ENVIRONMENTAL REPORT

CHAPTER 5

ENVIRONMENTAL IMPACTS OF STATION OPERATION

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5.0 ENVIRONMENTAL IMPACTS OF STATION OPERATION

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5.1 LAND USE IMPACTS

The following sections describe the impacts of Bell Bend Nuclear Power Plant (BBNPP operations on land use at the BBNPP site, the Owner Controlled Area (OCA), the 6 mi (10 km) vicinity, and associated transmission line corridors, including impacts to historic and cultural resources. The operation of BBNPP is not anticipated to affect any current or planned land uses.

5.1.1 THE SITE AND VICINITY

Land use impacts from construction are described in Section 4.1.1. An additional impact to land use from operations will be solids deposition from cooling tower drift. There are two cooling systems that have cooling towers, the Circulating Water System (CWS) and the Essential Service Water Supply System (ESWS). The plant cooling systems are described in Section 3.4.

The CWS for BBNPP uses two natural draft cooling towers to dissipate waste heat rejected from the main condenser and the Closed Cooling Water System during normal plant operation. The towers will be approximately 475 ft (145 m) high with an overall diameter of 350 ft (107 m). Evaporation in the cooling towers increases the level of solids in the circulating water. To control solids, a portion of the recirculated water must be removed or blown down and replaced with clean water. In addition to the blowdown and evaporative losses, a small percentage of water in the form of droplets (drift) would also be lost from the cooling towers. Makeup water to replace the losses from evaporation, blowdown, and drift will be taken from the Susquehanna River at a maximum rate of 23,808 gpm (90,113 lpm).

The CWS cooling tower system will occupy an area of approximately 8.8 acres (3.6 hectares). Details of cooling tower design are discussed in Section 3.4.2 and impacts of the heat dissipation system are discussed further in Section 5.3.3.1 and Section 5.3.3.2. The cooling towers for BBNPP will be located north of the BBNPP power block. The nearest cooling tower will be approximately 500 ft (152 m) from the center of the tower to the nearest site boundary (1,350 ft (411 m) to the nearest OCA boundary) to the west. The cooling tower plumes could occur in all compass directions.

The maximum salt deposition rate from the CWS cooling towers is provided in Table 5.3-9. The maximum predicted salt deposition rate is a very small fraction of the NUREG-1555 (NRC, 1999) significance level for possible vegetation damage of 8.9 lbs per acre per month (10 kg per hectare per month) in all directions from the cooling tower, during each season and annually. Therefore, impacts to vegetation from salt deposition are not expected at either onsite or offsite locations.

The average plume length and height was calculated from the frequency of occurrence for each plume by distance from the towers. The average plume length will range from 0.274 mi (0.440 km) to the south-southwest in the summer, to 0.615 mi (0.990 km) to the east-northeast in the winter. The annual average plume length will be 0.372 mi (0.599 km) to the south-southwest. The average plume height will range from 776 ft (236 m) in the summer, to 961 ft (293 m) in the winter. The annual average plume height will be 818 ft (249 m). Due to the varying directions and short average plume length, impacts from the larger plumes would be SMALL and not warrant mitigation.

The electrical switchyard for BBNPP will be located approximately 1,300 ft (400 m) to the south of the proposed location for the CWS cooling towers. A maximum predicted solids deposition rate of 0.0023 pounds per acre per month (0.0026 kg per hectare per month) is expected at the BBNPP switchyard during the spring season. Additionally, the electrical switchyard for SSES Units 1 and 2 is located approximately 3,300 ft (1,000 m) to the east-southeast, from the

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proposed location of the BBNPP CWS cooling towers. The maximum predicted solids deposition expected at the SSES Units 1 and 2 electrical switchyard due to operation of the BBNPP CWS cooling towers will be 0.0008 pounds per acre per month (0.0009 kg per hectare per month) during the spring season.

Based on industry experience, adjustments to maintenance frequencies (e.g., insulator washing) may be necessary due to solids deposition; however, the expected deposition rates will not affect switchyard component reliability or increase the probability of a transmission line outage at SSES Units 1 and 2, or BBNPP.

The safety-related ESWS provides cooling water to the Component Cooling Water System heat exchangers located in the Safeguards Building and to the heat exchangers of the emergency diesel generators located in the Emergency Power Generating Buildings. Four mechanical draft cooling towers with water storage basins comprise the Ultimate Heat Sink which functions to dissipate heat from the ESWS. Water loss from the UHS is expected to be greatest under shutdown/cooldown conditions and will be approximately 3,426 gpm (4,300 lpm). Maximum drift loss is estimated to be 4 gpm (15 lpm) with all four towers in operation.

Impacts from salt deposition from the BBNPP cooling towers would be SMALL. The modeling predicts salt deposition at rates well below the NUREG-1555 significance level of 8.9 lbs per acre per month (10.0 kgs per hectare per month), Section 5.3.3.2, presents information on the sensitivity of specific terrestrial species to salts.

Land use at the BBNPP OCA is indicated in Table 2.2-1. Forest is the most common land use within the BBNPP OCA. The forested area represents 45.6% of the BBNPP OCA acreage. Agricultural is the next highest land use area classification at the BBNPP OCA. The agricultural area represents 28.6% of the BBNPP OCA acreage.

Land use data for the 6 mi (10 km) site vicinity is presented in Table 2.2-2. Forest is the largest land use category and represents 65% of the area in the 6 mi (10 km) site vicinity radius. Agricultural is the next largest land use and represents approximately 21% of the land area, with the Urban/Built-up category representing 9% of the land area. Section 2.2.1 presents land use on the BBNPP site and its vicinity extending 6 mi (10 km) beyond the site boundary and includes maps showing land use and transportation routes.

As described in Section 2.5, the impact evaluation assumes that the residences of BBNPP employees will be distributed across the region of influence, defined as Luzerne County and Columbia County, in the same proportion as those of the SSES Units 1 and 2 employees. It is estimated that an additional operational work force of 363 onsite employees will be needed for BBNPP. Section 5.8.2 describes the impact of the new employees of the region's housing market and the increase in tax revenues.

Approximately 87% of the new employees are expected to settle in Luzerne and Columbia Counties, based on the fact that 87% of current SSES Units 1 and 2 employees live in Luzerne County and Columbia County. It is likely that the new employees who choose to settle near the BBNPP site will purchase homes or acreage in the Luzerne County and Columbia County area. As discussed in Section 5.8.2, the total number of housing units needed for these employees within the two counties represents less than 5% of the total vacant units. Also, although all tax revenues generated by the BBNPP and related workforce would be substantial in absolute dollars, they would be small compared to the overall tax base in the two-county region. There are no known lands within the vicinity of the BBNPP site in Luzerne County and Columbia County owned by the Federal government and unavailable for development.

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It is therefore concluded that impacts to land use in the vicinity will be SMALL and not warrant mitigation.

5.1.2 TRANSMISSION CORRIDORS AND OUTSIDE AREAS

As discussed in Section 2.2.2, the additional electricity generated from BBNPP will not require the addition of new offsite transmission lines. BBNPP will use existing transmission corridors including the Susquehanna-Roseland 500 kV line to connect to the electrical grid. However, as detailed in Section 2.2.2.2, BBNPP construction activities will include the following changes on the BBNPP site and OCA:

- One new 500 kV switchyard to transmit power from BBNPP.
- Two new 500 kV, 4,260 MVA circuits connecting the BBNPP switchyard to the existing Susquehanna 500 kV Yard and the proposed Susquehanna 500 kV Yard 2.
- One new 500 kV transmission system switchyard (Susquehanna 500 kV Yard 2)
- Expansion of the existing Susquehanna 500 kV Yard

Additionally, the 230 kV transmission lines currently passing through the BBNPP site will be relocated to run along the northern boundary of the OCA in order to provide a buffer from the BBNPP CWS cooling towers and provide additional areas for the location of plant-related structures.

In its generation interconnection Impact Study Restudy (PJM, 2008), PJM identified that BBNPP contributes to two previously identified upgrades for overloads initially caused by prior Queue position generation additions. Any related offsite modifications are due to prior Queue position generation additions.

The onsite transmission line work necessary to support BBNPP will require new towers and transmission lines to connect a new switchyard for BBNPP to the existing Susquehanna 500 kV Yard and the proposed 500 kV Susquehanna Yard 2. Line routing will be conducted to avoid or minimize impact to the existing wetlands and any threatened or endangered species identified in the local area. However, onsite transmission corridors passing through forested wetlands will cause a permanent disturbance due to vegetation management practices required to maintain the corridors. No other new operational land use impacts will occur as the result of the operation of the new connector transmission lines or the new switchyards.

In general, the transmission line owner, PPL Electric Utilities (PPL EU), ensures that land use in the corridors and underneath the high voltage lines is compatible with the reliable transmission of electricity. Vegetation communities in these corridors are kept at an early successional stage by mowing, trimming, and application of herbicides and growth-regulating chemicals. In some instances, PPL EU could allow agricultural activities in these rights-of-way. However, PPL EU's control and management of these rights-of-way precludes virtually all residential and industrial uses of the transmission corridors. As described in Section 3.7, PPL EU has established corridor vegetation management and line maintenance procedures that will continue to be used to maintain the corridor and transmission lines. Regular inspections and maintenance of the transmission system and rights-of-way are performed. These inspections and maintenance include patrols and maintenance of transmission line hardware on a periodic and as-needed basis. Vegetation maintenance may include tree trimming and application of herbicide.

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There will be no need for additional access roads along the existing offsite transmission corridors. Offsite corridor maintenance activities will be in accordance with existing rights-of-way agreements between PPL EU and current landowners, where applicable. Should additional access be warranted, PPL EU will negotiate/renegotiate access agreements with the appropriate landowner. Therefore, it is concluded that land use impacts to offsite transmission corridors from operation of BBNPP will be identical to impacts from the existing SSES Units 1 and 2.

Onsite transmission corridor activities are limited to tying about 0.7 mi (1.1 km) of onsite transmission line from a new BBNPP switchyard to the existing Susquehanna 500 kV Yard and 1.0 mi (1.6 km) of onsite transmission line to the proposed Susquehanna 500 kV Yard 2. The basic transmission system electrical and structural design parameters for this new onsite transmission corridor are addressed in Section 3.7. Land use impacts from construction of the new onsite transmission corridor and new BBNPP switchyard are described in Section 4.1.

It is therefore concluded that impacts to land use in the existing transmission corridors or offsite areas would be SMALL and not require mitigation.

5.1.3 HISTORIC PROPERTIES AND CULTURAL RESOURCES

Table 2.5-37 and Table 2.5-38 list historic properties within the project Area of Potential Effect (APE) that are potentially eligible or eligible for listing on the National Register of Historic Places (NRHP). As described in Section 2.5.3, the cultural resource survey of the BBNPP site identified 24 previously recorded archaeological sites within a 1 mi (1.6 km) radius of the project APE and five architectural resources within a 0.5 mi (0.8 km) radius of the project area. The previously recorded archaeological sites include 13 sites located west of the Susquehanna River and 11 mapped to the east. Of these 24 previously recorded sites, six prehistoric sites are located within the Phase Ia project footprint, along the low terrace/floodplain west of the river. As presented in Table 2.5-36, these sites represent Late Archaic through Late Woodland prehistoric occupations. Four of these sites are NRHP eligible, one is ineligible to the NRHP and the eligibility of one site is undetermined. Because of the exclusion of portions of the Phase Ia project area from proposed construction impacts only one of these sites is mapped within the Phase Ib project APE.

Five previously recorded architectural resources are identified within the project viewshed (approximately 0.5 mi (0.8 km) radius of the project footprint). The North Branch Pennsylvania Canal is considered NRHP eligible. The NRHP eligibility of the Union Reformed and Lutheran Church (Old River Church) is undetermined. Three bridges are not eligible for NRHP listing. The North Branch Pennsylvania Canal and the Union Reformed & Lutheran Church are located in the Phase Ia project study area. The North Branch Pennsylvania Canal extends through the project area on the floodplain/low terrace west of the Susquehanna River while the Union Reformed & Lutheran Church is situated in the project's Southeast Alternative, east of the river.

The architectural and historical survey, conducted in conjunction with Phase Ia studies, recorded 52 resources within the proposed project viewshed. Ten of these surveyed resources are recommended eligible for NRHP listing. The Wapwallopen Historic District, one of the eligible historic resources, is composed of ten individually identified resources. The Pennsylvania State Historic Preservation Office (SHPO) has requested Pennsylvania Historic Resource Survey (PHRS) forms for these ten NRHP eligible resources, as well as for 12 additional resources recommended ineligible for NRHP listing (PHMC/BHP, 2008). The remaining 21 resources require no further study.

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Five of the original 52 surveyed architectural resources are located within the Phase Ia project footprint west of the Susquehanna River, including three resources recommended as NRHP eligible: portions of the North Branch Pennsylvania Canal, the Canadian Pacific/ Bloomsburg Division of the Delaware, Lackawanna & Western Railway, and the Susquehanna and Tioga Turnpike. Table 2.5-38 summarizes the three NRHP eligible architectural and historic resources located in the Phase Ib project footprint.

Based on preliminary field results, Phase Ib archaeological survey of the project APE (defined for this stage of work as a 630-acre area west of the Susquehanna River) consisted of pedestrian ground survey of 114 acres and the excavation of 3,777 STPs, eleven trenches and eight 3x3 ft (1x1 m) test units (column samples), yielding 2,049 artifacts (1,970 historic artifacts and 79 prehistoric artifacts). The survey resulted in the identification of eleven archaeological sites (three prehistoric and eight historic) and 26 prehistoric isolated finds, as well as dispersed historic/modern surface artifacts representing field scatters. Figure 2.5-10 illustrates the location of identified archaeological sites. Table 2.5-41 summarizes the eleven sites. Table 2.5-42 summarizes the 26 isolated finds. Both Tables provide recommendations on potential NRHP eligibility for these resources.

Preliminary review of Phase Ib field data indicates that seven of the eleven identified sites are recommended as potentially eligible for listing in the NRHP. These include six historic sites and one prehistoric site. The six historic sites are all located in upland settings within the proposed West Alternative and the prehistoric site is situated in a low terrace/floodplain setting in Area 7 (Figure 2.5-10). Table 2.5-43 summarizes the seven potentially eligible sites identified witin the Phase 1b Project Area.

Additional Phase Ib cultural resource investigations were proposed for a 235 ac (95 ha) upland project area, located adjacent to the Western Alternative. Of these 235 ac (95 ha), 197 ac (80 ha) are considered to have moderate to high archaeological potential, 30 ac (12 ha) have low archaeological potential (slopes in excess of 15%) and 8 ac (3 ha) are characterized by disturbance/no archaeological potential. Of the 197 ac (80 ha), approximately 124 ac (50 ha) are in corn fields and 73 ac (29 ha) are typified by grass fields and woodlands. Supplemental Phase Ib fieldwork, performed between August 5 and November 13, 2008, investigated approximately 115 acres (46.5 hectares) of moderate to high archaeological potential within the 262.6-acre (106.3-hectare) project area. Phase Ib fieldwork consisted of the excavation of 1,937 shovel test pits.

The Supplemental Phase Ib survey identified no archaeological sites or isolated finds within the project area. Shovel testing produced just four historic artifacts, all representing field or roadway scatters. Based on these results, it is recommended that no further archaeological investigations of the supplemental BBNPP project area be performed.

The Supplemental Phase Ib project area includes seven architectural and historic resources identified during the previous architectural survey, two of which have been recommended as eligible for listing in the NRHP (Munford and Tuk, 2008).

As with any new project area, these investigations may identify resources in this location and assess their potential National Register eligibility. Upon completion of any Phase II investigations (if necessary) and assessment of effects, in consultation with the SHPO, BBNPP will identify measures to avoid, minimize, or mitigate and adverse effects, per Section 106 of the National Historic Preservation Act (USC, 2007).

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SHPO consultation on the Phase Ib study is pending. This consultation could result in changes to recommendations regarding the National Register of Historic Places eligibility of onsite resources.

Procedures have been previously developed to specify how construction activities will be preformed to minimize and avoid impacts to archaeological resources within the project site.

A procedure will be developed to outline the necessary course of action including consultation with the Pennsylvania Historical and Museum Commission following the discovery of new and significant historic resources during maintenance operations.

Section 4.1.3 identifies construction support facilities such as laydown, the batch plant and parking that are expected to occupy approximately 266 ac (108 ha). Areas occupied during operations, including the power block, cooling towers and switchyard, collectively are expected to encompass approximately 100 ac (40 ha). Once construction is complete, areas not utilized for operational purposes will be restored and no further impacts are expected to occur.

The BBNPP proposed construction lay down area includes the mapped locations of two previously recorded NRHP eligible resources; one archaeological site and portions of the North Branch Pennsylvania Canal. In addition, one potentially eligible archaeological site was identified in construction lay down area. As a result, the location of laydown areas will likely required additional investigation. Construction activities will be undertaken to preserve, to the extent possible, the integrity of cultural resources found within this laydown area. Once construction is complete, areas not utilized for operational purposes will be restored and no further impacts are expected to occur.

The project's proposed West Alternative, located west of the existing SSES facility, contains six archaeological sites identified by Phase Ib survey and are recommended potentially eligible for listing in the NRHP. As a result, additional investigations will likely be required in the West Alternative. Construction activities will be undertaken to preserve, to the extent possible, the integrity of cultural resources found within this area. Once construction is complete, areas not utilized for operational purposes will be restored and no further impacts are expected to occur.

BBNPP construction will require the installation of a new intake structure that would be located east of the BBNPP power block on the west bank of the North Branch Susquehanna River (near the terminus of the North Branch Pennsylvania Canal - North Canal). The area most likely to be affected by the new intake structure contains portions of one previously recorded, NRHP eligible architectural resource, the North Branch Pennsylvania Canal. In addition, the affected area contains two resources identified by the project's architectural and historical survey: the Delaware Lackawanna & Western Railway and the Susquehanna and Tioga Turnpike, both of which are recommended as eligible for listing in the NRHP. Construction activities will be undertaken to preserve, to the extent possible, the integrity of cultural resources found within the area of the intake structure. Once operation of the intake structure begins, no further impact on these resources will occur.

BBNPP will utilize cooling towers to dissipate heat from the Circulating Water System (CWS) and from the Essential Service Water System (ESWS). The CWS utilizes two natural draft cooling towers and the ESWS will utilize four smaller mechanical draft towers. Operation of the two CWS cooling towers will create visible plumes and evaporative deposition. The extent of the tower plumes will largely be limited to the project site and because no fogging or icing is

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anticipated, the impact on historic and cultural resources within the APE is expected to be SMALL.

Section 2.5.3 lists 723 previously recorded cultural resources within the 10 mi (16 km) radius of the BBNPP project (NPS, 2008). The only potential impact to these sites would be cooling tower drift. As stated above, because the plume is largely limited to within the site boundary, the impact of plume drift on the resources found offsite is expected to be SMALL.

Pennsylvania SHPO review of Phase Ia investigations is complete. However, SHPO consultation on results of the Phase Ib survey is pending. Following completion of the Phase Ib study, the SHPO will be consulted to obtain concurrence on recommendations of NRHP eligibility for resources identified within the proposed project area and on proposed plans for further cultural resource studies of those potentially eligible resources that cannot be avoided by proposed project construction. This consultation could result in changes to recommendations of NRHP eligibility of onsite resources. Subsequent Phase II archaeological investigations and continued SHPO consultation would be conducted on potentially eligible archaeological resources that are located within the proposed project area and cannot be avoided, to determine their NRHP eligibility (PHMC/BHP, 2008).

Upon completion of Phase II investigations and SHPO consultations, assessment of effects on NRHP eligible resources on the project site will be determined and consultation will be conducted with the SHPO to identify measures to avoid, minimize, or mitigate any adverse effects, per section 106 National Historic Preservation Act (USC, 2007).

With maintenance and operations activities, there is always the possibility for inadvertent discovery of previously unknown cultural resources or human remains. Prior to initiating land disturbing activities, procedures will be developed which include activities to protect cultural resources during operational maintenance activities. These procedures would comply with applicable Federal and State laws. Section 106 of the National Historic Preservation Act (USC, 2007) requires any project requiring licenses or permits, or that are funded by State and Federal agencies to examine the impact on significant cultural resources and to take steps to avoid, reduce or mitigate any adverse effects. The Pennsylvania Historical and Museum Commission (PHMC/BPH, 2001) provides the Commonwealth of Pennsylvania's guidance on the performance of archeological investigations. Based on results of cultural resources investigations conducted to date it is likely that there will be adverse impacts to cultural resources from construction.

The continued use of the existing transmission corridors by the proposed project would not result in new impacts to cultural and historical resources. There would be no new offsite transmission corridors or offsite transmission lines for the proposed project. Because there will be no new corridors or construction of new transmission lines within the existing corridors required for this project, there will be no new impacts as the result of this project. However, should new and significant cultural and historic resources be encountered during maintenance operations along the existing corridors, the SHPO will be contacted to consult on the discovery.

It is therefore concluded that BBNPP operations would have a SMALL impact on historic or cultural resources and would not require mitigation.

5.1.4 REFERENCES

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5.2 WATER RELATED IMPACTS

This section identifies impacts to surface water and ground water resources associated with operation of the BBNPP site and transmission corridors. As described in Section 3.3, BBNPP will require water for cooling and operational purposes. The source of this water will be the Susquehanna River. Normal plant operations will require an estimated 23,808 gpm (90,113 lpm) of surface water for the Circulating Water System (CWS), which provides cooling water to the turbine condenser.

The Raw Water Supply System (RWSS) will supply river water makeup to the Essential Service Water System (ESWS) cooling towers and Essential Service Water Emergency Makeup System (ESWEMS) Retention Pond, as well as other plant uses, such as the Fire and Demineralized Water Distribution Systems. During normal operation, it is estimated that 1,921 gpm (7,271 lpm) of water will be withdrawn from the Susquehanna River by the RWSS. RWSS water demands are further detailed in Table 5.2-1. For water usage values in Section 5.2, refer to Figure 3.3-1.

5.2.1 HYDROLOGIC ALTERATIONS AND PLANT WATER SUPPLY

Section 2.3.1 provides a description of surface water bodies and the ground water aquifers, including their physical characteristics.

5.2.1.1 Regional Water Use

Section 2.3.2 describes surface water and ground water uses that could affect or be affected by the construction or operation of BBNPP. Section 2.3.2.1 describes the potential sources of surface water, the current and future consumptive surface water uses in Luzerne County, and the non-consumptive surface water uses. Section 2.3.2.2 describes the sources of ground water available to the BBNPP siteand the current and future trends in ground water use in the BBNPP region, Luzerne County, and by Susquehanna Steam Electric Station (SSES) Units 1 and 2.

The standards and regulations applicable to the use of surface water are presented in Section 2.3.2.1.4. The ground water demands, regulations governing ground water withdrawal permits, and the ongoing comprehensive assessment of ground water resources in the vicinity of BBNPP are described and discussed in Section 2.3.2.2.4 through Section 2.3.2.2.7.

5.2.1.2 Plant Water Use

The following sections describe sources and uses of water associated with BBNPP. Additional detail on water sources, rates of consumption and return, and amounts used by various plant operating systems during normal operations and outages is presented in Section 3.3.

The average water demand from the Susquehanna River for plant operation is estimated at 25,729 gpm (97,384 lpm). During refueling outages, which occur approximately every eighteen months and last approximately 1 month, the maximum cooling water demand will rise to 28,179 gpm (106,656 lpm) for the initial period of plant cool down.

As described in Section 5.8.2, during outages, the permanent onsite workforce of approximately 363 would increase by an estimated 1000 additional workers. As discussed in Section 3.3, it is estimated that potable water demand from the municipal water supply and the associated sanitary effluents would increase from 103 gpm (390 lpm) during normal operations, to 236 gpm (893 lpm) during major outages.

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5.2.1.2.1 Surface Water

BBNPP is designed to use the minimum amount of water necessary to ensure safe, long-term operation of the plant. The intake for BBNPP (Circulating Water System (CWS) Intake Structure) will be located just downstream of the existing intake structure for SSES. The discharge outfall will enter the Susquehanna River downstream of the existing SSES discharge system through a buried pipe that will be connected to an approximately 120 ft (36.6 m) long multi-port diffuser positioned perpendicular to the Susquehanna River flow with 72 individual 4 in (10.2 cm) ports spaced 18 in (46 cm) apart. The first port will be located approximately 212 ft (64.6 m) offshore. Additional details on the intake and discharge systems are presented in Section 3.4. Water withdrawals for the operation of BBNPP are described in detail in Section 3.3.1.

5.2.1.2.1.1 Plant Construction

The primary water demands during construction are concrete mixing and curing, dust control, and potable water. Water for construction will come from the local public water supply once the line is brought to the site. Prior to the availability of the public water supply, water will be trucked in and stored onsite in temporary tanks. Ground water extracted via excavation dewatering will be used when possible for construction purpose but not for drinking water. Estimated average construction water demand on work days may range from 77,800 gpd (294,000 lpd) to 138,000 gpd (522,000 lpd). Construction uses of water are described in more detail in Table 5.2-2.

Construction water use is assumed to be entirely consumptive. Temporary dewatering will be required during excavation of the power block and ESWEMS Pumphouse foundations. This dewatering will have a temporary effect on the ground water supply. Section 4.2 further addresses water-related impacts of plant construction.

5.2.1.2.1.2 Circulating Water System and Essential Service Water System

BBNPP will utilize a closed-loop CWS System. The system will use two hyperbolic natural draft cooling towers for heat dissipation. The cooling tower system requires makeup water to replace that lost to evaporation, drift (entrained in water vapor), and blowdown (water released to regulate the concentration of solids in the circulating water).

Makeup water for the natural draft CWS cooling tower system will be withdrawn from the Susquehanna River. Based on Susquehanna River chemistry, three cycles of concentration were conservatively selected for cooling tower operation. This is consistent with typical cooling tower operation of 3 to 5 cycles of concentration when using surface water makeup. Maximum makeup and blowdown rates occur at this value. As indicated in Section 3.4, makeup water for the CWS will be pumped at a maximum rate of 23,808 gpm (90,113 lpm). At this makeup rate, water lost by evaporation will be approximately 15,872 gpm (60,076 lpm) and blowdown returned to the Susquehanna River will be approximately 7,928 gpm (30,007 lpm). The CWS water balance is affected minimally by cooling tower drift. Maximum drift losses will be less than 0.001% of the circulating water flow (720,000 gpm (2.73 million lpm)). This results in a maximum drift of 8 gpm (30 lpm).

The Essential Service Water System (ESWS), under normal plant operations with two trains operating, will operate at a nominal circulating flow rate of approximately 19,200 gpm (72,672 lpm). Normal Makeup for the ESWS will be withdrawn from the Susquehanna River. As discussed in Section 3.6.1, the ESWS cooling towers are expected to operate with at least three cycles of concentration. The maximum makeup and blowdown rates occur at this value. The water makeup rate required under normal operations is estimated to be 1,713 gpm (6,484 lpm) to offset an evaporation rate of approximately 1,142 gpm (4,322 lpm) and a maximum

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blowdown rate of approximately 569 gpm (2,154 lpm), and drift loss of approximately 2 gpm (8 lpm).

Water released to the Susquehanna River as blowdown is not lost to downstream users or downstream aquatic communities. Evaporative losses and drift losses are considered "consumptive" losses.

5.2.1.2.2 Ground Water Use

Ground water monitoring wells are installed on the site to study and model the ground water in the BBNPP site vicinity as described in Section 2.3. Ground water withdrawals will not be used during construction (except for water extracted via excavation dewatering) or to support operation of BBNPP.

5.2.1.3 Hydrological Alterations

Operational activities that could result in hydrological alterations within the site and vicinity and at offsite areas are described in Section 3.3, 3.4, and 3.7.

The principal hydrological alterations on site associated with BBNPP will occur during construction, when one pond (Farm Pond) within the site boundary will be filled and two sections of Walker Run (main stem and Unnamed Tributary No.1) will be filled and re-located. In the Canal, temporary cofferdams will be constructed to allow placement of the water intake and discharge lines. Walker Run may also be impacted by either sedimentation or reduced water flow due to measures taken to reduce sedimentation, as described in Section 4.3.2. Once construction is completed, and normal operations begin, it is expected that Walker Run will experience little ongoing impact.

There have been no clearly discernible onsite or offsite effects from hydrologic alterations related to the operation of SSES Units 1 and 2, and the supply of surface water from the North Branch of the Susquehanna River has been sufficient. Operation of BBNPP with a closed-loop cooling system will result in minimal additional effects on withdrawals and discharges. The use of a closed-loop cooling sytem will result in reduced operational effects as compared to an open-loop, once-through cooling system.

The BBNPP CWS Makeup Water Intake Structure will be located downstream of the existing intake structure for SSES. A sheet pile cofferdam and dewatering system will be installed to facilitate construction of the CWS Makeup Water Intake Structure. Pilings may also be driven to facilitate construction of new discharge system piping. This will not affect river levels or flow velocities.

Excavation of the CWS Makeup Water Intake Structure, pump house erection and the installation of mechanical, piping, and electrical systems follow the piling operations and continue through site preparation into plant construction. Excavated material will be transported to an onsite spoils area located outside the boundaries of designated wetlands.

5.2.2 WATER USE IMPACTS

5.2.2.1 Surface Waters

5.2.2.1.1 Consumptive Use

The maximum evaporation and drift from the BBNPP CWS cooling towers is estimated to be approximately 15,880 gpm (60,106 lpm). Evaporation and drift from the ESWS cooling towers,

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during normal operations, are estimated to be 1,144 gpm (4,330 lpm). Minor consumptive losses of 40 gpm (151 lpm) are expected from various power plant systems.

Consumptive uses of water during construction of BBNPP include concrete mixing and curing, dust control, and potable and sanitary water. Peak consumptive water use will occur for several years during construction, and will be approximately 39 million gpy (149 million lpy). A breakdown of construction water use by year is provided in Table 5.2-2.

The mean discharge of the Susquehanna River at Wilkes-Barre is 12,800 ft^3/sec (362.5 m^3/sec) (i.e., 5,745,039 gpm (21,747,338 lpm)) and the 7-day, 10-year low flow (7Q10) rate is 890 ft^3/sec (25.2 m^3/sec) (i.e., 399,460 gpm (1,512,121 lpm)) for the post-regulation period, 1980 to 1996 (USGS, 2008). The volume of water that will be lost to evaporation and drift from the BBNPP cooling towers and ESWS cooling towers is less than 1% of the mean discharge of the Susquehanna River and approximately 4.3% of the 7Q10 low flow discharge. No measurable impact of consumptive water use on river discharge during normal flows is expected, and operation of the BBNPP will therefore have a SMALL impact on the availability of water from the Susquehanna River (USGS, 2008).

5.2.2.1.2 Non-Consumptive Use

Non-consumptive uses of water downstream from the plant are described in Section 2.3.2.1.3. The major non-consumptive surface water use categories in the vicinity of the site are recreation, fisheries, and parks. The recreational activities include swimming, fishing and boating in the Susquehanna River. The river fishery is described in Section 2.4.2.

The existing intake structure for SSES Units 1 and 2 is located on the west bank of the Susquehanna River. The CWS Makeup Water Intake Structure will be located on the west bank just downstream of the existing SSES intake structure.

The CWS Makeup Water Intake Structure will meet the U.S. Environmental Protection Agency (EPA) 316(b) Phase 1 design criteria, as described in Section 5.3.1.1. The overall percentage of Susquehanna River water entrained will be less than 1% during average flow conditions.

While fish impingement and entrainment will occur, BBNPP will employ the impingement/ entrainment mitigation techniques (low through-screen velocity, closed-cycle cooling, etc.) currently utilized by SSES to minimize the impact on aquatic resources. The fish loss associated with impingement/entrainment will be negligible. There is no need for a fish return system because the intake structure meets the EPA 316(b) Phase I rule requirements and minimal losses of fish are expected due to impingement. Design through-screen velocities for the CWS Makeup Water Intake Structure will be less than 0.5 ft/s (0.15 m/s).

The primary external impact will be the discharge of cooling tower blowdown water to the Susquehanna River. During normal operations, the BBNPP maximum discharge (predominately cooling tower blowdown) is estimated to be 9,367 gpm (35,454 lpm). Prior to discharge into the river, the cooling tower blowdown and other plant effluents will be sent to a retention basin, thus slightly reducing thermal impacts to receiving waters.

