consumptive water use and discharge are met through operational controls and monitoring will minimize the potential for adverse impacts to water availability and water quality. It is anticipated that there would be a site-specific water treatment system or the use of a municipal system, if available. It is anticipated that overall water use impacts from operation activities would be SMALL based on adhering to the permitted water use requirements.

9.3.2.4.4 Terrestrial Ecology and Sensitive Species

Construction-related impacts on the terrestrial ecosystem would be similar to those described in Section 4.3.1 and Section 9.3.2.2.4. It is anticipated that less than 1 mi (1.6 km) of makeup and blowdown water system pipelines will be needed for the proposed nuclear facility. It is anticipated that pipelines would extend along existing disturbed property, if applicable to reduce potential impacts. Therefore, terrestrial ecology impacts related to the construction of the makeup and blowdown water pipeline would be SMALL. Approximately 3.5 mi (5.6 km) of transmission system corridor would be needed to connect to a 500 kV line access. The terrestrial ecology impacts from construction of transmission line corridors are anticipated to be SMALL because the corridor to be developed is, for the most part, previously disturbed. The conditions of applicable federal, state, and local permits would be met to minimize adverse environmental impacts, and to ensure that organisms are protected against potential construction related impacts.

Table 9.3-5 (PNHP, 2008) provides a list of federal-listed and state-listed threatened and endangered terrestrial species located within Mifflin County, Pennsylvania. The Indiana bat

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(*Myotis sodalis*) is a federal endangered species that is located in the county but not found on site (EDR, 2008c). Therefore, the potential impacts to threatened or endangered species at the site would be SMALL.

For the reasons stated in Section 5.3.3, impacts to terrestrial ecology from the operation of the proposed EPR nuclear facility would be SMALL.

9.3.2.4.5 Aquatic Ecology and Sensitive Species

The Sandy Bend site is located in central Pennsylvania on the southern shore of the Juniata River. The site is previously disturbed. There are several small ponds located on the site that may not be regulated. Any impacts to these bodies of water would need to be coordinated through USACE and the Commonwealth of Pennsylvania prior to construction activities. Therefore, the impacts to bodies of water at the site would be SMALL.

Construction related impacts and mitigation measures to the aquatic ecology would be similar to those described in Section 4.3.1 and Section 9.3.2.2.5 and include loss of wetlands and temporary loss of habitat with short-term degradation of water quality in isolated areas due to in-water and shoreline construction of the CWS Makeup Water Intake Structure, makeup water pipeline, and cooling system blowdown discharge pipeline. The size and location of wetlands on the site were determined by reviewing maps from the NWI of the U.S. Fish and Wildlife Service (EDR, 2008c). It is anticipated that less than 1 mi (1.6 km) of makeup and blowdown water system pipelines will be needed for the proposed nuclear facility. It is anticipated that pipelines would extend along existing disturbed property, if applicable, to reduce potential impacts. Therefore, impacts related to the construction of the makeup and blowdown water pipeline would be SMALL. It is anticipated that approximately 3.5 mi (5.6 km) of transmission corridor would be required to connect to a 500 kV transmission system. It is anticipated that there would be SMALL to MODERATE impacts to the aquatic ecosystem affected by construction of the required transmission corridor.

Table 9.3-5 (PNHP, 2008) provides a list of federal-listed and state-listed threatened and endangered aquatic species located within Mifflin County, Pennsylvania. No federally-listed or state-listed species are located in the immediate vicinity of the site (EDR, 2008c). Therefore, the potential impacts to threatened or endangered aquatic species at the site would be SMALL.

For the reasons stated in Section 5.3.1, impacts to aquatic ecology from the operation of the proposed EPR nuclear facility would be SMALL.

9.3.2.4.6 Socioeconomics

The Sandy Bend site is located within Census Block 3001, Block Group 3, Census Tract 9605, within Mifflin County, Pennsylvania. In 2007, Mifflin County had a population of approximately 46,941, a 1% increase from 2000. In 2000, the population within Census Tract 9605 was 3,724 with two people residing within Census Block 3001. The population density of Mifflin County is 112.9 ppsm. Census tract data were reviewed to determine the average population density within a 20 mi (32 km) radius of the Sandy Bend site. Based on these data, 121 ppsm, including seasonal transient populations, are within this area (USCB, 2000). Mifflin County is estimated to increase in population by 0.7% from 2000 to 2010, but decrease by 0.6% from 2010 to 2020 (PSDC, 2008).

There are 8 hospitals located within a 50 mi (80 km) radius of the Sandy Bend site, with Black and Lewistown hospitals located within Mifflin County (ESRI, 2006).

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The Mifflin County, Pennsylvania Fire Services consists of 11 fire departments, 5 of which are volunteer fire departments (Mifflin County, 2008).

There are approximately 549 public and private schools, which include elementary, middle, and high school, colleges, and universities, located within a 50 mi (80 km) radius of the Sandy Bend site, and there are 45 schools in Mifflin County. (ESRI, 2006)

There are approximately 54 public and private airports located within a 50 mi (80 km) radius of the Sandy Bend site. This does not include airstrips, airfields, or heliports. Eight airports are located in Mifflin County. (ESRI, 2006)

There are approximately 103 parks, which include gardens, game lands, some playgrounds, and athletic fields, located within a 50 mi (80 km) radius of the Sandy Bend site, and there are 3 parks in Mifflin County. (ESRI, 2006)

Employment projections within the area indicate a general upward trend in the availability of various construction jobs (PDLI, 2008). An increase of available jobs indicates additional competition in acquiring a workforce for the construction of the proposed EPR nuclear facility at Sandy Bend.

Data from the 2006 American Survey were not available for Mifflin County or the Lewistown Metropolitan Statistical Area (which includes Mifflin County). Therefore, an analysis was conducted of the most recent data available. According to 2000 census data, approximately 2,332 housing units are currently vacant, representing 11.24% of the total housing units within the county (USCB, 2006). Based on 2000 census data, approximately 31,934 housing units are vacant, representing 9.6% of the total housing within a 50 mi (80 km) radius of the site. Infrastructure necessary to support a large industrial facility is currently not in place.

The cooling tower plume from the facility would likely be visible at a considerable distance, which may change the aesthetics of the site.

The impact of the proposed facility on the population and demographics of Mifflin County is expected to be SMALL. The construction and operation of the new nuclear station would have a MODERATE beneficial economic impact to the surrounding area and region.

9.3.2.4.7 Transportation

The closest roads to the Sandy Bend site are U.S. Highway (US) 22 and SR 103. These roads are located approximately 2 mi (3.2 km) from the site, but neither provides direct access to the site. The site is accessed from Sandy Bend Road, a local road that would most likely need to be improved to accommodate construction and operation activities. The site also has access to an active rail line adjacent to the site.

It is anticipated that traffic impacts and mitigation measures associated with the construction and operation of the proposed EPR nuclear facility would be similar to those described in Section 9.3.2.2.7. It is expected that there would be MODERATE impact on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.4.8 Historic, Cultural, and Archeological Resources

Pennsylvania was inhabited by a number of Native American tribes before the arrival of the Europeans. Because archeological sites are often found along watercourses, the area bordering the Juniata River is considered an archeologically sensitive area (USGS, 2008c). A search of the

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EDR database indicated that there are no historic sites located within 1 mile (1.6 km) of the site (EDR, 2008c). One known historic site, a restored and watered portion of the Pennsylvania Main Line Canal, Juniata Division, is located in adjacent Granville Township (NRHP, 2008) (MCG, 2000). The canal parallels the Juniata River on the opposing bank from the Sandy Bend site, but is not expected to be directly impacted by construction or operation of the proposed facility. Aside from potential viewshed impacts, Impacts to historical, cultural, and archeological resources would be SMALL, but consultation with SHPO would be required regarding appropriate investigations prior to commencing the project.

9.3.2.4.9 Environmental Justice

The demographic characteristics of the areas surrounding the Sandy Bend site were evaluated to determine the potential for environmental justice claims based on disproportionate impacts to minorities or low income population near the site.

Demographics of the census tract and block groups around the site were examined and compared with the demographics of Mifflin County and the Commonwealth of Pennsylvania. Census block group data represent the smallest reported census area surrounding the site. Table 9.3-6 (USCB, 2000) provides a summary of the demographic characteristics of the area. Figure 9.3-12 presents the census tract and block groups that fall within a 6 mi (10 km) radius of the site. The minority populations and percentages that fall within the census tract and block groups within that 6 mi (10 km) radius are also identified on the figure (USCB, 2000).

The demographics of the census tract and block groups surrounding the Sandy Bend site consist of minority population percentages that are less than those found at the county and state levels.

The median household income for Mifflin County was $32,175, compared to an average of $40,106 for Pennsylvania (USCB, 2000). Nine percent of the Census tract was below the poverty level.

Based on the data presented in Table 9.3-6, no significant numbers of minorities or low income people are represented in the vicinity of the Sandy Bend site. Therefore, it is unlikely that more than one necessary condition for demonstrating the validity of a discriminatory effect complaint against the permitting of the project could be fulfilled. Therefore, environmental justice impacts are anticipated to be SMALL.

9.3.2.4.10 Transmission Corridors

The Sandy Bend site is currently vacant, but once housed industrial uses on the site. The site was not used for power generation and has no existing power transmission lines or corridors. New transmission lines and corridors would be necessary to connect the proposed facility to an existing transmission system. It is anticipated that approximately 3.5 mi (5.6 km) of new transmission system corridor would be needed for the site. Transmission corridor impacts would be SMALL to MODERATE due to the commitment of land and construction impacts associated with the transmission system upgrades on ecological resources.

Most transmission corridors would pass through land that is primarily agricultural and forest land. The areas are mostly rural and remote with low population densities. The lines would cross state and U.S. highways. The effect of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland.

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Specific monitoring requirements for upgrades of transmission lines and corridors would be designed to satisfy conditions of applicable federal, state, and local permits, to minimize adverse environmental impacts, and to ensure that organisms are protected against potential construction related impacts

Operational activities within the transmission corridors would be similar to those described in Section 9.3.2.2.10. Operation impacts are anticipated to be SMALL.

9.3.3 SUMMARY AND CONCLUSIONS

PPL has implemented the site selection process discussed in the above sections to select a proposed site for the location of a nuclear power generating facility within the identified ROI. The results of that selection process identified the BBNPP, located in Luzerne County, Pennsylvania, as the proposed site.

As summarized in Table 9.3-7, the evaluation and comparison of the alternative sites to the proposed site verified that none of the alternative sites is environmentally preferable, and thus obviously superior, to the selected proposed site. Therefore, the BBNPP site is the candidate site submitted to the NRC by the applicant as the proposed location for a new nuclear power generating station.

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

- The postulated consumptive use of water by a new unit at the BBNPP site would be no greater than water use at the alternative sites.
- The impacts of development of a new unit at the proposed site on endangered species are no greater than impacts postulated for the alternative sites.
- No federal, state, or Native American tribal lands are affected by the proposed site.
- The BBNPP site does not contain any spawning and/or nesting grounds for any threatened or endangered species. Thus the impacts on spawning or nesting areas are no greater than impacts at the alternative sites.
- Locating the BBNPP immediately adjacent to an existing nuclear facility would have lesser land use impacts than locating the site at an alternative greenfield site. Therefore, land use impacts would be no greater than the impacts at the alternative sites.
- The potential impacts of a new nuclear facility on terrestrial and aquatic ecology at the BBNPP would be no greater than at the alternative sites.
- The BBNPP site is located less than 1 mi from an existing 500 kV line and can be connected to the 500 kV switchyard. Therefore, transmission impacts would be no greater than at the alternative sites.
- The BBNPP site is in a generally rural area that has a population density less than 300 ppsm.

Overall, the alternative sites do not offer environmental advantages over the BBNPP site. In addition, operational experience at the adjacent SSES has shown that the environmental

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impacts are SMALL and operation of the new unit is expected to have essentially the same or less environmental impacts.

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Table 9.3-1—State and Federal Threatened and Endangered Species in Montour County, Pennsylvania

Scientific Name	Common Name	State Status	Federal Status
Plants			
Dodecatheon radicatum	Jeweled Shootingstar	S2	
Carya laciniosa	Shellbark Hickory	S3S4	
Rotala ramosior	Toothcup	S3	
Carex typhina	Cattail Sedge	S2	
Pinus echinata	Shortleaf Pine	S1S2	
Lysimachia hybrida	Lanceleaf Loosestrife	S1	
Platanthera hookeri	Hooker's Orchid	S1	
Rosa virginiana	Virginia Rose	S1	
Ranunculus flammula	Lesser Spearwort	SH	
Carex retrorsa	Backward Sedge	S1	
Trichostema setaceum	Bluecurls	S1	
Triosteum angustifolium	Horsegentian	S1	
Insects			
Lestes forcipatus	Sweetflag Spreadwing	S3S4	
Enodia anthedon	Northern Pearlyeye	S3S4	
Birds			
Cistothorus palustris	Marsh Wren	S2S3B	
Haliaeetus leucocephalus	Bald Eagle	S2B	Delisted in 2007
Porzana carolina	Sora	S3B	
Mammals			
Myotis sodalis	Indiana or Social Bat	SUB;S1N	LE
Mollusks			
Lampsilis cariosa	Yellow Lampmussel	S3S4	
Communities			
	Silver maple floodplain forest	S3	

Notes:
S1 = Critically Imperiled (typically 5 or fewer occurrences)
S2 = Imperiled (typically 6 to 20 occurrences)
S3 = Vulnerable (typically 21 to 100 occurrences)
S4 = Apparently Secure (typically more than 100 occurrences)
S5 = Secure (demonstrably widespread)
S#S# = Range Rank (numeric rank to indicate the range of uncertainty about exact status)
B = Breeding
LE = Listed Endangered

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Table 9.3-2—Demographic Characteristics of the Montour Site Area

	White (%)	Black or African American (%)	American Indian and Alaska Native (%)	Asian (%)	Native Hawaiian and other Pacific Islander (%)	Other Race (%)	Two or More Races (%)
Pennsylvania	85.38	9.87	0.16	1.76	0.03	1.53	1.26
Montour County	96.80	0.74	0.10	1.25	0.00	0.47	0.63
Tract 9501	98.19	0.81	0.05	0.18	0.00	0.16	0.60
Block 3025	87.50	0.00	0.00	12.50	0.00	0.00	0.00

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Table 9.3-3—State and Federal Threatened and Endangered Species in Warren County, New Jersey

Common Name	Scientific Name	State Status	Federal Status
	Birds		
Pied-billed Grebe	*Podilymbus podiceps*	Endangered	
Great Blue Heron	*Ardea herodias***	Threatened	
Bald Eagle	*Haliaeetus leucocephalus*	Endangered	
Red-shouldered Hawk	*Buteo lineatus#*	Threatened	
Cooper's Hawk	*Accipiter cooperii**	Endangered	
Barred Owl	*Strix varia*	Threatened	
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Threatened	
Upland Sandpiper	*Bartramia longicauda*	Endangered	
Cliff Swallow	*Hirundo pyrrhonota***	Threatened	
Vesper Sparrow	*Poocetes gramineus*	Endangered	
Savannah Sparrow	*Passerculus sandwichensis*	Threatened	
Grasshopper Sparrow	*Ammodramus savannarum*	Threatened	
Bobolink	*Dolichonyx oryzivorus*	Threatened	
	Reptiles		
Bog Turtle	*Clemmys muhlenbergi*	Endangered	
Wood Turtle	*Clemmys insculpta*	Threatened	
Timber Rattlesnake	*Crotalus horridus*	Endangered	
	Amphibians		
Long-tailed Salamander	*Eurycea longicauda*	Threatened	
	Mollusks		
Mitchell's Satyr	*Neonympha m. mitchelli@*	Endangered	Endangered
Dwarf Wedgemussel	*Alasmidonta heterodon@*	Endangered	Endangered
	Mammals		
Bobcat	*Lynx rufus*	Endangered	

Notes:
* Species status is currently being recommended for a change from endangered to threatened.
** Species status is currently being recommended for a change from threatened to stable.
# Non-breeding status is listed as threatened.