No effect on fisheries, navigation, or recreational use in the Susquehanna River is expected.

5.2.2.2 Ground Water

Onsite ground water withdrawals will not be used to support operation of BBNPP.

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5.2.3 WATER QUALITY IMPACTS

Water quality data for the Susquehanna River are presented in Section 2.3.3.

5.2.3.1 Chemical Impacts

Proper heat transfer is necessary for satisfactory nuclear power plant operation. To maintain effective heat transfer capabilities, various chemical control measures are employed in water treatment systems. These control measures are discussed below.

BBNPP will utilize cooling tower-based heat dissipation systems that remove waste heat by allowing water to evaporate to the atmosphere. The water lost to evaporation must be continuously replaced with makeup water. To prevent build-up of solids, a small portion of the circulating water stream is drained or blown down to the river.

Because cooling towers concentrate solids (minerals and salts) and organics that enter the system in makeup water, cooling tower water chemistry must be maintained with anti-scaling compounds and corrosion inhibitors. Similarly, because conditions in cooling towers are conducive to the growth of fouling bacteria and algae, biocides must be added to the system. Biocides are normally chlorine or bromine-based compounds, but occasionally non-oxidizing biocides are used as well. Table 3.3-2 lists the water treatment chemicals that are proposed for use at BBNPP. Section 5.3 specifically deals with the impacts of the cooling systems. The combined effects that both discharges (SSES and BBNPP) will have on the Susquehanna River will be considered in developing the National Pollutant Discharge Elimination System (NPDES) Permit for BBNPP

Limited treatment of raw water to prevent biofouling in the intake structures and makeup water piping may be required. Additional water treatment will take place in the cooling tower basin, and may include the addition of biocides, acid for alkalinity and pH control, anti-scaling compounds, corrosion inhibitors, and foam dispersants. Sodium hypochlorite is expected to be used to control biological growth in the CWS, ESWS, and RWSS.

The NPDES permit will be acquired prior to the startup of BBNPP. This permit will specify threshold concentrations of Free Available Chlorine (when chlorine is used) and Free Available Oxidants (when bromine or a combination of bromine and chlorine is used) in cooling tower blowdown when the dechlorination system is not in use. It is expected that the BBNPP NPDES permit will contain discharge limits for discharges from the cooling towers that are similar to SSES.

Based on Susquehanna River chemistry, three cycles of concentration were conservatively selected for cooling tower operation. This is consistent with typical cooling tower operation of 3 to 5 cycles of concentration when using surface water makeup. As a result, levels of solids and organics in cooling tower blowdown will be approximately three times as high as ambient concentrations in the Susquehanna River. Blowdown wastewater from the cooling towers will discharge to a retention basin to allow time for settling of suspended solids and to allow additional chemical treatment of the wastewater, if required, prior to discharge to the river. The final discharge from the retention basin will consist of cooling tower blowdown from the CWS and ESWS cooling towers, RWSS filter backwash discharge, miscellaneous low volume wastes, and other plant effluents.

The RWSS supplies filtered water from the Susquehanna River to the Demineralized Water Treatment System, Fire Protection System, Essential Service Water System (except under emergency operating conditions) and the ESWEMS Retention Pond during normal power

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operation, shutdown, maintenance, and construction with a normal flow of 1,921 gpm (7,271 lpm) and a maximum flow of 4,371 gpm (16,544 lpm). The RWSS pumps will be located in the CSW Makeup Water Intake Structure, and will utilize the CSW makeup pump traveling screens.

The RWSS has both continuous and intermittent water demand. The single largest intermittent demand is backwashing the media filters used to remove suspended solids from the Water Treatment Building's raw water. The backwash flow from the media filters will be discharged to the retention pond adjacent to the Water Treatment Building.

Under normal conditions, 8,665 gpm (32,797 lpm) of water will be discharged by pipe from the retention basin into the Susquehanna River; a maximum discharge of 9,367 gpm (35,454 lpm) is anticipated. Because the discharge stream volume will be small relative to the volume of the Susquehanna River, concentrations of solids and chemicals used in cooling tower water treatment will rapidly dilute and approach ambient concentrations in the river after exiting the discharge pipe.

The operation of BBNPP will comply with a Pennsylvania Department of Environmental Protection-issued NPDES permit, and the applicable State water quality standards. All biocides or chemical additives in the discharge will be among those approved by the EPA and the Commonwealth of Pennsylvania as safe for humans and the environment.

Based on the above, impacts of chemicals in the permitted blowdown discharge wastewater to the water quality of the Susquehanna River will be negligible and are not expected to warrant mitigation.

5.2.3.2 Thermal Impacts

As noted in Section 5.3.2.1, discharges from BBNPP will be permitted under the NPDES program, which regulates the discharge of pollutants into waters of the State. In this context, waste heat is regarded as a thermal pollutant and is regulated in much the same way as chemical pollutants. Thermal discharges are also regulated under the Pennsylvania Code Chapter 93, Water Quality Standards (PA, 2007). Further information describing thermal discharge and the physical impacts associated with operation of BBNPP is presented in Section 5.3.2.1.1.

The BBNPP multi-port diffuser discharge system is designed to minimize the potential impact of the thermal plume as it enters the Susquehanna River. The subsurface diffusers create rapid mixing of the thermal effluent with ambient river currents. The volume of river discharge largely determines plume size and shape. However, the areal extent of the plume is predicted to be minimal under normal and extreme river and operating conditions (Section 5.1).

5.2.3.3 SSES Units 1 and 2 Discharge

Descriptions of the discharge location for SSES Units 1 and 2 and the discharge location for BBNPP are provided in Section 5.3.2. The discharge for SSES influences the discharge of BBNPP due to its discharge mixing zone. The two discharge locations and the combined effects of the two discharges will meet environmental regulations in order to be permitted.

5.2.3.4 Discharge Mixing Zone

The discharge outfall for BBNPP will be located in the Susquehanna River, approximately 380 ft (116 m) downstream of the SSES discharge structure. The discharge piping will extend out from the river bank and connect to an approximately 120 ft (36.6 m) long multi-port diffuser. The diffuser will consist of a pipe having 72, 4-in (10-cm) diameter port holes spaced at 18 in (45

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cm) intervals. The centerline elevation of the discharge ports is 12 in (18 cm) above the normal river bottom.

5.2.3.5 Site Surface Water Impacts

The existing and proposed surface water bodies within the BBNPP site are described in Section 2.3.1 and Section 4.2.1. The potential for these bodies to be impacted by site operations are dependent upon operational conditions related to: site safety and spill containment training, a Spill Prevention Control and Countermeasures Plan (SPCCP), and a Stormwater Pollution Prevention Plan (SWPPP). These plans are addressed in Section 1.3.

Spills or operational debris potentially occurring on outdoor facilities could mix with site precipitation or washing wastewater and be conveyed to downstream impoundments, creeks, and the river. If proper spill and stormwater pollution prevention plans are implemented and practiced, the majority of polluted runoff can be controlled and prevented from escaping the BBNPP site. A monitoring plan implemented under the regulatory guidance for surface and ground water monitoring could identify future sources of pollution. Those areas could be addressed and point-sources of pollution removed before the area water bodies are impacted further.

Environmental impacts on water quality during construction and operations for BBNPP will be minimal. Ground water will not be used by BBNPP during plant operations. Water resulting from temporary dewatering during excavation of the power block and ESWEMS Pumphouse foundations will be used when possible for construction purposes, but not for drinking water. Surface water runoff and sedimentation effects will be minimized by implementation of a site safety plan, SPPP, and a SWPPP.

A retention basin will collect cooling tower blowdown and other plant effluents during plant operation. Effluent from the waste water retention basin, which will contain dilute quantities of chemicals and dissolved solids, and be elevated in temperature, will be discharged to the Susquehanna River within the limits of the site NPDES permit. When discharged and diluted, this small amount of discharge water would be expected to have SMALL impacts.

5.2.4 REFERENCES

PA, 2007. PA Code Section 93.7, Specific Water Quality Criteria, Amended January 5, 2007.

USGS, 2008. Low flow statistics for Pennsylvania streams, Website: http://pa.water.usgs.gov/pc38/flowstats/lowflow.ASP?WCI=stats&WCU;ID=2428, Date accessed: May 30, 2008.

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Table 5.2-1—RWSS Demand for Normal Operations

System	Demand	
	gpm	lmp
Essential Service Water System (ESWS) Makeup	1,713	7,124
Demineralized Water Distribution System (DWDS) Makeup	107	405
Fire Water Distribution System (FWDS) Makeup	5	19
Power Plant Floor Wash Drains	5	19
RWSS Filter Backwash Makeup	91	344
ESWEMS Retention Pond Makeup	Note 1	Note 1
Total	**1,921**	**7,271**

Notes:

1. Although the RWSS is designed to provide the ESWEMS Retention Pond with makeup water, it is expected based on the operating experience of the adjacent SSES that rainfall captured in the pond will generally exceed evaporative losses, and that under normal operating conditions only a minimal amount of makeup water will be required

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Table 5.2-2—Estimated Fresh Water Demand During BBNPP Construction

Construction Year	Year 1 gal (L)	Year 2 gal (L)	Year 3 gal (L)	Year 4 gal (L)	Year 5 gal (L)	Year 6 gal (L)
Potable and Sanitary	8,550,000[a] (32,361,750)	25,650,000[b] (97,085,250)	25,650,000[b] (97,085,250)	25,650,000[b] (97,085,250)	25,650,000[b] (97,085,250)	--
Concrete Mixing and Curing[c]	2,219,844 (8,402,110)	2,219,844 (8,402,110)	2,219,844 (8,402,110)	2,219,844 (8,402,110)	2,219,844 (8,402,110)	--
Dust Control[d]	11,400,000 (43,149,000)	11,400,000 (43,149,000)	11,400,000 (43,149,000)	11,400,000 (43,149,000)	11,400,000 (43,149,000)	--
Total	22,169,844 (83,912,860)	39,269,844 (148,636,360)	39,269,844 (148,636,360)	39,269,844 (148,636,360)	39,269,844 (148,636,360)	26,179,896[e] (99,090,906)

Notes:

(a) Estimated at 1,000 persons using 30 gallons per day for 285 days per year.

(b) Estimated at 3,000 persons using 30 gallons per day for 285 days per year.

(c) Estimated at 6,700 cubic yards per month using 27.61 gallons per cubic yard and 12 months per year.

(d) Estimated at 40,000 gallons per day for 285 days per year.

(e) Estimated at two-thirds of the amount used in years 2 through 5.

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5.3 COOLING SYSTEM IMPACTS

This section describes potential impacts from operation of the cooling systems at BBNPP. The BBNPP Circulating Water System (CWS) and Essential Service Water System (ESWS) (Ultimate Heat Sink (UHS)) will be closed-cycle systems. Water is recirculated through cooling towers to remove waste heat, primarily through evaporation. The amount of water required to be withdrawn for these systems is small compared to that of once-through cooling systems. To replace evaporative losses, blowdown, and drift losses from the cooling towers, makeup water from the Susquehanna River is supplied to the CWS and to the ESWS. The CWS will be supplied directly from the CWS Makeup Water Intake Structure. The Raw Water Supply System (RWSS) will supply makeup water from the CWS Makeup Water Intake Structure to the cooling towers associated with the ESWS during normal and shutdown/cooldown conditions. Under post-accident conditions lasting longer than 72 hours, the ESWS is supplied from an onsite ESWEMS Retention Pond.

Potential physical and aquatic impacts are associated with water withdrawal from the Susquehanna River at the CWS Makeup Water Intake Structure, heat dissipation to the atmosphere from the cooling towers, and elevated temperature of the blowdown as it is returned to the Susquehanna River.

5.3.1 INTAKE SYSTEM

The CWS Makeup Water Intake Structure is located 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. The CWS Makeup Water Intake Structure will be an approximately 124 ft (37.8 m) long, 90 ft (27.4 m) wide structure with three individual pump bays. In the intake structure, one CWS pump and one RWSS pump are located in each pump bay, along with one traveling screen. Section 3.4 provides the details regarding the design of these structures and systems.

Section 3.4.1.1 identifies that the maximum makeup flow from the Susquehanna River to the CWS is 23,808 gpm (90,113 lpm) during normal shutdown/cooldown. This accommodates the maximum evaporation rate, maximum blowdown rate, and drift loss for the CWS cooling towers.

Section 3.4.1.2 identifies that the maximum makeup flow from the Susquehanna River to the ESWS cooling towers will be 3,426 gpm (12,967 lpm) to accommodate the maximum evaporation rate and drift loss for the ESWS cooling towers during normal shutdown/cooldown.

The CWS Makeup Water Intake Structure is located approximately 300 ft (91.4 m) downstream of the existing SSES Units 1 and 2 River Intake Structure. The SSES River Intake Structure houses four pumps, each with a pumping capacity of 13,500 gpm (51,103 lpm).

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

Physical impacts of cooling water intake operation could include alteration of site hydrology and modifications to sediment deposition. BBNPP will employ closed-cycle, cooling tower-based heat dissipation systems to remove heat from the main steam condenser, and safety-related and auxiliary cooling systems. The relative volume of water withdrawn through the intake will be small compared to both a once-through cooling system and the average annual flow of the Susquehanna River at the site. At a maximum withdrawal rate of 28,179 gpm (106,656 lpm), which includes maximum flow for both the CWS and RWSS, BBNPP should remove less than 1% of the average annual flow of the Susquehanna River, 10,700 cfs (303.0 m^3/sec), and 7% of the 7Q10 flow calculated at 890 cfs (25.2 m^3/sec), as measured at the Wilkes-

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Barre USGS gage located about 20 mi (32 km) upstream from the BBNPP site, as discussed in Section 2.3.2.1.2. Water withdrawal is not expected to significantly alter the flow pattern of the Susquehanna River as it travels past the intake.

Periodic sediment removal via dredging may be required to maintain the depth of the area immediately in front of the entrance to the intake structure. Dredging activities will be performed in accordance with U.S. Army Corps of Engineers and Commonwealth of Pennsylvania requirements. Dredging impacts are expected to be SMALL due to the limited size of the intake structure.

Based on the facts that: 1) the amount of cooling water makeup withdrawn from the Susquehanna River will be small compared to a once-through cooling system; 2) the BBNPP water withdrawal from the Susquehanna River as a percentage of the rivers' average annual flow is low; and 3) the water intake velocities will be less than 0.5 ft/sec (0.15 m/sec), it is concluded that the physical impacts of the BBNPP intake will be SMALL.

5.3.1.2 Aquatic Ecosystems

Aquatic impacts attributable to the operation of the CWS Makeup Water Intake Structure are impingement and entrainment. Impingement occurs when larger organisms become trapped on the intake screens, and entrainment occurs when small organisms, suspended in the water column, pass through the traveling screens and subsequently through the cooling water system. Factors that influence impingement and entrainment include cooling system and intake structure location, design, construction, and capacity. Clean Water Act Section 316(b) requires that cooling water intakes be designed to represent the Best Technology Available (BTA) for minimizing adverse environmental impact for these factors. The U.S. Environmental Protection Agency (EPA) promulgated regulations implementing Section 316(b) in 2001 for new facilities (Phase I) (USEPA, 2001). The BBNPP intake and cooling water systems conform to these regulations.

The U.S. EPA design criteria for Phase I new facilities are as follows:

- Reduce intake flow, at a minimum, to a level commensurate with that which can be attained by a closed-cycle, recirculating cooling water system,
- Achieve a maximum through-screen intake velocity of 0.5 ft/sec (0.15 m/sec),
- For a facility on a fresh water river, intake flow must be less than or equal to 5% of the mean annual flow,
- Select and implement design and construction technologies or operational measures for minimizing impingement mortality of fish and shellfish, if:
    - There are threatened, endangered or otherwise protected species potentially impacted
    - Migratory, sport or commercial species pass through the hydraulic zone of influence
- Select and implement design and construction technologies or operational measures for minimizing entrainment of entrainable life stages of fish and shellfish, if:

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- There are threatened, endangered or otherwise protected species potentially impacted
- There would be undesirable cumulative stressors affecting entrainable life stages of species of concern.

The CWS Makeup Water Intake Structure will meet the U.S. EPA Phase 1 criteria as discussed above: BBNPP will employ closed-cycle, recirculating water cooling systems as discussed in Section 3.3 and Section 3.4. The percentage of Susquehanna River mean annual flow pumped through the CWS Makeup Water Intake Structure should be less than 1% at the maximum water demand of 28,179 gpm (106,636 lpm); and intake design through-screen velocities will be less than 0.5 ft/sec (0.15 m/sec). The water intake will feature bar grating to prevent large objects from entering the intake structure and a trash rake to clean the bar grating. A curtain wall will protrude down into the pumphouse bays to prevent any floating debris that passes the bar grating from approaching the pumps. The curtain wall will extend below the minimum water level in the forebay. The inlet area limited by the curtain wall will be sized large enough to maintain a flow velocity of less than 0.5 ft/sec (0.15 m/sec) during maximum flow through the inlet. Dual-flow traveling screens will screen the incoming water ahead of the pumps. Debris and aquatic organisms washed off of the traveling screens will be deposited into trash receptacles. As discussed below, based on current sampling data available at the SSES River Intake Structure and other locations on the Susquehanna River, additional design and construction technologies or operational measures to minimize impingement and entrainment are not required.

The CWS Makeup Water Intake Structure will be located approximately 300 ft (91 m) downriver of the existing SSES River Intake Structure. As such, information related to impingement and entrainment at the SSES River Intake Structure will be useful in predicting potential impingement and entrainment at the CWS Makeup Water Intake Structure. An entrainment study was completed in 1981 at the SSES River Intake Structure. Limited historic impingement sampling occurred at SSES in years when larval American shad were stocked upriver from SSES Units 1 and 2. This sampling was performed in the early fall and focused on impingement of outmigrating American shad young-of-year. No young-of-year American shad were collected during these investigations. In addition, two recent impingement studies have been completed at generating stations upstream and downstream of the BBNPP site which are used to evaluate potential impacts of the CWS Makeup Water Intake Structure on aquatic species present within the Susquehanna River. Impingement monitoring was performed during a year-long study in 2006 at Hunlock Power Station, which is approximately 10 mi (16 km) upstream from BBNPP. Impingement monitoring was also completed approximately 100 mi (161 km) downstream from BBNPP at Brunner Island Steam Electric Station (BISES) for a full year from 2005 to 2006. The study at BISES has very limited applicability to evaluation of potential impingement at BBNPP, but it is the most current impingement data known from a riverine section of the Susquehanna River.

The 1981 entrainment study at SSES Units 1 and 2 was completed during four sampling events, two in May, and once each in June and July (PPL, 1982). During each sampling event, samples were collected eight times. Each sample consisted of three replicate 5-minute samples, at both the surface and bottom of the water column, at the entrance to the SSES River Intake Structure. This sampling format yielded a total of seventy-two 5-minute samples during each sampling event. During the entrainment study, a total of 18 species and 3,374 larval fish was collected. Six species accounted for 82% of the total entrainment. Quillback was the most numerous (37%) followed by common carp (22%), tessellated darter (11%), spottail shiner (8%), and

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spotfin shiner (4%). Recreationally important species accounted for only a small percentage of the entrained organisms. No endangered, threatened, or rare species were collected.

Hunlock Power Station (HPS) consists of a 50 MWe coal-fired unit and a 44 MWe combustion turbine. The station withdraws water from the Susquehanna River through two conventional traveling screens. It is an open, once-through cooling system. However, the cooling water volumes are small and similar to those of SSES and the proposed BBNPP. The maximum plant intake flow rate during the study sampling events was 58.2 million gpd (220 million lpd) which is roughly comparable to the estimated maximum volume for BBNPP of 40.6 million gpd (154 million lpd). The impingement study performed in 2006 consisted of thirty-seven, 24-hour sampling events distributed throughout the year. A total of 282 fish representing 16 species was collected. This equates to 7.6 fish per day or approximately 228 fish per month. Gizzard shad was the numerically dominant species, accounting for 39% of the total impingement catch. Other abundant species included bluegill (23%), channel catfish (20%), and white crappie (5%). Note that most of the impingement (53%) occurred during two sampling events in the early fall and was associated with high river flows. No endangered, threatened, or rare species were collected.

Brunner Island Steam Electric Station (BISES) consists of three coal-fired generating units. The total generating capacity of the three units is 1,483 MWe. The station withdraws water from the Susquehanna River through three conventional traveling screens. BISES has a once-through, open-cycle cooling system. Thus, substantially greater volumes of water are withdrawn from the Susquehanna River as compared to the closed-cycle CWS at BBNPP. The total maximum volume of cooling water withdrawn from the Susquehanna River at BISES is 795 million gpd (3,009 million lpd)) compared to a maximum estimate of 40.6 million gpd (154 million lpd) at BBNPP. The impingement study conducted during 2005 to 2006 at BISES consisted of forty, 24-hour sampling events and yielded 399,490 individuals of 39 fish species (Klienschmidt, 2007). This equates to 9,987 fish per day or approximately 299,617 fish per month. Gizzard shad was the dominant species, comprising 93% of all fish impinged. Smallmouth bass, the second most abundant species, accounted for 4% of the total impingement catch. Other common species included channel catfish, bluegill, flathead catfish, and spotfin shiner. No endangered, threatened, or rare species were collected.

A year-long impingement and entrainment study was conducted at the SSES River Intake Structure during 2008 and 2009. The program included weekly entrainment sampling during the fish spawning period, April to August 2008 and March to April 2009, and weekly impingement sampling from April 2008 to April 2009. Two entrainment samples were collected during the night on the same day each week. Each sample consisted of approximately 28,000 gal (105,992 l) of water that was pumped from the entrance of the intake structure. Weekly impingement samples were completed by collecting all materials washed from the SSES River Intake Structure traveling screens over a 24-hr period. Both the impingement and entrainment sampling programs were initiated on April 22, 2008.

The impingement study collected a total of 45, 24-hr samples. Over the entire sampling period, a total of 398 fish and crayfish was collected (Table 5.3-10). Crayfish (*Orconected* sp.) was the dominant organism, with 220 individuals collected representing 55.3% of the total impingement. The remainder of the impingement catch was composed of 178 fish representing 18 species. the most abundant fish was bluegill, representing 11.1% of the total. Other abundant fish as a percentage of the total impingement were rock bass (8.5%), channel catfish (7.8%), tessellated darter (4.5%), and spotfin shiner (4.0%). Other species that represented at least 1% of the total impingement catch included spottail shiner, margined madtom, smallmouth bass, white crappie, and white sucker.

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The impingement catch was low throughout the study period with little week-to-week variation (FIgure 5.3-5). Impingement catch was the highest during a period from mid-February through April. A maximum of 42 fish and crayfish was collected during a single 24-hr sampling period on March 31. Fish or crayfish were collected on each collection date except for December 30.

Impingement was estimated for the entire year from April 2008 to April 2009. The total annual estimated impingement at SSES was 3,228 fish and crayfish. This equates to an average of 8.8 fish and crayfish per day and approximately 264 fish and crayfish per month. Estimates for fish alone were 3.95 per day, 120 per month and 1.442 per year.

Thrity-four entrainment samples were collected during 2008 over the 17 week sampling period. A total of 17 species and 3,039 fish were collected in the 34 samples (Table 5.3-11). Quillback (27.2%), Cyprinidae (17.6%), unidentified darter (12.6%), channel catfish (12.1%), common carp (11.4%), and white sucker (9.4%) were the numerically most abundant taxa. Other species that were colleted include the brown bullhead, chain pickerel, margined madtom, shield darter, rock bass, smallmouth bass, walleye, tessellated darter, banded darter, yellow perch, and spottail shiner.

A majority (55.9%) of the entrainment fish were larvae in the post yolk-sac life stage. Yolk-sac larvae was the second most abundant life stage comprising 17.0% of all individuals with the numbers of young-of-the-year (YOY) and the unknown life stage also being substantial, 14.1% and 12.9%, respectively. Only four yearling-plus individuals were collected and no fish eggs were collected in the entrainment samples during 2008.

Temporal variation in fish entrainment was evident with a majority of the fish being collected from the first week in May to mid-June (Figure 5.3-6). Few fish were collected in entrainment samples during April. The number of entrained fish was variable during July and August with two larger collections ocurring during the first week in July and the first week of August. The single largest entrainment sample collection ocurred on May 6 when 250 individuals were collected.

The overall estimated number fo fish entrained during the 2008 sampling period was 13,324,384 individuals. Cyprinidae was estimated to be the most abundant taxon entrained, comprising 21.5% of the total entrainment estimate. Other abundant taxa included channel catfish (19.3%), quillback (16.2 %), unidentified darter (12.3%), white sucker (9.8%), and common carp (6.7%).

Ten entrainment samples were collected during 2009 over the five week sampling period. A single Catostomidae egg was collected. The egg was collected on April 17, the last sampling event during 2009. No fish larvae or yearlings were collected. Estimated entrainment during the 2009 sampling period was 7,022 catostomid eggs.

No endangered, threatened, or species of special concern were collected in the impingement or entrainment samples. In addition, no migratory species (American Shad or American eel) were collected in the impingement or entrainment samples.

The report of the completed Impingement and Entrainment study is provided in COLA Part 11K.

Based on compliance with the 316(b) Phase I design criteria as well as the aforementioned impingement and entrainment data at SSES, HPS, and BISES, the CWS Makeup Water Intake

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Structure is not expected to have a substantial adverse effect on the Susquehanna River fish assemblage. The probability of entrainment and impingement will be low compared to other generating stations located on freshwater rivers. Importantly, no endangered, rare, or threatened fish species have been collected from the Susquehanna River in the vicinity of the BBNPP site. Numbers of recreationally important species that may be impinged at BBNPP will be low based on both the SSES and HPS data. Similarly, recreational species were entrained in low numbers at SSES during the 1981 and current entrainment study. Furthermore, low numbers of recreationally important fish species are likely to be entrained at BBNPP due to the reproductive strategy employed by these fishes (i.e., most are nest builders) and the location of spawning in relation to the CWS Makeup Water Intake.

The only species of special concern identified in the Susquehanna River in the vicinity of the proposed CWS Makeup Water Intake Structure are the mussels, green floater (subviridis) and yellow lampmussel (Lampsilis cariosa) as discussed in Section 2.4.2. It is highly unlikely that juveniles or adults of these species will be susceptible to impingement or entrainment. Mussels are burrowing, bottom oriented species and it is unlikely that these organisms would become entrained in the water column and enter the CWS Makeup Water Intake Structure. Neither of these species has been collected in impingement studies at SSES, BISES, or HPS. However, the small possibility does exist that fish that have been infected with glochidia (mussel larvae) could become entrained or impinged. This occurrence could make the glochidia susceptible to both entrainment and impingement. The host fish species for larvae of green floater are unknown. Yellow lampmussel glochidial hosts include white perch and yellow perch. No white perch were collected during impingement and entrainment sampling at SSES during 2008. Yellow perch was collected in low numbers in both entrainment (n=52) and impingement samples (n=3) at SSES during 2008.

Finally, because the proposed cooling tower-based heat dissipation system will withdraw small amounts of Susquehanna River water, the design of the CWS Makeup Water Intake Structure incorporates a number of features that will reduce impingement, and the results of fisheries studies performed in the vicinity of the SSES River intake suggest that the Susquehanna River fish populations have not been adversely affected by operation of SSES Units 1 and 2. It is concluded that the CWS Makeup Water Intake Structure impacts will be SMALL and will not warrant mitigation measures.

5.3.1.3 References

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5.3.2 DISCHARGE SYSTEM

5.3.2.1 Thermal Description and Physical Impacts

A description of the cooling water system in general, and the blowdown return in particular, to the Susquehanna River is found in Section 3.4. Parameters important to estimating the thermal impacts of the blowdown discharge are summarized in this section.

In assessing the impact of the thermal discharge from the BBNPP, the average total effluent discharge flow was conservatively estimated to be 11,172 gpm (42,290 lpm). The BBNPP discharge structure will consist of a subsurface multi-port diffuser located approximately 720 ft (220 m) south of the CWS Makeup Water Intake Structure, extending about 310 ft (95 m) into the river at a depth of 10 ft (3.05 m). The diffuser will be similar to the existing SSES diffuser and will consist of seventy-two, 4 in (10 cm) nozzles located close to the bottom. The subsurface diffuser will rapidly mix blowdown discharge with the Susquehanna River.

The temperature rise from intake to the blowdown discharge will vary with electrical generation and seasonally with performance of the cooling tower. For the purposes of thermal plume modeling, a maximum summertime delta-T of 3.5°F (1.9°C) and a maximum winter time delta-T of 33.8°F (18.8°C) were assumed.

5.3.2.1.1 Susquehanna River Datasets

To capture the seasonal behavior of the thermal plume, a summer and a winter period were chosen for simulation. An examination of daily observations of Susquehanna River temperature at SSES from 1974 to the present showed a maximum temperature of 86.5°F (30.3°C) recorded on August 15, 1988 and on August 4, 2007. A minimum water temperature of 32.0°F (0.0°C) was recorded numerous times in January. August and January were therefore selected as representative months for simulation.

Susquehanna River flows, upstream of the BBNPP at the Wilkes-Barre gauge, shows a value of 890 cfs for the annual 7-day, 10-year low flow (7Q10). This annual 7Q10 value was multiplied by Pennsylvania Department of Environmental Protection default multiplier to convert the annual 7Q10 to a monthly 7Q10 rate. The multiplier for January is 3.2, and the multiplier for August is 1.4 (PADEP, 2003), yielding a January 7Q10 of 2,848 cfs (80.6 m^3/sec) and an August 7Q10 of 1,246 cfs (35.3 m^3/sec). For comparison, the monthly mean flows are 12,482 cfs (353.5 m^3/sec) and 4,473 cfs (126.7 m^3/sec) for January and August, respectively (USGS, 2008a) (USGS, 2008b).

Bathymetric data in the vicinity of BBNPP were developed from two sources: US Army Corps of Engineers, Philadelphia District (USACE) provided digital terrain maps (TIN's), shoreline data in ARC/INFO interchange file format (e00), and cross-section data from their FEMA HEC-RAS model (Arabatzis, 2008). More spatially-detailed bathymetric contours in the immediate vicinity of the SSES intake and discharge (1978) are provided in Figure 2.3-11. The elevation of the bottom of the Susquehanna River at the BBNPP discharge is 476 ft (145 m).

To compute surface heat exchange, the coefficient of surface heat exchange (K) and equilibrium temperature (E) method was used. Monthly average and extreme values of K and E for National Weather Service sites in the U.S. are cataloged by the Environmental Protection Agency (EPA, 1971). The nearest cataloged site to BBNPP is Avoca, Pennsylvania (WBAN 14777),

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27 mi (43 km) to the northeast of the site. Values for K and E, as well as for all other Susquehanna River datasets are shown in Table 5.3-1.

5.3.2.1.2 Discharge Thermal Plume Regulations

The Commonwealth of Pennsylvania provides the following criteria for temperature (PA, 2007):

> "Maximum temperatures in the receiving water body resulting from heated waste sources are regulated under Chapters 92, 96 and other sources where temperature limits are necessary to protect designated and existing uses. Additionally, these wastes may not result in a change by more than 2°F during a 1-hour period."

The protected water use for the Susquehanna River adjacent to BBNPP is Warm Water Fishes (WWF), as shown in Pennsylvania Code, Chapter 93. Water Quality Standards, Section 93.9(k) for the reach from the Lackawanna River to the West Branch Susquehanna River. The WWF temperatures are shown in Table 5.3-2. These values represent the maximum allowable water temperatures at an unspecified distance downstream of the discharge where fully-mixed conditions occur.

The Pennsylvania Department of Environmental Protection guidance document (PADEP, 2003) indicates that Pennsylvania Department of Environmental Protection may include in a NPDES permit issued to a permittee with a cooling water discharge an end-of-pipe limit of 110°F and a heat load limit based on the difference between ambient temperature and the critical use temperatures shown in Table 5.3-2. Because actual limits are set when the NPDES permit is issued, the thermal discharge limits that will be established for the BBNPP cannot be estimated at this time. In developing the NPDES permit conditions for BBNPP, Pennsylvania Department of Environmental Protection may choose to consider the cumulative effects of the combined SSES and BBNPP thermal discharge.

5.3.2.1.3 Discharge Plume Model

To compute the size and configuration of the thermal plume and provide the dilution rates, two types of models were used. These models are CORMIX for the near-field and GEMSS® for the far-field. The Cornell Mixing Zone Expert System (CORMIX) is primarily a design tool that has also been used by regulatory agencies to estimate the size and configuration of proposed and existing mixing zones resulting from wastewater discharges. CORMIX is a near-field model, i.e., it applies to the region adjacent to the discharge structure in which the wastewater plume is recognizable as separate from the ambient water and its trajectory is dominated by the discharge rate, effluent density, and geometry of the discharge structure.

The hydrodynamic model chosen to assess the far-field characteristics of the thermal plume and dilution is the Generalized Environmental Modeling System for Surface Waters (GEMSS®). GEMSS is an integrated system of 3-D hydrodynamic and transport modules embedded in a geographic information and environmental data system. GEMSS is in the public domain and has been used for similar studies throughout the U.S. and worldwide.

Thermal plume configuration and size for the BBNPP thermal discharge for two extreme scenarios are reported herein: August and January low Susquehanna River flows combined with extreme Susquehanna River temperatures. To show the combined thermal effects of the BBNPP and SSES discharges, the size and configuration of the thermal plume from the existing cooling tower blowdown discharge from the SSES was also simulated using the far-field model. For the near-field, only the BBNPP was modeled because CORMIX is incapable of modeling two plumes simultaneously. This approach is satisfactory because in the near-field, the plumes do

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not overlap due to the 380 ft (116 m) separation of the SSES and BBNPP discharges. For each extreme scenario, design values of the SSES and BBNPP intake and discharge rates, temperatures, and total dissolved minerals were used as shown in Table 5.3-3. Winter temperature rises for the blowdown discharge are significantly higher than the summer temperature rises due to differences in cooling tower performance from winter to summer.

5.3.2.1.4 Thermal Plume Configuration and Size

The near-field thermal plume size from the BBNPP thermal discharge computed with CORMIX is shown in Table 5.3-4 and Table 5.3-5.

CORMIX simulations for thermal plume also provided near-field dilution values. At 50 ft (15 m) from the discharge, the dilution is 11.8 for the August scenario and 19.2 for the January scenario.

The impact of the combined BBNPP and the SSES discharges are shown in Figure 5.3-1 and Figure 5.3-3 for the August and January scenarios. These figures show the surface thermal plume. The extent of this combined plume is very small. The surface excess temperatures are less than 0.8°F (0.4°C) for August and less than 0.6°F (0.3°C) for January.

The corresponding figures for the thermal plume attributable only to the BBNPP discharge are Figure 5.3-2 and Figure 5.3-4 for the August and January scenarios, respectively. The maximum excess temperatures at the surface are less than 0.3°F (0.2°C) for August and less than 0.3°F (0.2°C) for January.

To assess compliance with WWF temperature limits at seasonal extremes, additional near-field simulations were made to determine the size of the thermal plume under conditions when blowdown temperatures are at a maximum and Susquehanna River temperatures are at a minimum, yielding the maximum temperature rise in the River. These simulations utilized average Susquehanna River flows to represent a severe, but not extreme, case. The comparison metric is the distance along the centerline downstream of the BBNPP discharge where WWF temperatures are attained. These distances are shown in Table 5.3-6. In this table, the blowdown temperature rise is the difference between the blowdown temperature and the WWF ambient stream temperature (PPL, 2006). The WWF ambient stream temperature is an assumed natural temperature typically used by the Pennsylvania Department of Environmental Protection in computing waste heat load allocations. The target excess temperature in Table 5.3-6 is the difference between the WWF ambient temperature and the WWF temperature limit; this difference represents the excess temperature isotherm at which the WWF temperature limit is attained.

Centerline distances are very small and none of the target excess temperature contours reach the water surface. The results of this calculation indicate that the BBNPP blowdown plume will be in compliance with WWF temperatures during other WWF periods.

5.3.2.2 Aquatic Ecosystems

The potential effects of power plant discharges on aquatic ecosystems have been vigorously studied and documented (Majumdar, 1987). They include attraction of fish to the thermal plume, cold shock, blockage of movement and migration, changes in benthic species composition, growth of nuisance species, habitat modification, alteration of reproductive patterns, and chemical effects of biocides. These effects are typically lessened by installation of a closed-cycle, wet cooling system, which is the type of cooling system proposed for BBNPP (Section 3.4). Discharge effects have been studied at SSES and provide a basis for assessing the

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potential ecological impacts of the BBNPP discharge (Ecology III, 1995) (Ecology III, 2004) (Ecology III, 2007a) (Ecology III, 2007b) (Ecology III, 2008). The effects of the BBNPP discharge are anticipated to be similar to the SSES discharge. The existing SSES discharge will be used to gauge and evaluate the potential for impacts to result from the BBNPP discharge.

No substantial detrimental ecological impacts resulting from operation of the SSES discharge have been documented in 24 years of monitoring (Ecology III, 1995) (Ecology III, 2004) (Ecology III, 2007a) (Ecology III, 2007b) (Ecology III, 2008). The studies have shown that populations of many of the key recreational fish species have increased in abundance. In fact, improvements in overall water quality and increases in abundance of sensitive benthic macroinvertebrates have occurred (Ecology III, 1995). This long-term monitoring suggests that the discharge of cooling tower blowdown and wastewaters from BBNPP will have a SMALL impact on the Susquehanna River in the vicinity of BBNPP.

5.3.2.2.1 Thermal Effects

Pennsylvania provides water quality standards that include temperature criteria to protect designate water use and temperature limits for water bodies within the Commonwealth (PA, 2007). The guidelines provide maximum allowable temperatures for critical periods during the year and state that a discharge may not change the temperature of the receiving water body by more than 2°F (1.1°C) during any one hour period. The designated water use of the Susquehanna River in the vicinity of the BBNPP site is warm water fishery (WWF). This WWF designation requires the maintenance and propagation of fish species and additional flora and fauna which are indigenous to warm water habitats.

The BBNPP thermal plume is predicted to be similar to the existing SSES thermal plume. Based on its location, the BBNPP plume will likely have minimal interaction with the SSES plume. Its small cross-sectional area is unlikely to create a barrier to fish migration and the small area of thermal enhancement should limit attraction of fish such that they will not become acclimated and entrapped there, particularly during winter when fish are susceptible to cold shock from plant shutdown. Since fish are unlikely to become acclimated to the small plume, gas bubble disease should not occur.

The existing SSES plume was determined to have limited downstream temperature impact (Ecology III, 1987 and Ecology III, 2009). Both sets of studies yielded vertical temperature profiles consisting of temperature measurements made at 1-ft (0.3-m) intervals at 20 to 27 locations immediately downstream of the SSES diffuser structure.. Spring, fall, and winter studies were completed in 1986 and 1987 that measured the temperature and downstream extent of the thermal increase. During these studies the maximum increase above ambient temperatures within the plume ranged from 0.5 to 1.0°F (0.3 to 0.6°C) and the plume extent varied from 25 to 130 ft (7.6 to 40 m) downstream from the diffuser pipe. The study indicated that Susquehanna River flow, not discharge temperature increase above ambient, was the most important determinant of the temperature and areal extent of the plume.

In 2008, summer season plume studies were performed at about mid-day on August 21 and September 3 at river flows of 3,230 cfs (91.5 m^3/s) and 2,140 cfs (60.6 m^3/s), respectively. During each survey, both boiling water reactors were at full power. The river water withdrawal at the intake on both days was approximately 39,000 gpm (147,631 lpm) with a mean temperature of 74.4 °F (23.6°C), and the blowdown, as it exited the cooling tower basins on site, was 12,000 gpm (45,425 lpm) at an average of 82.7 °F, (28.2 °C). The August study found that the 0.5 °F (0.3 °C) isotherm thermal plume was less than 40 ft (12.2 m) wide at the diffuser and narrowed as it extended 120 ft (36.6m) downriver. The thermal plume did not reach the river surface. In September, the 0.5 °F (0.3 °C) isotherm thermal plume was 100 ft (30.5m) wide and extended

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300 ft (91.4m) downriver from the diffuser. A much smaller subsurface plume within the 1.0 °F (0.6 °C) isotherm was observed immediately downriver of the diffuser. The summer season surveys confirmed that the thermal plume from the SSES diffuser is very limited, even during low flow conditions, and does not pose a hazard to aquatic life.

Modeling of the BBNPP discharge was performed to predict the temperature gradient and downstream extent of the plume. The modeling effort evaluated the maximum possible size of the plume during winter and summer. To accomplish this, summer and winter low flow conditions and extreme water temperatures were inputs to the model. The model indicated that within the near-field plume, the discharge temperature decreased quickly to very small values above ambient river temperature due to rapid mixing. During the summer period, the discharge has an excess temperature of 3.46°F (2.0°C) which decreases to 0.13 to 0.29°F (0.07 to 0.16°C), depending on river flow, within 50 ft (15 m) of the discharge. During the winter period, the discharge has an excess temperature of 33.81°F (19.0°C) that decreases to 0.5 to 1.75°F (0.3 to 1.0°C), depending on river flow, within 50 ft (15 m) of the discharge.

Modeling was also performed to evaluate the combined impact of the SSES and BBNPP thermal plumes. The model indicated that the combined thermal plume at the bottom of the Susquehanna River was slightly warmer than for BBNPP alone, but the extent of the plume was very small under the summer and winter conditions evaluated. Effects for the surface were even smaller.

The potential for fish kills resulting from attraction of fish to the BBNPP plume are unlikely given that the existing SSES plume temperatures are typically less than 1°F (0.6°C) above ambient temperature and no fish kills are known to have occurred as a result of the plume (Ecology III, 1987).

Both the minimal temperature increase and the small areal extent of the plume are predicted to have no significant impact on the benthic macroinvertebrate, mussel, or fish community. The increase in Susquehanna River temperature from the plume is within the range of natural temperature variability in lotic systems. Assuming that the characteristics of the BBNPP discharge will be similar to that of SSES's discharge and the predictive model, impacts to the aquatic community are expected to be SMALL.

5.3.2.2.2 Chemical Effects

Chemical effects of the discharge include the addition of biocides to limit fouling within the cooling water systems and other chemical agents to limit scaling. Discharge concentrations of these constituents will be limited by the National Pollutant Discharge Elimination System (NPDES) permit issued by the Pennsylvania Department of Environmental Protection. These concentration limits are set to protect the designated water use within the receiving water body and the concentrations in the BBNPP discharge will be lower than concentrations that could harm aquatic organisms present in the Susquehanna River. In addition, the NPDES permit will account for the combined impacts of both the BBNPP and SSES discharges.

Based on this, the chemical effects of the BBNPP discharge to the aquatic biota will be SMALL. Similar conclusions were drawn regarding the existing SSES discharge which is similar in volume to the proposed BBNPP discharge (NRC, 1981).

5.3.2.2.3 Physical Effects

Physical effects from the discharge will be limited to the turbulence created by the diffuser jets. These jets will direct the water downstream at a 45-degree angle toward the surface of the

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river. This turbulence will not harm aquatic organisms (PPL, 1978). The velocities created by the jets are sufficient to discourage fish from swimming in the mixing area near the diffuser for extended periods, thus eliminating the potential for gas-bubble disease. The action of the jets quickly mixes the heated water and limits the potential for fish to be attracted to the area. The spatial extent of the heated discharge and length of the diffuser pipe will be too small to create a thermal block across the river. A similar design at the existing SSES thermal discharge has limited physical impacts. It is expected that the physical impacts associated with BBNPP will also be SMALL due to similar design and operation of the diffuser bar.

No loss or alteration of unique habitat is expected or reduction in density, species composition or community structure of the aquatic community.

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5.3.3 HEAT DISCHARGE SYSTEM

5.3.3.1 Heat Dissipation to the Atmosphere

BBNPP requires water for cooling and operational uses. Primary water consumption is for turbine condenser cooling. Cooling water for the turbine condenser and closed-cooling heat exchanger for normal plant operating conditions is provided by the Circulating Water System (CWS). The excess heat from the CWS is dissipated to the environment with a closed-loop cooling system. A closed-loop cooling system recirculates water through the plant components and cools this water for reuse by transferring excess heat to air, or the atmosphere, with a cooling tower.

The cooling system for BBNPP will be a closed-cycle, wet cooling system, consisting of two natural draft cooling towers for heat dissipation. The existing SSES Units 1 and 2 also use a closed-loop cooling system each with a natural draft cooling tower.

There will also be four smaller Essential Service Water System (ESWS) cooling towers to dissipate heat from system. The ESWS provides cooling water to the Component Cooling Water System heat exchangers and the heat exchangers of the Emergency Diesel Generators. Each of these four safety-related trains uses a safety-related two-cell mechanical draft cooling tower to dissipate heat. Heated ESWS water returns through piping to the spray distribution header of the ESWS cooling tower. Water exits the spray distribution piping through spray nozzles and falls through the tower fill. Two fans provide upward air flow to remove latent heat and sensible heat from the water droplets. The heated air exits the tower and mixes with ambient air, completing the heat rejection process. The cooled water is collected in the tower basin for return to the pump suction for recirculation through the system. Table 3.4-1 provides nominal heat loads and flow rates in different operating modes for the ESWS. Makeup water is normally provided from the RWSS but can also be supplied from the safety-related ESWEMS pumps housed in the ESWEMS Pumphouse. Table 3.4-3 provides ESWS Cooling Tower design specifications.

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5.3.3.1.1 Circulating Water System Cooling Tower Plume

A visible mist or plume is created when the evaporated water from the cooling tower undergoes partial recondensation. The plume creates the potential for shadowing, fogging, icing, localized increases in humidity, and possibly water deposition. In addition to evaporation, small water droplets drift out of the tops of the wet cooling tower. The drift of water droplets can deposit dissolved solids on vegetation or equipment.

For BBNPP, the impacts from fogging, icing, shadowing, and drift deposition were modeled using the Electric Power Research Institute's Seasonal/Annual Cooling Tower Impact (SACTI) prediction code. This code incorporates the modeling concepts (Policastro, 1993) which were endorsed by the NRC in NUREG-1555 (NRC, 1999). The model provides predictions of seasonal, monthly, and annual cooling tower impacts from mechanical or natural draft cooling towers. It predicts average plume length, rise, drift deposition, fogging, icing, and shadowing, providing results that have been validated with experimental data (Policastro, 1993).

Detailed cooling tower design information is provided in Section 3.4. This information was used to develop input to the SACTI model. A summary of the design parameters are provided in Table 5.3-7.

SACTI requires the following inputs on an hourly basis: wind speed, wind direction, dry bulb temperature, dew point temperature, relative humidity, cloud cover, and wet bulb temperature if dry bulb and dew point temperatures are missing. All of these parameters were available from the onsite meteorological data set for calendar years 2001 through 2007 from the SSES Units 1 and 2 site meteorological tower except for cloud cover. Hourly meteorological parameters, including wind speed, wind direction, cloud cover, dry bulb temperature, and dew point temperature for the period 2001-2007 were obtained for the Wilkes-Barre International Airport (WBAN 14777; call sign AVP) through the National Climatic Data Center (NCDC) Climate Data Online (CDO) web site.

A composite data set was created from onsite and the Wilkes-Barre International Airport sources. Dry bulb and dew point temperatures from the the Wilkes-Barre data were included in this composite data set. Relative humidity was calculated from dew point and dry bulb temperatures utilizing algorithms adapted from U.S. EPA's AERMET processor. The composite data set was created in the format (CD-144) required as input to SACTI. Additionally, twice-daily mixing heights for 2001-2007 were calculated based on upper air soundings obtained from the Albany, New York National Weather Service (NWS) station (the closest sounding station to Bell Bend). Sounding data were obtained from NOAA, and processed with USEPA's MIXHT program. The composite data set therefore contained temperature and cloud cover data from Wilkes-Barre and winds (speed and direction) from the onsite tower 60 meter level.

The normal heat loads from the ESWS cooling towers are approximately 3% of the heat load to the CWS cooling towers. The maximum heat load is less than 7% of the CWS cooling towers heat load. Any impacts from the heat dissipation to the atmosphere by the ESWS cooling towers would be much less than the CWS cooling tower. In addition, a cumulative effect would be negligible. Therefore, the ESWS cooling towers are not considered further in the analysis.

5.3.3.1.2 Length and Frequency of Elevated Plumes

The SACTI code calculated the expected plume lengths annually and for each season by direction for the CWS cooling towers. The plumes would occur in all compass directions. The average plume length and height was calculated from the frequency of occurrence for each

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plume by distance from the tower. Modeled plume parameters for the cooling tower are provided in Table 5.3-8.

The average plume length would range from 0.274 mi (0.440 km) in the summer season to 0.615 mi (0.990 km) for the spring season. The annual prediction for average plume length would be 0.372 mi (0.549 km). The median plume lengths would range from 0.231 mi (0.371 km) in the summer season to 0.578 mi (0.931 km) in the winter season. The annual median plume length is 0.263 mi (0.423 km). The median plume length would not reach the site boundary in the predominant direction of the plume except in the winter season.

The average plume height would range from 776 ft (236 m) in the summer season to 961 ft (294 m) for the winter season. The annual prediction for average plume height would be 818 ft (249 m). The median plume height would range from 808 ft (247 m) in the summer season to greater than 982 ft (299 m) in the winter season. Due to the varying directions that the plume travels and short average and median plume height and length, impacts from elevated plumes would be SMALL and not warrant mitigation.

5.3.3.1.3 Ground-Level Fogging and Icing

The SACTI output indicated that no fogging and icing would occur for the Bell Bend natural draft cooling towers. The SACTI model suspends this calculation, since ground-level impacts are not possible for plumes from tall natural draft cooling towers.

Salt Deposition

Cooling tower drift is water droplets in the cooling tower that get entrained in the buoyant air of the cooling tower exhaust and leave the tower. These droplets eventually evaporate or settle out of the plume onto the ground, vegetation or equipment nearby.

The drift rate was based on 0.001% of the Circulating Water System flow. The makeup water for the CWS has a maximum chloride concentration of 39.6 milligrams per liter of water. The equivalent concentration of sodium chloride of 326.3 milligrams per liter was conservatively used for the salt concentration of the makeup water. The Circulating Water System was assumed to have five cycles of concentration. Water droplets drifting from the cooling tower would have the same concentration of salt as the water in the Circulating Water System. Therefore, as these droplets evaporate, either in the air or on vegetation or equipment, they deposit these salts.

The maximum salt deposition rate from the cooling tower is provided in Table 5.3-9. The maximum predicted salt deposition is well below the NUREG-1555, Section 5.3.3.2 (NRC, 1999) significance level for possible vegetation damage of 8.9 lb/ac per month (10 kg/ha per month) in all directions from the cooling tower during each season and annually. The maximum predicted salt deposition is less than 0.1 kg/ha per month. Therefore, no impacts to vegetation from the salt deposition would be expected for both on site and off site locations.

The electrical switchyard for BBNPP will be located approximately 1,300 ft (400 m) to the south of the proposed location for the CWS cooling towers. A maximum predicted solids deposition rate of 0.0023 lb/ac per month (0.0026 kg/ha per month) is expected at the BBNPP switchyard during the spring season. Additionally, the electrical switchyard for SSES Units 1 and 2 is located approximately 3,300 ft (1,000 m) to the east southeast from the proposed location of the BBNPP CWS cooling towers. The maximum predicted solids deposition expected at the SSES Units 1 and 2 electrical switchyard due to operation of the BBNPP CWS cooling towers will be 0.0008 lb/ac per month (0.0009 kg/ha per month), during the spring season.

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Based on industry experience, adjustments to maintenance frequencies (e.g., insulator washing) may be necessary due to salt deposition; however, the expected deposition rates will not affect switchyard component reliability or increase the probability of a transmission line outage at SSES Units 1 and 2, or BBNPP.

The ESWS cooling towers will be operated using fresh water from the Susquehanna River. Salt deposition at the SSES Units 1 and 2, and BBNPP electrical switchyards resulting from operation of the BBNPP ESWS cooling towers will be small, and is bounded by the salt deposition estimates for the BBNPP CWS cooling towers.

In summary, impacts from salt deposition from the BBNPP cooling towers would be SMALL. The modeling predicts salt deposition at rates below the NUREG-1555 significance level where visible vegetation damage may occur for both onsite and offsite locations.

5.3.3.1.4 Cloud Shadowing and Additional Precipitation

Vapor from a cooling tower can create clouds or contribute to existing clouds. The clouds would prevent or reduce the amount of sunlight reaching the ground. This shadowing is of particular importance in agricultural areas. There are several agricultural areas in the BBNPP site vicinity as described in Section 2.2. Cloud shadowing at the nearest agricultural area would occur a maximum of 56 hours during the spring season. Cloud shadowing at nearest roadway would occur for a maximum of approximately 157 hours in the summer season. Annually, cloud shadowing is predicted to occur for 202 hours at nearest roadway.

Rain and snow from vapor plumes are known to have occurred at some locations. SACTI predicts the amount of water deposited in the vicinity of a natural draft cooling tower, i.e. the additional precipitation due to the tower discharge. The additional precipitation amounts would range from 0.0001 in (0.00254 mm) in the spring season to 0.00014 in (0.00356 mm) in the fall season. This value is small when compared to the annual rainfall amount at the Wilkes-Barre International Airport of 37.56 in (954.02 mm). Impacts from cloud shadowing and additional precipitation would be SMALL and would not require mitigation.

5.3.3.1.5 Ground-Level Humidity Increase

For the same reasons that ground level fogging and icing do not occur with natural draft cooling towers, ground level humidity increases also do not occur and are not evaluated by SACTI.

5.3.3.1.6 Noise

The principal noise sources associated with normal operation of the BBNPP cooling water system are the CWS and ESWS cooling towers. Noise generated from cooling towers is more specific to mechanical draft cooling towers, which use numerous fans to aid in heat dissipation. Noise levels from natural draft cooling towers (i.e., no use of fans) are expected to be insignificant. A noise survey was conducted in the vicinity of SSES in February and March 2008, to measure ambient environmental community noise levels to establish a baseline noise level in the presence of the existing two-unit SSES. Environmental sound levels were measured continuously at five area-wide locations over a 312-hour period during leaf-off seasonal conditions. As a result, any noise emissions from the existing two-unit SSES would be highest due to the lack of tree leaf noise reduction. The instantaneous sound level was measured at five locations on a continuous and simultaneous basis over the 312-hour period using precision data loggers. In addition, attended 10-minute sampling measurements were carried out at each location during day and night periods using hand-held precision data loggers. The attended measurements were carried out to observe sources of environmental sounds and to

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record the frequency spectrum of the sound level. The residual ambient noise was found to be essentially constant for all practical purposes at any of the monitoring locations near the SSES cooling towers. This occurs in areas where the environmental sound sources are far off in distance relative to the distance between monitoring points and where the natural sources are similar at all locations. The sound of rain and high wind were indicated on the plot of sound levels. The major source of environmental noise in the project area is from far-off unidentifiable traffic. Absolutely no sounds were detectable during attended measurement for normal operation on February 28, 2008, when the plant was operating. Measured ambient sound levels during plant operation could be attributed to normal, current environmental sources, such as traffic noise, high wind and rain and are not related to the existing SSES plant.

As such, impact would be SMALL and would not require mitigation.

5.3.3.1.7 Similar Operating Heat Dissipation Systems

Data and information on similar heat dissipation systems within a 31 mi (50 km) radius or similar climate are available for the SSES Units 1 and 2. Both units use natural draft cooling towers with the Susquehanna River as the makeup water. At these units, impacts from salt drift were not observed. Based on the cooling tower plume modeling that was conducted for the SSES Environmental Report - Operating License, it was concluded that "frequent long visible plumes are the primary projected meteorological effect of the operation of the cooling towers. No occurrence of fogging or icing are expected. Other weather modification effects, such as rainfall augmentation, are unlikely due to the small increase in atmospheric moisture introduced by cooling tower operation into the already moisture-laden environment."

The NRC described impacts from mechanical and natural draft cooling towers in the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NRC, 1996). As stated in Draft NUREG-1437, Supplement 35: "Based on information in the GEIS, the Commission found that impacts from salt drift, icing, fogging, or increased humidity have not been a problem at operating nuclear power plants and are not expected to be a problem during the renewal term. The NRC staff has not identified any new and significant information during its independent review of the SSES ER, or the site audit, the scoping process, and evaluation of other available information, such as the EA that evaluated impacts of the EPU at SSES (NRC, 2007a). Documents reviewed included Effects of Simulated Salt Drift from the Susquehanna Steam Electric Station Cooling Towers on Field Crops Summary Report (Ecology III, 1987c). Therefore the NRC staff concludes that there would be no cooling tower impacts on crops and ornamental vegetation during the renewal term beyond those discussed in the GEIS." The NRC came to a similar conclusion for the potential cooling tower impacts on native plants.

Modeling of the SSES cooling tower plumes revealed that the plumes are at average heights of 640 to 1,140 ft (195 to 347 m). Modeling of the BBNPP cooling tower plumes revealed an annual average height of 818 ft (249 m). The proposed location of the BBNPP cooling towers is west-west southwest of the existing SSES cooling towers at a distance of approximately 4,000 ft (1,200 m). The predominant directions that visible cooling tower plumes from SSES and BBNPP would travel are toward the west-southwest (SSES) and south-southwest (BBNPP). The cooling tower plumes from the two plants could only interact when the wind is from the east-east northeast or west-west southwest (based on the two plant locations). Modeling indicates that the BBNPP plumes will travel beyond the SSES cooling towers in the east-east northeast direction at most approximately 3.2% of the time during the winter when the plume lengths are expected to be longest. Modeling indicated that the SSES plumes will travel beyond the BBNPP cooling towers approximately 12.5% of the time in the west-west southwest direction. Visible cooling tower plumes for BBNPP and the two cooling towers of SSES would be expected to occur in the same general predominant direction and would be expected to fluctuate in a

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similar manner, so that no synergistic effects with the proposed CWS cooling towers with respect to mixing fog or drift would be expected to occur.

Interaction with Existing Pollution Sources

There are no major sources of air pollution in the vicinity of the BBNPP site. Existing diesel generators and boilers at SSES Units 1 and 2 operate for limited periods. Diesel generators that are associated with BBNPP will also operate for limited periods. Interactions between pollutants emitted from these sources and the plumes from the cooling towers for SSES Units 1 and 2 are of sufficient distance and would not have a significant impact on air quality. Impacts would be SMALL and would not require mitigation.

5.3.3.1.8 References

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Nuclear Regulatory Commission, May 1996.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

Policastro, 1993. A Model for Seasonal and Annual Cooling Tower Impacts, Atmospheric Environment, Volume 28, No. 3, Pages 379-395, A. Policastro, W. Dunn, and R. Carhart, 1993.

5.3.3.2 Terrestrial Ecosystems

Heat dissipation systems associated with nuclear power plants have the potential to impact terrestrial ecosystems through salt drift, vapor plumes, icing, precipitation modifications, noise, and avian collisions with cooling towers.

5.3.3.2.1 Potential Impacts Due to Salt Drift

The cooling towers constructed to provide heat dissipation for BBNPP will release drift capable of depositing as much as 0.0045 lb/ac per month (0.0050 kg/ha per month) of dissolved solutes, primarily originating from the Susquehanna River makeup water, during the fall season on terrestrial ecosystems located in the vicinity of the BBNPP site. This value represents the maximum overall deposition rate during the fall. Maximum overall deposition rates during the winter, spring and summer were similar and ranged from 0.0036 lb/ac per month (0.0040 kg/ha per month) to 0.0042 lb/ac per month (0.0047 kg/ha per month).

The component of terrestrial ecosystems most vulnerable to cooling tower drift is vegetation, especially the upper stratum of vegetation whose foliage lies directly under the released droplets of water forming the drift (NRC, 1996). Forest communities are the predominant vegetation cover in the BBNPP Owner Controlled Area (OCA). Hence, woody vegetation forming the tree canopy and woody understory is potentially subject to the greatest exposure. However, vegetation damage from drift-based salt deposition originating from natural draft cooling towers has been shown to be SMALL (NRC, 1996).

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5.3.3.2.1.1 Plant Communities Potentially Affected by Salt Deposition Isopleths

The results of the vapor plume analysis for the BBNPP natural draft cooling towers indicated that salt deposition rates for the vicinity of the OCA were well below levels with documented impacts to vegetation as discussed below.

Plant Communities Exposed to Highest Salt Deposition Levels

The results of the vapor plume analysis for the BBNPP natural draft cooling towers indicated that salt deposition rates for the vicinity of the OCA were well below levels with documented impacts to vegetation as discussed in Section 5.3.3.2.1.2. Therefore, maps showing salt deposition rates across the OCA have not been provided.

Plant Communities Exposed to Lower Salt Deposition Rates

The results of the vapor plume analysis for the BBNPP natural draft cooling towers indicated that salt deposition rates for the vicinity of the OCA were well below the levels with documented impacts to vegetation in Section 5.3.3.2.1.2. Therefore, map showing salt depostion rates across the OCA have not been provided.

5.3.3.2.1.2 Potential Effects of Salt Deposition to Specific Plant Species

Salt drift deposited at rates approaching or exceeding 10 kg/ha per month in any month during the growing season may cause leaf damage in many species. However, deposition rates of 1 to 2 kg/ha per month are generally not damaging to plants (NRC, 1996). Since the highest salt deposition rate projected for the proposed BBNPP cooling towers is only 0.0045 lb/ac per month (0.0050 kg/ha per month), the risk of acute injury to vegetation is low. However, information in the published scientific literature regarding the sensitivity of individual plant species to salt deposition is limited. This is especially true with respect to low level chronic injury such as stunted growth that is not as visually apparent as acute injury such as browned leaves.

According to NUREG-1437, the most sensitive native plant species on the BBNPP site is flowering dogwood *(Cornus florida),* which experiences acute injury at salt deposition rates exceeding approximately 4.7 lb/ac per month (5.2 kg/ha per month). Flowering dogwood occurs occasionally in the understory of deciduous forest on the BBNPP site but is not dominant in any vegetative stratum.

Although acute injury is unlikely, given the low projected deposition rates, there is still risk of chronic injury to flowering dogwood such as reduced growth rate and reduced vigor. Chronic injury might not be visible, but could leave affected trees more susceptible to environmental stresses such as drought or biotic stresses such as dogwood anthracnose, a fungal disease that has killed many dogwoods in the northeast. Because flowering dogwood is not a dominant tree in either the canopy or understory of forests within the BBNPP site, the overall character of the affected forest vegetation would not be substantially changed even if the few flowering dogwoods in the affected areas were to eventually die. The ability of the affected forest vegetation to provide habitat for forest interior dwelling species and other wildlife favoring forest habitat would not be substantially diminished.

Of other tree species on the BBNPP OCA, NUREG-1437 provides information only for white ash *(Fraxinus americana),* eastern hemlock *(Tsuga canadensis),* white pine *(Pinus strobus),* chestnut oak *(Quercus prinus),* black locust *(Robinia pseudoacacia)* and red maple *(Acer rubrum)*. Red maple is the most abundant species in the OCA and is dominant in both upland and wetland

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vegetation communities. White ash and black locust are also common onsite. The minimum salt deposition rates reported to cause acute injury to these species range from approximately 36 lb/ac per month (41 kg/ha per month) for eastern hemlock to approximately1,833 lb/ac per month (2,054 kg/ha per month) for red maple. These values are more than several orders of magnitude higher than the maximum projected deposition rate 0.0045 lb/ac per month (0.0050 kg/ha per month) for the BBNPP cooling towers. Although the potential for chronic injury to these species can not be definitively ruled out, the risk appears to be substantially lower than for flowering dogwood.

Quantitative studies of vegetation and plant diseases were conducted for SSES from 1977 through 1994. Significant changes detected in plant community composition over this time were attributed to normal vegetation dynamics such as succession and animal interaction, and not to SSES Units 1 and 2 operation (Ecology III, 1995). In addition, findings for plant diseases were similar for preoperational (1977 to 1982) and post-operational (1983 to 1994) study periods. No effects of salt drift were detected.

5.3.3.2.1.3 Potential Overall Effects on Terrestrial Ecosystems

Since the highest projected salt deposition rate of 0.0045 lb/ac per month (0.0050 kg/ha per month) is well below the rates reported in the scientific literature to cause acute injury to woody vegetation, the likelihood of salt drift causing rapid or extensive changes to the general structure and composition of affected vegetation is low. The tree canopy in forested areas is unlikely to die rapidly or extensively. Hence, conversion of forest to scrub-shrub vegetation unsuited to wildlife favoring forested habitat, including forest interior dwelling species, is unlikely. The ability of affected forest vegetation to stabilize soil on steep slopes is unlikely to be impaired.