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Table 9.3-4—Demographic Characteristics of the Proposed Martins Creek, Warren County, New Jersey Site Area

	White (%)	Black or African American (%)	American Indian and Alaska Native (%)	Asian (%)	Native Hawaiian and other Pacific Islander (%)	Other Race (%)	Two or More Races (%)
New Jersey	72.6	13.7	0.2	5.7	0.04	5.4	2.5
Warren County	94.5	1.9	0.1	1.2	0.02	1.0	1.2
Census Tract 316.01	96.3	1.2	0.2	0.6	0.05	0.3	1.3
Census Tract 316.01, Block Group 3	96.2	0.1	0.0	1.0	0.05	0.5	0.7

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Table 9.3-5—State and Federal Threatened and Endangered Species in Mifflin County, Pennsylvania

(Page 1 of 2)

Scientific Name	Common Name	State Status	Federal Status
Plants			
Potamogeton hillii	Hill's Pondweed	S1	
Woodwardia areolata	Netted Chainfern	S2	
Euphorbia obtusata	Bluntleaved Spurge	S1	
Cacalia muehlenbergii	Great Indianplantain	S1	
Orontium aquaticum	Golden Club	S4	
Pinus echinata	Shortleaf Pine	S1S2	
Oenothera argillicola	Shalebarren Eveningprimrose	S2	
Senna marilandica	Wild Senna	S1	
Lathyrus venosus	Veiny Pea	S2	
Phlox ovata	Mountain Phlox	S1	
Stellaria borealis	Mountain Starwort	S1S2	
Scirpus ancistrochaetus	Northeastern Bulrush	S3	LE
Carex lupuliformis	False Hop Sedge	S1	
Lithospermum canescens	Hoary Puccoon	S2	
Bartonia paniculata	Screwstem	S3	
Carex disperma	Softleaved Sedge	S3	
Amelanchier sanguinea	Roundleaf Serviceberry	S1	
Lactuca hirsuta	Downy Lettuce	S3	
Matelea obliqua	Oblique Milkvine	S1	
Sida hermaphrodita	Sida	S2	
Carex sprengelii	Sedge	S3	
Polymnia uvedalia	Leafcup	SNR	
Planaria			
Sphalloplana pricei	Refton Cave Planarian	S1	
Crustaceans			
Stygobromus allegheniensis	Allegheny Cave Amphipod	S2S3	
Caecidotea pricei	Price's Cave Isopod	S2S3	
Stygobromus pizzinii	Pizzini's Cave Amphipod	S1	
Stygobromus stellmacki	Stellmack's Cave Amphipod	S1	
Mollusks			
Lampsilis cariosa	Yellow Lampmussel	S3S4	
Alasmidonta marginata	Elktoe	S4	
Alasmidonta undulata	Triangle Floater	S3S4	
Insects			
Tachopteryx thoreyi	Gray Petaltail	S3	
Callophrys henrici	Henry's Elfin	S1S3	
Calopteryx aequabilis	River Jewelwing	S2	
Calopteryx angustipennis	Appalachian Jewelwing	S1S2	
Chlosyne nycteis	Silvery Checkerspot	S3S4	
Euphydryas phaeton	Baltimore Checkerspot	S2S4	
Enodia anthedon	Northern Pearlyeye	S3S4	
Cicindela ancocisconensis	Appalachian tiger beetle	S1	
Calephelis borealis	Northern Metalmark	S1S2	
Reptiles			
Crotalus horridus	Timber Rattlesnake	S3S4	
Birds			
Accipiter gentilis	Northern Goshawk	S2S3B;S3N	

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Table 9.3-5—State and Federal Threatened and Endangered Species in Mifflin County, Pennsylvania

(Page 2 of 2)

Scientific Name	Common Name	State Status	Federal Status
Ardea herodias	Great Blue Heron	S3S4B;S4N	
Falco peregrinus	Peregrine Falcon	S1B;S1N	LE
Tyto alba	Barnowl	S3B;S3N	
Mammals			
Myotis leibii	Eastern Smallfooted Bat	S1B;S1N	
Myotis sodalis	Indiana or Social Bat	SUB;S1N	LE
Neotoma magister	Allegheny Woodrat	S3	
Myotis septentrionalis	Northern Bat	S3B,S3N	
Sorex palustris albibarbis	Water Shrew	S3	
Bat Hibernaculum	Winter Bat Colony	SU	
Communities			
	Scrub oak shrubland	S3	
	Hemlock tuliptree birch forest	S4	
	Hemlock (white pine) forest community	S4	
	Kettlehole	SNR	
	Ephemeral/fluctuating Natural Pool	S3	
	Erosional Remnant	SNR	

Notes:
S1 = Critically Imperiled (typically 5 or fewer occurrences)
S2 = Imperiled (typically 6 to 20 occurrences)
S3 = Vulnerable (typically 21 to 100 occurrences)
S4 = Apparently Secure (typically more than 100 occurrences)
S5 = Secure (demonstrably widespread)
S#S# = Range Rank (numeric rank to indicate the range of uncertainty about exact status)
SNR = State Not Ranked
SU = Unrankable Currently unrankable due to lack of information or due to substantially conflicting information about status or trends
B = Breeding
N = Nonbreeding
LE = Listed Endangered

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Table 9.3-6—Demographic Characteristics of the Sandy Bend Site Area

	White (%)	Black or African American (%)	American Indian and Alaska Native (%)	Asian (%)	Native Hawaiian and other Pacific Islander (%)	Other Race (%)	Two or More Races (%)
Pennsylvania	85.38	9.87	0.16	1.76	0.03	1.53	1.26
Mifflin County	98.67	0.48	0.07	0.19	0.00	0.21	0.39
Tract 9605	99.49	0.16	0.00	0.08	0.00	0.03	0.24
Block 3001	100.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table 9.3-7—Summary Comparison of Alternative Sites

Location	BBNPP Site	Montour Site	Martins Creek Site	Sandy Bend Site
Land Use	SMALL	SMALL	SMALL	SMALL
Air Quality	SMALL	SMALL	SMALL	SMALL
Water	SMALL to MODERATE	SMALL	SMALL	SMALL
Terrestrial Ecology	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL
Aquatic Ecology	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Socioeconomics	SMALL to LARGE	SMALL	SMALL	MODERATE
Historic, Cultural, and Archeological Resources	SMALL	SMALL	SMALL	SMALL
Environmental Justice	SMALL to MODERATE	SMALL	SMALL	SMALL
Transmission Corridors	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Transportation	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Is this Site a Candidate Site?	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	No	No	No

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Figure 9.3-1—Region of Interest

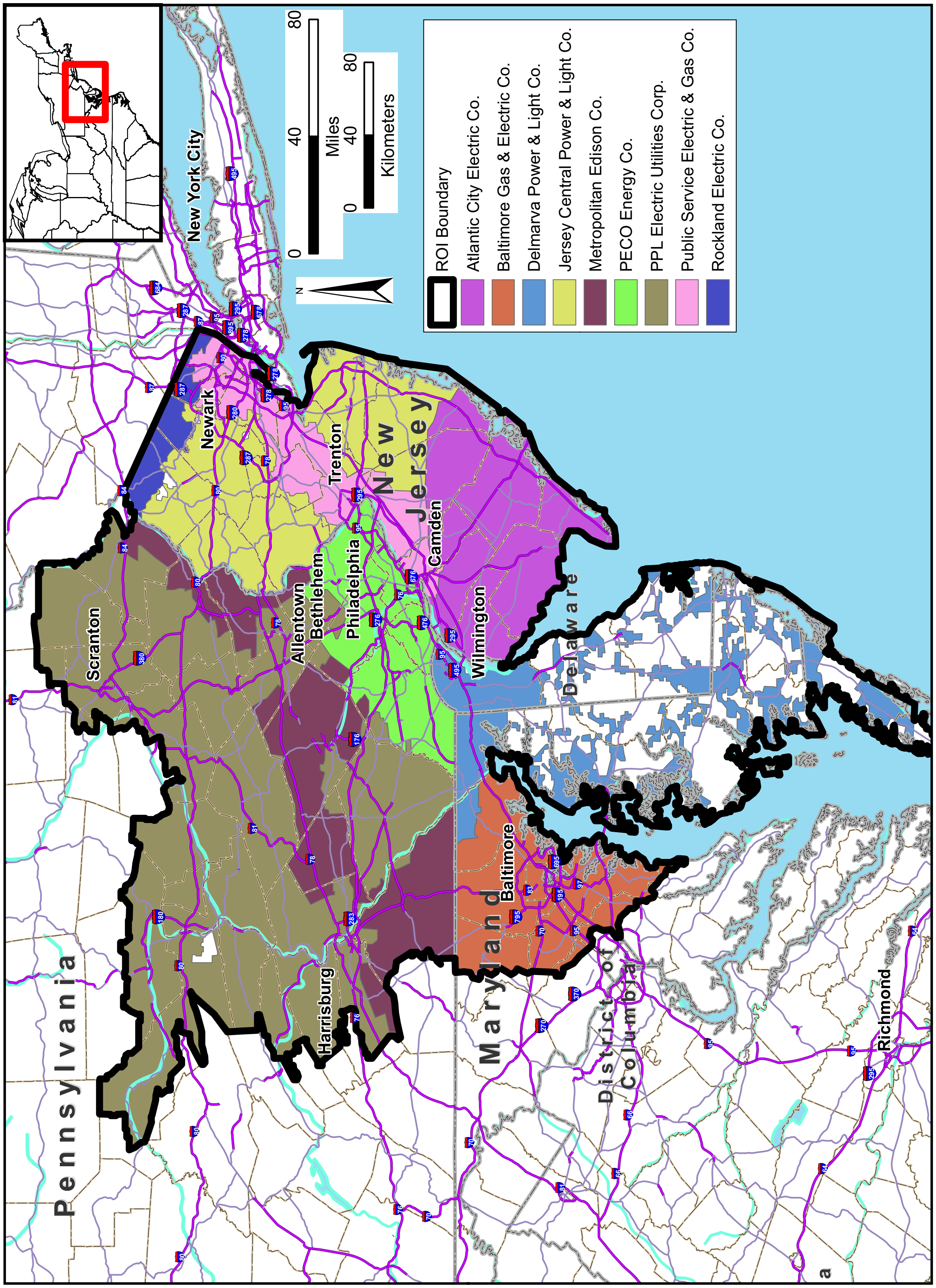

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Figure 9.3-2—Candidate Area Exclusionary Criteria

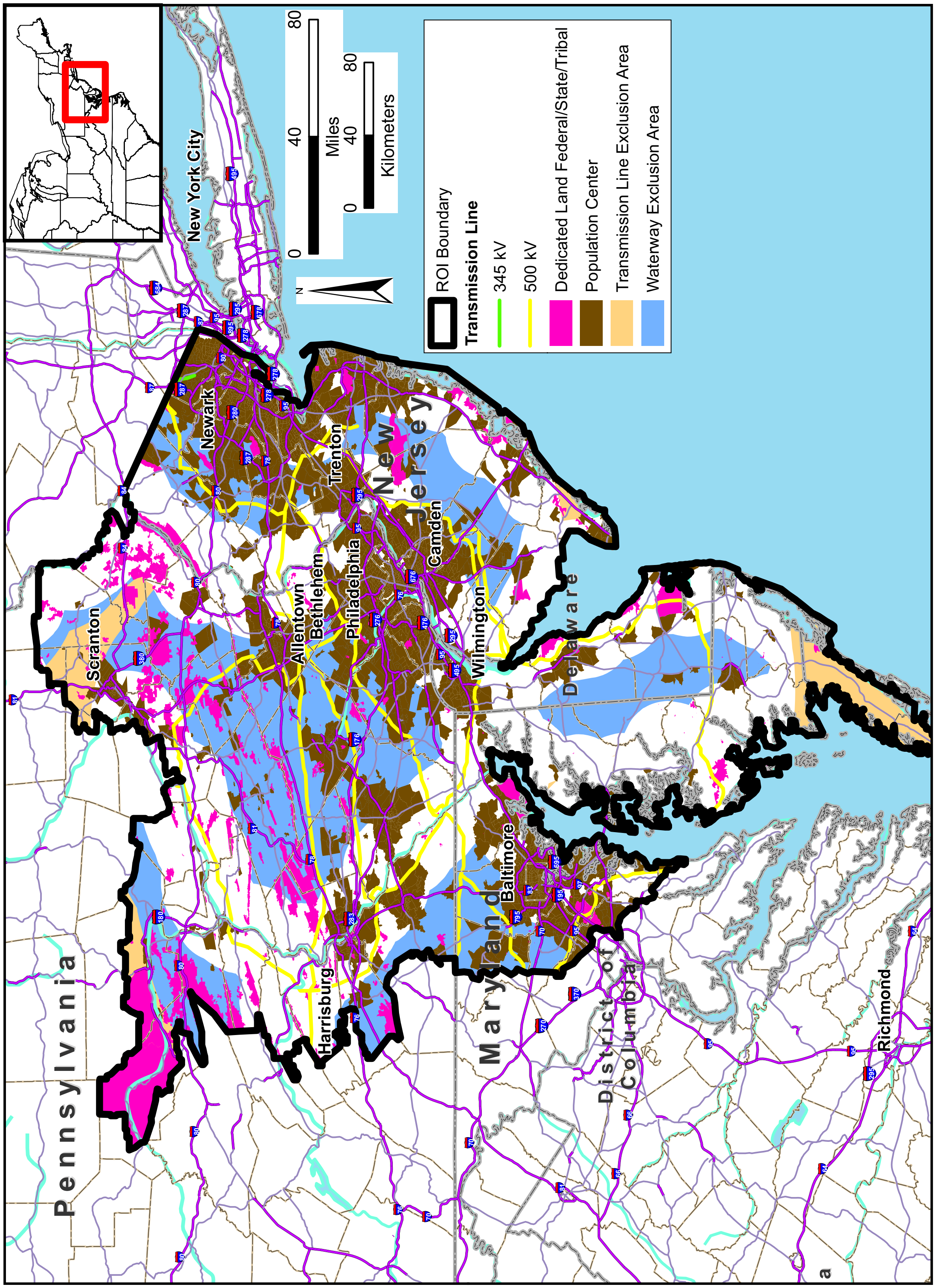

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Figure 9.3-3—Candidate Areas