Occasional trees or shrubs, especially in the area of higher salt deposition, could experience chronic injury such as reduced vigor, reduced growth rate, or slow and gradual die off. The risk is greatest for individuals that are simultaneously of a salt-sensitive species (such as flowering dogwood), old, or subject to localized environmental stresses such as sandy soils, which are subject to greater drought stress that could act synergistically with the projected low salt deposition levels to injure trees.

Small gaps in the tree canopy resulting from the death of individual trees would mimic the natural die-off of individual trees in mature forests and not substantially alter the suitability of the forests for most wildlife species. Dead trees would be left in place to provide nesting cavities and snags for wildlife.

The potential for injury to terrestrial vegetation or to terrestrial wildlife inhabiting areas of terrestrial vegetation, as a result of salt drift, is low. Thus, the impacts of salt drift on terrestrial ecology would be SMALL, and would not warrant mitigation.

5.3.3.2.2 Potential Impacts of increased Fogging, Humidity, and Precipitation

The vapor plume analysis indicated that no icing or fogging events, or ground level humidity increases will result from the operation of the BBNPP natural draft cooling towers. Maximum rates of additional precipitation are predicted to range from 0.00010 in (0.00254 mm) per year during the spring to 0.00014 in (0.00356 mm) per year during the fall. Therefore, potential adverse impacts from these phenomena are expected to be SMALL and, therefore, not require mitigation.

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5.3.3.2.3 Potential Impacts from Cooling Tower Noise

Noise caused by human and vehicular activity at the BBNPP could discourage use by terrestrial wildlife of adjoining natural habitats on the BBNPP site. However, noise generated by the CWS and ESWS cooling towers is expected to be below EPA and HUD requirements, and unlikely to have deleterious effects on wildlife. Wildlife is generally more sensitive to sudden and random noise events, which can induce a startle response similar to that induced by a predator, than to the steady continuous noise produced by operation of a cooling tower (Manci, 1988). Potential adverse impacts to terrestrial wildlife caused by cooling tower noise are therefore expected to be SMALL and not require mitigation.

5.3.3.2.4 Potential Impacts Due to Bird Collisions with Cooling Towers

As summarized in Section 4.3.1, the proposed natural draft cooling towers would not be expected to cause substantially elevated bird mortality due to collisions. Although infrequent bird collisions with the cooling towers are possible, the overall mortality potentially resulting from bird collisions with cooling towers are reported to have only SMALL impacts on bird species populations (NRC, 1996). The forest interior bird species would not find suitable habitat close to the cooling towers, which would be constructed on a cleared, treeless pad. Strobe lights installed on the cooling towers would be expected to reduce the probability of collision by eagles or raptors migrating along the Susquehanna River corridor and minimize attraction of nocturnal migrating birds. No other mitigation appears to be necessary to prevent substantial adverse impacts to bird species populations caused by collisions with the cooling towers.

5.3.3.2.5 References

Ecology III, 1995. Environmental Studies in the Vicinity of the Susquehanna Stream Electric Station, 1994 Annual Report, Ecology III Inc, May 1995.

Manci, 1988. Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis, U.S. Fish and Wildlife Service, National Ecology Research Center, NERC-88/29, p 88, K. Manci, D. Gladwin, R. Villella, and M. Cavendish, 1988.

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plant, NUREG-1437, Nuclear Regulatory Commission, May 1996.

5.3.4 IMPACTS TO MEMBERS OF THE PUBLIC

Operation of the BBNPP cooling water systems includes heat transfer to the atmosphere from the cooling towers and the discharge of blowdown to the Susquehanna River. Potential impacts to the public include the release of thermophilic bacteria from within the towers and noise from tower operation.

5.3.4.1 Thermophilic Microorganism Impacts

Thermophilic organisms are typically associated with fresh water. Health consequences of thermally enhanced microorganisms have been linked to plants that use cooling ponds, lakes, or canals that discharge to small rivers. Elevated temperatures within cooling tower systems are known to promote the growth of thermophilic bacteria including the enteric pathogens Salmonella sp. and Shigella sp, as well as Pseudomonas aeruginosa and fungi. The bacteria Legionella sp, and the amoeba Naegleria and Acanthamoeba have also been found in these systems. The presence of the amoeba N. fowleri in fresh water bodies adjacent to power plants has also been identified as a potential health issue linked to thermal discharges (CDC, 2007) (NRC, 1999).

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The Center for Disease Control (CDC) maintains records of outbreaks of waterborne diseases and reported 16 cases of Legionella sp. infection in Pennsylvania between 2001 and 2004, all associated with drinking water (CDC, 2004) (CDC, 2006).

The CWS design cooling tower outlet temperature is approximately 90°F (32.2°C) and the maximum hot year CWS inlet temperature is 94.8°F (34.9°C). Biocide treatment of the inlet water should minimize the propagation of micro-organisms. As a result, pathogenic thermophilic organisms are not expected to propagate within the condenser cooling tower system and should not create a public health issue.

Makeup water for the natural draft towers will be supplied from the Susquehanna River. The CWS will require approximately 23,808 gpm (30,010 lpm) of makeup water. Of this, approximately 7,928 gpm (90,123 lpm) will be used in blowdown. Biocide treatment of the CWS will limit the propagation of thermophilic organisms. Blowdown will discharge to the Susquehanna River.

Potential health impacts to workers from routine maintenance activities associated with the towers will be controlled through the application of industrial hygiene practices including the use of appropriate personal protective equipment.

It is concluded that the risk to public health from thermophilic microorganisms will be SMALL and will not warrant mitigation, except for the noted biocide treatment of the condenser cooling and service water systems.

5.3.4.2 Noise Impacts

Operation of the two CWS cooling towers and four ESWS for BBNPP will generate additional noise.

There were no known State or County noise ordinances. Salem Township has a qualitative noise standard in Section 318 of the Zoning Ordinance. It states "Noise which is determined to be objectionable because of volume, frequency or beat shall be muffled or otherwise controlled."

EPA developed human health noise guidelines to protect against hearing loss and annoyance and established an outdoor activity guideline of 55 dBA (EPA 1974).

To determine ambient noise levels in the vicinity of the BBNPP site, a survey was conducted during the February and March 2008 leaf-off period at one location on the proposed BBNPP site, at the 3 closest residential land uses and on the power line rights-of-way approximately 200 ft (61 m) from Route 11. There were no observed audible levels from the operations of SSES Units 1 and 2 at any of the sampling stations for continuous measurements. The major source of environmental noise in the project area is from far-off unidentifiable traffic. The Ldn 24-hour logarithmic average Day/Night sound levels ranged from 57 dBA to 65 dBA during the leaf-off survey and ranged from 53 dBA to 58 dBA during the leaf-on survey (AREVA 2008 b, c).

As indicated in Section 5.8.1.3, modeled noise contours show that cooling tower sound pressure levels are approximately equal to or less than the measured ambient at most sound survey locations and less than the EPA guideline value. Subjectively, cooling tower noise would be essentially imperceptible at the offsite receptors except at location 4 (Figure 5.8-1), which is the closest residence to the towers. Cooling tower noise would be perceptible at this location at an Leq of 40 dBA during quiet periods of the day or night and imperceptible at other times. The typical noise level from the two cell ESWS mechnical draft cooling tower is approximately

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54 dBA at 800 ft (244 m), which is below the EPA guideline. The nearest residences is approximately 900 ft (274 m) from the ESWS cooling tower, and noise levels are expected to be less than the EPA and HUD criteria.

Power plants generally do not result in offsite noise levels greater than 10 dB(A) above background and noise at levels between 60 and 65 dB(A) were generally considered of small significance (NRC, 1999). As a result, the impact of noise generation associated with the operation of cooling towers at BBNPP on members of the public will be SMALL, and will not warrant any mitigation.

5.3.4.3 References

CDC, 2004. Surveillance for Waterborne-Disease Outbreaks Associated with Drinking Water - United States, 2001-2002, Centers for Disease Control, October 22, 2004 / 53(SS08), 23-45, Website:http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5308a4.htm.

CDC, 2006. Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking - United States, 2003-2004, Centers for Disease Control, December 22, 2006 / 55(SS12); 31-58, Website:http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5512a4.htm.

CDC, 2007. Centers for Disease Control Fact Sheet, Naegleria Infection, Website: http://www.cdc.gov/ncidod/dpd/parasites/naegleria/2007_Naegleria.pdf.

EPA, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, Environmental Protection Agency, PB 550/9-74-004, Website:http://www.nonoise.org/library/levels74/levels74.htm#table%20of%20contents.

NRC, 1999. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Nuclear Regulatory Commission, Website:http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/v1/index.html.

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Table 5.3-1—Parameter Values for the Simulations

Parameter	Units	January	August
Extreme ambient temperature	˚F (°C)	32.0 (0.0)	86.5 (30.3)
Discharge temperature	˚F (°C)	65.8 (18.8)	90.0 (32.2)
Temperature rise	˚F (°C)	33.8 (18.8)	3.5 (1.9)
Discharge TMS	mg/l	556	642
Average intake rate	gpm (lpm)	27,850 (105,273)	27,850 (105,273)
Maximum intake rate	gpm (lpm)	34,460 (130,259)	34,460 (130,259)
Average discharge rate	gpm (lpm)	9,290 (35,116)	9,290 (35,116)
Maximum discharge rate	lpm (lpm)	11,170 (42,223)	11,170 (42,223)
Low Susquehanna River flow	cfs (cms)	2,848 (80)	1,246 (35)
Low Susquehanna River elevation	ft (m)	486.8 (148.4)	486.0 (148.1)
Mean Susquehanna River flow	cfs (cms)	12,482 (349)	4,473 (125)
Mean Susquehanna River elevation	ft (m)	489.8 (149.3)	487.5 (148.6)
Susquehanna River TMS	mg/l	134	196
Heat exchange coefficient (K)	BTU ft^{-2} day^{-1} $°F^{-1}$ (KW m^{-2} $°C^{-1}$)	58 (13.7)	104 (24.6)
Equilibrium Temperature (E)	˚F (°C)	34 (1.1)	85 (29.4)

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Table 5.3-2—Protected Use Receiving Water Body Temperatures °F (°C)

Critical use period	Warm Water Fishes (WWF) temperature
January 1-31	40 (4.4)
February 1-29	40 (4.4)
March 1-31	46 (7.8)
April 1-15	52 (11.1)
April 16-30	58 (14.4)
May 1-15	64 (17.8)
May 16-31	72 (22.2)
June 1-15	80 (26.7)
June 16-30	84 (28.9)
July 1-31	87 (30.6)
August 1-15	87 (30.6)
August 16-30	87 (30.6)
September 1-15	84 (28.9)
September 16-30	78 (25.6)
October 1-15	72 (22.2)
October 16-31	66 (18.9)
November 1-15	58 (14.4)
November 16-30	50 (10.0)
December 1-31	42 (5.6)

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Table 5.3-3—Simulation Summary with Scenario Descriptions

Parameter	**August**	**January**
Susquehanna River flow, cfs (cms)	1,246 (35)	2,848 (80)
Water surface elevation, ft (m)	486.0 (148.1)	486.8 (148.4)
Susquehanna River Temperature, °F (°C)	86.5 (30.3)	32.0 (0.0)
SSES		
Temperature rise, °F (°C)	12.5 (6.9)	31.0 (17.2)
Intake rate, gpm (lpm)	42,300 (160,123)	42,300 (160,123)
Discharge rate, gpm (lpm)	11,200 (42,397)	11,200 (42,397)
BBNPP		
Temperature rise, °F (°C)	3.5 (1.9)	33.8 (18.8)
Intake rate, gpm (lpm) (Note 1)	34,458 (130,251)	34,458 (130,251)
Discharge rate, gpm (lpm) (Note 1)	11,172 (42,290)	11,172 (42,290)

Note(s)
1. These values bound those presented in Table 3.3-1.

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Table 5.3-4—Near-Field Plume Area (ft^2) and Volume (ft^3)

Temperature rise isotherm, °F	August		January	
	Area	Volume	Area	Volume
10	-	-	118	15.4
5	-	-	569	305.7
3	26	3.4	1,739	2,851.5
2	83	10.9	4,034	15,759.5
1	296	89.8	Not achieved in near-field	Not achieved in near-field

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Table 5.3-5—Near-Field Plume Area (m^2) and Volume (m^3)

Temperature rise isotherm, °C	August		January	
	Area	Volume	Area	Volume
5.6	-	-	11	0.4
2.8	-	-	53	8.7
1.7	2	0.1	162	80.8
1.1	8	0.3	375	446.3
0.6	28	2.5	Not achieved in near-field	Not achieved in near-field

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Table 5.3-6—Extreme Period Analysis of Plume Size

Period	WWF, °F (°C)	WWF ambient, °F (°C)	Blowdown temperature, °F (°C)	Blowdown temperature rise, °F (°C)	Target excess temperature for compliance, °F (°C)	Centerline distance to WWF, ft (m)
January 1-31	40 (4.4)	35 (1.7)	65.8 (18.8)	30.8 (17.1)	5.0 (2.8)	1.0 (0.3)
July 1-31	87 (30.6)	75 (23.9)	90 (32.2)	15.0 (8.3)	12.0 (6.7)	0.3 (0.1)
August 1-15	87 (30.6)	74 (23.3)	90 (32.2)	16.0 (8.9)	13.0 (7.2)	0.3 (0.1)
August 16-30	87 (30.6)	74 (23.3)	90 (32.2)	16.0 (8.9)	13.0 (7.2)	0.3 (0.1)

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Table 5.3-7—CWS Cooling Tower Design Parameters

Design Parameter	Value
Number of cooling towers	2
Diameter overall	350 ft (107 m)
Diameter outlet	222 ft (68 m)
Height total	475 ft (145 m)
Altitude (above mean sea level)	694 ft (212 m)
Design duty	11,081 MMBtu/hr (3,238 MW)
Typical drift rate (percentage of circulating water flow rate)	0.001%
Circulating water flow rate	720,000 gpm (2,725,496 lpm)
Cooling range	27.6°F (15.3°C)
Approach	17°F (9.4°C)
Air flow rate total	54,848,028 ft^3/min (25,885 m^3/s)
Air mass flow rate	56,692 lb/s (25,715 kg/s)
Cycles of concentration	3.0
Salt (NaCl) concentration (mg/l)	326.3 max. 211.8 ave.

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Table 5.3-8—Modeled Plume Parameters

	Winter	Spring	Summer	Fall	Annual
Predominant direction[a]	East Northeast	South Southwest	South Southwest	South Southwest	South Southwest
Average plume length	0.615 mi (0.990 km)	0.359 mi (0.578 km)	0.274 mi (0.440 km)	0.385 mi (0.620 km)	0.372 mi (0.599 km)
Median plume length	0.578 mi (0.931 km)	0.246 mi (0.396 km)	0.231 mi (0.371 km)	0.289 mi (0.465 km)	0.263 mi (0.423 km)
Predominant direction [Note a]	East Northeast	South Southwest	South Southwest	South Southwest	South Southwest
Average plume height [Note b]	961 ft (293 m)	809 ft (247 m)	776 ft (236 m)	830 ft (253 m)	818 ft (249 m)
Median plume height [Note b]	982 ft (299 m)	828 ft (252 m)	808 ft (247 m)	846 ft (258 m)	836 ft (255 m)

Note(s)
a. Direction toward which plume is traveling.
b. Plume height from top of cooling tower.

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Table 5.3-9—Maximum Salt Deposition Rate

Maximum deposition rate	0.0045 lbs/ac per month (0.0050 kg/ha per month)
Distance to maximum deposition	328.1 ft (100 m)
Direction to maximum deposition	South Southwest
Maximum deposition at the BBNPP substation/switchyard	0.0023 lbs/ac per month (0.0026 kg/ha per month)
Maximum deposition at the SSES Units 1 and 2 substation/switchyard	0.0008 lbs/ac per month (0.0009 kg/ha per month)

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Table 5.3-10—Total number and percent composition of fish and crayfish collected in impingement samples at the SSES River Intake Structure from April 22 , 2008 to April 20, 2009.

Common Name	Scientific Name	Total Number	Percent Composition
crayfish	Orconectes sp.	220	55.3
bluegill	Lepomis macrochirus	44	11.1
rock bass sp.	Ambloplites rupestris	34	8.5
channel catfish	Ictalurus punctatus	31	7.8
tessellated darter	Etheostoma olmstedi	18	4.5
spotfin shiner	Cyprinella spiloptera	16	4.0
spottail shiner	Notropis hudsonius	5	1.3
margined madform	Noturus insignis	4	1.0
smallmouth bass	Micropterus dolomieu	4	11.0
white crappie	Poxomis annularis	4	1.0
white sucker	Catostomus commersoni	4	1.0
yellow perch	Perca flavescens	3	.8
banded darter	Etheostoma zonale	2	.5
pumpkinseed	Lepomis gibbosus	2	.5
walleye	Sander vitreus	2	.5
bluntnose minnow	Pimephales notatus	1	.3
brown trout	Salmo trutta	1	.3
northern hog sucker	Hypentelium nigricans	1	.3
unidentified fish	-	1	.3
yellow bullhead	Ameiurus natalis	1	.3
Total		398	

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Table 5.3-11—Total number and percent composition of each life stage of fish collected in entrainment samples from SSES River Intake Structure from April 22 to August 13, 2008.

Common Name	Scientific Name	Life Stage					Total	Percent Composition
		Unknown	Yolk-sac larvae	Post yolk-sac larvae	YOY	Yearling plus		
banded darter	*Etheostoma zonale*	0	0	0	0	2	2	0.1
brown bulhead	*Ameirus natalis*	0	0	0	2	0	2	0.1
common carp	*Cyprinus carpio*	161	5	179	0	0	345	11.4
chain pickerel	*Esox niger*	0	1	1	0	0	2	0.1
channel catfish	*Ictalurus punctatus*	0	0	0	367	0	367	12.1
Clupeidae	*Clupeidae*	0	0	1	0	0	1	<0.1
Cyprinidae	*Cyprinidae*	0	40	495	0	0	535	17.6
Lepomis sp.	*Lepomis sp.*	0	0	5	0	0	5	0.2
margined madtom	*Noturus Insignis*	0	0	0	10	0	10	0.3
Percidae	*Percidae*	3	3	40	0	0	46	1.5
quillback	*Carpiodes cyprinus*	190	202	433	3	0	828	27.2
rock bass	*Ambloplites rupestris*	0	0	40	1	0	41	1.3
shield darter	*Percina peltata*	0	0	0	0	1	1	<0.1
smallmuoth bass	*Mocriopterus dolomieu*	0	0	60	2	0	62	2.0
spottail shiner	*Notropis hudsonius*	0	0	4	23	0	27	0.9
tessellated darter	*Etheostoma olmstedi*	0	0	0	0	1	1	<0.1
unidentified fish	-	7	0	0	0	0	7	0.2
unidentified darter	-	31	246	105	0	0	382	12.6
walleye	*Sander vitreus*	0	6	31	0	0	37	1.2
white sucker	Catosstomus commersoni	0	11	256	19	0	286	9.4
yellow perch	Perca flavescens	0	4	48	0	0	52	1.7
Total		392	518	1.698	427	4	3,039	

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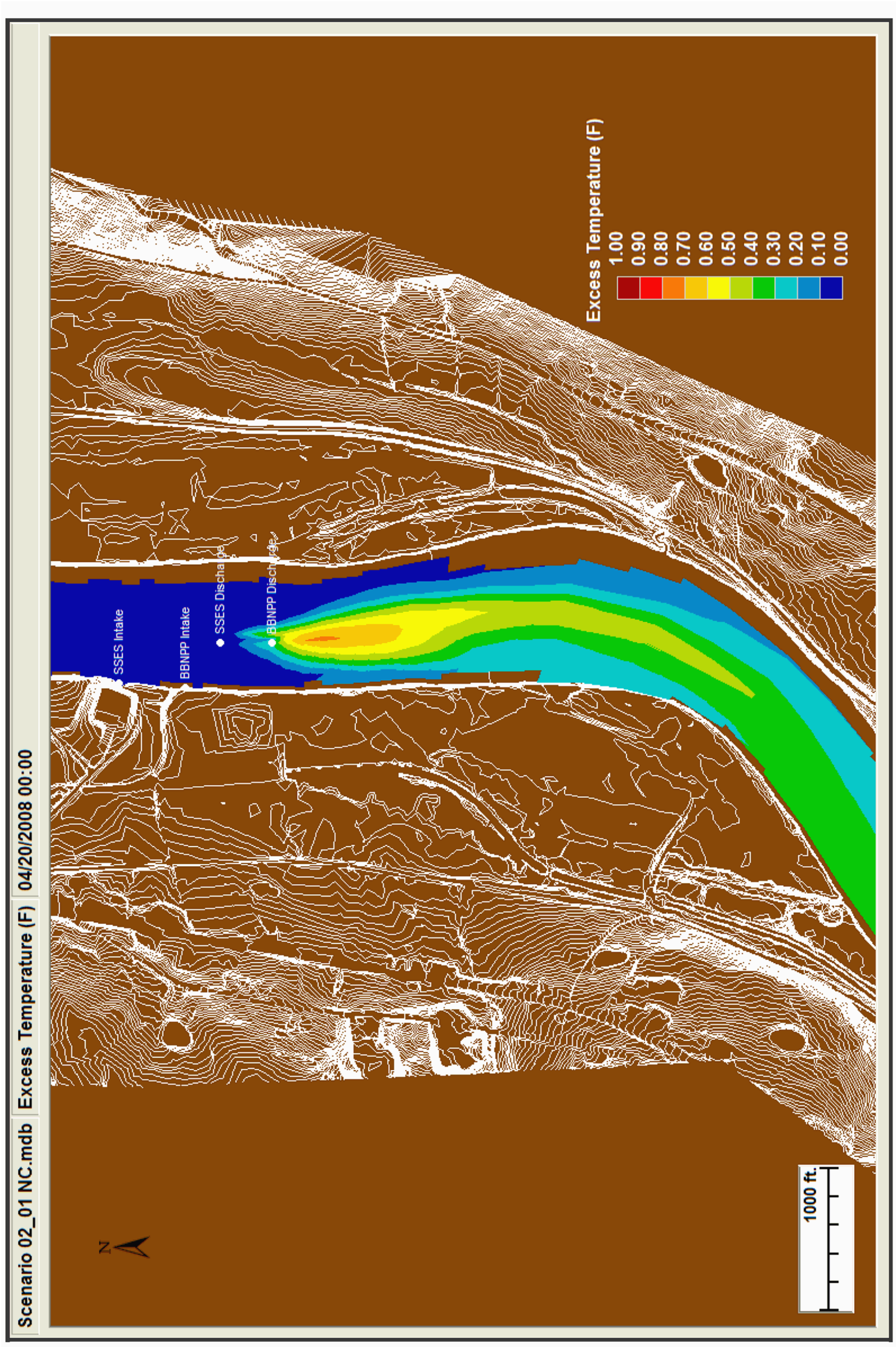
Figure 5.3-1—Temperature Rise Above Ambient at the Surface for the Combined BBNPP and SSES Blowdown Discharges for August



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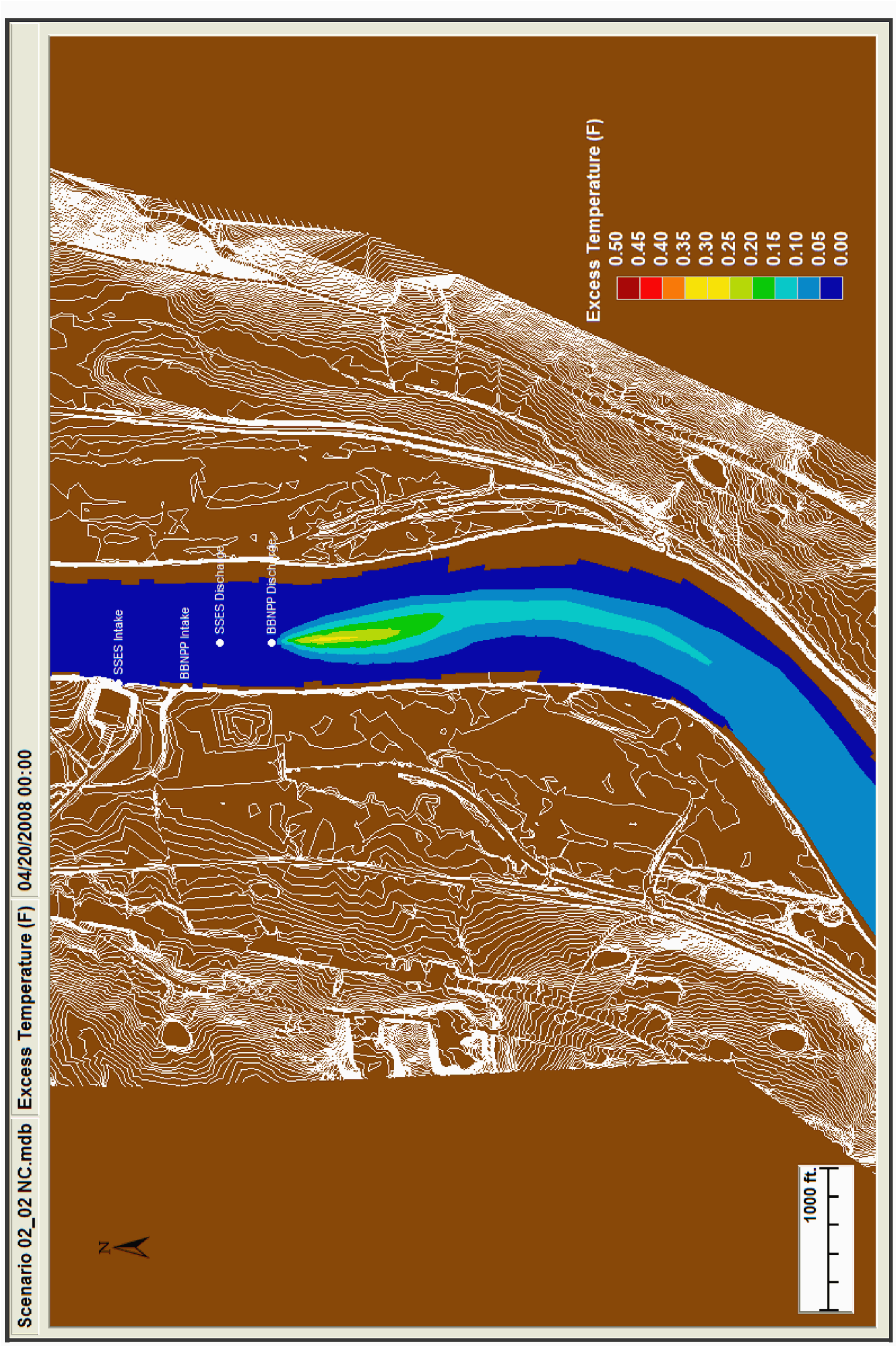

Figure 5.3-2—Temperature Rise Above Ambient at the Surface for the BBNPP Blowdown Discharge for August

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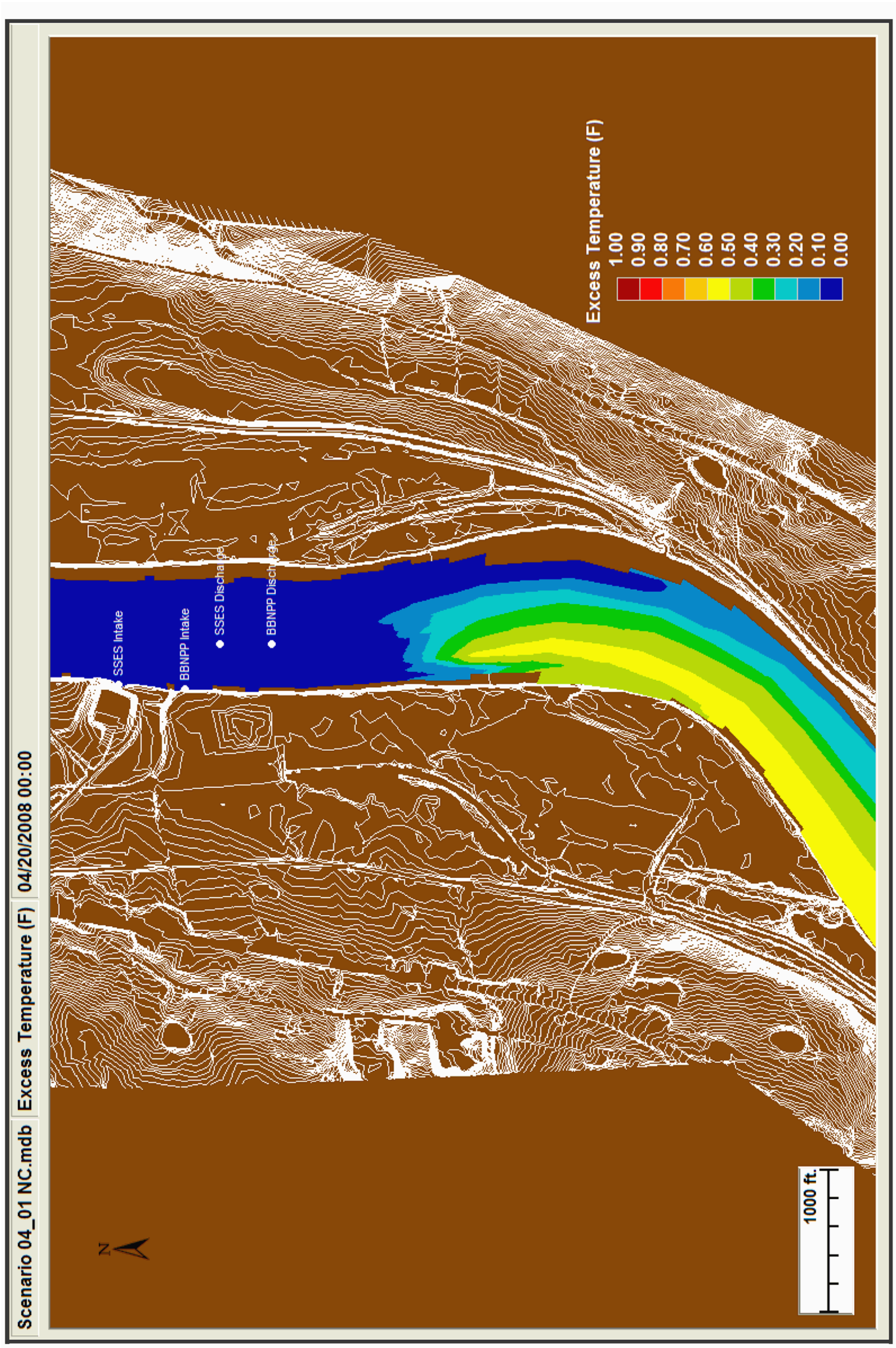

Figure 5.3-3—Temperature Rise Above Ambient at the Surface for the Combined BBNPP and SSES Blowdown Discharges for January

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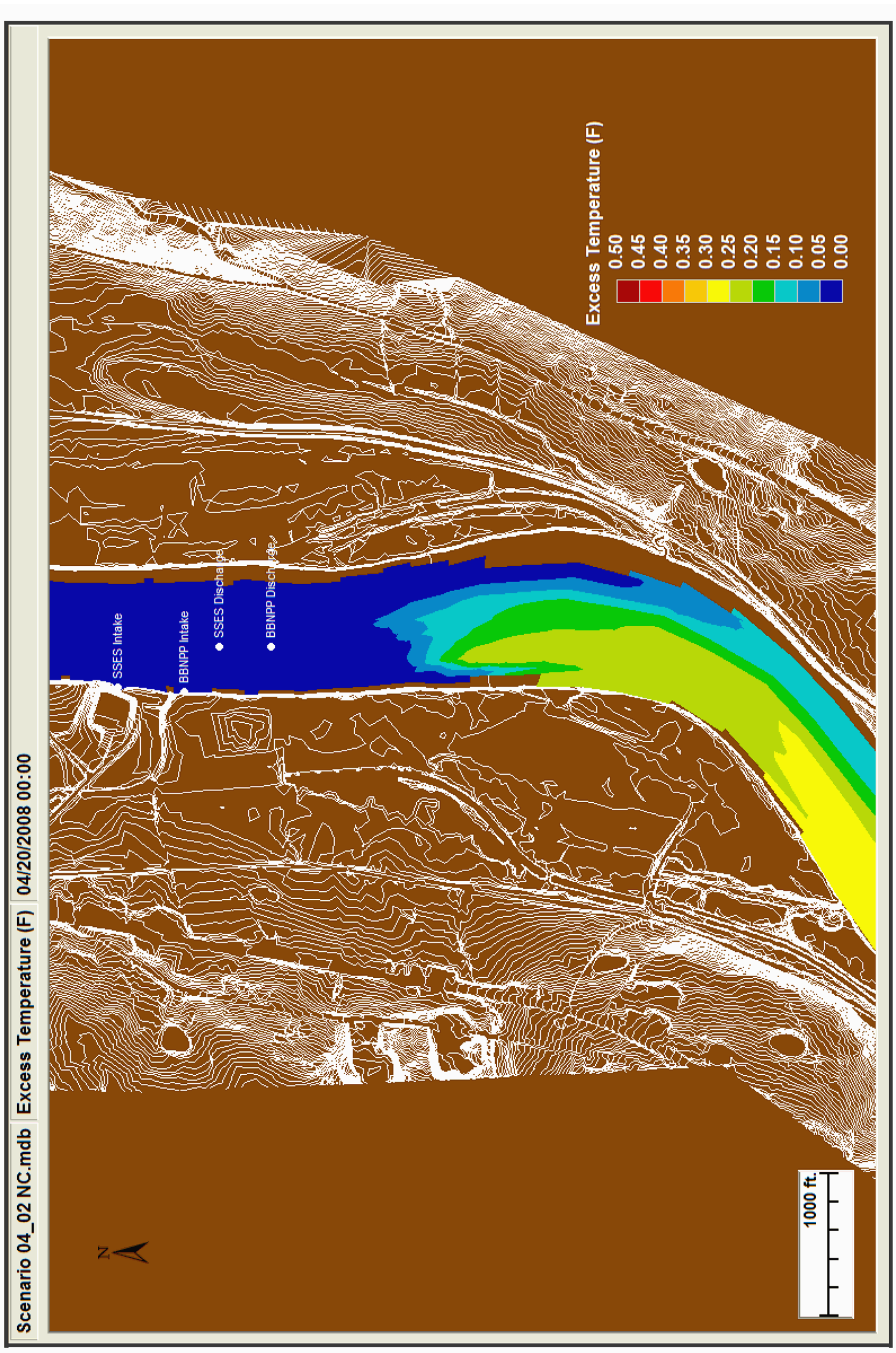

Figure 5.3-4—Temperature Rise Above Ambient at the Surface for the BBNPP Blowdown Discharge for January

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Figure 5.3-5—Total Number of Fish and Crayfish Collected in Impingement Samples at the SSES CWS, April 22, 2008 to August 12, 2008

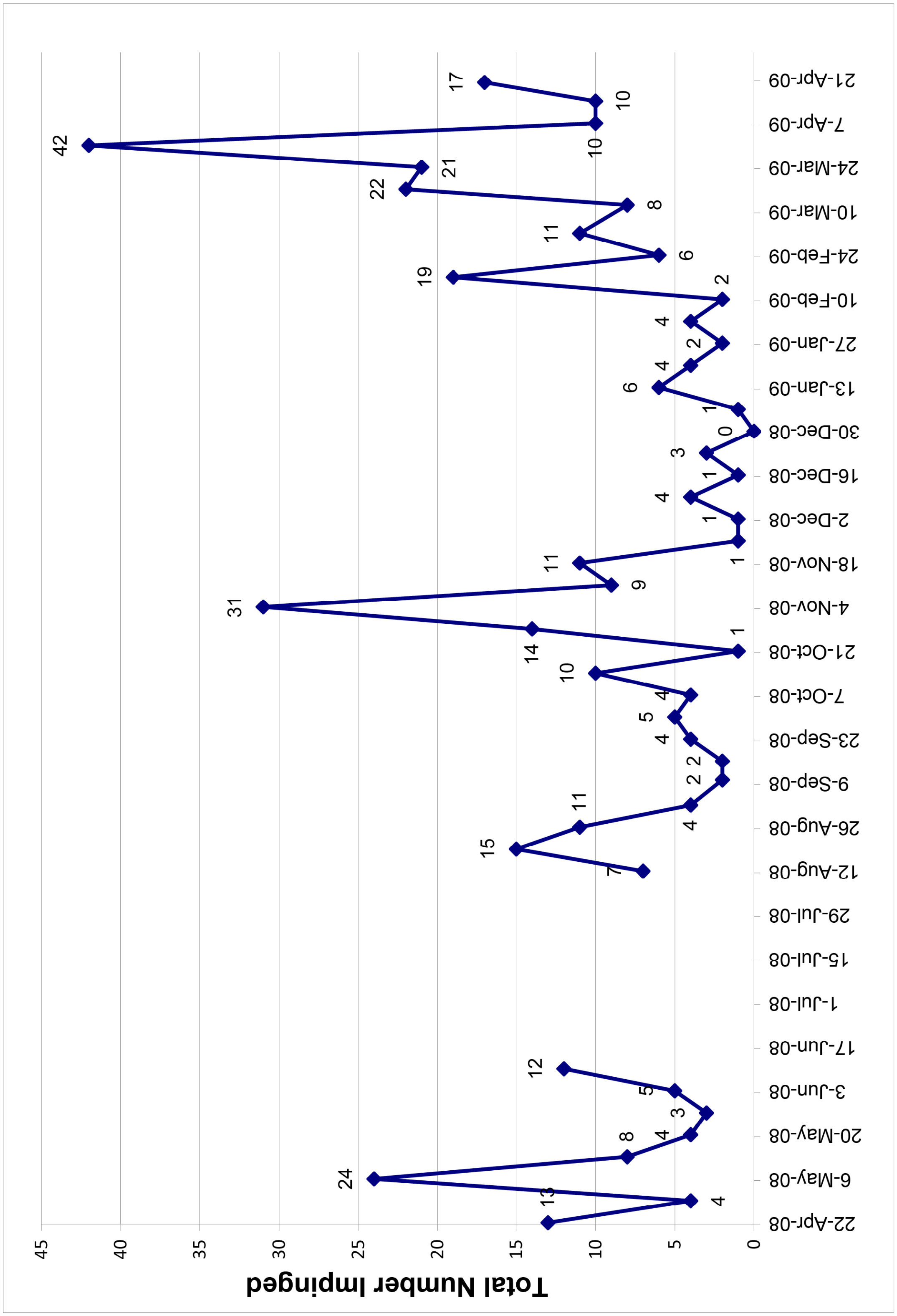

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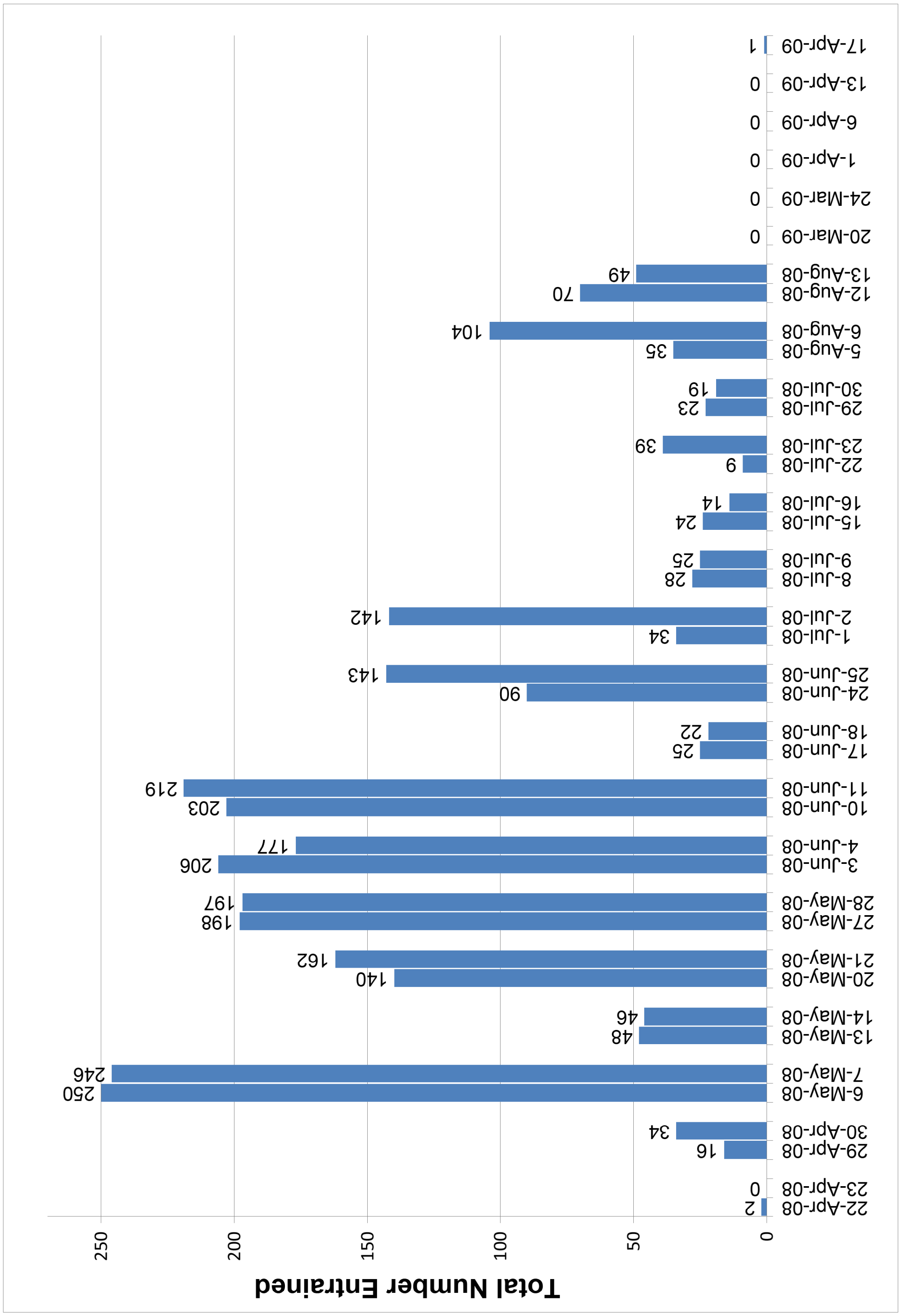
Figure 5.3-6—Total Number of Fish Collected in Entrainment Samples at the SSES River Intake Structure, April 22, 2008 to June 4, 2008



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5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATIONS

The radioactive waste management systems, as discussed in Section 3.5, are designed such that the radiological impacts due to the normal operational releases from BBNPP are within guidelines established in Appendix I to 10 CFR 50 (CFR, 2007). This section evaluates the impacts of radioactive effluents on human beings and other biota inhabiting the general vicinity of the BBNPP site resulting from expected routine operations. Primary exposure pathways to man are examined and evaluated according to the mathematical model described in Regulatory Guide 1.109 (NRC, 1977a). The resulting radiological impacts for BBNPP are compared to regulatory limits for a single unit.

In addition, the radiological impact of BBNPP in conjunction with Susquehanna Steam Electric Station (SSES) Units 1 and 2, including direct radiation, is compared to the corresponding regulatory limits under 40 CFR 190 (CFR, 2007b).

The radioactive waste system's cost benefit analysis is provided in ER 3.5. It includes the dose impact to the general population within 50 mi (80 km) radius from routine operations of BBNPP.

Finally, consideration of the dose impact to biota other than man that appear along the exposure pathways or that are on endangered species lists is presented. Other than the endangered species identified, there are no unusual animals, plants, agricultural practices, game harvest or food operations in the vicinity of BBNPP that need to be considered for radiological impacts.

5.4.1 EXPOSURE PATHWAYS

Routine radiological effluent releases from BBNPP are a potential source of radiation exposure to both humans and biota other than man. The major pathways are those that could lead to the highest potential radiological dose to humans and biota. These pathways are determined from the amount and isotopic distribution of activity released in liquids and gases, the environmental transport mechanism, and how the BBNPP site environs are utilized (e.g., location of site boundary, residences, gardens, milk animals, beaches, etc.) and the consumption or usage factors applied to exposed individuals. The environmental transport mechanism includes the BBNPP site-specific meteorological dispersion of airborne effluents and aquatic dispersion in the Susquehanna River of liquid releases. This information is used to evaluate how the radionuclides will be distributed within the surrounding area.

The potential exposure pathways are impacted by both aquatic (liquid) and gaseous effluents. The radioactive liquid effluent exposure pathways include internal exposure due to ingestion of aquatic foods (fish and invertebrates), external exposure due to recreational activities on the shoreline and in the water (swimming and boating), ingestion of irrigated crops, and drinking water.

The radioactive gaseous effluent exposure pathways include external exposure due to immersion in airborne effluent and exposure to a deposited material on the ground plane. Internal exposures are due to ingestion of food products grown in areas under influence of atmospheric releases and inhalation.

An additional exposure pathway considered is the direct radiation from the facility structures during normal operation of BBNPP.

The description of the exposure pathways and the calculation methods utilized to estimate doses to the maximally exposed individual and to the population surrounding the BBNPP site

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are based on Regulatory Guide 1.109 (NRC 1977a) and Regulatory Guide 1.111 (NRC 1977b). The source terms used in estimating exposure pathway doses are based on the projected normal effluent values provided in Section 3.5. The source term for both liquids and gases are calculated using the Nuclear Regulatory Commission GALE code for PWRs (NRC, 1985).

As indicated in Section 3.5, the liquid and gaseous source term for BBNPP was generated with the a total shim bleed flow rate of 2160 gpd (8176 lpd) to reflect total letdown flow for boron control with all the reactor coolant liquid being recycled. This deviates from the GALE application in the U.S. EPR FSAR where it was assumed that 5% of the letdown flow was sent to the liquid waste system for processing. This approach better approximates anticipated operations. The primary impact of this input assumption to the GALE code causes the annual release of Kr-85 to drop from a very conservative estimate of 34,000 Ci (1.26E+06 GBq) to 2,800 Ci (1.04E+05 GBq) in gaseous effluents. In addition, the GALE code has a fixed annual release value for C-14 of 7.3 Ci (270 GBq), (NRC, 1985) regardless of size (power output) of the reactor, and with no determination of the chemical form of the carbon in the waste gas. This fixed C-14 production in GALE does not recognize that its production in nuclear power plants is mainly produced by activation of O-17 content of water in the primary coolant circuit. The quantity released is directly linked to energy provided by the reactor. Since the U.S. EPR is significant larger (approximately 1,600 MWe) than the size of power plants when the GALE code was developed, the annual release of C-14 is increased for analysis purposes to 18.9 Ci (0.7 TBq) which is estimated to be in the chemical form of 80% methane and only 20% carbon dioxide.

5.4.1.1 Liquid Pathways

Treated liquid radwaste effluent is released to the Susquehanna River at a flow rate of 11 gpm (42 lpm) (see Section 3.3.1) via the BBNPP discharge line situated downstream of the Waste Water Retention Basin. The average discharge flow rate from the retention basin for waste water streams other than treated liquid radiological waste, is conservatively assumed to be 8,579 gpm (0.5413 m^3/sec), resulting in a total average flow of 8,590 gpm (0.5706 m^3/sec) for all liquid effluents discharged to the river. Retention basin flow provides dilution flow to discharged treated liquid radiological waste. As shown in Table 5.4-1, a near-field dilution factor of 11.8 (a mixing ratio of 0.085) was utilized for calculating the maximum individual dose to man for exposures associated with fish and invertebrate ingestion and boating pathways. For swimming and shoreline exposure pathways, an environmental dilution factor of 44 (a mixing ratio of 0.023) was applied for the maximum impacted shoreline. This value is based upon the maximally impacted shoreline dilution factor. These dilution factors are based on a submerged, multi-port diffuser (with seventy-two nozzles), a discharge line situated near the shoreline with the nozzles directed out into the Susquehanna River. Table 5.4-2 provides far-field dilution factors. The physical description of the cooling water discharge system is provided in Section 3.4. Dilution effects for both near-field and far-field mixing are described in Section 5.3.

Table 5.4-3 provides information on major fish catch locations within 50 mi (80 km) of the BBNPP site. For conservatism, no credit is taken for radioactive decay in the environment during transit time from the release point to the receptors in unrestricted areas.

The ability of suspended and bottom sediments to absorb and adsorb radioactive nuclides from solution is recognized as contributing to important pathways to man through the sediment's ability to concentrate otherwise dilute species of ions. The pathways of importance in the site area are by direct contact with the populace such as those persons engaged in shoreline activities, and by transfer to aquatic food chains, irrigated terrestrial food products and potable water derived from the Susquehanna River.

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The models used to determine the concentration of radioactivity in sediments and aquatic foods for the purpose of estimating doses were taken from Regulatory Guide 1.109, Appendix A (NRC, 1977a). The concentration of radioactivity in the sediment is assumed to be dependent upon the concentration of activity in the water column plus a transfer constant from water to sediment. The concentration in terrestrial food and drinking water depends upon the water concentration at the point of withdrawal.

The LADTAP II computer program (NRC, 1986) was used to calculate the doses to the maximum exposed individual (MEI), population groups, and biota other than humans. This program implements the radiological exposure models described in Regulatory Guide 1.109 (NRC, 1977a) for radioactivity releases in liquid effluent. The following exposure pathways are considered in the LADTAP II model for the BBNPP site:

- Ingestion of aquatic foods (fish and invertebrates);
- External exposure to shoreline sediments;
- External exposure to water through boating and swimming;
- Potable water; and
- Ingestion of irrigated foods.

The input parameters for the liquid pathway are presented in Table 5.4-4 and Table 5.4-5 in addition to default maximum individual food consumption factors from Regulatory Guide 1.109 (Table E-5) (NRC, 1977a).

5.4.1.2 Gaseous Pathways

The GASPAR II computer program (NRC, 1987) was used to calculate the doses to the maximum exposed individual (MEI), population groups, and biota. This program implements the radiological exposure models described in Regulatory Guide 1.109 (NRC 1977a) to estimate the radioactivity released in gaseous effluent and the subsequent doses. The following exposure pathways are considered in the GASPAR II model for the BBNPP site:

- External exposure to airborne plume;
- External exposure to deposited radioactivity on the ground plane;
- Inhalation of airborne radioactivity; and
- Ingestion of agricultural products impacted by atmospheric deposition.

The gaseous effluent is transported and diluted in a manner determined by the prevailing meteorological conditions. Section 2.7 discusses the meteorological modeling which has been used for all dose estimates, including estimated dispersion values for the 50 mi (80 km) radius of the BBNPPsite. Dilution factors due to atmospheric dispersion are deduced from historical onsite meteorological data and summarized for the maximum exposed individual in Table 5.4-14. The gaseous source term for BBNPP during expected routine operations is provided in Section 3.5. The BBNPP stack is located adjacent to the reactor building and qualifies as a mixed mode release point. All ventilation air from areas of significant potential contamination, along with waste gas processing effluents, is released through the plant stack.

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The input parameters for the gaseous pathway are presented in Table 5.4-7, and the receptor locations are shown in Table 5.4-14 (ORNL, 1983).

5.4.1.3 Direct Radiation From Station Operations

The U.S. EPR design contains all radioactive sources and systems, including tanks, inside shielded structures such that the radiation levels at the outside surface of the building was not expected to require any radiation protection monitoring for general occupancy beyond the immediate area of the buildings. The fence line with the maximum annual dose rate is located over 1,000 ft (311 m) west of the BBNPP power block. For this direction, there are three buildings that could contribute to the dose at the western fence line: the Fuel Building; the Nuclear Auxiliary Building; and the Radioactive Waste Processing Building. The shielding design for these buildings limit the projected annual dose at the western fence line to no more than 8.07E-01 mrem/yr (8.07E+00 µSv/yr) assuming a full year occupancy of 8,760 hrs/year for a maximum exposed individual. With respect to the nearest site boundary, the northern direction has a minimum distance of approximately 880 ft (268 m) between BBNPP and the site boundary. In this direction, the Fuel Building is the only structure which contains significant radiation sources that could contribute to direct dose at that boundary line. This is due to the shielding effect of other plant structures that are situated between buildings with radiation sources and the BBNPP site boundary line. The exterior walls of the Fuel Building provide sufficient shielding to limit the exterior dose rate to 4.00E-12 mrem/hr (4.00E-11 µSv/hr) at 1 ft (30 cm) from the exterior walls. The projected direct annual dose at the northern BBNPP site boundary from BBNPP would not exceed 2.04E-10 mrem/yr (2.04E-09 µSv/yr) for uninterrupted occupancy over the year. The fence line, approximately 1,350 ft (411 m) south of the BBNPP, has dose contributions from the radiological waste building alone. The shielding design of these buildings in this direction limit the projected annual dose to no more than 1.57E-02 mrem/yr (1.57E-01 µSv/yr) assuming a full 8,760 hr occupancy.

The primary fixed sources of direct radiation associated with SSES Units 1 and 2 is the Independent Spent Fuel Storage Installation (ISFSI), Turbine Building, the Low Level Radioactive Waste Handling Facility, the Steam Dryer Storage Vault, and SEALAND containers.

Implementation of a radiation environmental monitoring program for BBNPP, compliance with requirements for maintaining doses ALARA, and attention to design of plant shielding to ensure direct dose is ALARA, will result in doses to the public and to construction workers due to direct radiation being SMALL, i.e. less than the effluent dose limits 10 CFR 20, 40 CFR 190 and 10 CFR 50, Appendix I.

5.4.2 RADIATION DOSES TO MEMBERS OF THE PUBLIC

For members of the public, doses to MEIs from liquid and gaseous effluents from routine operation of BBNPP are estimated using the methodologies and parameters specified in Section 5.4.1. Additionally, the collective occupational doses to plant workers at BBNPP during normal operations and the performance of in-service inspections and maintenance activities is expected to be less than 50 person-Rem/yr (0.5 person-Sv/yr) for the U.S. EPR design.

5.4.2.1 Liquid Pathway Doses

BBNPP liquid radioactive effluent is mixed with the cooling tower blowdown discharged downstream of the Waste Water Retention Basin.

Mixing of the diluted radioactive effluent with the Susquehanna River water provides for both near and far field mixing zones as described in Section 5.3.2. The isotopic releases in the liquid

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effluent and the concentration at the point of discharge to the environment are given in Section 3.5.

Maximum dose rate estimates to man due to liquid effluent releases were determined for the following activities:

- Eating fish or invertebrates caught near the point of discharge;
- Swimming and using the shoreline for recreational activities at the nearest shoreline of maximum impact;
- Boating on the Susquehanna River near the point of discharge;
- Potable water; and
- Irrigated foods consumption

The dose assessments were made according to the land use information pertaining to fishing (Table 5.4-3), agricultural production (Table 5.4-9, Table 5.4-10, Table 5.4-11 and Table 5.4-12) and irrigation practices according to the pathway data contained in Table 5.4-6 and Table 5.4-13. Table 5.4-18 summarizes the annual liquid dose impact to the maximum exposed individual compared to the dose objectives of 10 CFR 50, Appendix I (CFR, 2007a). These doses are within the limits given in 10 CFR 50, Appendix I, and are conservatively assumed to occur only under conditions that maximize the resultant dose. It is unlikely that any individual would receive doses of the magnitude calculated because of the limited shoreline activities at the BBNPP site.

5.4.2.2 Gaseous Pathway Doses

Dose rates for the maximum exposed individual via the gaseous pathways are evaluated based on the models and dose factors given in Regulatory Guide 1.109, Appendices B and C (NRC, 1977a), and according to site area land use information pertaining to agricultural production listed in Table 5.4-9, Table 5.4-10, Table 5.4-11 and Table 5.4-12. The resulting annual dose assessments are contained in Table 5.4-20 and Table 5.4-21.

Based on existing site land use patterns, four locations for maximum radiological impact are specified, as shown in Table 5.4-14, according to the dose pathway being evaluated: the site boundary, nearest garden, the nearest beef animal, and nearest milk cow. The locations for the BBNPP site boundary, vegetable gardens, meat and milk animals selected for analysis correspond to the respective locations in any of the 16 compass directions with the most limiting atmospheric dispersion and deposition factors, not necessarily the location of the site boundary, garden, or animal closest to the reactor centerline.

A dose assessment for a hypothetical maximum individual, where all applicable receptors were located at the site boundary was also calculated to account for the possibility for future patterns not commonly practiced.

5.4.3 IMPACTS TO MEMBERS OF THE PUBLIC

Appendix I to 10 CFR Part 50 (CFR, 2007a) provides design objectives on the levels of exposure to the general public from routine effluent releases that may be considered to be "as low as reasonably achievable" (ALARA). The estimated doses to individuals in the general public in the site vicinity, for the pathways described in Section 5.4.2.1 and Section 5.4.2.2, demonstrate that

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the proposed plant design is capable of keeping radiation exposures consistent with the ALARA objectives. In addition to the ALARA dose objectives for individuals, 10 CFR 50 Appendix I also requires that an evaluation of alternate radwaste system designs be made to determine the most cost-benefit effective system to keep total radiation exposures to the public as low as reasonably achievable. This cost-benefit evaluation, comparing costs of alternate radwaste systems against their ability to reduce the population doses from plant effluents, is discussed in Section 3.5.2.3 for liquid waste systems process options, and Section 3.5.3.3 for the gaseous waste system alternative design. The cost-benefit ratios for the alternative radwaste augments investigated indicate that no alternate system to the present plant design can be justified on a cost effective basis.

For gaseous effluent ingestion pathways of exposure, the production of milk, meat and vegetables grown within 50 mi (80 km) has been included in the estimation of dose along with plume, ground plane exposures and inhalation. For liquid pathways, the population that can be supported by the recorded harvest of fish and shellfish (invertebrates) within 50 mi (80 km), along with estimated recreational uses of beaches and boating activities, are factored into the aquatic pathway population dose impact assessment.

The population dose assessments which were used in the cost-benefit analysis are based on the models and dose factors given in Regulatory Guide 1.109 (NRC, 1977a). The population which is projected to be contained within 50 mi (80 km) of the site for in the year 2070 has been used for calculating annual population doses for the gaseous releases.

In addition to the BBNPP dose impacts assessed for the maximum exposed individual and general population, the combined historical dose impacts of SSES Units 1 and 2 and a future projection of the dose impacts of the SSES ISFSI are added to the BBNPP projected impacts to compare to the uranium fuel cycle dose standard of 40 CFR 190 (CFR, 2007b). Since there are no other fuel cycle facilities within 5 mi (8.0 km) of the BBNPP/SSES site, the combined impacts for three units can be used to determine the total impact from liquid and gaseous effluents along with direct radiation from fixed radiation sources onsite to determine compliance with the dose limits of the standard 25 mrem/yr (0.25 mSv/yr) whole body, 75 mrem/yr (0.75 mSv/yr) thyroid, and 25 mrem/yr (0.25 mSv/yr) for any other organ). Table 5.4-23 illustrates the impact from SSES Units 1 and 2 over a recent eight year historical period. Using the highest observed annual dose impact from SSES Units 1 and 2, Table 5.4-24 shows the combined impact along with the projected contributions from BBNPP.

5.4.3.1 Impacts From Liquid Pathways

Release of radioactive materials in liquid effluents to the discharge flow, from where they mix with the Susquehanna River, results in minimal radiological exposure to individuals and the general public. The use of the Susquehanna River for agricultural irrigation is minimal accounting for approximately 1 % of all agriculture in the 50 mi (80 km) radius surrounding BBNPP. As such, water irrigation of farm fields is not assumed for the population pathway assessments around the BBNPP site. Since it is a possible pathway for a given individual, it was retained for the assessment of the maximally exposed individual.

With respect to drinking water, the Pennsylvania Division of Drinking Water Management has identified a total of three municipal water supplies using the Susquehanna River as a source of water within the 50 mi (80 km) radius, downstream of the BBNPP liquid discharge. Two of the three are in Danville of Montour County, approximately 30 mi (48 km) down river. The third supply is in Sunbury of Northumberland County, approximately 40 mi (64 km) down stream. The annual average dilution for these locations is estimated to be 500 to 1 and the transit time to the nearest public water supply is estimated to be about 63 hours. The combined pumping

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capacity is recorded as 11.5 million gpd (43.5 million lpd), and is a water supply for a total of 15,940 people.

The BBNPP annual radiation exposures to the maximum exposed individual via the pathways of aquatic foods and shoreline deposits are provided in Table 5.4-16 for total body dose to four age groups (Adult, Teen, Child, Infant) from each dose pathway of exposure, and Table 5.4-17 for the limiting organ dose for each pathway and age group. Table 5.4-18 summarizes the liquid effluent dose to a hypothetical MEI. Population dose impacts within a 50 mi (80 km) radius of the BBNPP site are listed in Table 5.4-19.

For the cost-benefit assessment of liquid radiological waste equipment options, the annual release source terms produced with and without demineralizer processing of evaporator and centrifuge treated liquid waste streams are listed in Section 3.5.2.3. The cost-benefit population dose assessment evaluated the "unadjusted" releases from the two waste processing options in order to assess the relative difference between the two cases of processing with and without a waste demineralizer. However, total expected annual radioactivity release used to determine the expected liquid population dose in Table 5.4-19 includes an adjustment to account for the potential anticipated operational occurrences that add to the expected treated discharge stream. This adjustment factor adds 0.16 curies per year to the normal effluent. The liquid effluent population doses provided in Section 3.5.2.3 uses the unadjusted releases so as not to be dominated by the adjustment factor which is not impacted by any treatment option.

As can be seen from Table 5.4-18, the maximum exposed individual annual doses from the discharge of radioactive materials in liquid effluents projected from BBNPP meets the design objectives of Appendix I to 10 CFR Part 50. In addition, Section 3.5 shows that the effluent concentration being discharged to the Susquehanna River also meets the effluent release standards of 10 CFR Part 20, (Appendix B, Table 2, Column 2). The maximally exposed individual dose calculated from liquids was also included in the BBNPP site assessment of 40 CFR 190 criteria as shown in Table 5.4-24.

Based on this, the release of radioactive materials in liquid effluents results in minimal radiological exposure to individuals and the general public. As such, the impacts would be SMALL and do not warrant mitigation.

5.4.3.2 Impacts From Gaseous Pathways

The release of radioactive materials in gaseous effluents from BBNPP to the environment results in minimal radiological impacts. Annual radiation exposures to the maximum exposed individual near the BBNPP site via the pathways of submersion, ground contamination, inhalation and ingestion are provided in Table 5.4-20 for the four age groups of interest. Table 5.4-21 provides a summary of the dose to the MEI compared to the dose limits of 10 CFR 50, Appendix I. Table 5.4-21 indicates that the critical organ dose to the current real MEI is 1.2 mrem/yr (12 μSv/yr) to a child's bone via the identified exposure pathways in the BBNPP site vicinity. All projected dose impacts are well within the design objects of Appendix I. If a hypothetical individual is postulated to be exposed to all potential pathways (ground plane, inhalation, vegetable gardens, goat's milk and meat) at the same limiting BBNPP site boundary location, the maximum critical organ (child bone) dose increases to 6.6 mrem/yr (66 μSv/yr) which is still below the dose objective of 10 CFR 50, Appendix I, Section II.C (CFR, 2007a).

Population dose impacts within a 50 mi (80 km) radius of the BBNPP site from atmospheric releases from BBNPP are listed in Table 5.4-15. Annual production rates of milk, meat, and vegetables for the 50 mi (80 km) radius are provided in Table 5.4-9 through Table 5.4-12. For

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the cost-benefit assessment of gaseous radiological waste equipment options, the annual release source terms produced by processing the waste purge gas through the base configuration of three charcoal delay beds, as well as the effect of adding a fourth delay bed in series, are provided in Section 3.5.3.3. The estimated holdup times for decay before release are also provided along with the estimated reduction in the population dose afforded by the treatment option.

The estimated population distribution in the year 2070 within a 50 mi (80 km) radius of the BBNPP site is given in Section 2.5.1. The total effective dose equivalent to individuals living in the U.S. from all sources of natural background radiation averages about 300 mrem/yr (3 mSv/yr) (NCRP, 1987). Therefore, the 50 mi (80 km) population (2,456,110) in year 2070 projected in the BBNPP site area will receive a collective population dose of approximately 7.4E+05 person-rem/yr (7,400 person-Sv/yr) from natural background radiation.