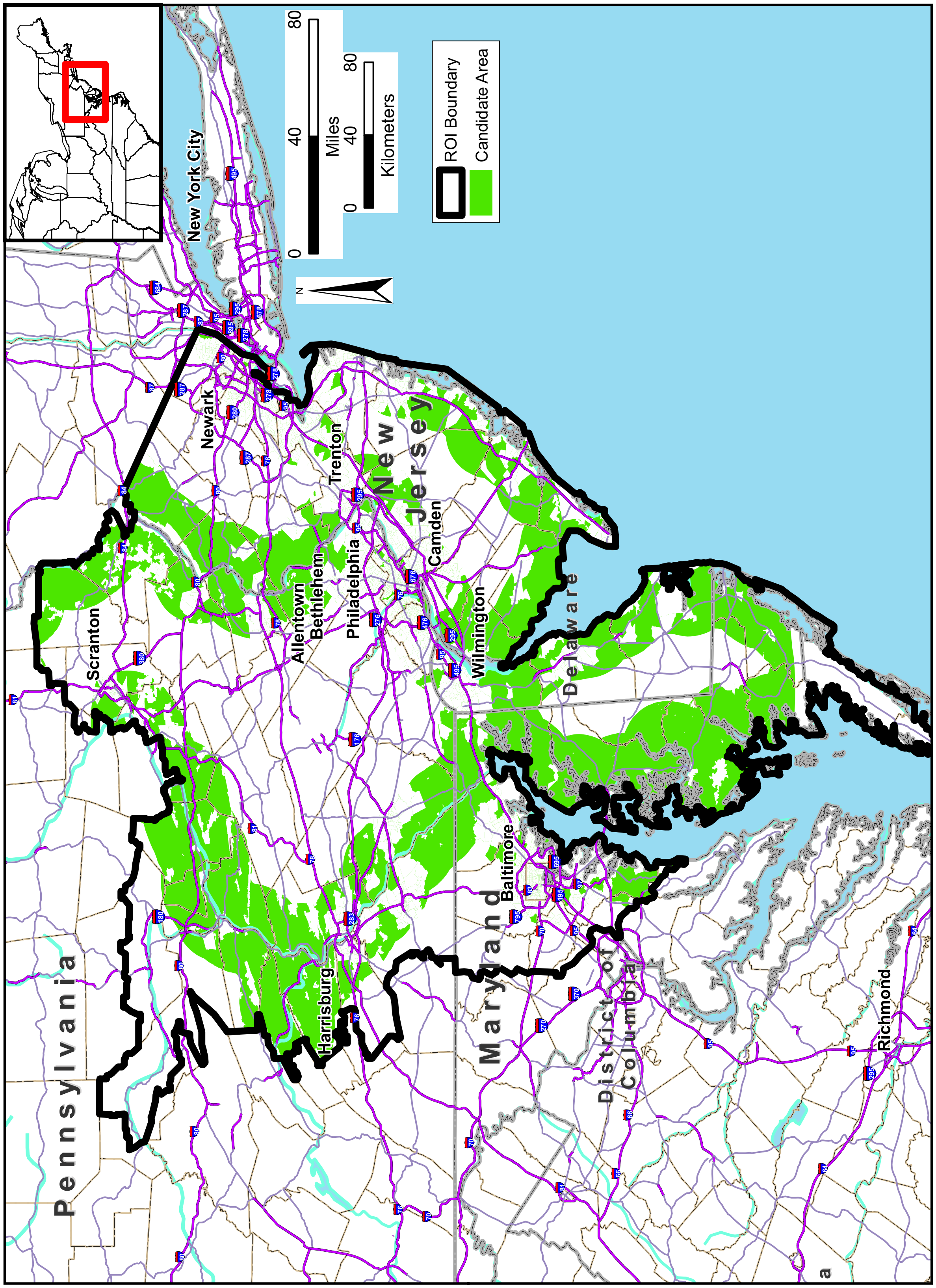

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Figure 9.3-4—Potential Sites

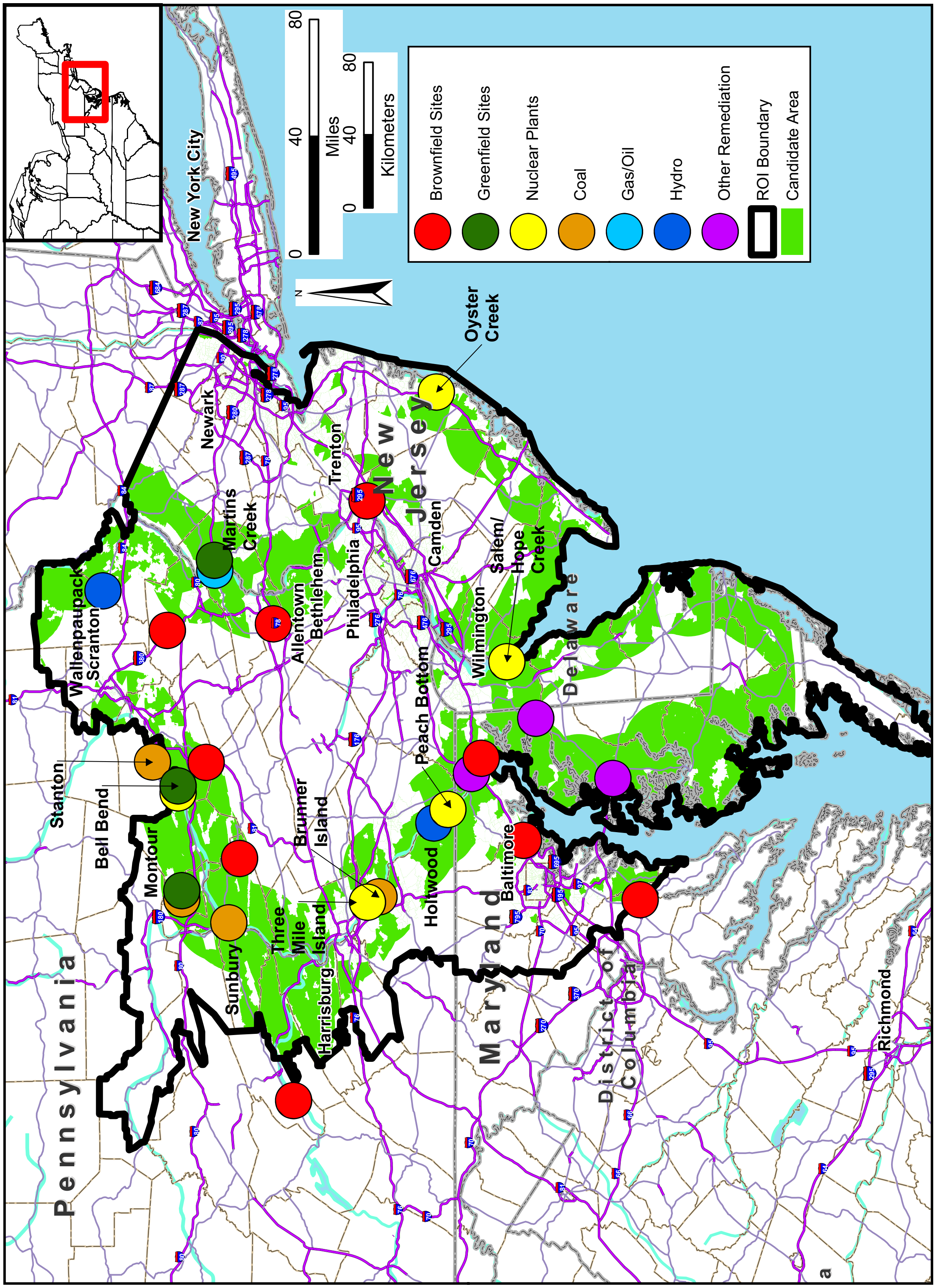

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Figure 9.3-5—Candidate Sites

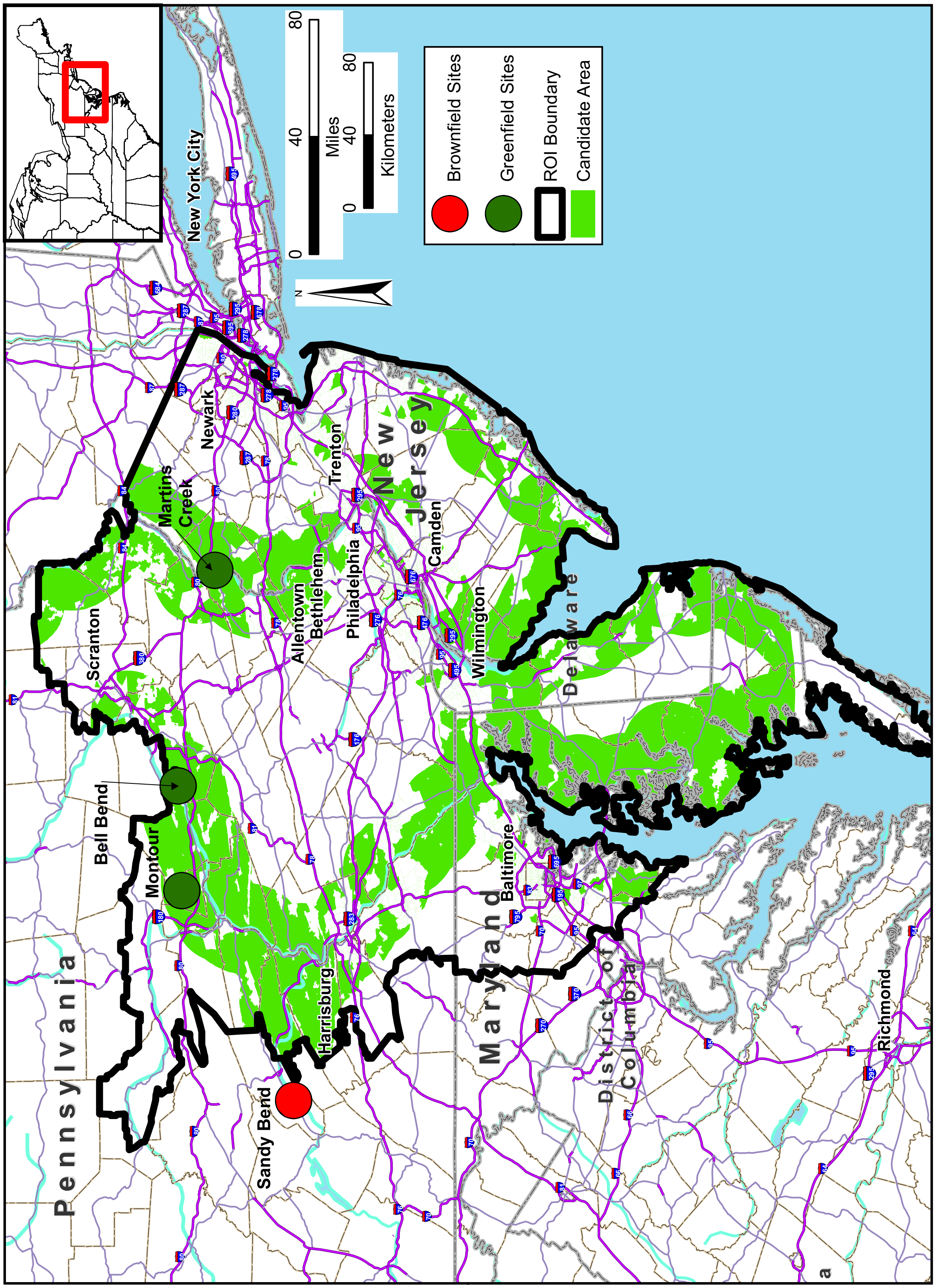

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Figure 9.3-6—BBNPP Vicinity Map