The concentration of radionuclides released as gaseous effluents at BBNPP conform to the limits as specified in Column 1 of Table 2 of 10 CFR Part 20 Appendix B (CFR, 2008). Table 5.4-22 shows that the cumulative air concentrations of all radionuclides released is approximately 2% of the levels permissible under 10 CFR 20 Appendix B.

In addition, the maximally exposed individual dose calculated was also compared to 40 CFR 190 criteria (CFR, 2007b) as shown in Table 5.4-24.

Based on this, the release of radioactive materials in gaseous effluents from BBNPP to the environment results in SMALL radiological impacts and do not warrant mitigation.

5.4.3.3 Direct Radiation Doses

Direct radiation doses are discussed in Section 5.4.1.3. Table 5.4-24 includes a projected direct dose (assuming full time occupancy) to the nearest site boundary, from BBNPP as part of the total site dose assessment for compliance with the uranium fuel cycle dose standards of 40 CFR 190.

Based on these projections, direct radiation doses from BBNPP to the environment results in SMALL radiological impacts and do not warrant mitigation.

5.4.4 IMPACTS TO BIOTA OTHER THAN MEMBERS OF THE PUBLIC

Environmental exposure pathways in which biota other than humans could be impacted by plant radiological effluents were examined to determine if doses to biota could be significantly greater than those predicted for humans. This assessment was based on the use of surrogate species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms. Surrogates are used since important attributes are well defined and are accepted as a method for judging doses to biota.

Site specific important biological species include any endangered, threatened, commercial, recreationally valuable, or important to the local ecosystem. Section 2.4 identifies important biota for the BBNPP site. Surrogate biota used includes algae (surrogate for aquatic plants), invertebrates (surrogate for fresh water mollusks and crayfish), fish, muskrat, raccoon, duck, and heron. Table 5.4-25 identifies the important species near the BBNPP site and the assigned surrogate species employed in the assessment of radiation doses.

This assessment uses dose pathway models adopted from Regulatory Guide 1.109 (NRC 1977a). Exposure pathways are outlined in Table 5.4-26.

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Internal exposures to biota from the accumulation of radionuclides from aquatic food pathways are determined using element-dependent bioaccumulation factors. The terrestrial doses are calculated as total body doses resulting from the consumption of aquatic plants, fish, and invertebrates. The terrestrial doses are the result of the amount of food ingested, and the previous uptake of radioisotopes by the "living" food organism. The total body doses are calculated using the bioaccumulation factors corresponding to the "living" food organisms and dose conversion factors for adult man, modified for terrestrial animal body mass and size. The use of the adult factors is conservative since the full 50 year dose commitment predicted by the adult ingestion factors would not be received by biota due to their shorter life spans. These models show that the largest contributions to biota doses are from liquid effluents via the food pathway.

5.4.4.1 Liquid Pathways

The model used for estimating nuclide concentrations in the near-field discharge environment is similar to that used in the analysis for doses to man described in Section 5.4.2. The dose to biota that can swim (fish, invertebrate, algae, muskrat and duck) is based upon the near-field mixing credit of 11.8 to 1. The dose to biota that are confined to the shoreline (raccoon and heron) is based upon the minimum shoreline mixing credit of 46 to 1. The calculation of biota doses was performed using LADTAP II (NRC, 1986). The near-field concentrations are used in estimating the dose of aquatic biota (fish, invertebrates, algae) and of biota that could swim into the near-field (muskrat and duck). The far-field concentrations are used in estimating the dose of biota that primarily inhabit the shoreline (heron and raccoon). Ingestion rates, body mass, and effective size used in the dose calculations are shown in Table 5.4-27 (NRC 1986). Residence times for the surrogate species are shown in Table 5.4-28. Surrogate biota doses from liquid effluents are shown in Table 5.4-29.

Liquid pathway doses for wildlife populations in the BBNPP site area are estimated at the site boundary with the highest calculated human exposure potential. Though onsite locations may have higher dose rates due to being closer to the plant facilities, the site boundary provides a reasonable reference distance away from the human occupied spaces of the plant proper for estimating the dose impact to biota as they tend to avoid human contact. The Waste Water Retention Basin (WWRB), as an open water source, may attract some birds and mammals. However, the nature of the WWRB will provide little feed material to support wildlife, while the release of liquid radioactive waste is a point downstream of the WWRB thereby limiting the potential exposure to any biota that finds their way to it.

5.4.4.2 Gaseous Pathway

Gaseous effluents also contribute to terrestrial biota total body doses. External exposures occur due to immersion in a plume of noble gases and deposition of radionuclides on the ground from a passing gas plume. The inhalation of radionuclides followed by the subsequent transfer from the lung to the rest of the body also contributes to total body doses. Inhaled noble gases are poorly absorbed into the blood and do not contribute significantly to the total body dose. The noble gases do contribute to a lung organ dose but do not make a contribution via this path to the total body dose. Immersion and ground deposition doses are largely independent of organism size and the doses for the maximally exposed individual located at the site boundary as described in Section 5.4.2 can be applied to all terrestrial biota doses. The external ground doses described in Section 5.4.2 calculated by GASPAR II (NRC, 1987) are increased by a factor of 2 to account for the closer proximity to the ground of terrestrial species. This approach is similar to the adjustments made for biota exposures to shoreline sediment performed in LADTAP II (NRC 1986). The inhalation pathway doses for biota are the internal total body doses calculated by GASPAR II as described in Section 5.4.2 for man (NRC, 1987). The

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total body inhalation dose (rather than organ specific doses) is used since the biota doses are assessed on a total body basis. Surrogate biota doses from gaseous effluents are shown in Table 5.4-29.

5.4.4.3 Direct Radiation from Station Operations

Doses to biota from the normal operations of BBNPP are assumed to be equal to those described in Section 5.4.1.3. The maximum projected dose rate along the site boundary of BBNPP will not exceed 8.07E-01 mrem/yr (8.07 Sv/yr). This pathway was applied to all biota with a habitat that have access to the site boundary fence line surrounding BBNPP.

5.4.4.4 Biota Doses

Doses to biota from both liquid and gaseous effluents and fixed sources from BBNPPare shown in Table 5.4-29. Table 5.4-30 compares the biota doses to the criterion given in 40 CFR 190. These dose criteria are applicable to man, and are considered conservative when applied to biota. The total body dose is taken as the sum of the internal and external dose for all pathways considered as outlined in Table 5.4-26. Table 5.4-30 shows that annual doses for all of the seven surrogate biota species meet the dose criterion of 40 CFR 190. The total pathway doses for all surrogate biota are less than 100 mrem/yr (1 mSv/yr). The dose assessments included in Table 5.4-29 are from sources originating from BBNPP. The dose criterion given in 40 CFR 190 is given for all uranium fuel cycle operations. Based on the data given in Table 5.4-24 for the whole body, the addition would have a minimal impact on the results of the site as whole.

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "...if man is adequately protected then other living things are also likely to be sufficiently protected" and uses human protection to infer environmental protection from the effects of ionizing radiation. This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans. Conversely, it is also known that biota with the same environment and exposure pathways as man can experience higher doses without adverse effects. Species in most ecosystems experience dramatically higher mortality rates from natural causes than man. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota have been discovered that show significant changes in morbidity or mortality to radiation exposures predicted for nuclear power plants.

The NRC reports in NUREG-1555, Section 5.4.4, that existing literature including the "Recommendations of the International Commission on Radiological Protection (ICRP, 1977), found that appreciable effects in aquatic populations would not be expected at doses lower than 1 rad/day (10 mGy/day) and that limiting the dose to the maximally exposed individual organisms to less than this amount would provide adequate protection of the population. The NRC also reports in NUREG-1555 that chronic dose rates of 0.1 rad/day (1 mGy/day) or less do not appear to cause observable changes in terrestrial animal populations. The assumed lower threshold occurs for terrestrials rather than for aquatic animals primarily because some species of mammals and reptiles are considered more radiosensitive than aquatic organisms. The permissible dose rates are considered screening levels and higher species-specific dose rates could be acceptable with additional study or data.

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Based on this, operation of BBNPPwill result in SMALL radiological impacts to biota and do not warrant mitigation.

5.4.4.5 References

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Table 5.4-1—Near Field Environmental Dilution Values (50 feet from the discharge) for BBNPP Discharges to the Susquehanna River

Scenario 1 (1)	Scenario 2 (2)	Scenario 3 (3)	Scenario 4 (4)	Scenario 5 (5)
26.9	11.8	67	19.2	68.7

Notes:
1. This value corresponds to the summer mean river flow, given in August.
2. This value corresponds to the summer low river flow, given in August.
3. This value corresponds to the winter mean river flow, given in January.
4. This value corresponds to the winter low river flow, given in January.
5. This value corresponds to the annual mean flow.

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Table 5.4-2—Surface Far Field Dilution Values for BBNPP Discharges to the Susquehanna River

Location	Transit Time (hrs)	Dilution
Fully Mixed[(1)]	> 3.08[(2)]	46
Max. Impacted Shoreline[(3)]	5.50	44
Property Boundary[(4)]	1.08	224
Public Water Supply Intake (at Danville)[(5)]	63	500
Recreational Shore (at Sunbury)[(6)]	290	175

Notes:

1. The limiting scenario for the fully mixed condition is the summer low river flow.
2. The fully mixed condition occurs after S. Hicks Ferry Rd, which has a travel time of 3.08 hrs.
3. The limiting scenario for the maximum impacted shoreline is the summer low river flow.
4. The limiting scenario for the property boundary is the winter mean river flow.
5. The realistic value for the public water supply is the annual mean river flow.
6. The realistic value for the recreation shoreline is the summer mean river flow.

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Table 5.4-3—Present Average Susquehanna River Recreational Fishing Harvest

County	Harvest Weight (lbs)			Harvest Weight (kg)		
	Small Mouth Bass	Channel Catfish	Walleye	Small Mouth Bass	Channel Catfish	Walleye
Bradford	36,506	6,153	1,957	16,559	2,791	888
Columbia	44,531	7,505	2,387	20,199	3,404	1,083
Lackawanna	95,687	16,127	5,129	43,403	7,315	2,326
Luzerne	138,265	23,303	7,411	62,716	10,570	3,362
Montour	2,317	390	124	1,051	177	56
Northumberland	36,262	6,112	1,944	16,448	2,772	882
Snyder	39,025	6,577	2,092	17,701	2,983	949
Wyoming	27,351	4,610	1,466	12,406	2,091	665
TOTAL	419,945	70,778	22,509	190,484	32,104	10,210
Internet	6,830	1,151	366	3,098	522	166
TOTAL	426,735	71,922	22,873	193,564	32,623	10,375

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Table 5.4-4—Liquid Pathway Parameters

Description	Parameter
Effluent Discharge Flow (normal)[(1)]	8,590 gpm (32,517 lpm)
Source Term[(2)]	See Section 3.5
Mixing Ratios (in Susquehanna River)	See Table 5.4-1 and Table 5.4-2
Shore Width factor[(3)]	0.2
Transit Time boating	See Table 5.4-2 for transit times
Sport Fishing harvest[(4)]	236,562 kg/yr
Recreational Usage for 50 mi (80 km) population : Boating[(5)]	393,584 Person-hrs/yr
Drinking Water (Danville and Sunbury)[(6)]	11,500,000 gpd
Transit Time, drinking water	See Table 5.4-2 for transit times

Notes:

1. See Section 3.3.
2. See Section 3.5 for annual expected effluent releases per the GALE code.
3. From Regulatory Guide 1.109, Table A-2 for a river shoreline.
4. Projected edible total recreation fish landing from Table 5.4-3.
5. Projected from the National Recreational Boating Survey Report for Pennsylvania.
6. Source Pumping Capacity from Pennsylvania Department of Environmental Protection.

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Table 5.4-5—Recreational Liquid Pathway Usage Parameters for MEI

Usage Parameter	Age Group	Value Used in Calculations[1] (hrs/yr)
Shoreline Usage[1]	Adult	12
	Teen	67
	Child	14
	Infant[2]	12
Swimming Usage[3]	Adult	12
	Teen	67
	Child	14
	Infant[2]	12
Boating Usage[4]	Adult	52
	Teen	52
	Child	29
	Infant[2]	52

Note:

1. From R.G. 1.109 Rev. 1 Table E-5
2. Assumed to be equal to Adult usage.
3. Assumed to be equal to Shoreline Usage.
4. From R.G. 1.109 Rev. 0, Table A-2

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Table 5.4-6—rrigated Food Crops Production Rates

County[1]	Vegetable				Milk			
	Rate (lb/yr)	Rate (kg/yr)	Yield (lb/ft^2)	Yield (kg/m^2)	Rate (gal/yr)	Rate (l/yr)	Yield (lb/ft^2)	Yield (kg/m^2)
Columbia	4.30E+06	1.95.E+06	3.20E-01	4.43E-02	2.91E+05	1.10E+06	1.86E-01	2.57E-02
Luzerne	2.60E+05	1.18.E+05	8.25E-02	1.14E-02	1.23E+04	4.65E+04	3.33E-02	4.60E-03
Montour	4.72E+05	2.14.E+05	2.99E-01	4.13E-02	7.36E+04	2.79E+05	3.99E-01	5.51E-02
Northumberland	6.83E+06	3.10.E+06	4.81E-01	6.65E-02	3.92E+05	1.48E+06	2.36E-01	3.26E-02
Snyder	4.41E+06	2.00.E+06	2.94E-01	4.06E-02	9.40E+05	3.56E+06	5.36E-01	7.41E-02
Total	1.63E+07	7.38.E+06	1.48E+00	2.04E-01	1.71E+06	6.47E+06	1.39E+00	1.92E-01
County[1]	**Leafy Vegetable**				**Meat**			
Columbia	3.99E+04	1.81E+04	2.98E-03	4.12E-04	4.52E+05	2.05E+05	3.37E-02	4.66E-03
Luzerne	5.09E+03	2.31E+03	1.61E-03	2.23E-04	2.02E+04	9.16E+03	6.39E-03	8.84E-04
Montour	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.59E+04	1.63E+04	2.28E-02	3.15E-03
Northumberland	8.09E+03	3.67E+03	5.70E-04	7.88E-05	1.55E+06	7.04E+05	1.09E-01	1.51E-02
Snyder	3.51E+04	1.59E+04	2.34E-03	3.23E-04	6.42E+06	2.91E+06	4.27E-01	5.91E-02

Notes
1. The counties identified above are the only counties within the 50 mi (80 km) radius of BBNPP that border the Susquehanna River with the potential to irrigate crops

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Table 5.4-7—Gaseous Pathway Parameters

Parameter Description	Value
Growing season, fraction of year (April - October)(1)	0.583
Fraction time animals on pasture per year	0.583
Intake from Pasture when on Pasture	1.0
Absolute Humidity (g/m^3)	6.6
Average Temperature in growing Season: °F (°C)(1)	63.2 (17.3)
Population Distribution	Section 2.5.1
Milk Production within 50 mi (80 km): gal/yr (l/yr)(2)	2.51E+08 (9.50E+08)
Meat Production within 50 mi (80 km): lbs/yr (kb/yr)(3)	5.55E+08 (2.52E+08)
Vegetable/Grain Production within 50 mi (80 km): lbs/yr (kg/yr)(4)	1.67E+09 (7.58E+08)
Consumption Parameters	Table 5.4-8

Notes:

1. The growing season is the span of months when the temperature is above freezing for all days during the month. This occurs from April through October.
2. From 50 mi (80 km) cow milk production shown in Table 5.4-9.
3. From 50 mi (80 km) poultry, beef, hog, and sheep production show in Table 5.4-10.
4. From 50 mi (80 km) grain, leafy vegetable, other above ground vegetables and other below ground vegetables production shown in Table 5.4-11.

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Table 5.4-8—Gaseous Pathway Consumption Factors for the MEI

Consumption Factor	Adult	Teen	Child	Infant
Leafy Vegetables lbs/yr (kg/yr)	141 (64)	93 (42)	57 (26)	0 (0)
Meat Consumption lbs/yr (kg/yr)	243 (110)	143 (65)	90 (41)	0 (0)
Milk Consumption gal/yr (l/yr)	82 (310)	106 (400)	87 (330)	87 (330)
Vegetable/Fruit Consumption lbs/yr (kg/yr)	1147 (520)	1389 (630)	1147 (520)	0 (0)

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Table 5.4-9—Milk Production gal/yr (l/yr)
(Page 1 of 2)

	Distance miles (km)										
Sector	**0-1 (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (3.2-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
N	603	1,807	3,013	4,216	5,423	45,180	180,745	2,086,315	6,466,416	8,314,332	17,108,050
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(684,195)	(7,897,561)	(24,478,049)	(31,473,171)	(64,761,016)
NNE	603	1,807	3,013	4,216	5,423	45,180	180,745	2,086,315	3,860,778	4,963,857	11,151,937
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(684,195)	(7,897,561)	(14,614,634)	(18,790,244)	(42,214,674)
NE	603	1,807	3,013	4,216	5,423	45,180	180,745	2,086,315	2,920,068	4,963,857	10,211,227
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(684,195)	(7,897,561)	(11,053,659)	(18,790,244)	(38,653,699)
ENE	603	1,807	3,013	4,216	5,423	45,180	180,745	600,508	2,706,153	3,479,339	7,026,987
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(684,195)	(2,273,171)	(10,243,902)	(13,170,732)	(26,600,040)
E	603	1,807	3,013	4,216	5,423	45,180	180,745	301,285	118,066	98,452	758,790
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(684,195)	(1,140,488)	(446,927)	(372,683)	(2,872,333)
ESE	603	1,807	3,013	4,216	5,423	45,180	180,745	301,285	1,966,986	2,529,093	5,038,351
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(684,195)	(1,140,488)	(7,445,854)	(9,573,659)	(19,072,235)
SE	603	1,807	3,013	4,216	5,423	45,180	422,418	704,115	1,059,008	11,041,103	13,286,885
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(1,599,024)	(2,665,366)	(4,008,780)	(41,795,122)	(50,296,333)
SSE	603	1,807	3,013	4,216	5,423	45,180	422,418	704,115	8,587,525	11,041,103	20,815,402
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(1,599,024)	(2,665,366)	(32,507,317)	(41,795,122)	(78,794,869)
S	603	1,807	3,013	4,216	5,423	45,180	422,418	704,115	8,587,525	27,808,941	37,583,240
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(1,599,024)	(2,665,366)	(32,507,317)	(105,268,293)	(142,268,040)
SSW	603	1,807	3,013	4,216	5,423	252,445	1,009,782	2,138,634	985,813	27,808,941	32,210,676
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(955,610)	(3,822,439)	(8,095,610)	(3,731,707)	(105,268,293)	(121,930,674)
SW	603	1,807	3,013	4,216	30,283	252,445	1,009,782	3,613,358	2,994,809	4,958,703	12,869,019
	(2,281)	(6,842)	(11,405)	(15,961)	(114,634)	(955,610)	(3,822,439)	(13,678,049)	(11,336,585)	(18,770,732)	(48,714,538)
WSW	603	1,807	3,013	23,562	30,283	252,445	1,009,782	3,613,358	6,801,464	10,553,996	22,290,312
	(2,281)	(6,842)	(11,405)	(89,190)	(114,634)	(955,610)	(3,822,439)	(13,678,049)	(25,746,341)	(39,951,220)	(84,378,011)
W	603	1,807	3,013	23,562	30,283	252,445	1,009,782	3,613,358	8,208,663	10,553,996	23,697,512
	(2,281)	(6,842)	(11,405)	(89,190)	(114,634)	(955,610)	(3,822,439)	(13,678,049)	(31,073,171)	(39,951,220)	(89,704,840)
WNW	603	1,807	3,013	23,562	30,283	252,445	1,009,782	1,682,969	1,574,981	2,024,975	6,604,420
	(2,281)	(6,842)	(11,405)	(89,190)	(114,634)	(955,610)	(3,822,439)	(6,370,732)	(5,961,951)	(7,665,366)	(25,000,450)
NW	603	1,807	3,013	4,216	30,283	252,445	1,009,782	1,124,986	1,574,981	8,314,332	12,316,449
	(2,281)	(6,842)	(11,405)	(15,961)	(114,634)	(955,610)	(3,822,439)	(4,258,537)	(5,961,951)	(31,473,171)	(46,622,830)
NNW	603	1,807	3,013	4,216	5,423	45,180	1,009,782	2,086,315	6,466,416	8,314,332	17,937,087
	(2,281)	(6,842)	(11,405)	(15,961)	(20,527)	(171,024)	(3,822,439)	(7,897,561)	(24,478,049)	(31,473,171)	(67,899,260)

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Table 5.4-9—Milk Production gal/yr (l/yr)

(Page 2 of 2)

	Distance miles (km)										
Sector	**0-1 (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (3.2-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
Total	9,641	28,919	48,206	125,498	211,064	1,966,471	9,420,195	27,447,347	64,879,651	146,769,353	250,906,346
	(36,496)	(109,471)	(182,478)	(475,063)	(798,966)	(7,443,902)	(35,659,317)	(103,899,512)	(245,596,195)	(555,582,439)	(949,783,840)

Goat milk accounts for less than 0.03% of the production in the 50 mi (80 km) radius of BBNPP. The above data includes only the cow milk production.

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Table 5.4-10—Meat Production lb/yr (kg/yr)

(Page 1 of 2)

	Distance miles (km)										
Sector	**0-1 (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (3.2-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
N	992	2,974	4,959	6,941	8,924	74,368	297,384	1,656,844	5,526,363	6,918,580	14,498,328
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(134,891)	(751,532)	(2,506,716)	(3,138,215)	(6,576,331)
NNE	992	2,974	4,959	6,941	8,924	74,368	297,384	1,573,397	3,192,309	4,105,969	9,268,216
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(134,891)	(713,681)	(1,448,007)	(1,862,436)	(4,203,992)
NE	992	2,974	4,959	6,941	8,924	74,368	297,384	1,573,397	2,202,839	4,139,318	8,312,096
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(134,891)	(713,681)	(999,191)	(1,877,563)	(3,770,303)
ENE	992	2,974	4,959	6,941	8,924	74,368	297,384	815,834	2,153,167	2,767,339	6,132,881
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(134,891)	(370,056)	(976,660)	(1,255,244)	(2,781,828)
E	992	2,974	4,959	6,941	8,924	74,368	297,384	580,356	477,056	373,331	1,827,284
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(134,891)	(263,245)	(216,389)	(169,340)	(828,842)
ESE	992	2,974	4,959	6,941	8,924	74,368	340,004	566,917	1,844,132	2,180,370	5,030,579
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(154,223)	(257,149)	(836,484)	(988,999)	(2,281,832)
SE	992	2,974	4,959	6,941	8,924	74,368	2,786,822	4,643,894	6,696,828	17,049,824	31,276,525
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(1,264,081)	(2,106,435)	(3,037,630)	(7,733,670)	(14,186,793)
SSE	992	2,974	4,959	6,941	8,924	74,368	2,786,430	4,642,538	13,261,753	17,049,824	37,839,702
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(1,263,903)	(2,105,820)	(6,015,430)	(7,733,670)	(17,163,800)
S	992	2,974	4,959	6,941	8,924	74,368	2,786,430	4,642,538	13,256,477	76,497,715	97,282,318
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(1,263,903)	(2,105,820)	(6,013,037)	(34,698,780)	(44,126,517)
SSW	992	2,974	4,959	6,941	8,924	391,569	3,350,610	8,752,698	6,500,612	76,497,715	95,517,993
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(177,613)	(1,519,811)	(3,970,157)	(2,948,628)	(34,698,780)	(43,326,233)
SW	992	2,974	4,959	6,941	46,997	391,569	1,566,409	8,762,912	11,849,317	15,945,705	38,578,774
	(450)	(1,349)	(2,249)	(3,149)	(21,317)	(177,613)	(710,511)	(3,974,790)	(5,374,760)	(7,232,850)	(17,499,037)
WSW	992	2,974	4,959	36,549	46,997	391,569	1,566,409	8,762,912	46,413,788	59,654,795	116,881,942
	(450)	(1,349)	(2,249)	(16,578)	(21,317)	(177,613)	(710,511)	(3,974,790)	(21,052,940)	(27,058,960)	(53,016,757)
W	992	2,974	4,959	36,549	46,997	391,569	1,566,409	2,626,786	21,183,866	25,756,068	51,617,167
	(450)	(1,349)	(2,249)	(16,578)	(21,317)	(177,613)	(710,511)	(1,191,490)	(9,608,840)	(11,682,756)	(23,413,153)
WNW	992	2,974	4,959	36,549	46,997	391,569	1,566,409	2,610,533	2,753,034	3,539,645	10,953,659
	(450)	(1,349)	(2,249)	(16,578)	(21,317)	(177,613)	(710,511)	(1,184,118)	(1,248,755)	(1,605,556)	(4,968,496)
NW	992	2,974	4,959	6,941	46,997	391,569	1,566,409	1,966,199	2,753,034	7,421,955	14,162,027
	(450)	(1,349)	(2,249)	(3,149)	(21,317)	(177,613)	(710,511)	(891,853)	(1,248,755)	(3,366,542)	(6,423,787)
NNW	992	2,974	4,959	6,941	8,924	74,368	1,566,409	1,656,844	5,505,787	6,918,580	15,746,777
	(450)	(1,349)	(2,249)	(3,149)	(4,048)	(33,733)	(710,511)	(751,532)	(2,497,383)	(3,138,215)	(7,142,618)

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Table 5.4-10—Meat Production lb/yr (kg/yr)
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	Distance miles (km)										
Sector	**0-1 (0-1.6)**	**1-2 (1.6-3.2)**	**2-3 (3.2-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
Total	15,864	47,581	79,337	199,883	333,145	3,093,097	22,935,667	55,834,601	145,570,361	326,816,732	554,926,267
	(7,196)	(21,583)	(35,987)	(90,665)	(151,112)	(1,403,005)	(10,403,444)	(25,326,149)	(66,029,605)	(148,241,576)	(251,710,321)

Meat production consists of 49.6% poultry, 30% hog, 20.2% beef, and 0.2% Sheep.

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Table 5.4-11—Vegetable Production lb/yr (kg/yr)

(Page 1 of 2)

	Distance miles (km)										
Sector	0-1 (0-1.6)	1-2 (1.6-3.2)	2-3 (3.2-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
N	13,012	39,039	65,061	91,093	117,127	976,033	3,903,902	7,436,920	7,972,334	9,174,096	29,788,617
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(1,770,780)	(3,373,330)	(3,616,190)	(4,161,300)	(13,511,889)
NNE	13,012	39,039	65,061	91,093	117,127	976,033	3,903,902	7,436,920	8,408,850	10,813,674	31,864,710
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(1,770,780)	(3,373,330)	(3,814,190)	(4,905,000)	(14,453,589)
NE	13,012	39,039	65,061	91,093	117,127	976,033	3,903,902	7,710,293	8,344,915	6,568,739	27,829,214
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(1,770,780)	(3,497,330)	(3,785,190)	(2,979,530)	(12,623,119)
ENE	13,012	39,039	65,061	91,093	117,127	976,033	3,903,902	6,781,640	6,506,591	6,335,049	24,828,547
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(1,770,780)	(3,076,100)	(2,951,340)	(2,873,530)	(11,262,039)
E	13,012	39,039	65,061	91,093	117,127	976,033	3,903,902	6,804,788	5,613,851	4,849,178	22,473,084
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(1,770,780)	(3,086,600)	(2,546,400)	(2,199,550)	(10,193,619)
ESE	13,012	39,039	65,061	91,093	117,127	976,033	3,992,042	6,654,080	52,416,005	65,694,447	130,057,940
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(1,810,760)	(3,018,240)	(23,775,500)	(29,798,500)	(58,993,289)
SE	13,012	39,039	65,061	91,093	117,127	976,033	9,946,375	15,808,026	70,642,282	87,560,776	185,258,824
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(4,511,600)	(7,170,400)	(32,042,800)	(39,716,900)	(84,031,989)
SSE	13,012	39,039	65,061	91,093	117,127	976,033	9,909,558	15,022,519	71,203,138	85,984,493	183,421,073
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(4,494,900)	(6,814,100)	(32,297,200)	(39,001,910)	(83,198,399)
S	13,012	39,039	65,061	91,093	117,127	976,033	9,909,558	15,022,519	40,411,174	82,271,225	148,915,841
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(4,494,900)	(6,814,100)	(18,330,200)	(37,317,600)	(67,547,089)
SSW	13,012	39,039	65,061	91,093	117,127	3,878,703	16,794,815	46,090,061	21,031,659	89,897,235	178,017,805
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(1,759,350)	(7,618,000)	(20,906,100)	(9,539,800)	(40,776,700)	(80,747,518)
SW	13,012	39,039	65,061	91,093	465,418	3,759,124	15,032,748	44,626,412	59,160,607	77,594,339	200,846,853
	(5,902)	(17,708)	(29,511)	(41,319)	(211,110)	(1,705,110)	(6,818,740)	(20,242,200)	(26,834,800)	(35,196,200)	(91,102,600)
WSW	13,012	39,039	65,061	362,021	451,055	3,759,124	15,032,748	44,626,412	60,138,357	75,245,975	199,732,804
	(5,902)	(17,708)	(29,511)	(164,210)	(204,595)	(1,705,110)	(6,818,740)	(20,242,200)	(27,278,300)	(34,131,000)	(90,597,276)
W	13,012	39,039	65,061	362,021	451,055	3,759,124	15,032,748	29,687,889	55,658,476	38,192,640	143,261,065
	(5,902)	(17,708)	(29,511)	(164,210)	(204,595)	(1,705,110)	(6,818,740)	(13,466,200)	(25,246,260)	(17,323,890)	(64,982,126)
WNW	13,012	39,039	65,061	362,021	451,055	3,878,703	15,032,748	25,075,819	10,924,589	14,046,687	69,888,733
	(5,902)	(17,708)	(29,511)	(164,210)	(204,595)	(1,759,350)	(6,818,740)	(11,374,200)	(4,955,310)	(6,371,470)	(31,700,996)
NW	13,012	39,039	65,061	91,093	465,418	3,878,703	15,511,460	7,983,203	11,177,834	14,501,853	53,726,676
	(5,902)	(17,708)	(29,511)	(41,319)	(211,110)	(1,759,350)	(7,035,880)	(3,621,120)	(5,070,180)	(6,577,930)	(24,370,010)
NNW	13,012	39,039	65,061	91,093	117,127	976,033	15,511,460	7,436,920	7,225,739	9,079,959	40,555,443
	(5,902)	(17,708)	(29,511)	(41,319)	(53,128)	(442,721)	(7,035,880)	(3,373,330)	(3,277,540)	(4,118,600)	(18,395,639)

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Table 5.4-11—Vegetable Production lb/yr (kg/yr)
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Sector	Distance miles (km)										
	0-1 (0-1.6)	**1-2 (1.6-3.2)**	**2-3 (3.2-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
Total	208,194	624,624	1,040,970	2,270,278	3,572,399	32,673,808	161,225,772	294,204,419	496,836,399	677,810,365	1,670,467,229
	(94,435)	(283,325)	(472,176)	(1,029,781)	(1,620,413)	(14,820,590)	(73,130,780)	(133,448,880)	(225,361,200)	(307,449,610)	(757,711,190)

Vegetable production includes 79% grains, 14% above ground vegetables, 6% below ground vegetables, 1% leafy vegetables.