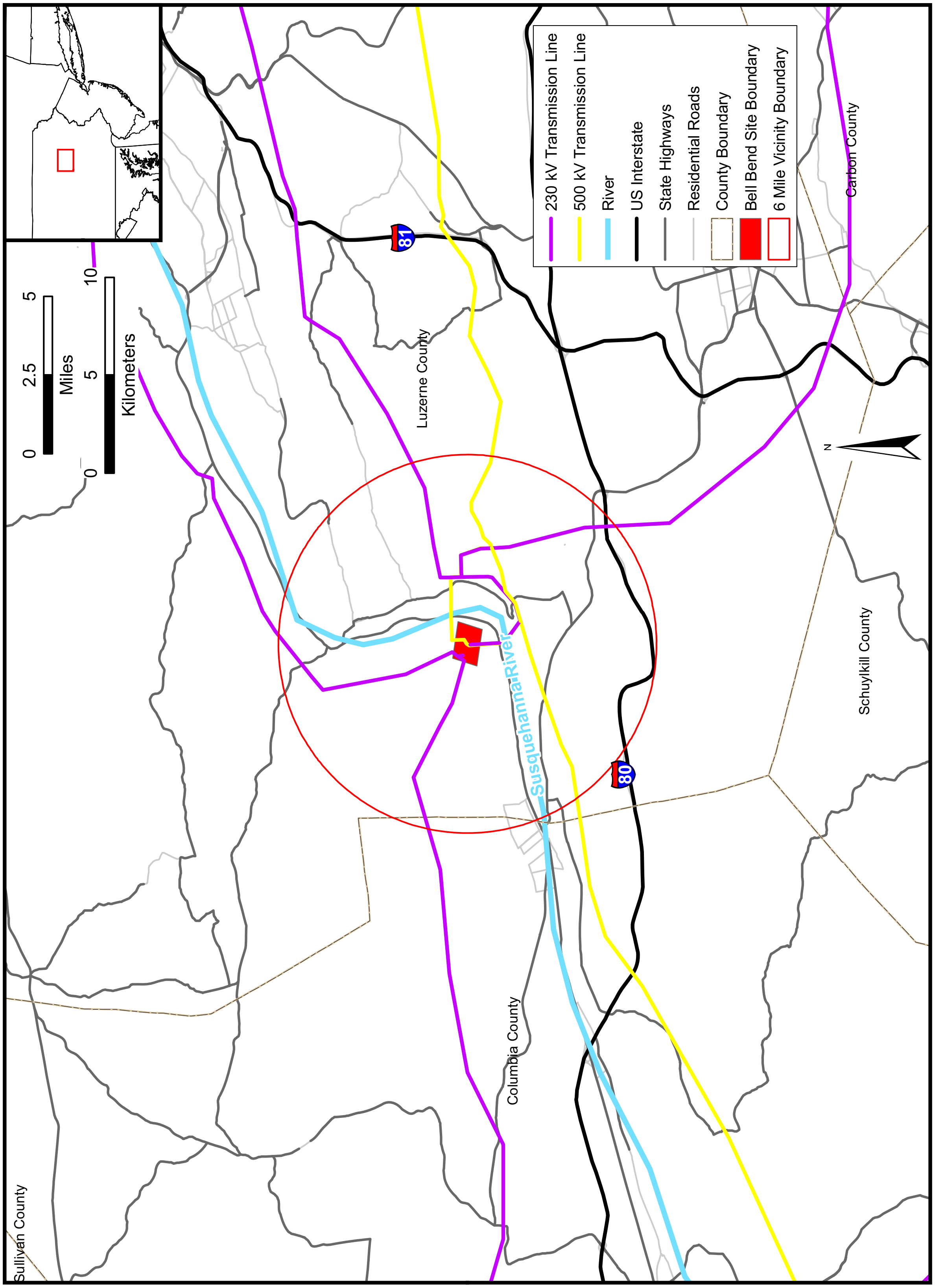

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Figure 9.3-7—Montour Site Vicinity Map

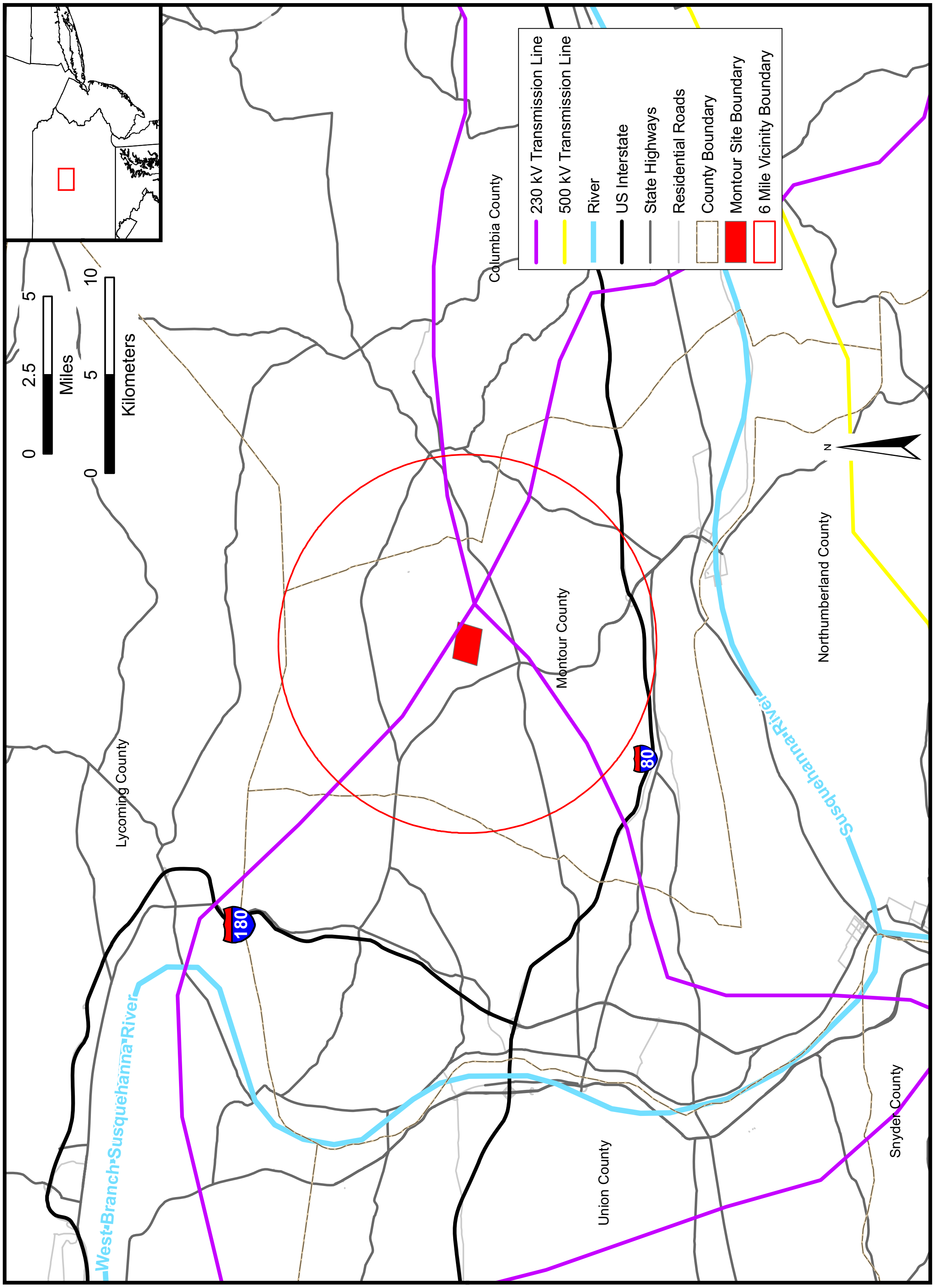

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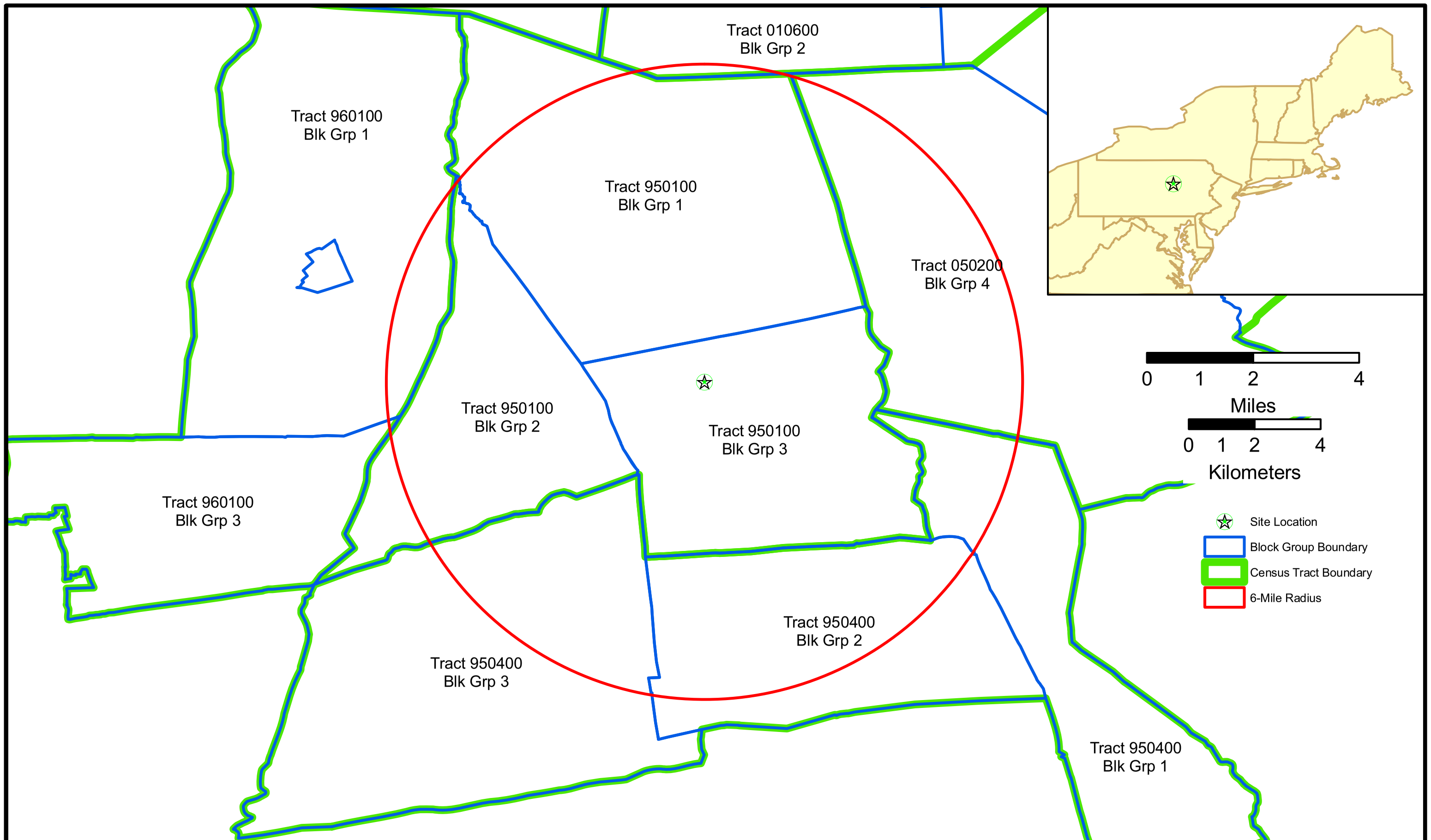
Figure 9.3-8—Montour Site Census Tracts



Census Tract	Block Group	Total Population in 2000	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and other Pacific Islander	Other Race	Two or more Races	Hispanic	Minority Populaton	Hispanic Population
050200	4	1590	1574	3	3	2	0	0	8	6	1.01%	0.38%
010600	2	1036	1031	2	1	0	0	0	2	0	0.48%	0.00%
950100	1	1399	1384	0	2	4	0	4	5	7	1.07%	0.50%
950100	2	993	976	5	0	0	0	2	10	3	1.71%	0.30%
950100	3	1416	1379	26	0	3	0	0	8	0	2.61%	0.00%
950400	1	1699	1669	17	0	6	0	5	2	11	1.77%	0.65%
950400	2	2093	2049	13	1	13	0	7	10	14	2.10%	0.67%
950400	3	1476	1461	4	2	4	0	2	3	3	1.02%	0.20%
960100	1	1865	1853	3	1	3	0	1	4	4	0.64%	0.21%
960100	3	1677	1634	21	0	5	1	6	10	14	2.56%	0.83%

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Figure 9.3-9—Martins Creek Site Vicinity Map