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Table 5.4-12—Leafy Vegetable Production lb/yr (kg/yr)

(Page 1 of 2)

	Distance miles (km)										
Sector	0-1 (0-1.6)	1-2 (1.6-3.2)	2-3 (3.2-4.8)	3-4 (4.8-6.4)	4-5 (6.4-8.1)	5-10 (8.1-16.1)	10-20 (16.1-32.2)	20-30 (32.2-48.3)	30-40 (48.3-64.4)	40-50 (64.4-80.5)	Total
N	250	751	1,252	1,753	2,253	18,786	75,134	152,185	211,622	93,917	557,903
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(34,080)	(69,030)	(95,990)	(42,600)	(253,061)
NNE	250	751	1,252	1,753	2,253	18,786	75,134	152,185	211,622	272,050	736,037
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(34,080)	(69,030)	(95,990)	(123,400)	(333,861)
NE	250	751	1,252	1,753	2,253	18,786	75,134	152,185	211,622	148,217	612,203
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(34,080)	(69,030)	(95,990)	(67,230)	(277,691)
ENE	250	751	1,252	1,753	2,253	18,786	75,134	125,223	235,013	148,217	608,632
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(34,080)	(56,800)	(106,600)	(67,230)	(276,071)
E	250	751	1,252	1,753	2,253	18,786	75,134	243,170	340,394	174,055	857,798
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(34,080)	(110,300)	(154,400)	(78,950)	(389,091)
ESE	250	751	1,252	1,753	2,253	18,786	95,152	158,601	415,571	272,491	966,861
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(43,160)	(71,940)	(188,500)	(123,600)	(438,561)
SE	250	751	1,252	1,753	2,253	18,786	520,952	867,299	1,214,306	288,585	2,916,188
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(236,300)	(393,400)	(550,800)	(130,900)	(1,322,761)
SSE	250	751	1,252	1,753	2,253	18,786	520,952	867,299	1,217,393	41,689	2,672,379
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(236,300)	(393,400)	(552,200)	(18,910)	(1,212,171)
S	250	751	1,252	1,753	2,253	18,786	520,952	867,299	1,217,393	371,258	3,001,948
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(236,300)	(393,400)	(552,200)	(168,400)	(1,361,661)
SSW	250	751	1,252	1,753	2,253	34,723	584,666	974,664	1,214,306	1,820,357	4,634,976
	(114)	(341)	(568)	(795)	(1,022)	(15,750)	(265,200)	(442,100)	(550,800)	(825,700)	(2,102,390)
SW	250	751	1,252	1,753	4,167	34,635	138,538	230,824	1,214,306	1,561,314	3,187,791
	(114)	(341)	(568)	(795)	(1,890)	(15,710)	(62,840)	(104,700)	(550,800)	(708,200)	(1,445,958)
WSW	250	751	1,252	3,241	4,156	34,635	138,538	230,824	253,752	326,284	993,684
	(114)	(341)	(568)	(1,470)	(1,885)	(15,710)	(62,840)	(104,700)	(115,100)	(148,000)	(450,727)
W	250	751	1,252	3,241	4,156	34,635	138,538	230,824	61,862	92,352	567,861
	(114)	(341)	(568)	(1,470)	(1,885)	(15,710)	(62,840)	(104,700)	(28,060)	(41,890)	(257,577)
WNW	250	751	1,252	3,241	4,156	34,723	138,538	230,824	71,827	92,352	577,914
	(114)	(341)	(568)	(1,470)	(1,885)	(15,750)	(62,840)	(104,700)	(32,580)	(41,890)	(262,137)
NW	250	751	1,252	1,753	4,167	34,723	138,847	51,302	71,827	169,822	474,694
	(114)	(341)	(568)	(795)	(1,890)	(15,750)	(62,980)	(23,270)	(32,580)	(77,030)	(215,318)
NNW	250	751	1,252	1,753	2,253	18,786	138,847	152,185	73,061	93,917	483,056
	(114)	(341)	(568)	(795)	(1,022)	(8,521)	(62,980)	(69,030)	(33,140)	(42,600)	(219,111)

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Table 5.4-12—Leafy Vegetable Production lb/yr (kg/yr)
(Page 2 of 2)

Sector	Distance miles (km)										
	0-1 (0-1.6)	**1-2 (1.6-3.2)**	**2-3 (3.2-4.8)**	**3-4 (4.8-6.4)**	**4-5 (6.4-8.1)**	**5-10 (8.1-16.1)**	**10-20 (16.1-32.2)**	**20-30 (32.2-48.3)**	**30-40 (48.3-64.4)**	**40-50 (64.4-80.5)**	**Total**
Total	4,007	12,021	20,036	32,516	45,585	395,928	3,450,190	5,686,890	8,235,875	5,966,877	23,849,926
	(1,818)	(5,453)	(9,088)	(14,749)	(20,677)	(179,590)	(1,564,980)	(2,579,530)	(3,735,730)	(2,706,530)	(10,818,144)

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Table 5.4-13—Distance to Nearest Gaseous Dose Receptors

Sector	64(mi/m)	Residence (mi/km)	Vegetable Garden (mi/km)	Meat Animal (mi/km)	Milk Animal (mi/km)
N	0.20/320	-	1.8/2.9	-	-
NNE	0.47/753	1.1/107	3.9/6.2	-	-
NE	0.58/929	1.3/2.1	3.2/5.1	3.2/5.1	-
ENE	0.58/936	2.4/3.9	2.4/3.9	3.4/5.5	-
E	0.63/1020	1.3/2.1	1.3/2.1	-	5.4/8.7
ESE	0.39/633	1.2/1.9	-	-	4.8/7.6
SE	0.32/514	0.66/1.1	1.1/1.8	-	-
SSE	0.31/492	-	0.86/1.4	-	-
S	0.31/492	-	-	2.9/4.6	2.5/4.1
SSW	0.28/454	-	1.08/1.7	-	12.2/19.6
SW	0.24/387	0.28/0.46	-	0.65/1.0	0.65/1.0
WSW	0.21/334	0.28/0.45	0.28/0.45	-	-
W	0.21/334	-	-	-	-
WNW	0.21/334	-	-	-	4.1/6.6
NW	0.21/334	-	-	-	-
NNW	0.20/320	0.49/0/79	0.49/0.79	-	-
Distance measured from the center of containment.					

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Table 5.4-14—Receptor Locations for Gaseous Effluent Maximum Dose Evaluations

Location (Distance, Sector)	Dose Pathways Evaluated	Undecayed χ/Q (sec/m^3)	Depleted χ/Q (sec/m^3)	D/Q (1/m^2)
Site Boundary 0.20 mi (0.32 km) N	Plume Ground Inhalation	9.672E-06	9.607E-06	9.453E-09
Site Boundary 0.58 mi (0.93 km) NE	Plume Ground Inhalation	2.424E-06	2.320E-06	1.721E-08
Nearest Garden 0.28 mi (0.45 km) WSW	Vegetable	2.443E-06	2.303E-06	4.540E-09
Nearest Meat Animal 0.65 mi (1.04 km) SW	Meat	4.976E-07	4.654E-07	1.954E-09
Nearest Milk Animal 0.65 mi (1.04 km) SW	Milk	4.976E-07	4.654E-07	1.954E-09

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Table 5.4-15—50 Mi (80 km) Population Doses from Gaseous Effluents

Person-Rem
(Person-Sieverts)

Pathway	Total Body	Skin	Thyroid	Critical Organ Bone
Plume	4.18E+00 (4.18E+02)	1.63E+01 (1.63E-01)	4.18E+00 (4.18E-02)	4.18E+00 (4.18E-02)
Ground Plane	6.24E-03 (6.24E-05)	7.32E-03 (7.32E-05)	6.24E-03 (6.24E-05)	6.24E-03 (6.24E-05)
Inhalation	1.29E-01 (1.29E-03)	1.29E-01 (1.29E-03)	2.94E-01 (2.974E-03)	1.91E-03 (1.91E-05)
Vegetable Ingestion	5.92E-01 (5.92E-03)	5.91E-01 (5.91E-03)	5.96E-01 (5.96E-03)	2.33E+00 (2.33E-02)
Milk Ingestion	1.70E-01 (1.70E-02)	1.69E-01 (1.69E-03)	3.23E-01 (3.23E-03)	6.91E-01 (6.91E-03)
Meat Ingestion	2.33E-01 (2.33E-03)	2.33E-01 (2.33E-03)	2.42E-01 (2.42E-03)	1.03E+00 (1.03E-02)
Total	5.31E+00 (5.31E-02)	1.74E+01 (1.74E-01)	5.64E+00 (5.64E-02)	8.23E+00 (8.23E-02)

Notes:

Based on projected 50 mi (80 km) population for the year 2070 (decade after the 40 year operating license period of BBNPP). Food production within the 50 mi (80 km) radius is presented in Table 5.4-9 through Table 5.4-12.

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Table 5.4-16—Whole Body Dose from Liquid Effluent to MEI

Dose Pathway	Adult mrem/yr (µSv/yr)	Teen mrem/yr (µSv/yr)	Child mrem/yr (µSv/yr)	Infant mrem/yr (µSv/yr)
Fish	1.30E-01 (1.30E+00)	7.60E-02 (7.60E-01)	3.31E-02 (3.31E-01)	0.00E+00 (0.00E+00)
Invertebrates	1.82E-02 (1.82E-01)	1.15E-02 (1.15E-01)	6.64E-03 (6.64E-02)	0.00E+00 (0.00E+00)
Potable Water	3.63E-01 (3.63E+00)	2.55E-01 (2.55E+00)	4.90E-01 (4.90E+00)	4.81E-01 (4.81E+00)
Irrigation	4.12E-02 (4.12E-01)	3.30E-02 (3.30E-01)	3.97E-02 (3.97E-01)	0.00E+00 (0.00E+00)
Shoreline	3.57E-05 (3.57E-04)	1.99E-04 (1.99E-03)	4.16E-05 (4.16E-04)	3.57E-05 (3.57E-04)
Swimming	3.72E-06 (3.72E-05)	2.08E-05 (2.08E-04)	4.34E-06 (4.34E-05)	3.72E-06 (3.72E-05)
Boating	3.01E-05 (3.01E-04)	3.01E-05 (3.01E-04)	1.68E-05 (1.68E-04)	3.01E-05 (3.01E-04)
Total	5.52E-01 (5.52E+00)	3.76E-01 (3.76E+00)	5.69E-01 (5.69E+00)	4.81E-01 (4.81E+00)

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Table 5.4-17—Limiting Organ Dose from Liquid Effluent to MEI

Dose Pathway	Adult (Thyroid) mrem/yr (µSv/yr)	Teen (Thyroid) mrem/yr (µSv/yr)	Child (Thyroid) mrem/yr (µSv/yr)	Infant (Thyroid) mrem/yr (µSv/yr)
Fish	1.14E-01 (1.14E+00)	1.05E-01 (1.05E+00)	1.09E-01 (1.09E+00)	0.00E+00 (0.00E+00)
Invertebrates	1.07E-02 (1.07E-01)	9.66E-03 (9.66E-02)	1.02E-02 (1.02E-01)	0.00E+00 (0.00E+00)
Potable Water	6.23E-01 (6.23E+00)	4.81E-01 (4.81E+00)	1.04E+00 (1.04E+01)	1.35E+00 (1.35E+01)
Irrigation	8.46E-01 (8.46E+00)	7.46E-01 (7.46E+00)	1.18E+00 (1.18E+01)	0.00E+00 (0.00E+00)
Shoreline	3.57E-05 (3.57E-04)	1.99E-04 (1.99E-03)	4.16E-05 (4.16E-04)	3.57E-05 (3.57E-04)
Swimming	3.72E-06 (3.72E-05)	2.08E-05 (2.08E-04)	4.34E-06 (4.34E-05)	3.72E-06 (3.72E-05)
Boating	3.01E-05 (3.01E-04)	3.01E-05 (3.01E-04)	1.68E-05 (1.68E-04)	3.01E-05 (3.01E-04)
Total	1.59E+00 (1.59E+01)	1.34E+00 (1.34E+01)	2.34E+00 (2.34E+01)	1.35E+00 (1.35E+01)

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Table 5.4-18—Summary Liquid Effluent Annual Dose to MEI

Assessment Type	BBNPP Calculated Dose mrem (μSv)	10 CFR 50 Appendix I Limit[1] mrem (μSv)	Fraction of Appendix I Objective
Total Body	5.69E-01 (5.69E+00) Child	3 (30)	1.90E-01
Maximum Organ	2.34E+00 (2.34E+01) Thyroid-Child	10 (100)	2.34E-01

Note:
1. Numerical dose objectives from 10 CFR 50 Appendix I, Section II.A.

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Table 5.4-19—General Population Doses from Liquid Effluents

Total Body Person-Rem (Person-Sieverts)	Person-Thyroid-Rem (Person-Thyroid-Sieverts)
1.65E-01 (1.65E-03)	1.68E-01 (1.68E-03)
Includes dose contribution from sport fishing, boating, and consumption of potable water exposures to the 50 mi (80 km) population impacted by water uses of the Susquehanna River 50 mi (80 km) downstream.	

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Table 5.4-20—Gaseous Pathway Doses for Maximally Exposed Individuals (MEI)

Location	Pathway	Total Body mrem/yr (µSv/yr)	Max. Organ mrem/yr (µSv/yr)	Skin mrem/yr (µSv/yr)
Site Boundary 0.20 mi (0.32 km) N	**Plume**	1.76E+00 (1.76E+01)	1.76E+00 (1.76E+01)	5.52E+00 (5.52E+01)
	Ground Plane	1.33E-03 (1.33E-02)	1.33E-03 (1.33E-02)	1.57E-03 (1.57E-02)
	Inhalation			
	Adult	3.98E-02 (3.98E-01)	7.38E-04 (7.38E-03)	3.96E-02 (3.96E-01)
	Teen	4.02E-02 (4.02E-01)	8.96E-04 (8.96E-03)	4.00E-02 (4.00E-01)
	Child	3.55E-02 (3.55E-01)	1.10E-03 (1.10E-02)	3.53E-02 (3.53E-01)
	Infant	2.04E-02 (2.04E-01)	5.71E-04 (5.71E-03)	2.03E-02 (2.03E-01)
Nearest Garden 0.28 mi (0.45 km) WSW	**Vegetable**			
	Adult	7.13E-02 (7.13E-01)	2.58E-01 (2.58E+00)	7.09E-02 (7.09E-01)
	Teen	1.08E-01 (1.08E+00)	4.28E-01 (4.28E+00)	1.08E-01 (1.08E+00)
	Child	2.42E-01 (2.42E+00)	1.04E+00 (1.04E+01)	2.41E-01 (2.41E+00)
	Infant	0.00E+00 (0.00E+00)	0.00E+00 (0.00E+00)	0.00E+00 (0.00E+00)
Nearest Meat 0.65 mi (1.0 mi) SW	**Meat**			
	Adult	4.68E-03 (4.68E-02)	2.02E-02 (2.02E-01)	4.67E-03 (4.67E-02)
	Teen	3.79E-03 (3.79E-02)	1.70E-02 (1.70E-01)	3.79E-03 (3.79E-02)
	Child	6.87E-03 (6.78E-02)	3.20E-02 (3.20E-01)	6.86E-03 (6.86E-02)
	Infant	(0.00E+00) 0.00E+00	(0.00E+00) 0.00E+00	(0.00E+00) 0.00E+00
Nearest Milk 0.65 mi (1.0 mi) SW	**Cow Milk**			
	Adult	5.99E-03 (5.99E-02)	2.22E-02 (2.22E-01)	5.91E-03 (5.91E-02)
	Teen	1.02E-02 (1.02E-01)	4.09E-02 (4.09E-01)	1.01E-02 (1.01E-01)
	Child	2.32E-02 (2.32E-01)	1.00E-01 (1.00E+00)	2.30E-02 (2.30E-01)
	Infant	4.67E-02 (4.67E-01)	1.96E-01 (1.96E+00)	4.64E-02 (4.64E-01)

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Table 5.4-21—BBNPP Gaseous Effluent MEI Dose Summary

10 CFR 50 Appendix I Section	Dose Assessment	Calculated Dose	10 CFR 50 Appendix I Limit
II.B.1	Beta Air Dose mrad/yr (µGy/yr)	1.6 (16.0)	20 (200)
	Gamma Air Dose mrad/yr (µGy/yr)	0.70 (7.0)	10 (100)
II.B.2	External Total Body Dose mrem/yr (µSv/yr)	0.45 (4.5)	5 (50)
	External Skin Dose mrem/yr (µSv/yr)	1.4 (14.0)	15 (150)
II.C	Organ Dose (Child, Bone) mrem/yr (µSv/yr)	1.2 (12.0)	15 (150)

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Table 5.4-22—Site Boundary Air Concentration by Nuclide

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Isotope	Release Rate Ci/yr (Bq/yr)	Air Concentration μCi/ml (Bq/ml)	Fraction of 10 CFR 20 Limit
H-3	1.80E+02	5.52E-11	5.52E-04
	6.66E+12	2.04E-06	
C-14	1.89E+01	5.80E-12	1.93E-03
	6.99E+11	2.14E-07	
Ar-41	3.40E+01	1.04E-11	1.04E-03
	1.26E+12	3.86E-07	
I-131	8.80E-03	2.70E-15	1.35E-05
	3.26E+08	9.99E-11	
I-133	3.20E-02	9.81E-15	9.81E-06
	3.26E+08	3.63E-10	
Kr-85m	1.50E+02	4.60E-11	4.60E-04
	5.55E+12	1.70E-06	
Kr-85	2.80E+03	8.59E-10	1.23E-03
	1.04E+14	3.18E-05	
Kr-87	5.30E+01	1.63E-11	8.13E-04
	1.96E+12	6.01E-07	
Kr-88	1.80E+02	5.52E-11	6.13E-03
	6.66E+12	2.04E-06	
Xe-131m	2.70E+03	8.28E-10	4.14E-04
	9.99E+13	3.06E-05	
Xe-133m	1.70E+02	5.21E-11	8.69E-05
	6.29E+12	1.93E-06	
Xe-133	7.20E+03	2.21E-09	4.42E-03
	2.66E+14	8.17E-05	
Xe-135m	1.40E+01	4.29E-12	1.07E-04
	5.18E+11	1.59E-07	
Xe-135	1.20E+03	3.68E-10	5.26E-03
	4.44E+13	1.36E-05	
Xe-138	1.20E+01	3.68E-12	1.84E-04
	4.44E+11	1.36E-07	
Cr-51	9.70E-05	2.97E-17	9.92E-10
	3.59E+06	1.10E-12	
Mn-54	5.70E-05	1.75E-17	1.75E-08
	2.11E+06	6.47E-13	
Co-57	8.20E-06	2.51E-18	2.79E-09
	3.03E+05	9.31E-14	
C0-58	4.80E-04	1.47E-16	1.47E-07
	1.78E+07	5.45E-12	
Co-60	1.10E-04	3.37E-17	6.75E-07
	4.07E+06	1.25E-12	
Fe-59	2.80E-05	8.59E-18	1.72E-08
	1.04E+06	3.18E-13	
Sr-89	1.60E-04	4.91E-17	2.45E-07
	5.92E+06	1.82E-12	
Sr-90	6.30E-05	1.93E-17	3.22E-06
	2.33E+06	7.15E-13	
Zr-95	4.20E-05	3.07E-18	7.67E-09
	3.70E+05	1.13E-13	

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Table 5.4-22—Site Boundary Air Concentration by Nuclide
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Isotope	Release Rate Ci/yr (Bq/yr)	Air Concentration µCi/ml (Bq/ml)	Fraction of 10 CFR 20 Limit
Nb-95	4.20E-05	1.29E-17	6.44E-09
	1.55E+06	4.77E-13	
Ru-103	1.70E-05	5.21E-18	5.79E-09
	6.29E+05	1.93E-13	
Ru-106	7.80E-07	2.39E-19	1.20E-08
	2.89E+04	8.85E-15	
Sb-125	6.10E-07	1.87E-19	2.67E-10
	2.26E+04	6.92E-15	
Cs-134	4.80E-05	1.47E-17	7.36E-08
	1.78E+06	5.45E-13	
Cs136	3.30E-05	1.01E-17	1.12E-08
	1.22E+06	3.74E-13	
Cs137	9.00E-05	2.76E-17	1.38E-07
	3.33E+06	1.02E-12	
Ba-140	4.20E-06	1.29E-18	6.44E-10
	1.55E+05	4.77E-14	
Ce-141	1.30E-05	3.99E-18	4.98E-09
	4.81E+05	1.48E-13	

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Table 5.4-23—Annual Historical Dose Compliance with 40 CFR 190 for SSES Units 1 & 2

Year	Whole Body[1] mrem (μSv)	Thyroid mrem (μSv)	Maximum Organ[2] mrem (μSv)
2000	1.68E-01 (1.68E+00)	1.73E-01 (1.73E+00)	1.73E-01 (1.73E+00)
2001	2.15E-01 (2.15E+00)	2.18E-01 (2.18E+00)	2.23E-01 (2.23E+00)
2002	1.30E+00 (1.30E+01)	1.29E+00 (1.29E+01)	1.31E+00 (1.31E+01)
2003	1.20E+00 (1.20E+01)	1.21E+00 (1.21E+01)	1.21E+00 (1.21E+01)
2004	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)	1.22E+00 (1.22E+01)
2005	8.34E-01 (8.34E+00)	8.38E-01 (8.38E+00)	8.34E-01 (8.34E+00)
2006	5.27E-01 (5.27E+00)	5.32E-01 (5.32E+00)	5.32E-01 (5.32E+00)
2007	8.25E-01 (8.25E+00)	8.24E-01 (8.24E+00)	8.28E-01 (8.28E+00)
Maximum Value any Year	1.30E+00 (1.30E+01)	1.29E+00 (1.29E+01)	1.32E+00 (1.32E+01)
SSES ISFSI Projection	4.7E+00 (4.7E+01)	4.7E+00 (4.7E+01)	4.7E+00 (4.7E+01)
Total SSES Dose Contribution	6.01E+00 (6.01E+01)	5.99E+00 (5.99E+01)	6.02E+00 (6.02E+01)

Notes:
1. This is the sum of direct radiation, gaseous and liquid effluents
2. The maximum organ dose from liquids was summed with the thyroid dose from gases and the direct radiation

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Table 5.4-24—40 CFR 190 Annual Site Dose Compliance

Facility	Pathway	Whole Body mrem (µSv)	Thyroid mrem (µSv)	Maximum Organ[1] mrem (µSv)
BBNPP	Plume	1.76E+00 (1.76E+01)	1.76E+00 (1.76E+01)	1.76E+00 (1.76E+01)
	Ground	1.33E-03 (1.33E-02)	1.33E-03 (1.33E-02)	1.33E-03 (1.33E-02)
	Inhalation	3.55E-02 (3.55E-01)	1.17E-01 (1.17E+00)	1.10E-03 (1.10E-02)
	Vegetable	9.55E-01 (9.55E+00)	1.27E+00 (1.27E+01)	4.06E+00 (4.06E+01)
	Meat	1.33E-01 (1.33E+00)	1.38E-01 (1.38E+00)	6.22E-01 (6.22E+00)
	Milk	4.99E-01 (4.99E+00)	9.17E-01 (9.17E+00)	1.94E+00 (1.94E+01)
	Fish	3.31E-02 (3.31E-01)	1.09E-01 (1.09E+00)	1.22E-01 (1.22E+00)
	Invertebrate	6.64E-03 (6.64E-02)	1.02E-02 (1.02E-01)	1.73E-02 (1.73E-01)
	Drinking water	4.90E-01 (4.90E+00)	1.04E+00 (1.04E+01)	8.32E-03 (8.32E-02)
	Irrigation	3.97E-02 (3.97E-01)	1.18E+00 (1.18E+01)	9.42E-02 (9.42E-01)
	Shoreline	4.16E-05 (4.16E-04)	4.16E-05 (4.16E-04)	4.16E-05 (4.16E-04)
	Swimming	4.34E-06 (4.34E-05)	4.34E-06 (4.34E-05)	4.34E-06 (4.34E-05)
	Boating	1.68E-05 (1.68E-04)	1.68E-05 (1.68E-04)	1.68E-05 (1.68E-04)
	Fixed Direct	8.07E-01 (8.07E+00)	8.07E-01 (8.07E+00)	8.07E-01 (8.07E+00)
	Total	4.76E+00 (4.76E+01)	7.35E+00 (7.35E+01)	9.43E+00 (9.43E+01)
SSES 1 & 2	Total	6.01E+00 (6.01E+01)	5.99E+00 (5.99E+01)	6.02E+00 (6.02E+01)
All Units	Total	1.08E+01 (1.08E+02)	1.34E+01 (1.34E+02)	1.55E+01 (1.55E+02)

Notes:
1. The critical organ for all pathways was the child bone.

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Table 5.4-25—Important Biota Species and Analytical Surrogates

Species Type	Species	Significance	Surrogate Species Assigned
Mammal	Indiana Bat	Endangered	Heron
	Eastern Small footed Myotis	Threatened	Heron
	Allegheny Woodrat	Threatened	Muskrat
	Northern Myotis	Rare (candidate)	Heron
	White-tailed Deer	Recreation	Raccoon
	Black Bear	Recreation	Raccoon
	Meadow Vole	Ecological	Muskrat
	Deer Mouse	Ecological	Muskrat
	White-footed Mouse	Ecological	Muskrat
	Peregrine Falcon	Endangered	Heron
Bird	Bald Eagle	Threatened	Heron
	Osprey	Threatened	Heron
	Wild Turkey	Recreation	Heron
	Scarlet Tanager	Ecological	Heron
Reptile	Redbelly Turtle	Threatened	Muskrat
	Timber Rattlesnake	Candidate	Muskrat
	Eastern Hognose Snake	Concern	Muskrat
	Eastern Spadefoot	Endangered	Muskrat
Insect	Northern Peary-eye	Vulnerable	(1)
	Long Dash	Vulnerable	(1)
	Mulberry Wing	Vulnerable	(1)
	Baltimore Checkerspot	Vulnerable	(1)

Note:
1. No direct surrogate species for terrestrial insects.

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Table 5.4-26—Biota Exposure Pathways

Biota	Aquatic Pathways	Atmospheric Pathways	Fixed Source Direct Radiation
Fish	Internal exposure from bioaccumulation of radionuclides External exposure from swimming and the shoreline	NA	NA
Invertebrates	Internal exposure from bioaccumulation of radionuclides External exposure from swimming and the shoreline	NA	NA
Algae	Internal exposure from bioaccumulation of radionuclides External exposure from swimming and the shoreline	NA	NA
Muskrat	Internal exposure from ingestion of aquatic plants External exposure from swimming and the shoreline	External gaseous plume immersion External exposure to ground plane deposition Gaseous effluent inhalation	External exposure to fixed sources of radiation
Raccoon	Internal exposure from ingestion of invertebrates External exposure from swimming and the shoreline	External gaseous plume immersion External exposure to ground plane deposition Gaseous effluent inhalation	External exposure to fixed sources of radiation
Heron	Internal exposure from ingestion of fish External exposure from swimming and the shoreline	External gaseous plume immersion External exposure to ground plane deposition Gaseous effluent inhalation	External exposure to fixed sources of radiation
Duck	Internal exposure from ingestion of aquatic plants External exposure from swimming and the shoreline	External gaseous plume immersion External exposure to ground plane deposition Gaseous effluent inhalation	External exposure to fixed sources of radiation

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Table 5.4-27—Terrestrial Biota Parameters

Terrestrial Biota	Food Organism	Food Intake lb/day (gm/day)	Body Mass lb (gm)	Effective Body Radius in (cm)
Muskrat	Aquatic Plants	0.22 (100)	2.21 (1,000)	2.36 (6)
Raccoon	Invertebrates	0.44 (200)	26.5 (12,000)	5.51 (14)
Heron	Fish	1.32 (600)	10.1 (4,600)	4.33 (11)
Duck	Aquatic Plants	0.22 (100)	2.21 (1,000)	1.97 (5)

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Table 5.4-28—Biota Residence Time

Biota	Shoreline / Sediment Exposure (hr/yr)	Swimming Exposure Time (hr/yr)
Fish	4,380	8,760
Invertebrates	8,760	8,760
Algae	--	8,760
Muskrat	2,922	2,922
Raccoon	2,191	--
Heron	2,922	2,920
Duck	4,383	4,383

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Table 5.4-29—Dose to Biota from all Sources

	Liquid Effluents		Gaseous Effluents		Fixed Sources	Total
Biota	**Internal Dose[(1)] mrad/yr (µGy/yr)**	**External Dose[(1)] mrad/yr (µGy/yr)**	**Internal Dose mrem/yr (µSv/yr)**	**External Dose mrem/yr (µSv/yr)**	**External Dose mrem/yr (µSv/yr)**	**All Pathways Dose[(1)] mrad/yr (µGy/yr)**
Fish	9.32E-01 (9.32E+00)	6.86E-01 (6.86E+00)	NA	NA	NA	1.62E+00 (1.62E+01)
Invertebrate	4.37E+00 (4.37E+01)	1.36E+00 (1.38E+01)	NA	NA	NA	5.73E+00 (5.73E+01)
Algae	1.87E+01 (1.87E+02)	1.40E-02 (1.40E-01)	NA	NA	NA	1.87E+01 (1.87E+02)
Muskrat	4.77E+00 (4.77E+01)	4.53E-01 (4.53E+00)	4.54E-02 (4.54E-01)	1.96E+00 (1.96E+01)	9.24E-01 (9.24E+00)	8.15E+00 (8.15E+01)
Raccoon	3.46E-01 (3.46E+00)	8.62E-02 (8.62E-01)	4.54E-02 (4.54E-01)	1.96E+00 ()1.96E+01	9.24E-01 (9.24E+00)	3.37E+00 (3.37E+01)
Heron	4.50E+00 (4.50E+01)	1.16E-01 (1.16E+00)	4.54E-02 (4.54E-01)	1.96E+00 ()1.96E+01	9.24E-01 (9.24E+00)	7.55E+00 (7.55E+01)
Duck	4.39E+00 (4.39E+01)	6.76E-01 (6.76E+00)	4.54E-02 (4.54E-01)	1.96E+00 (1.96E+01)	9.24E-01 (9.24E+00)	7.99E+00 (7.99E+01)

Note:
1. For approximations of total doses, assume that 1 mGy = 1 mSv (1 mrad = 1 mrem).

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Table 5.4-30—Biota Doses Compared to the 40 CFR 190 Whole Body Dose Criterion (25 mrem/yr)

Biota Meeting 40 CFR 190	Biota Exceeding 40 CFR 190 Limit
Fish	None
Invertebrates	
Raccoon	
Heron	
Algae	
Muskrat	
Duck	

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5.5 ENVIRONMENTAL IMPACT OF WASTE

This section describes the potential environmental impacts that may result from the operation of the nonradioactive waste system and from storage and disposal of mixed wastes. As demonstrated in the following subsections, environmental impacts from BBNPPoperational wastes will be minimal because of regulatory control and the small quantities generated.

5.5.1 NONRADIOACTIVE WASTE SYSTEM IMPACTS

A detailed description of nonradioactive waste management and effluents is provided in Section 3.6, which also includes estimates of nonradioactive liquid and gaseous effluents, and solid waste quantities.

Nonradioactive waste systems for BBNPP include the Circulating Water Treatment System, the Essential Service Water Treatment System, the Raw Water Supply Treatment System, the Demineralized Water Treatment System, and the the Liquid Waste Processing System. Quantities, composition, and frequency of waste discharges to water, land, and air are shown in Section 3.6.

All nonradioactive waste generated at BBNPP (i.e., solid wastes, liquid wastes, air emissions) will be managed in accordance with applicable federal, Pennsylvania, and local laws, regulations, and permit requirements. Management practices will be similar to those implemented at the SSES Units 1 and 2, and will include the following:

- Nonradioactive solid wastes (e.g., office waste, recyclables) would be collected temporarily on the BBNPP site and disposed of at offsite licensed commercial waste disposal and recycling facilities.
- Debris (e.g., vegetation) collected on trash racks and screens at the water intake structure would be disposed of as solid waste in accordance with the National Pollutant Discharge Elimination System (NPDES) and Pennsylvania waste regulations permits applicable at the time of operation.
- Scrap metal, used oil, antifreeze (ethylene or propylene glycol), and universal waste will be collected and stored temporarily on the BBNPP site and recycled or recovered at an offsite permitted recycling or recovery facility, as appropriate. Waste oil is not a hazardous waste in Pennsylvania unless it is mixed with listed hazardous waste or contains more than 1,000 parts per million total halogens. A mixture of waste oil and a characteristic hazardous waste is regulated as a hazardous waste unless the characteristic hazardous waste is hazardous solely because it exhibits the toxicity characteristic for benzene, arsenic, cadmium, chromium, or lead or ignitability and the resulting mixture does not exhibit the hazardous waste characteristic. Antifreeze is not a listed hazardous waste in Pennsylvania and is managed as a Redidual Waste unless it exhbits a characteristic of a hazardous waste. (PA, 2008a) Typically, used oil and antifreeze are recycled. If they are not recyclable or recoverable, they will be disposed of as a solid or hazardous waste in accordance with applicable regulations at the time of operation.
- Water from cooling and auxiliary systems will be discharged to the Susquehanna River through a permitted NPDES outfall.
- Sanitary wastewater will be collected and discharged into the municipal sanitary sewer system where it will be conveyed to a publicly-owned treatment works for treatment.