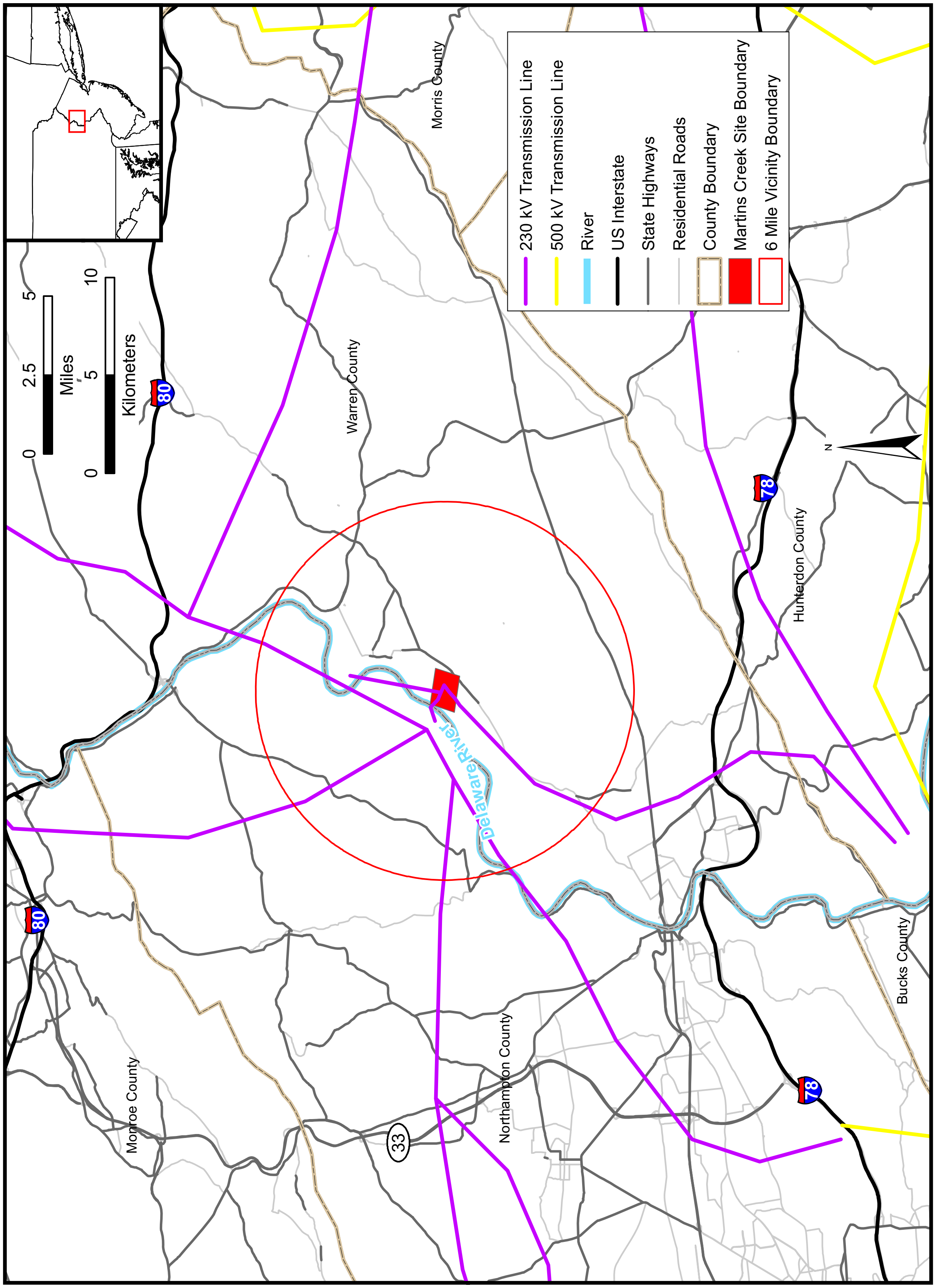

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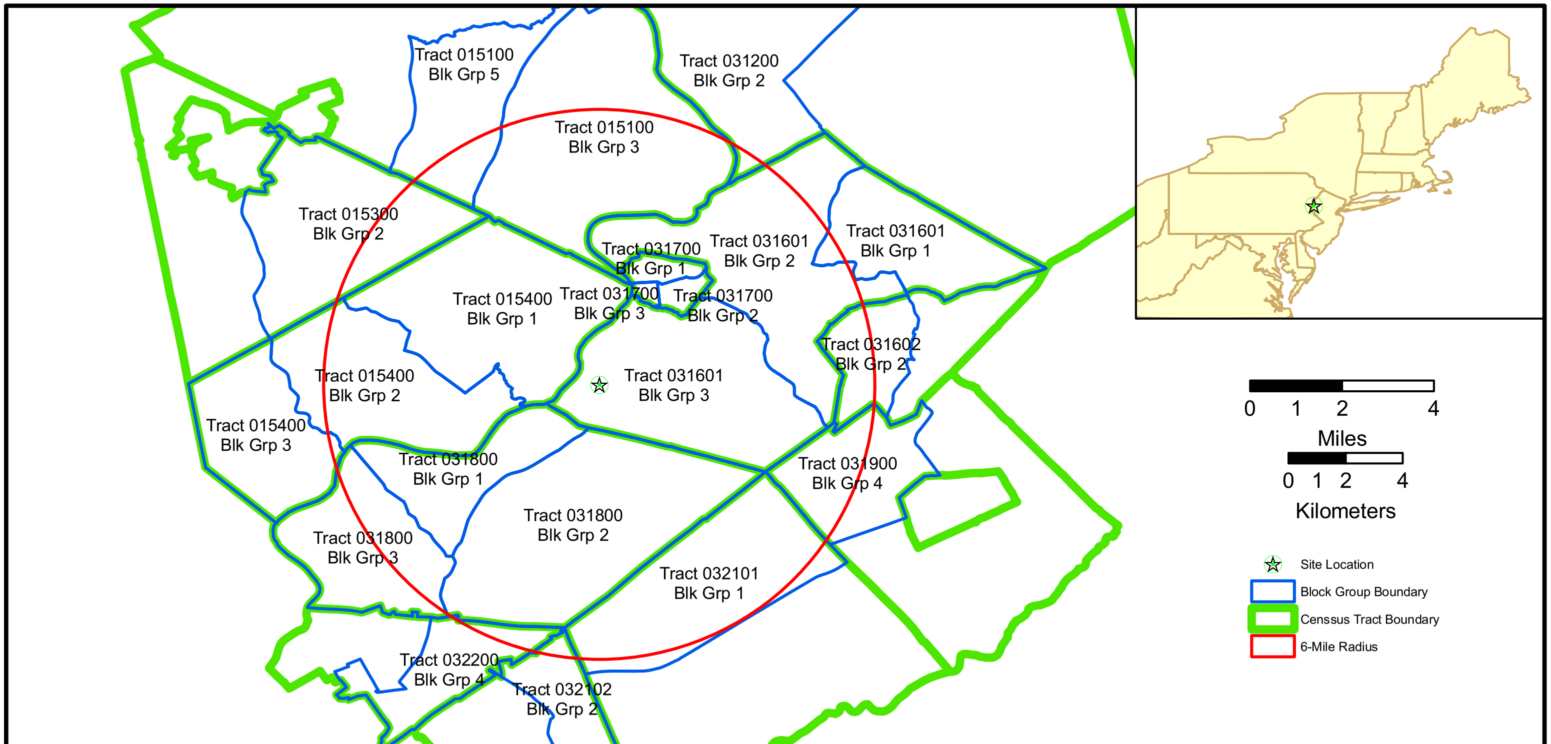
Figure 9.3-10—Martins Creek Site Census Tracts



Census Tract	Block Group	Total Population in 2000	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and other Pacific Islander	Other Race	Two or more Races	Hispanic	Minority Populaton	Hispanic Population
031200	2	1306	1272	4	1	15	0	7	7	28	2.60%	2.14%
031601	1	1103	1063	15	3	5	1	2	14	15	3.63%	1.36%
031601	2	1121	1083	3	5	3	0	2	25	24	3.39%	2.14%
031601	3	2021	1944	33	0	18	1	10	15	51	3.81%	2.52%
031602	2	829	814	1	2	1	0	4	7	25	1.81%	3.02%
031700	1	893	863	10	1	1	0	4	14	29	3.36%	3.25%
031700	2	1144	1130	1	0	10	0	0	3	18	1.22%	1.57%
031700	3	734	723	3	0	3	0	3	2	17	1.50%	2.32%
031800	1	610	596	6	0	2	0	4	2	10	2.30%	1.64%
031800	2	1331	1314	3	1	6	0	1	6	16	1.28%	1.20%
031800	3	788	762	10	1	3	0	0	12	9	3.30%	1.14%
031900	4	2220	2135	58	0	7	0	9	11	45	3.83%	2.03%
032101	1	1571	1521	15	2	18	0	3	12	41	3.18%	2.61%
032102	2	1251	1203	5	7	14	3	4	15	35	3.84%	2.80%
032200	4	1540	1510	8	2	12	0	3	5	19	1.95%	1.23%
015100	3	1890	1847	10	4	10	0	5	14	25	2.28%	1.32%
015100	5	1412	1397	4	1	3	0	6	1	9	1.06%	0.64%
015300	2	1701	1689	1	0	3	0	2	6	10	0.71%	0.59%
015400	1	1030	1013	12	1	1	0	0	3	8	1.65%	0.78%
015400	2	1199	1173	10	1	3	1	0	11	4	2.17%	0.33%
015400	3	999	987	0	0	4	0	8	0	20	1.20%	2.00%

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Figure 9.3-11—Sandy Bend Site Vicinity Map

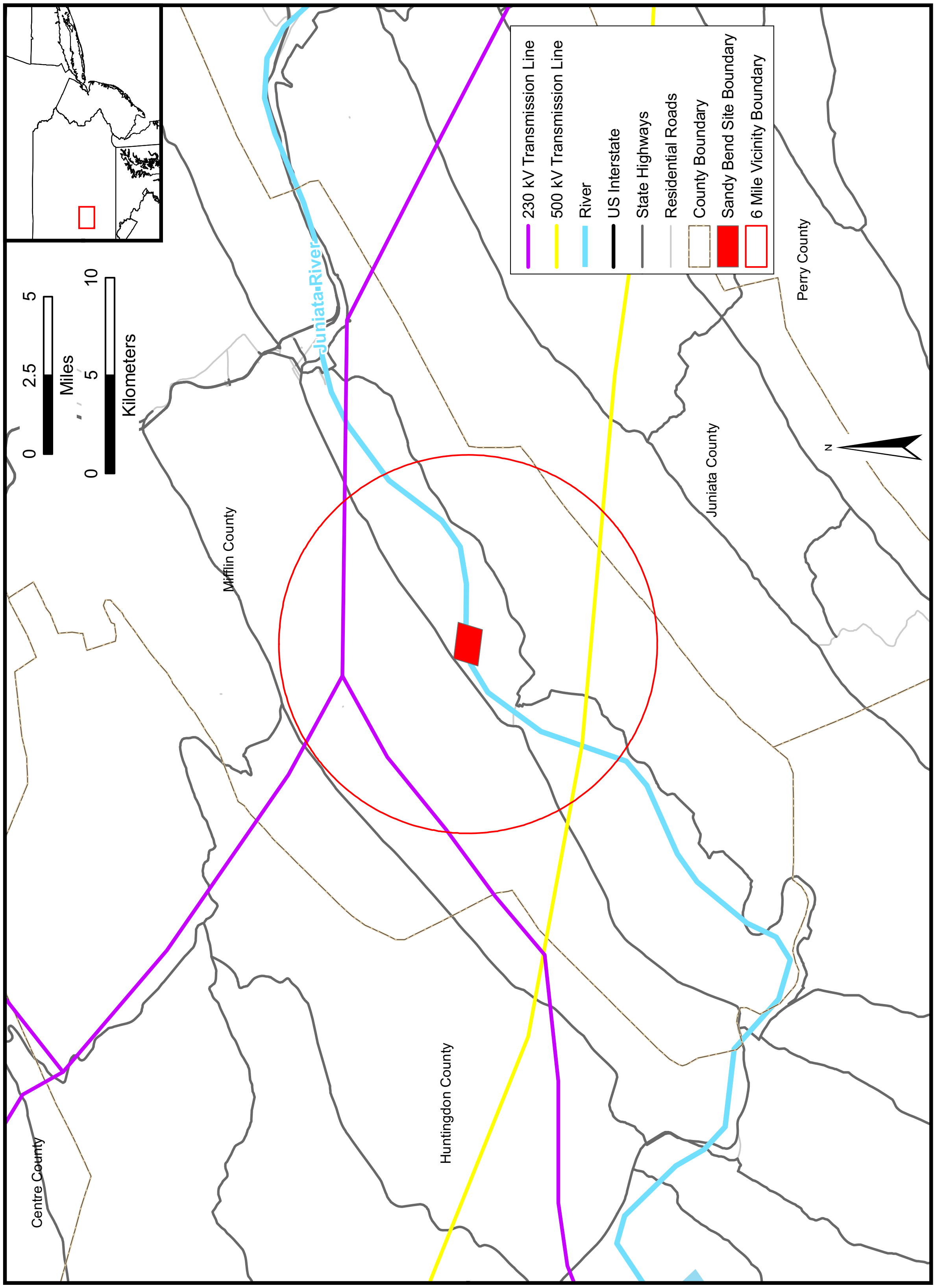

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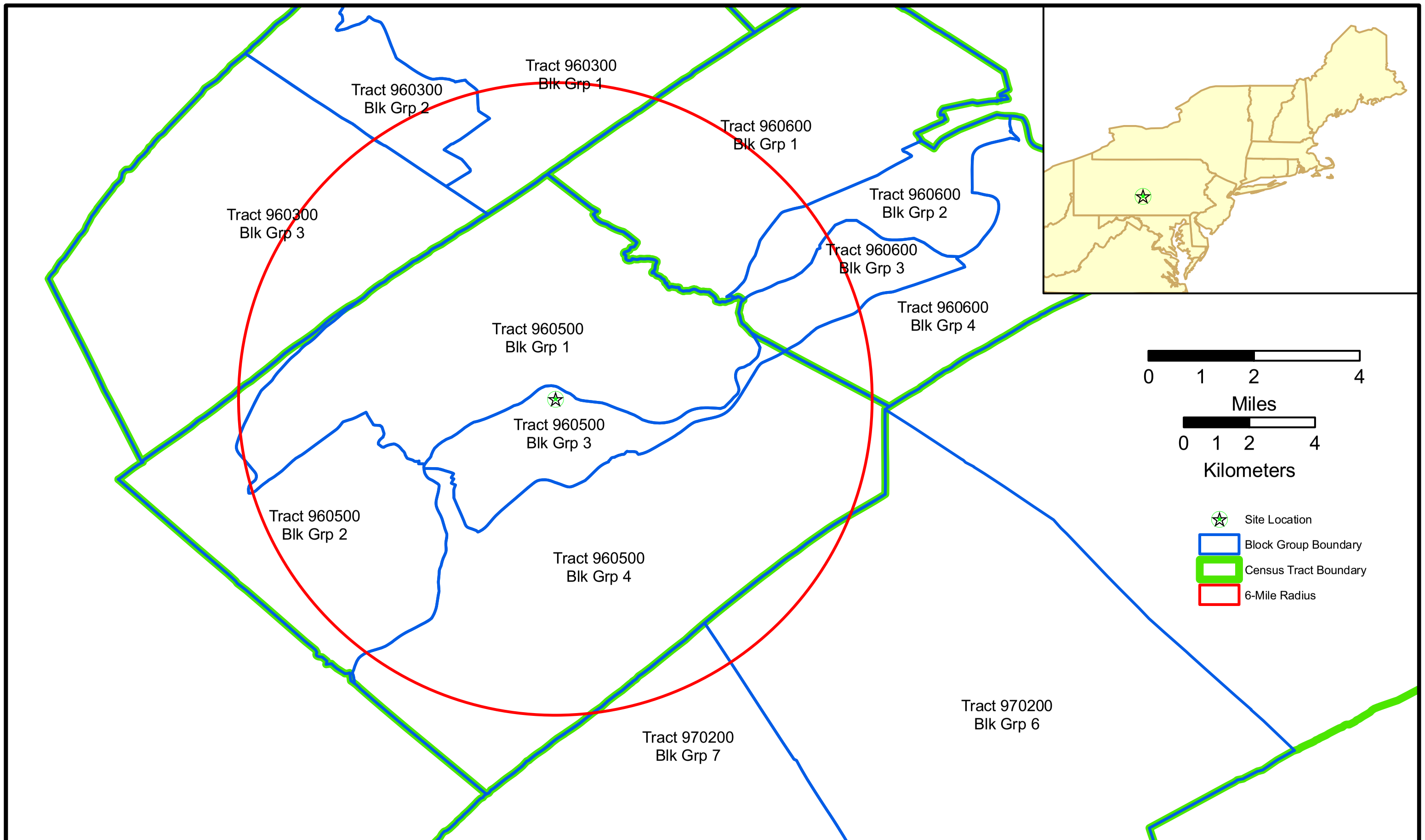
Figure 9.3-12—Sandy Bend Site Census Tracts



Census Tract	Block Group	Total Population in 2000	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and other Pacific Islander	Other Race	Two or more Races	Hispanic	Minority Populaton	Hispanic Population
970200	6	1159	1146	2	3	3	0	0	5	11	1.12%	0.95%
970200	7	750	743	1	0	0	0	0	6	2	0.93%	0.27%
960300	1	2486	2470	4	1	1	0	5	5	10	0.64%	0.40%
960300	2	827	819	3	1	2	0	0	2	0	0.97%	0.00%
960300	3	1763	1719	29	0	1	0	3	11	7	2.50%	0.40%
960500	1	1252	1247	2	0	1	0	0	2	1	0.40%	0.08%
960500	2	1213	1205	4	0	1	0	0	3	4	0.66%	0.33%
960500	3	555	549	0	0	1	0	1	4	0	1.08%	0.00%
960500	4	704	704	0	0	0	0	0	0	1	0.00%	0.14%
960600	1	2158	2117	12	3	10	0	5	11	14	1.90%	0.65%
960600	2	934	927	0	4	2	0	0	1	1	0.75%	0.11%
960600	3	849	837	5	2	0	0	0	5	1	1.41%	0.12%
960600	4	1456	1444	7	1	0	0	0	4	8	0.82%	0.55%

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9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

The information presented in this section describes the evaluation of the alternative plant and transmission systems for heat dissipation, circulating water, and power transmission associated with the 1,600 MWe Bell Bend Nuclear Power Plant (BBNPP) facility. The information provided in this section is consistent with the items identified NUREG-1555 (NRC, 2007).

Throughout this chapter, environmental impacts of the alternatives will be assessed based on the significance of impacts, with the impacts characterized as being SMALL, MODERATE, or LARGE. This standard of significance was developed using the guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Appendix B to Subpart A (NRC, 2001):

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, (NRC, 1996).

Section 9.4.1 discusses alternative heat dissipation systems. Section 9.4.2 discusses alternative circulating water systems. Section 9.4.3 discusses the transmission systems.

9.4.1 HEAT DISSIPATION SYSTEMS

This section discusses alternatives to the proposed heat dissipation system that was described in Section 3.4, and is presented using the format provided in NUREG 1555 (NRC, 2007), i.e., Environmental Standard Review Plan (ESRP) 9.4.1.

These alternatives 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 water body) following its circulation through the normal heat sink (i.e., main condenser). Generally, closed-loop cooling systems require the intake of significantly less water than the volume required by once-through cooling systems because the water performing the cooling is continually recirculated through the normal heat sink (i.e., the main condenser), and normally only makeup water for evaporative losses, drift, and blowdown is required.

In closed-loop systems, two pumping stations are usually required-a makeup water system and a cooling water circulation system. Closed-loop systems include cooling towers and a cooling pond or 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 also categorized as wet or dry, and the use of either system depends on the site characteristics. Both wet and dry cooling systems use water as the heat exchange medium. Wet heat dissipation systems cool water by circulating it through a cooling tower. Heat from the water is dissipated by direct contact with air circulating through the

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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 may 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 may 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, which 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 are usually 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 drift eliminator configurations include herringbone, wave form, and cellular (or honeycomb) designs. The cellular units are generally the most efficient. Drift eliminators may 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 may include other features, such as corrugations and water removal channels, to enhance the drift removal further (USEPA, 1995).

Dry cooling systems transfer heat to the atmosphere without the evaporative loss of water. There are two types of dry cooling systems: direct dry cooling and indirect dry cooling. Direct dry cooling systems use air to directly condense steam, while indirect dry cooling systems use a closed-loop water cooling system to condense steam and air to cool the heated water.

The most common type of direct dry cooling system is a recirculated cooling system with mechanical draft towers. For dry cooling towers, the turbine exhaust steam exits directly to an air-cooled, finned-tube condenser. Because dry cooling systems do not evaporate water for heat transfer, dry cooling towers are quite large in comparison to similarly sized wet cooling towers. Also, because dry cooling towers rely on sensible heat transfer, a large quantity of air must be forced across the finned tubes by fans to improve heat rejection. This results in a larger number of fans being required for a mechanical draft dry cooling tower than would be needed for a mechanical draft wet cooling tower.

The key feature of dry cooling systems is that no evaporative cooling or release of heat to the surface water occurs. As a result, water consumption rates are very low compared to wet cooling. Because the unit does not rely in principle on evaporative cooling like the wet cooling tower, large volumes of air must be passed through the system compared to the volume of air used in wet cooling towers. As a result, dry cooling towers need larger heat transfer surfaces and therefore tend to be larger than comparable wet cooling towers.

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Dry cooling towers require high capital and operating and maintenance costs that are sufficient to pose a barrier to entry to the marketplace for some facilities (USEPA, 2001). Dry cooling technology has a detrimental effect on electricity production by reducing the energy 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 electricity. The energy penalty would result in an increase in environmental impacts because replacement generating capacity would be needed to offset the loss in efficiency from dry cooling.

9.4.1.1 Evaluation of Alternative Heat Dissipation Systems

Heat dissipation system alternatives were identified and evaluated. The alternatives considered were those generally included in the broad categories of "once- through" and "closed-loop" systems. The evaluation includes the following types of heat dissipation systems:

- Other heat dissipation systems
  - Cooling Ponds
  - Spray Ponds
- Once-through cooling
- Natural draft cooling tower
- Mechanical draft cooling tower
- Hybrid (plume abated) cooling towers
- Dry cooling systems (closed-loop cooling system)

An initial evaluation of the once-through cooling alternative and the closed-loop alternative designs was performed to eliminate systems that are unsuitable for use at the BBNPP site. The evaluation criteria included aesthetics, public perception, space requirements, environmental effects, noise impacts, fog and drift, water requirements, capital and operating costs, and legislative restrictions that might preclude the use of any of the alternatives.

The screening process identified two natural draft cooling towers as the preferred closed loop heat dissipation system for the BBNPP site. The analysis of this alternative is discussed in Section 9.4.1.3. The discussion of non preferred alternatives that were considered is provided below. Selection of the preferred heat dissipation alternative was supported by detailed net present value (NPV) analysis.

Table 9.4-1 and the following sections provide a discussion of the heat dissipation alternatives, and Table 9.4-2 provides a summary of the environmental impacts of the alternatives.

<u>Cooling Ponds and Spray Ponds</u>

Cooling ponds are usually man-made water bodies that are used by power plants and large industrial facilities for heat dissipation. In a conventional static type cooling pond, warmed cooling water exiting the main condenser and other plant heat loads would be routed to the cooling pond where some of the water would evaporate, and the remaining water would be cooled and recirculated to the plant. The primary heat transfer mechanism in a cooling pond is evaporation. If there is no vertical mixing in the pond, layers (or thermoclines) of warm and cold

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water can form causing horizontal flows which in turn can restrict the movement of warmer water to the surface for evaporation and cooling. This can result in only portions of the pond cooling capacity being used.

Although the conventional static type cooling pond is probably the oldest form of water cooling it is not preferred for several reasons. The modern spray pond offers the following advantages over a conventional cooling pond: (1) a spray pond requires less than 10% of the land area required for a conventional pond, and (2) they provide over 30 times the cooling capacity of a conventional pond on a BTU/ft^2 basis.

A spray pond is typically a bentonite-lined structure in the ground, and is typically long and narrow to improve efficiency. The spray pond structure contains a volume of water and consists of an intake structure that houses pumps to transfer the water from the pond through their respective loops and back to the pond through a network of sprays located in the pond. The spray pond size depends on the number of nozzles required. It is important that the long, narrow spray pond have its long side perpendicular to the prevailing summer wind direction in order to benefit from a better spray droplet surface area and air contact interface. Generally, a spray pond long side dimension would be in the range of two to four times that of the narrow side dimension.

The area of the pond is determined by the quantity of water which it can treat per hour per unit area of the pond. Accepted industry practice for sizing spray ponds is based on values that are typically between 120 lb/ft^2/hr (585 kg/m^2/hr) and 150 lb/ft^2/hr (732 kg/m^2/hr). In actual practice, a spray pond will only cool the water to a point approximately midway between the hot water and wet bulb temperatures. Because of the various factors in spray pond applications, it is virtually impossible to accurately calculate the expected cooled water temperature. The 50% design efficiency factor (cooling to halfway point between hot water and wet bulb temperature) is considered to be a reasonable value for a well designed and located, long and narrow, spray pond.

Due to evaporation loss of water from the pond, the water levels in cooling and spray ponds are usually maintained by rainfall or augmented by a makeup water system operating on pond level.

Cooling ponds require a relatively large amount of land. For example, for a 1,300 MW power plant, a cooling pond with a surface area of approximately 2,470 ac (10 km^2) is required to be able to maintain a cooling water temperature of 70°F (21°C) with a dry air temperature of 54°F (12°C) and relative humidity of 57% (ENS, 2008). Given the relatively large amount of land that would be required for a cooling pond or spray pond option, which is not available at the BBNPP site, and expected thermal performance, neither the spray pond nor the cooling pond alternative is suitable for the BBNPP.

Once-through Cooling System Using Susquehanna River Water

In a once-through cooling system, water is withdrawn from a water body, passes through the heat exchanger, and is discharged back to the same water body. The discharged water temperature is higher than the intake by the temperature gained when passing through the heat exchanger. For BBNPP, a once-through cooling system would require approximately 2.5 million gpm (9.5 million lpm) considering a 10°F (5.6°C) temperature rise across the condenser. Because this exceeds 36% of the average annual flow of the Susquehanna River in the vicinity of the Susquehanna Steam Electric Station (SSES) Units 1 and 2, which is approximately 6.87 million gpm (NRC, 2008), this option was not considered feasible for BBNPP.

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Once-through cooling systems are required to comply with Federal and State regulations for thermal discharges into the Susquehanna River. Additionally, U.S. Environmental Protection Agency (USEPA) regulations governing cooling water intake structures under Section 316(b) of the Title 33 United States Code (USC) Part 1326, Federal Water Pollution Control Act (USC, 2007) make it difficult for steam electric generating plants to use once through cooling systems (FR, 2004).

Natural Draft Cooling Tower

Wet cooling towers predominantly rely on the latent heat of water evaporation to exchange heat between the water and the air passing through the tower. In a natural draft cooling tower, warm water is brought into direct contact with cooler air. When the 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 more sensible heat to be absorbed. A natural draft cooling tower receives its air supply from natural wind currents that result in a convective flow up the tower. This air convection cools the water on contact.

Because of the significant size of natural draft cooling towers (typically 500 ft (152 m) high, 400 ft (122 m) in diameter at the base), their use is generally reserved for use at flow rates above 200,000 gpm (757,000 lpm) (Young, 2000). They are typically sized to be loaded at about 2 to 4 gpm/ft^2 (1.4 to 2.7 lps/m^2). Natural draft cooling towers were evaluated in the heat dissipation optimization study. As discussed in Section 9.4.1.3, two round natural draft cooling towers with a 16°F approach temperature were selected as the preferred heat dissipation system for the BBNPP. The towers will have concrete shells and heights of approximately 475 ft, with basin diameters of 350 ft and tower diameters of 222 ft. The recommended flow rate of cooling water through the two natural draft towers at the BBNPP is 720,000 gpm. The footprint for the two towers is 16 acres.

Mechanical Draft Cooling Tower

A wet mechanical draft cooling tower system, operated completely as a wet type cooling tower, would consist of multi-cell cooling tower banks, and associated intake/discharge, pumping, and piping systems. This closed-loop system would receive makeup water from the Susquehanna River and transfer heat to the environment via evaporation and conduction. These towers would have a relatively low profile of approximately 80 ft (24 m). Mechanical draft towers use fans to produce air movement.

A mechanical draft cooling tower would typically consist of a continuous row of rectangular cells in a side-by-side arrangement sharing a common cold water basin. Water to be cooled is pumped to a hot water distribution system above the fill, and then falls over the fill to the cold water basin. Air is drawn through the falling water by fans, 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

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air through the cooling tower fill (i.e., the internal packing that provides an expanded surface for air-water interface).

As discussed in Section 9.4.1.3, both round and rectangular mechanical draft cooling tower designs were considered feasible for BBNPP and evaluated further in the heat dissipation optimization study. Both concrete and fiberglass were considered as materials for construction of the mechanical draft cooling towers. Based on a detailed NPV analysis, the mechanical draft cooling tower options had a higher total NPV for BBNPP than the two natural draft cooling tower option.

Hybrid Plume Abatement Cooling Tower

A cooling tower plume occurs when the heated and saturated air leaving a wet cooling tower mixes with the relatively cooler ambient air under atmospheric conditions, and a supersaturated condition occurs during the process of mixing and dispersion. The excess vapor condenses (the amount in excess of saturation vapor) and becomes a visible plume.

A cooling tower plume may be visually objectionable or may result in problems of fogging or icing. A plume abatement hybrid cooling tower (i.e., combination wet-dry tower) combines dry cooling and wet cooling to reduce the cooling tower plume. The dry cooling section adds heat to the discharge air without adding moisture (sensible heat transfer). This results in a subsaturated air stream leaving the tower (less than 100% relative humidity) and therefore reduced plume potential.

Although the hybrid plume abatement cooling tower results in reduced water consumption and no visible plume, construction costs, operating and maintenance costs, and land use requirements are significantly higher. Therefore, the hybrid plume abatement cooling tower was not the preferred alternative for BBNPP.

Dry Cooling System

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 (USEPA, 2001). 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 nuclear power generating facility 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 loop 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 generating facilities because a water cooled condenser would already be in place for a once through or closed loop cooling system (USEPA, 2001).

Because there are no evaporative or drift losses in this type of system, there are no potential issues with blowdown disposal, water availability, chemical treatment, fogging, or icing when dry cooling towers are utilized. However, the dry towers have associated technical obstacles

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such as high turbine backpressure and possible freezing in cooling coils during periods of light load and startup.

Unfortunately, a dry cooling system affects plant performance so significantly that the net effect is an increased environmental impact. Dry cooling results in a significant reduction in plant output (approximately 25%). An objective comparison of dry versus wet cooling would therefore require the installation of a larger facility to compensate for the impact of dry cooling. The environmental impact of a larger facility far outweighs the environmental advantages of dry cooling.

Use of a dry system would also require a significant increase in dry cooling land use compared to wet cooling. An air-cooled condenser, where steam turbine exhaust is transported directly to a steam-to-air heat exchanger, has technical limitations due to its physical size. The distances from the main steam turbine condensers to the air-cooled condensers and the size of the steam ducting required would be uncommonly large and would far exceed the largest steam duct ever attempted.

Dry cooling material operation and maintenance (O&M) costs would be significantly greater than wet cooling. Dry cooling land use would increase significantly, and the system would require periods of significant unit power output reduction during periods of high ambient air temperatures. For the reasons stated above, the use of a dry tower was not considered as a feasible alternative for BBNPP.

This alternative is not considered suitable for BBNPP for the reasons discussed in the USEPA preamble to the final rule addressing circulating water intake structures for new facilities.

9.4.1.2 Analysis of Hybrid Cooling Tower without Plume Abatement Alternative

A hybrid cooling tower system without plume abatement has higher operating and maintenance costs and electric power demand than the natural draft towers. Therefore, this alternative is not preferred for proposed BBNPP.

9.4.1.3 Summary of Alternative Heat Dissipation Evaluation

As discussed earlier in this section, natural draft cooling towers provide a lower life-cycle cost due to the lower O&M costs. It is therefore the preferred alternative to transfer heat loads from the CWS to the environment.

Four cooling tower options were evaluated as part of the heat rejection system optimization study:

- Natural draft towers (one and two shells variations at two different design approach temperatures)
- Rectangular mechanical draft cooling towers (two and three tower variations)
- Round mechanical draft cooling towers (three and four shell variations)
- One round mechanical draft cooling tower (also known as fan-assisted natural draft cooling tower)

The evaluation assumed that if the predicted differences in net economic benefit were small, then other considerations might be given higher weight. Other considerations include site

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layout, aesthetics, corporate preferences related to O&M issues, initial cost, risk associated with tower technology or vendor capability, and associated site work for arrangement and fitting of cooling water piping fit up to tower.

A review of the cooling tower blowdown in hot months was performed. To maintain tower blowdown at temperatures below expected environmental constraints, several blowdown cooling options were reviewed. The need for such a system will depend on final permitting requirements.

Each of the cooling tower options were evaluated at three different circulating water flow rates using two different weather profiles (the representative "hot" year and the "average" year): 1,604.16 ft^3/sec (45.43 m^3/s), or 720,000 gpm; 1,782.40 ft^3/sec (50.48 m^3/s), or 800,000 gpm; and 1,960.64 ft^3/sec (55.53 m^3/s), or 880,000 gpm. In addition, an energy rate was applied to the net production differences between the base case and each option. 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, the natural draft cooling tower option with a 1,782.40 ft^3/s (50.48 m^3/s) or 800,000 gpm circulating water flow rate was used.

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

- Production - This evaluation calculated the detailed NPV for production benefits for an average and the hot single year of facility operation for each cooling tower option (summation of 8,760 hourly computations).

- Initial cost - The 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 facility life.

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 permits. It was assumed that the blowdown would be limited to a maximum temperature of 87°F (30.6°C), for purposes of the study, based on the protection of warm water fishes in the Susquehanna River.

With expected extreme wet bulb tempertatures in range of 70°F to 75°F (21.1°C to 23.9°C), and expected approach temperatures for aged towers to be in the range of 10°F to 15°F (5.6°C to 8.3°C), a potential exists that blowdown temperatures might exceed 87°F for critical production times in the hottest weather.

Two options were considered to address high blowdown temperatures: (1) a dedicated small cooling tower for blowdown and (2) blowdown cooled by makeup using a plate-and-frame heat exchanger. A makeup/blowdown system designed to cool blowdown using a plate-and-frame heat exchanger was determined to be a cost-effective option to reduce blowdown temperatures as needed to maintain environmental limits and eliminate constraints on main

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tower performance. This option would be common to all of the alternatives in the study and would depend on the final NPDES permit.

The cooling tower performance evaluation demonstrated that the two shell natural draft cooling tower design resulted in the largest yearly gross generation revenue for all cases considered. However, this is also the cooling tower option with the highest initial cost.

Two natural draft cooling towers with basin diameters of 350 ft (107 m), tower diameters of 222 ft (68 m), and heights of 475 ft (145 m) were selected for the proposed BBNPP based on an evaluation of the economics, siting, and risk associated with tower technology and vendor capability. Increased capital costs associated with installing natural draft towers were offset by increased net electricity generated.

9.4.2 CIRCULATING WATER SYSTEMS

In accordance with NUREG-1555 (NRC, 2007), ESRP 9.4.2, this section discusses alternatives to the following components of the CWS for the BBNPP. These components include the intake systems, discharge systems, water supply, and water treatment processes. A summary of the environmental impacts of the circulating water intake system alternatives for BBNPP is provided in Table 9.4-3.

The CWS is an integral part of the heat dissipation system. It provides the interface between (1) the normal heat sink (i.e., main steam turbine condenser) 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 types of CWSs 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 water body). 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 Section 9.4.1, the CWS for BBNPP will be a closed-loop system with two round natural draft cooling towers with associated pumps, piping, and cold water retention basins that will be operated as wet cooling towers year-round.

BBNPP requires water for cooling, operational, and potable and sanitary uses. The sources of water supply are the Susquehanna River and municipal water from the Berwick District of Pennsylvania American Water (PAW). Water from the Susquehanna River provides makeup water for facility cooling and power facility operations. Municipal water from PAW is used to satisfy the demands of potable, sanitary, and miscellaneous facility systems, such as the demineralized water treatment system and the fire protection system.

Water from the CWS will be pumped from the cooling tower basin through the main steam turbine condensers and turbine facility auxiliary heat exchangers, where heat transferred to the cooling water in the condenser will 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. 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 drift droplets will be lost from the cooling tower.

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As stated in Section 3.3.1 and Section 3.4.1.1, the cooling water withdrawal rate for the CWS will normally be approximately 23,808 gpm (90,113 lpm), and maximum water withdrawal will be approximately 26,200 gpm (99,200 lpm). These withdrawals include consideration of losses due to evaporation, drift, and blowdown. A fraction of the intake water will be used to clean debris from the traveling screens. Blowdown from the CWS cooling tower will be returned to the Susquehanna River. The blowdown water will enter the discharge pipe where it will mix with the blowdown from the Essential Service Water System cooling towers during its passage to the outfall. The discharge is not likely to produce tangible aesthetic or recreational impacts.

Mechanical draft cooling towers with water storage basins (i.e., one basin for each of the four trains) comprise the Ultimate Heat Sink (UHS) System which functions to dissipate heat rejected from the Essential Service Water System (ESWS) as described in ER Section 3.3.1. The supply of the ESWS is vital for all phases of plant operation and is designed to provide cooling water during power operation and shutdown of the plant. Under normal operating and normal shutdown/cool down conditions, the UHS water storage basins will be supplied with treated non-safety related makeup water provided by the Raw Water System (RWS).

9.4.2.1 Intake and Discharge Systems

For both once-through and closed-loop cooling systems, the water intake and discharge structures can be of various configurations to accommodate the source water body and to minimize impact to the aquatic ecosystem. The intake structures are generally 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 may be mixed with the condenser cooling water and discharged from the system.

Cooling water intake structures (CWIS) are typically regulated under Section 316(b) of the Federal CWA and its implementing regulations (FR, 2004). A federal court decision in January 2007 changed that regulatory process. The regulations that implement Section 316(b) were effectively suspended, and the USEPA recommended that all permits for Phase II facilities should include conditions under Section 316(b) developed on a best professional judgment basis (USEPA, 2007). In the Commonwealth of Pennsylvania, the 316(b) process is being managed by the Pennsylvania Department of Environmental Protection.

The Federal CWA and associated cooling water intake structures implementing regulations for Section 316(b) define acceptable levels of impingement and entrainment. Cooling water intake structure regulations require the facility to mitigate impingement loss to the extent that the costs for the mitigation are not greater than the benefits. Specifically, the location, design, construction and capacity of cooling water intake structure must reflect the best technology available (BTA) for minimizing adverse environmental impact.

Intake and discharge structures will be required for operation of BBNPP. Alternatives evaluated for BBNPP are described in the following sections.

Impacts associated with the CWS Makeup Water Intake Structure and discharge structure for BBNPP are described below (see also Table 9.4-3). No long term physical changes in land use are anticipated from construction of the CWIS, the pumphouse, and the makeup water and blowdown pipeline corridor. Construction activities will cause only temporary effects to shallow pools, streams, and wetlands. The proposed CWIS and discharge structure will be designed to meet applicable O&M and navigation criteria and requirements. The discharge

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structure will be designed to allow for an acceptable mixing zone for the thermal plume per state regulations for thermal discharges.

Long-term changes in land use from operation of BBNPP intake and discharge system will be associated primarily with the makeup water pipeline, CWS Makeup Water Intake Structure, pumphouse, and blowdown pipeline. The long term impacts on land use are expected to be SMALL to MODERATE.

Short term changes in land use from operation of BBNPP intake and discharge system will be associated primarily with impacts resulting from the increase in the stormwater due to development of BBNPP intake and discharge structures and equipment. Short-term changes in land use would be minor. More detail on short-term changes in land use is provided in Section 4.1.

Measures, such as accepted best management practices (BMPs), will be taken during construction activities at BBNPP intake and discharge system site to minimize effects to ground and surface waters. 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 the Susquehanna River water quality. More detail on erosion control measures to be implemented is provided in Section 4.1 though Section 4.3. In addition, BBNPP site preparation and construction activities will comply with BMPs and with federal, state, and local regulations to prevent adverse aquatic ecological effects along the Susquehanna River.

PPL is committed to conducting a Phase I cultural resource assessment for the proposed BBNPP intake and discharge system site to determine the potential to affect cultural resources (such as archeological, historical, or architectural resources). Both a Phase Ia assessment and a Phase Ib assessment have been completed. During site preparation for the proposed BBNPP intake and discharge system, 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. 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 (PM) and combustion byproducts might occur during proposed BBNPP intake and discharge system site preparation and construction activities.

Construction-related dust and air emissions from equipment are expected to be SMALL and will be controlled by implementing mitigation measures. More detail on construction-related impacts is provided in Chapter 4 of the BBNPP ER.

Site preparation and construction activities may 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.

Intake System

Alternative intake systems and locations were evaluated for the BBNPP based on engineering, regulatory, and environmental factors. Key considerations in determining the intake system and location included considerations associated with the size of the intake structure, distance and routing of the pipeline to the source location, accessibility of the intake system/structure,

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location of the existing SSES blowdown line, and environmental impacts from construction and operation (e.g., wetlands, archeological resources, aquatic ecology, etc.). Areas to the south and north of the existing SSES intake location at the Susquehanna River were considered in the evaluation. Areas south and north present potential impacts to wetlands and archeological sites. Distance of the pipeline was also a potential issue with sites to the south of the existing SSES discharge location.

The location of the intake structure and associated pipeline was selected on PPL property along the Western bank of the Susquehanna River. Locating the intake structure on PPL property maximizes the use of previously disturbed areas and avoids impacts associated with the acquisition of additional property or easements to support the new intake line. Locating the intake structure and pipeline on PPL property also provides the added benefit of utilizing existing infrastructure, such as access roads, further reducing environmental impacts.

As stated previously, the evaluation of the intake structure location also considered wetlands located both south and north of the existing SSES intake structure. The evaluation also considered known archeological sites near the existing SSES intake structure. The area selected for the intake structure has been previously disturbed and would not impact wetlands or archeological sites.

Thermal and radiological modeling was also factored into the selection of the intake location. A key parameter in the modeling was a minimum distance between the BBNPP intake and the SSES discharge of 275 ft (84 m). The actual distance between the BBNPP intake and SSES discharge is approximately 380 ft (168 m).

Table 9.4-3 presents a comparison of the alternate intake systems and locations considered in the review.

As stated in Section 3.4.2.1, the intake structure will be located east of the BBNPP power block on the west bank of the Susquehanna River. The forebay of the intake structure is on the bank of the Susquehanna River, perpendicular to the river's flow to minimize the potential of fish entering the intake structure as shown on Figure 3.4-3. The flow velocities at the intake structure would be less than 0.5 fps (0.15 mps). The area from the river bed to the forebay is designed to allow for gradual transition without excessive turbulence. The new intake structure will be an approximately 124 ft (37.8 m) long, 90 ft (27.4 m) wide structure with individual pump bays. Three 50% capacity, vertical shaft CWS makeup pumps provide up to 26,200 gpm (99,200 lpm) of makeup water. Three 50% capacity, vertical shaft RWSS pumps provide up to 5,800 gpm (22,000 lpm) of service water. In the intake structure, one CWS makeup pump and one RWSS pump are located in each pump bay, along with one traveling screen. There are cross bay stop log slots to permit isolation of pumps on an individual bay basis. Flow through the bar grating from the river feeds the pumps. Debris collected by the bar grating and the traveling screens will be collected in a debris basin for cleanout and disposal as solid waste. The through-bar grating and through-screen mesh flow velocities will be less than 0.5 fps (0.15 mps). The dual flow type of traveling screens with a flow pattern of double entry-center exit will be used for each bay. This arrangement prevents debris carry over. The screen panels have a mesh size of 0.08 in^2 (2 mm^2). The screen mesh is mechanically rotated above the water for cleaning via spray water. The screen wash system consists of three screen wash pumps that provide a pressurized spray to remove debris from the water screens. There is no need for a fish return system since the flow velocities through the screens are less than 0.5 fps (0.15 mps) in the worst case scenario (minimum bay level with highest makeup demand flow).

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The growth of slime, algae, and other organic materials will be monitored in the intake structure and their components, as well as the accumulation of debris on the bar grating and trash rake. Cleaning will be performed, as necessary.

Discharge System

The appropriate location of the BBNPP discharge structure was evaluated based on engineering design factors and potential environmental impacts.

Careful consideration was given to potential thermal and radiological impacts during siting of the BBNPP discharge structure near the existing SSES discharge structure. Thermal and radiological modeling performed identified a minimum distance of 380 ft (116 m) for separation of the two discharge structures.

As described in Section 3.4.2.2, the discharge structure will be designed to meet all applicable navigation and maintenance criteria, and to provide an acceptable mixing zone for the thermal plume per the Commonwealth of Pennsylvania regulations for thermal discharges. Figure 3.4-6 shows details of the discharge system. The discharge point is near the southwest bank of the Susquehanna River approximately 700 ft (210 m) south of the intake structure for BBNPP and extends about 150 ft (46 m) into the river through a 24 in (61 cm) discharge pipe with diffuser port holes at the end of the line. The centerline elevation of the discharge diffuser is Elevation 476 ft (145 m) msl. The seventy-two 4 in (10 cm) diameter port holes are spaced center-to-center at 1.5 ft (0.5 m). The height of the port holes above the river bed varies as the river bed elevation varies. The angle of discharge is 45 degrees to horizontal. Riprap will be placed around the discharge diffuser to resist potential erosion. Fish screens are not required on the diffuser since there will always be flow through the discharge piping, even during outages, to maintain discharge of treated liquid radioactive waste within the concentration limits of the applicable local, state, and federal requirements.

As stated in Section 5.3.2.2, the effects of the proposed BBNPP discharge are anticipated to be similar to the SSES discharge, which has been monitored for 24 years. Based on the long-term monitoring of the SSES discharge and modeling of both the SSES and BBNPP discharges, the discharge of cooling tower blowdown and wastewaters from BBNPP is predicted to have a SMALL aquatic impact on the Susquehanna River in the vicinity of BBNPP.

9.4.2.2 Water Supply (Makeup Water System Alternatives)

BBNPP will require makeup water for the CWS and ESWS cooling towers to replace water inventory lost to evaporation, drift, and blowdown. Makeup water to the ESWS is normally supplied from the plant RWSS.

Several potential source water alternatives for BBNPP were identified based on engineering, regulatory, and environmental factors. Key considerations in determining the viability of source water alternatives were considerations associated with routing the pipeline to the source location; water quantity and quality; the reliability of future water supply; and environmental impacts (e.g., previous disturbances, archeological resources).

The following makeup water system alternatives were analyzed:

- Groundwater sources
- Municipal sources

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- Susquehanna River

Summary of Makeup Water Alternatives

During normal plant operations, the BBNPP will require approximately 25,729 gpm (97,384 lpm) for cooling purposes (Section 5.2.1.2). This water demand (withdrawal) will rise to approximately 28,179 gpm (106,656 lpm) during refueling outages, which occur for approximately one month every two years.

Ground water is available at the site. The primary aquifer that has the greatest capacity to provide water is the Glacial Overburden aquifer. This aquifer is composed of sand and gravel outwash, kame, kame terrace, and morainal units that were deposited during the last major Pleistocene glacial advance. Two water production wells at the SSES can produce 50 and 150 gpm (189 and 568 lpm, respectively). One pumping test of a monitoring well at the BBNPP site showed that the aquifer could yield 60 gpm (227 lpm). Thus, the maximum sustained yield for a single well in this aquifer is estimated to be approximately 60 gpm (227 lpm). To produce sufficient water for refueling outages (i.e., peak demand), approximately 470 wells would be required. The wells would have to be separated sufficiently far apart so as not to cause interference problems, thus requiring a very large area for the wellfield. The aquifer is not capable of supporting such a large demand. If groundwater were to be extracted at such a high rate, the aquifer would be greatly dewatered and would impact the SSES production wells and the wetlands surrounding the site. Overall, the aquifer is not capable of supplying such a large water demand.

The local municipal water supply company Pennsylvania American Water Company - Berwick District) will be supplying potable water to the BBNPP for drinking water, sanitary, and other non-cooling purposes. However, the maximum estimated water usage for these purposes is 236 gpm (893 lpm), which is less than one percent of the amount needed for cooling during refueling outages. The Pennsylvania American Water Company - Berwick District well field in Berwick, Pennsylvania (located five miles southwest of the BBNPP) is the largest public water supply company in Columbia and Luzerne counties. The average production rate of this well field is 1.74 million gpd (6.58E+06 lpd), or 1,208 gpm (4,574 lpm). The maximum daily production rate is 2.48 million gpd (9.39E+06 lpd), or 1,722 gpm (6,510 lpm) (PPL, 2006). Thus, the BBNPP cooling water demand exceeds the largest municipal water supply in the area.

Because the local groundwater resources and the largest municipal water supplier in the area cannot provide a sufficiently large supply of water to the plant, the Susquehanna River was selected as a safe and reliable source of cooling water for the BBNPP. Withdrawal (demand) and consumptive use on the Susquehanna River is regulated by the Susquehanna River Basin Commission (SRBC). The SRBC is an independent agency that manages water use along the entire length of the Susquehanna River (NRC, 2008). An SRBC docket approval will be required for the operation of the BBNPP and will include water use limits and applicable mitigative measures. Section 2.3.1 provides additional description of the Susquehanna River and consumptive water use from the river. Additional information on the makeup water pumps and withdrawal rates for the CWS and RWSS are provided in Section 9.4.2 and Section 9.4.2.1.

9.4.2.3 Water Treatment

Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases scaling tendencies of the cooling water. The RWSS supplies filtered water from the Susquehanna River to the

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demineralized water treatment system, fire protection, and essential service water (except under emergency operating conditions) systems during the periods of normal power operation, shutdown, maintenance, and construction. The RWSS also supplies unfiltered water from the Susquehanna River to the ESWEMS Retention Pond during all modes of normal operation. The emergency make up to the essential service water system is provided by a dedicated, safety related system.

An automatic self cleaning strainer is located at the discharge of each raw water pump to remove particulate material from the river water prior to filtration by the media filters. The strainers are set to backwash based on the pressure differential exceeding a preset limit, or a timed backwash cycle based on a preset service time. The strainers can backwash while on line without interruption of raw water flow. The backwash water from the strainers is discharged to the Susquehanna River.

Media filters are provided to remove suspended solids from the raw water before it is distributed for use, with the exception of makeup flow to the ESWEMS Retention Pond. The filters use a dual media potentially comprised of silica sand and anthracite. The use of dual media improves the effectiveness of the filters in removing suspended solids and lengthening the time between backwashes.

The media filters are backwashed to remove collected solids and the backwash water is discharged to the retention pond. Four media filters are provided; each nominally sized for the continuous makeup flow requirements during facility power operation. The media filter vessels are located in the Water Treatment Building. The final dimensions and number of media filter vessels, depths of the media layers, and media particle size distributions will be determined during the detailed design.

Compressed air is supplied to the bottoms of the filter vessels to augment the reverse water flow and improve the backwash effectiveness by air scouring of the media.

The Susquehanna River is the source of water supplied to the CWS cooling towers and RWSS. This water is characterized as a moderately hard, alkaline water with a low dissolved solids content averaging 143 mg/l.

There have been sightings of zebra mussels along the Susquehanna River, as shown in the most recent U.S. Geological Survey (USGS) distribution map, so treatment may be required at the intake structure for control of zebra mussels.

Treatment will be required to control microbial growth in the RWSS piping to control biofouling, microbiological deposits, and microbially induced corrosion, especially in the smaller pipes. An oxidizing biocide was selected as the treatment. Sodium hypochlorite solution (also referred to as bleach) will be injected intermittently. Facilities for sodium hypochlorite storage and injection will be located near the intake structure and chemical will be injected near the RWSS pumps.

Chemical treatment system pumps, valves, tanks, instrumentation, and controls provide the means of monitoring water chemistry. Monitoring will be consistent with chemical vendor recommendations required for chemical dosage and performance. The NPDES permit may require additional environmental compliance monitoring at point sources, such as pump discharges to an oil/water separator. Residual chlorine is measured to monitor the effectiveness of biocide treatment. Conductivity and pH are also monitored.

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The discharge from the retention basin will consist primarily of blowdown from the CWS and from the ESWS cooling towers. The combined water composition will depend on the cycles of concentration and on the specific cooling water chemistry control strategy used for deposit control. Alternative deposit control strategies using higher pH levels with lower acid dosages and more aggressive deposit control chemical programs would have similar compositions but with higher pH levels, higher alkalinities, and lower sulfate levels.

9.4.3 TRANSMISSION SYSTEMS

Section 9.4.3 of NUREG-1555 (NRC, 2007) provides guidelines for the preparation of the summary discussion that identifies the feasible and legislatively compliant alternative transmission systems.

As discussed in Section 3.7, the existing 500 kV transmission system in close proximity to BBNPP consists of the Susquehanna 500 kV Yard adjacent to SSES and two 500 kV circuits (Sunbury, Wescosville). Additionally, the Susquehanna 500 kV Yard is connencted to the Susquehanna 230 kV Yard via a 500 kV / 230 kV transformer.

In addition to this existing transmission infrastructure, PPL Electric Utilities Corporation (PPL EU) is developing a new 500 kV transmission line from Susquehanna to the Roseland substation (New Jersey). This expansion effort is a PJM regional Transmission Expansion Plan (RTEP) initiative. PJM has determined that this new 500 kV line is required for grid reliability in the region without considering whether BBNPP is constructed. The in-service date of the Susquehanna-Roseland RTEP project is planned for the year 2012.

No additional transmission corridors or other offsite land use will be required to connect BBNPP to the existing transmission system or to upgrades to the transmission system that are in process. The following facilities will be constructed to support BBNPP:

- One new BBNPP 500 kV Switchyard located in close proximity to the Turbine Building.
- One new switchyard named Susquehanna 500 kV Yard 2.
- Expansion of the existing Susquehanna 500 kV Yard.
- Two new 500 kV, 4,260 MVA (normal rating) circuits connecting the BBNPP 500 kV Switchyard to the expansion of the existing Susquehanna 500 kV Yard and to the new Susquehanna 500 kV Yard 2.

Aditionally, the 230 kV transmission lines currently passing through the BBNPP site will be relocated to run along the northern boundary of the project area.

The new transmission facilities to support BBNPP will be constructed within the BBNPP project area. Thus, environmental impacts are limited to the project area.

No new corridors, widening of existing corridors or crossings over main highways, primary roads waterways or railroad lines, will be required. Therefore, there would be no impacts from land use changes. Operational impacts from the new transmission facilities needed to support BBNPP are discussed in Section 5.6.

The power transmission needs of BBNPP can be satisfied with relatively minimal changes to the existing 500 kV transmission system. Based on this conclusion and on the small expected impact to the environment from utilizing the existing transmission facilities and independent

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upgrades that are in progress, no other alternatives were considered since they were less preferable.

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Table 9.4-1—Comparison of Cooling Tower Evaluation Criteria

Type of Cooling	Footprint per Plant Unit (1,562 MWe) (a)	Maximum Height	Materials of Construction	Plant Efficiency Impact Difference e)	Auxiliary Load Difference (e)	Water Makeup (b)	Drift Rate	Pump Head	Visible Plume	Noise	Annual O&M Cost Difference (c, e)	Capital Cost(d)
	Acres	Ft(m)		%	MW	gpm(Lpm)	gpm (Lpm)	Feet H_2O		dBA @ 1m	103 USD	103 USD
Natural Draft (2 Hyperbolic Towers)	16	~600(183)	Concrete	0	0	23,808(90,123)	8(30)	60	Yes	82	0	173,727
Rectangular Mechanical Draft (3 Towers)	24	~60(18)	Fiberglass (FRP)	-0.046	6.22	23,808(90,123)	8(30)	36	Yes	88	468	130,710
Round Mechanical Draft (4 Towers)	16	~60(18)	Fiberglass	-0.044	4.05	23,808(90,123)	8(30)	36	Yes	88	374.4	143,103
One Round Mechanical Draft (aka Fan-assisted Natural Draft)	8	~164(50)	Concrete	-0.101	8.49	23,808(90,123)	8(30)	44	Yes	88	374.4	135,429

Notes:
(a) Footprint includes the required separation between towers, if applicable.
(b) Water total makeup includes drift, evaporation, and blowdown (at 2 cycles of concentration).
(c) O&M costs are calculated at 1% or 2% of the capital cost, based on vendor input.
(d) The cost shown includes the initial cost of the cooling tower(s) and construction cost differences.
(e) The value shown is the difference between the identified option and the Natural Draft (2 Hyperbolic Towers) option.

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Table 9.4-2—Environmental Impacts of Alternative Cooling Tower Systems

Factors Affecting System Selection	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)
Land Use: Onsite Land Requirements	Impacts would be SMALL.	Impacts would be SMALL.
Land Use: Terrain Considerations	Terrain features of the BBNPP site are suitable for a natural draft cooling tower system. Impacts would be SMALL.	Terrain features of the BBNPP are suitable. Impacts would be SMALL.
Water Use	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	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.
Thermal and Physical Effects	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 comply with applicable thermal discharge regulations. Discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be SMALL.
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.
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 the Susquehanna River 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 the Susquehanna River is expected. Impacts would be SMALL.
Legislative Restrictions	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 the Susquehanna River. 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 the Susquehanna River. These regulatory restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be SMALL to MODERATE.
Environmental impacts	SMALL to MODERATE	SMALL to MODERATE
Is this an environmentally suitable alternative heat dissipation system?	Yes	Yes

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Table 9.4-3—Alternate Intake Systems

	Proposed System (closed loop)	Alternative Systems (open loop)	Alternative Intake Location (South)	Alternative Intake Location (North)
Construction Impacts	Some adverse impacts as discussed in Section 4.1, but mitigated as noted in Section 4.6. SMALL	Adverse impacts due to large intake structure required. LARGE	Additional adverse impacts would occur due to construction activities in previously undisturbed areas and requirement for additional infrastructure (e.g., roads). SMALL to MODERATE	Additional adverse impacts would occur due to construction activities in previously undisturbed areas and requirement for additional infrastructure (e.g., roads). SMALL to MODERATE
Aquatic Impacts	No expected long-term impacts; entrainment and impingement expected to be minimal. SMALL	Adverse impacts from entrainment of resident species. LARGE	No expected long-term impacts; entrainment and impingement expected to be minimal. SMALL	impacts; entrainment and impingement expected to be minimal. SMALL
Water Use Impacts	No expected long term impacts; water consumption minimal. SMALL	High water use would require large intake structure from Susquehanna River LARGE	No expected long term impacts; water consumption minimal. SMALL	No expected long term impacts; water consumption minimal. SMALL
Compliance with Regulations	Satisfies regulatory performance standards for CWA and Pennsylvania regulations. SMALL	Does not meet current CWA and Pennsylvania criteria for entrainment LARGE	Additional regulatory requirements associated with anticipated impacts to wetland and archeological sites. SMALL to MODERATE	Additional regulatory requirements associated with anticipated impacts to wetland and archeological sites. SMALL to MODERATE
Environmental Preferability	Environmentally preferable: limits entrainment and lower water use.	Cost prohibitive not compliant with regulations.	Due to additional construction impacts and regulatory requirements, this alternative is not environmentally preferable.	Due to additional construction impacts and regulatory requirements, this alternative is not environmentally preferable.

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