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5.5.1.1 Impacts of Discharges to Water

Nonradioactive wastewater discharges from BBNPP to surface water will include cooling water blowdown, permitted wastewater from other BBNPP waste systems, and storm water runoff from impervious surfaces.

In addition, potential impacts from chemical constituents in discharges from the cooling water and other plant waste systems will be minimized through compliance with a NPDES wastewater discharge permit. BBNPP will maintain engineering controls that prevent or minimize the release of chemical constituents to the Susquehanna River. Concentrations in the discharge from the plant will be limited by NPDES requirements, and will be minimal or non-detectable in the Susquehanna River following dilution with upstream river flow (Section 5.3.2) as listed in Table 5.5-1. Section 5.2 provides a discussion on effluent limitations and permit conditions.

The NPDES permit will also require a Storm Water Pollution Prevention Plan (SWPPP), which prevents or minimizes the discharge of potential pollutants with the storm water discharge, to reflect the addition of new paved areas and facilities and changes in drainage patterns. Impacts from increases in the volume or concentrations of pollutants in the storm water discharge will be minimized by implementation of best management practices (BMPs). Potential impacts of BBNPP discharges to water are SMALL.

5.5.1.2 Impacts of Discharges to Land

Anticipated volumes of nonradioactive solid wastes from the operation of BBNPP are presented in Section 3.6. It is not anticipated that there will be any fundamental change in the characteristics of these wastes or the way in which they are currently managed as compared to SSES Units 1 and 2. Applicable Federal, State, and local requirements and standards will be met for handling, transporting, and disposing of the solid waste. Solid waste will be reused or recycled to the extent possible. Solid wastes appropriate for recycling or reclamation (e.g., used oil, antifreeze (e.g., ethylene or propylene glycol), scrap metal, and universal waste) will be managed using approved and licensed contractors. Nonradioactive solid waste destined for offsite land disposal will be disposed of at approved and licensed offsite commercial waste disposal sites. Therefore, potential impacts from land disposal on nonradioactive solid waste will be SMALL.

5.5.1.3 Impacts of Discharges to Air

Operation of BBNPP will increase gaseous emissions to the air, primarily from equipment associated with the diesel generators. Six diesel generators (four to provide emergency power and two to provide power in the event of a station blackout) will be utilized by BBNPP. Emissions from these systems are shown in Section 3.6. Cooling tower impacts on terrestrial ecosystems are addressed in Section 5.3.3.2.

All air emission sources associated with BBNPP, as described in Section 5.8.1, will be managed in accordance with Federal, State, and local air quality control laws and regulations (PA, 2008b). Hence, impacts to air quality will be SMALL.

5.5.1.4 Sanitary Waste

The Sanitary Sewer System will collect sanitary wastes during the operation of BBNPP. The sanitary wastes (sewage) will be discharged into the municipal sanitary sewer through a lift station that will pump the sewage into a 32-inch diameter sewer main that is located parallel to U.S. Highway 11. The sewage will be conveyed to a local publicly-owned treatment works

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operated by the Berwick Municipal Sewer Authority. The Sanitary Sewer System will be designed for sanitary waste only and exclude industrial materials, such as chemical laboratory wastes. The system will be independent of SSES Units 1 and 2. The Sanitary Sewer System will be sized to accommodate the needs of personnel associated with this unit during both operation and outages.

Discharge of sewage from BBNPP into the municipal sanitary system will be done in accordance with local ordinances and permit requirements. Maximum limits for sanitary effluents discharged to the Berwick Joint Area Sewer Authority are described in Table 3.6-4. Hence impacts from sanitary waste will be SMALL.

5.5.2 MIXED WASTE IMPACTS

Mixed waste contains hazardous waste and a low level radioactive source, special nuclear material, or byproduct material. BBNPP will manage mixed waste in accordance with Pennsylvania's regulations (PA, 2008c) (PA, 2008d) and the U.S. Environmental Protection Agency's (EPA's) 1991 Mixed Waste Enforcement Policy (USEPA, 1991).

Nuclear power plants, in general, are not significant generators of mixed waste, with quantities accounting for less than 3% of the annual low level radioactive waste generated (NRC, 1996). Typical types of mixed waste generated include:

- Organic solvents, reagents, and compounds, and associated materials such as rags and wipes
- Metals such as lead from shielding applications and chromium from solutions and acids
- Metal-contaminated organic sludges and other chemicals
- Aqueous corrosives consisting of organic and inorganic acids
- Outdated laboratory chemicals
- Dilute acid from heat exchanger cleanings
- Result of testing to determine waste chemical/radiological contents

Mixed waste generation at SSES, in particular, is very limited. In the years 2003 through 2007, four mixed waste shipments to treatment facilities were made. In 2003, one shipment consisting of one drum of solvent contaminated rags and one drum of lead penetration barrier material was made. In 2004, one shipment of mixed wastes consisting of one drum of waste paint, one drum of solvent contaminated rags, and six drums of lead penetration barrier was made. In 2005, one shipment of mixed waste consisting of one drum of phosphoric acid and two drums of lead penetration barrier material was made. No mixed waste shipments were made in 2006. In 2007, one shipment consisting of one drum waste paint, one drum solvent contaminated rags, one drum lead penetration barrier material and one drum lab pack chemicals was made. Mixed waste generation rates at Bell Bend are expected to be similar.

NUREG 1437, Supplement 1, determined that the relatively small quantities of mixed waste generated by nuclear power plants as having a SMALL impact.

A source reduction plan has been developed for SSES Units 1 and 2. Based on the size of BBNPP compared to SSES Units 1 and 2, the types and quantities of mixed waste generation are

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anticipated to be bounded by SSES Units 1 and 2. BBNPP will institute a waste minimization plan that will reduce the accumulation of these wastes. Accumulation issues will be addressed in the corrective action program. As a result, the potential impacts will be SMALL. The small quantities of mixed waste will be temporarily stored within the protected area, similar to SSES, and then shipped for treatment and disposal to an offsite permitted facility. As a result, the potential impactes will be SMALL.

Minimal environmental impacts would result from storage or shipment of mixed wastes. In the event of a spill, emergency procedures would be implemented to limit any onsite impacts. Emergency response personnel would be properly trained and would maintain a current facility inventory, which would include types of waste, volumes, locations, hazards, control measures, and precautionary measures to be taken in the event of a spill.

5.5.2.1 References

NRC, 1996. NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, U.S. Nuclear Regulatory Commission, May 1996.

PA, 2008a. Title 25, Pennsylvania Code, Section 298, Management of Waste Oil.

PA, 2008b. Title 25, Pennsylvania Code, Section 122, Standards of Performance.

PA, 2008c. Title 25, Pennsylvania Code, Article VII, Hazardous Waste Management.

PA, 2008d. Title 25, Pennsylvania Code, Article V, Radiological Health.

USEPA, 1991. U.S. EPA's 1991 Mixed Waste Enforcement Policy, Volume 56, Federal Register, 42730-42734, August 29, 1991.

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Table 5.5-1—Anticipated Water Chemical Concentrations in the Susquehanna River Downstream of BBNPP Discharge

Parameter	Units	Estimated Maximum Concentration in BBNPP Discharge	Estimated Mean Concentration in BBNPP Discharge	Estimated Maximum Concentration in River Downstream	Estimated Mean Concentration in River Downstream
Total Alkalinity	mg/l	180	78	95.3	61.3
Total Suspended Solids	mg/l	447	87	87.6	17.2
Silica (Silocon Dioxide)	mg/l	14	8	4.9	2.9
Bicarbonate at $CaCO_3$	mg/l	279	187	97	66
Chloride	mg/l	121	83	41	27
Fluoride	mg/l	0.3	0.3	0.1	0.1
Nitrate at NO_3	mg/l	10	6	3.5	2.2
Nitrate as N	mg/l	2	1	0.8	0.5
Phosphorus as PO_4	mg/l	2	1	0.7	0.2
Sulfate	mg/l	253	186	54	29
Aluminum, Total	µg/l	8,123	1,359	2,783	453
Barium, Total	µg/l	172	97	56.8	33.0
Calcium, Total	mg/l	114	78	40	27
Iron, Total	mg/l	17	4	5.8	1.3
Magnesium, Total	mg/l	30	18	10.9	6.5
Manganese, Total	µg/l	762	331	239.1	131.0
Potassium, Total	mg/l	7	5	2.4	1.6
Sodium, Total	mg/l	74	43	24.9	15.6
Strontium, Total	µg/l	495	299	181.9	105.0
Zinc, Total	µg/l	77	45	24.8	15.6
Arsenic, Total	µg/l	9	3	2.9	0.8
Lead, Total	µg/l	15	15	5.2	5.1
Total Dissolved Solids	mg/l	713	553	209	149
Calcium Hardness	mg/l	285	195	99	68
Total Hardness	mg/l	388	270	136	95
HEDP	mg/l	5	5	0	0
Dispersant	mg/l	5	5	0	0

Notes:

Downstream river concentrations were calculated using 2006 and 2007 Susquehanna River water quality data, a river flow rate for August low-flow conditions and estimated plant discharge flows

mg/l - milligrams per liter
µg/l - micrograms per liter
TDS - total dissolved solids

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5.6 TRANSMISSION SYSTEM IMPACTS

This section discusses transmission system operation and maintenance impacts on terrestrial and aquatic ecosystems and members of the public. The significance of these predicted impacts are evaluated and alternative practices to mitigate the impacts are proposed, as needed. The discussion is limited to the transmission facilities associated with BBNPP and modifications or upgrades to the existing transmission system required to connect the additional generation capacity from the unit. Impacts from the existing transmission system, constructed and operated for SSES Units 1 and 2, were addressed in the Environmental Report submitted with the original plant license application (PPL, 1972) and re-evaluated in the Environmental Report submitted with the license renewal application (PPL, 2006).

5.6.1 TERRESTRIAL ECOSYSTEMS

This section considers the effects of transmission facility operation and maintenance on the terrestrial ecosystem. The review evaluates the significance of these predicted impacts on important terrestrial species and habitats, and evaluates alternative practices to mitigate the impacts, as needed.

5.6.1.1 Terrestrial Ecosystems

The terrestrial ecology of the BBNPP site was characterized in a series of field studies. Vegetation of the BBNPP project area was recently surveyed. Major plant community type (terrestrial habitat types) comprise old field, upland shrub habitat, upland deciduous forest, palustrine emergent wetlands, palustrine scrub/shrub wetlands and palustrine forested wetlands.

The terrestrial ecology of the BBNPP site was characterized in a series of field studies conducted between July 2007 and September 2008. This section reports on results available through July 24, 2008. Field studies included a flora survey (Summer 2008), a faunal survey(October 2007 through September 2008), a rare butterfly survey (June and July, 2008), and an Indiana bat mist net survey (June and July, 2008), as well as wetland delineation efforts (July 2007 through August 2008).

5.6.1.2 Important Terrestrial Species and Habitats

As noted in Section 2.4.1, the following species and habitats of the project site have been designated as important according to Federal and Commonwealth of Pennsylvania criteria:

Species important because of rarity:

- Bald Eagle *(Haliaeetus leucocephalus):* State Threatened
- Peregrine Falcon *(Falco peregrinus):* State Threatened
- Osprey *(Pandion haliaetus):* State Threatened
- Indiana Bat *(Myotis sodalis):* Federal Endangered and State Endangered
- Eastern Small-footed Myotis *(Myotis leibii):* State Threatened
- Northern Myotis *(Myotis septemtrionalis):* State Candidate Rare
- Allegheny Woodrat *(Neotoma magister):* State Threatened

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- Eastern Spadefoot *(Scaphiopus holbrookii):* State Endangered
- Redbelly Turtle *(Pseudemys rubiventris):* State Threatened
- Timber Rattlesnake *(Crotalus horridus):* State Special Concern
- Eastern Hognose Snake *(Heterodon platyrhinos):* State Species of Special Concern
- Northern Peary-eye *(Enodia anthedon):* State Vulnerable
- Long Dash *(Polites mystic):* State Vulnerable
- Mulberry Wing *(Poanes massasoit):* State Vulnerable
- Baltimore Checkerspot *(Euphydryas phoeton):* State Vulnerable
- Plants: No plant species designated as important according to Federal and/or Commonwealth of Pennsylvania criteria are present within a 0.5 mi (0.8 km) radius of the project area

Commercially or recreationally valuable species:

- White-tailed Deer *(Odocoileus virginianus)*
- Black Bear *(Ursus americana)*
- Wild Turkey *(Melagris gallopovo)*
- Black Cherry *(Prunus serotina)*

Species critical to the structure and function of local terrestrial ecosystems:

- Meadow vole *(Microtus pensylvanicum)*
- Deer Mouse *(Peromyscus manniculatus)*
- White-footed Mouse *(Peromyscus leucopus)*
- Red Maple *(Acer rubrum)*
- River Birch *(Betula nigra)*
- Spicebush *(Lindera benzoin)*
- Skunk Cabbage *(Symplocarpus foetidus)*
- Canada Goldenrod *(Solidago canadensis)*

Species that could serve as biological indicators of effects on local terrestrial ecosystems:

- Scarlet Tanager *(Piranga olivacea)*

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- Vegetation cover in the project area consists of relatively common plants with widespread distributions. None of these species are considered to be particularly reliable for monitoring impacts to terrestrial habitats. An alternate approach would be to monitor sensitive habitats such as wetlands for adverse changes to hydrologic regimes, plant survival and species compositions. Study plots could be located in undeveloped wetland habitat remaining onsite and in nearby wetlands, particularly those located downstream from the project area.

Important habitats:

- Palustrine emergent wetlands - jurisdictional wetland
- Palustrine scrub/shrub wetlands - jurisdictional wetland
- Palustrine forested wetlands - jurisdictional wetland

5.6.1.3 Potential Adverse Effects of Operation and Maintenance Practices

No additional offsite transmission corridors or other offsite land use will be required to connect BBNPP to the existing electrical grid. Two new 500 kV switchyards, and two new 500 kV, 4,260 MVA circuits on individual towers, will be constructed on site. An expansion of the existing Susquehanna 500 kV switchyard will also be required. The new transmission lines will connect the new BBNPP switchyard to an expansion of the existing Susquehanna 500 kV Yard, and to the new 500 kV Susquehanna Yard 2. Additionally, 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 PPL EU will follow the standard industry practices for operation and maintenance of transmission line rights-of-way. Vegetation management will be practiced to avoid any power outages and injury to the public and company employees from overgrown or diseased trees. Trees are pruned or cut, and integrated vegetation management performed, according to the relevant PPL EUprocedures.

Routine maintenance in and along the onsite transmission corridor requires periodic cutting of herbaceous and low woody growth, saplings, larger shrubs, and small trees. Herbicide applications are used only on an occasional basis, if at all. Access roads for construction and subsequent maintenance are stabilized wherever necessary with a course of stones to prevent formation of ruts and gullies in the exposed soil. These road surfaces will be allowed to grass over and cut only as necessary to maintain occasional vehicular access.

The clearing of forest habitat for the construction of onsite transmission lines could have a negative impact on the Indiana bat, the only Federally and State listed endangered species likely to occur at the BBNPP site. To avoid possible negative impacts on the Indiana bat, cutting of trees > 5 in (13 cm) diameter at breast height (dbh) during non-hibernating periods will be done in consultation with appropriate Federal and State Regulatory Agencies.

Operation and maintenance of the power line rights-of-way as a permanent old-field habitat is likely to benefit, over the long term, each of the commercially or recreationally important animals listed in Section 2.4.1, including white-tailed deer, black bear, and wild turkey. This should stimulate growth of low vegetation for deer grazing and browsing, summer berry (raspberry, blackberry) production for black bears, and important insect food for developing wild turkey poults. In addition, this maintained old-field habitat may provide improved food

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and cover conditions for important prey species, also listed in Section 2.4.1, such as the meadow vole, deer mouse, and white-footed mouse.

Maintenance of the newly cleared segment of the onsite power line corridor might provide new opportunities for the brown-headed cowbird, a nest parasite, to penetrate the forest edge and impair the nesting success of host birds, including some forest-interior bird species like the scarlet tanager. Although considered a slight impact, this adverse impact would persist as long as the power line corridor is maintained in a primarily old-field stage of ecological succession adjoining sizeable forest tracts. There may also be continuously adverse impacts on scarlet tanager and other forest-interior bird species from competition with and predation by other forest-edge vertebrate species.

The power line corridor is subject to direct adverse impacts in the form of intermittent disruptions associated with control of corridor vegetation by maintenance through cutting or spraying activities. These impacts could include the mortality of small, relatively sedentary vertebrates and invertebrates.

With regard to the four important butterfly (insect) species listed in Table 2.4-1 that are known to utilize adjacent areas to the east of the BBNPP site (northern peary-eye, long dash, mulberry wing and Baltimore checkerspot), the following plants are preferred hosts: willows, poplars, milkweed, mountain laurel, bluegrasses, upright sedge, flower nectar, violets, and turtlehead. During the construction and maintenance of the power line corridors the Pennsylvania Department of Conservation and Natural Resources (PDCNR) recommends that particular attention be paid to these host plants to minimize negative impacts and possibly even enhance habitat.

Construction of new transmission line corridors through forested lands in the project area will adversely affect forest ecosystem critical woody species, particularly red maple and spicebush. These species predominate in both upland and wetland forests. However, both the forest communities and ecosystem critical species present onsite occur widely throughout northeastern Pennsylvania. Therefore, development of new transmission line facilities within the confines of the project boundaries will not result in cumulative impacts to forest communities or critical species at either a local or regional scale.

In contrast, forest clearing will favor the development of old field habitat and other early successional vegetation communities. Regular removal of woody vegetation through routine rights-of-way maintenance will preserve these areas as permanent openings that will benefit ecosystem critical species such as Canada Goldenrod, as well as other herbaceous plants.

The height of the transmission lines will meet the PPL EU and National Electric Safety Code NESC) requirements to prevent induced current due to electrostatic effects for any ecological species by assuming a large truck or farm machinery may travel underneath the transmission lines. Therefore, there are no adverse effects due to induced current.

Noise impacts associated with the transmission system lines are due to corona discharge (a crackling or hissing noise). Corona noise for a 500 kV line has been estimated to be 59.3 dBA during a worst case rain with heavy electrical loads (SCE, 2006). For reference, normal speech has a sound level of approximately 60 dB. Therefore, noise from the transmission lines will not have an adverse effect on the terrestrial ecology. (SCE, 2006)

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5.6.1.4 Measures and Controls to Mitigate Potential Impacts

Project design attempts first to avoid impacts on wetlands, and on other important habitats as well as important species. Where impacts are unavoidable, they are minimized to the greatest possible extent. Unavoidable impacts are then mitigated as part of the overall project plan.

The bare soil exposed on access roads will be rendered stable by covering it with a permeable cover of loose stone through which vegetation will be encouraged to grow to improve long-term post-construction stability. All other areas of disturbed soil will be similarly revegetated and maintained in such condition as a routine part of right-of-way management.

There are no rare or important plant species.

Biocides will be used sparingly if ever, in response to highly selective problems, and away from water.

Streams and wetlands in the rights-of-way that are connected with water bodies containing fish will be maintained in as well-shaded a state as practicable to minimize the warming effect of direct sunlight on surface water.

5.6.1.5 Wildlife Management Practices

There are no ongoing formal wildlife management practices on the project site.

5.6.1.6 Consultation with Agencies

Affected Federal, State, and Regional agencies will be contacted regarding the potential impacts to the terrestrial ecosystem resulting from transmission system operation and maintenance.

The U.S. Fish and Wildlife Service was consulted for information on known occurrences of Federally-listed threatened, endangered, or special status species and critical habitats (USFWS, 2008). For State-listed threatened, endangered, or special status species and critical habitats, the Pennsylvania Game Commission was consulted concerning mammals and birds (PGC, 2008); the Pennsylvania Fish and Boat Commission was consulted consulted concerning reptiles, amphibians, and other aquatic biota (PFBC, 2008), and the Pennsylvania Department of Conservation and Natural Resources was consulted concerning plants, natural communities, terrestrial invertebrates, and geologic features (PDCNR, 2008). Wetlands regulatory officials with the U.S. Corps of Engineers and Pennsylvania Department of Environmental Protection were consulted regarding wetlands issues. Identification of the important species discussed above was based, in part, on information provided by that consultation. (PDCNR, 2008) (PFBC, 2008) (PGC, 2008) (PPL, 1972)

5.6.1.7 References

PDCNR, 2008. Pennsylvania Department of Conservation and Natural Resources, Endangered and Threatened Species of Pennsylvania, Index, Website: http://www.dcnr.State.pa.us/wrcf/pubindex.aspx, Date accessed: April 2, 2008.

PFBC, 2008. Pennsylvania Fish and Boat Commission, Letter from Christopher A. Urban to Rod Krich (Unistar Nuclear), Re: threatened and endangered reptiles and amphibians concerning the Bell Bend Nuclear Power Site, Berwick, Luzerne County, PA, April 14, 2008.

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PGC, 2008. Pennsylvania Game Commission, Letter from James R. Leigey to Rod Krich (Unistar Nuclear), Re: PNDI Database Search, Berwick, PA NPP-1 Project, Salem Township, Luzerne County, PA, April 10, 2008.

PPL, 1972. Pennsylvania Power and Light Company. Susquehanna Steam Electric Station, Applicant's Environmental Report, Revised, July 1972.

PPL, 2006. PPL Susquehanna, LLC, Appendix E, Applicant's Environmental Report - Operating License Renewal Stage, Susquehanna Steam Electric Station, September 2006.

SCE, 2006. Southern California Edison, Transmission Upgrades West of Devers Substation, Corona Noise Impacts, Website: http://docs.cpuc.ca.gov/published/FINAL_DECISION/64017-05.htm, Date accessed: May 6, 2008.

USFWS, 2008. U.S. Fish and Wildlife Service, Letter from David Densmore to Rod Krich (Unistar Nuclear), Re: USFWS Project #2008-518, Federally Listed Endangered and Threatened Species for the Bell Bend Nuclear Power Plant Site, Berwick, Luzerne County, PA, January 18, 2008.

5.6.2 AQUATIC ECOSYSTEMS

This section considers the effects of transmission facility operation and maintenance on the aquatic ecosystems. The review evaluates the significance of these predicted impacts on important aquatic species and habitats, and evaluates alternative practices to mitigate the impacts, as needed.

5.6.2.1 Aquatic Ecosystems

As described in Section 2.4.2.1, surveys of benthic macroinvertebrates and fish in Walker Run and the onsite ponds were conducted during 2007 and 2008. For the offsite water body, Susquehanna River, a historic record of field studies was available for the fish assemblage, and records from 2004 to 2007 were included. The benthic macroinvertebrate community present in the Susquehanna River was assessed in 2007. Information on the fish community believed to be present in the section of the North Branch Division of the Pennsylvania Canal System in the vicinity of the access road leading to the intake structures is available from fishery surveys of Lake Took-A-While. Results of the surveys are summarized for each water body in Section 2.4.2.1 and Section 2.4.2.2.

PPL EU has not initiated detailed design of the new transmission facilities. Water bodies that are impacted by the project are identified in Section 2.3 and listed below:

- Unnamed tributary of and Walker Run,
- Johnson's Pond,
- Beaver Pond,
- West Building Pond,
- Unnamed Pond 1,
- Unnamed Pond 2,
- Farm Pond,

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- North Branch Division of the Pennsylvania Canal System, and
- Susquehanna River.

5.6.2.2 Important Aquatic Species and Habitats

As described in Section 2.4.2, extensive surveys of these water bodies were conducted. No rare or unique aquatic species were identified in onsite water bodies in the project vicinity. The aquatic species that are present onsite are ubiquitous, common, and easily located in nearby waters. Typical fish species included blacknose dace, white sucker, sunfish and creek chub. Recreationally important species included largemouth bass and bluegill in the onsite ponds and brown trout in Walker Run. However, access to these onsite water bodies is restricted, thus no angling opportunities exist or will be lost. The most important aquatic macroinvertebrate species in the ponds and stream were the juvenile stages of aquatic insects.

For the Susquehanna River, two species of mussels were identified as species of special concern: yellow lampmussel *(Lampsillis cariosa)* and green floater (*subviridis)*. Both were collected in the vicinity of the location for the BBNPP discharge and intake structures. No rare or unique fish species were identified from the Susquehanna River. The fish community was comprised of common species which are ubiquitous throughout Pennsylvania. Abundant fish included smallmouth bass, walleye, spotfin shiner, and spottail shiner. Several species of recreationally important fish were identified from the Susquehanna River including smallmouth bass, walleye, muskellunge, northern pike, and channel catfish.

No important species are known or anticipated to be present within the North Branch Canal. The community present in the canal most likely mimics that of Lake Took-a-While. The fish community in the lake is typical of other warm-water lentic water bodies in Pennsylvania.

Section 2.4.2 also provides a discussion on the physical, chemical, and biological factors known to influence distribution and abundance of aquatic life. No important aquatic habitats were identified in the project vicinity.

5.6.2.3 Potential Impacts from Operation and Maintenance

No additional offsite transmission corridors or other offsite land use will be required to connect BBNPP to the existing electrical grid. Two new 500 kV switchyards, and two new 500 kV, 4,260 MVA circuits on individual towers, will be constructed on site. An expansion of the existing Susquehanna 500 kV switchyard will also be required. The new transmission lines will connect the new BBNPP switchyard to an expansion of the existing Susquehanna 500 kV Yard, and to the new 500 kV Susquehanna Yard 2. Additionally, 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 BBNPP transmission facilities will be constructed in areas that, at present, are vegetated, have varying topography, and some of which contain delineated wetlands.

Transmission system operations and maintenance have the potential to cause impacts to water bodies and aquatic ecology.

The PPL EU will follow the standard industry practices for operation and maintenance of transmission line rights-of-way. Vegetation management will be practiced to avoid any power outages and injury to the public and company employees from overgrown or diseased trees.

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Trees are pruned or cut, and integrated vegetation management performed, according to the relevant PPL EU procedures.

Routine maintenance in and along the onsite transmission corridor requires periodic cutting of herbaceous and low woody growth, saplings, larger shrubs, and small trees. Herbicide applications are used only on an occasional basis, if at all. Access roads for construction and subsequent maintenance are stabilized wherever necessary with a course of stones to prevent formation of ruts and gullies in the exposed soil. These road surfaces will be allowed to grass over and cut only as necessary to maintain occasional vehicular access.

Increased runoff from impervious surfaces from the switchyard could cause a modification to the hydrograph and increases in temperature, sediment and nutrients in receiving water bodies, and corresponding impacts to aquatic invertebrates, plants, and fish. Impacts from these affects would be mitigated by the provision of storm water retention facilities.

PPL EU procedures for vegetation management control the use of herbicides to mitigate the potential to contaminate water bodies and aquatic species. As previously noted, application of these chemicals is anticipated to be very infrequent.

Since the transmission facilities are not located offsite no direct impacts to the Susquehanna River aquatic ecosystem is expected. Indirect impacts may result from increased sedimentation and heat loads to tributary streams, but would most likely be mitigated by storm water retention facilities.

Onsite aquatic ecosystems may be affected by operation and maintenance of transmission facilities. Impacts will likely include increased runoff from impervious surfaces into the water bodies. Increased runoff may change the hydrograph of Walker Run and increase the magnitude of flood events. Large flood events could result in stream-bed scour and increased transport of stream substrate. With the increased runoff from impervious surfaces it is possible that an increase in stream water temperature may occur in the summer. Defoliants and herbicides may also be transported to the onsite water bodies after rainfall events. Defoliants and herbicides could potentially impact the aquatic species present in Walker Run.

These potential impacts could be monitored by evaluating post-construction fish and macroinvertebrate communities in Walker Run downstream from the transmission facilities. The loss of certain fish species or change in relative abundance of sensitive taxa could indicate potential impacts. Changes in the benthic macroinvertebrate community species composition and abundance could also be evaluated. Benthic macroinvertebrates are routinely used to measure anthropogenic impacts to water bodies (EPA, 1999).

5.6.2.4 Measures and Controls to Mitigate Potential Impacts

The bare soil exposed on transmission facility access roads will be rendered stable by covering it with a permeable cover of loose stone through which vegetation will be encouraged to grow to improve long-term post-construction stability. All other areas of disturbed soil will be similarly revegetated and maintained in such condition as a routine part of rights-of-way management.

Biocides will be used sparingly if ever, in response to highly selective problems, and away from water, under the exclusive control of a licensed biocide applicator.

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Streams and wetlands in the rights-of-way that are connected with water bodies containing fish will be maintained in as well-shaded a state as possible to minimize the warming effect of direct sunlight on surface water.

As described in Section 2.4.2, no important species were found onsite and thus none are present within the zone of influence of the transmission facilities. Two important species were determined to be present in the Susquehanna River. However, no adverse impacts to these species are anticipated from operation of the transmission facilities.

5.6.2.5 Consultation with Agencies

Affected Federal, State, and Regional agencies have already been or will be contacted regarding the potential impacts to the aquatic ecosystem resulting from transmission system operation and maintenance.

Affected Federal, Commonwealth and Regional agencies have been contacted regarding the potential impacts to the aquatic ecosystem resulting from transmission system operation and maintenance. The United States Fish and Wildlife Service was consulted for information on known occurrences of Federally listed threatened, endangered, or special status species and critical habitats (USFWS, 2008). The Pennsylvania Fish and Boat Commission was consulted for information on known occurrences of State-listed threatened, endangered, or special status aquatic species and critical habitats (PFBC, 2008). Identification of the important species discussed above was based on information provided by that consultation.

5.6.2.6 References

EPA, 1999. Environmental Protection Agency, Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition, EPA-841-B-99-002.

PFBC, 2008. Pennsylvania Fish and Boat Commission, Letter from Christopher A. Urban to George Wrobel (Unistar Nuclear), Re: Species Impact Review (SIR) - Rare, Candidate, Threatened, Endangered Species, Berwick, Luzerne County, PA NPP-1, April 14 2008.

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5.6.3 IMPACTS TO MEMBERS OF THE PUBLIC

This section describes the transmission system impacts from the BBNPP to its connection with the transmission system. The description is limited to the transmission facilities associated with the new BBNPP and modifications or upgrades to the existing transmission system required to connect the additional generation capacity from BBNPP. Impacts from the existing transmission system, constructed and operated for SSES Units 1 and 2, were addressed in the Environmental Report submitted with the original plant license application (PPL, 1972) and re-evaluated in the Environmental Report submitted with the SSES Units 1 and 2 license renewal application (PPL, 2006).

5.6.3.1 Electrical Design Parameters

As described in Section 3.7, the BBNPP switchyard will be electrically interconnected to the 500 kV transmission system by constructing two 500 kV, 4,260 MVA independent lines on individual towers entirely within the boundaries of the project area. One circuit will connect the BBNPP

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switchyard to the existing Susquehanna 500 kV switchyard and a separate circuit will connect to the new 500 kV Susquehanna Yard 2. The transmission line circuits will be designed to meet the power delivery requirements. Each phase will use the same three-subconductor bundles comprised of three 1,590 circular mills, 45/7 aluminum conductor, steel reinforced (ACSR) conductors with 18 in (46 cm) separation. There will typically be two 1/2-inch extra-high strength (EHS) overhead ground wires (OHGW) on each transmission line. The new lines will be designed to preclude crossing of lines wherever possible.

The design of the new transmission circuits would consider the potential for induced current as a design criterion. The National Electric Safety Code (NESC) has a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98 kV alternating current to ground (NESC, 2007). The clearance must limit the induced current due to electrostatic effects to 5 mA if the largest anticipated truck, vehicle, or equipment were short-circuited to ground. For this determination, the NESC specifies that the lines be evaluated assuming a final unloaded sag at 120°F (49°C). The calculation is a 2-step process in which the analyst first calculates the average field strength at 1 m (3.3 ft) above the ground beneath the minimum line clearance, and second calculates the steady-state current value. The design and construction of the BBNPP substation and transmission circuits would comply with this NESC provision. At a minimum, conductor clearances over the ground would equal or exceed 29 ft (9 m) phase-to-ground over surfaces that could support a large truck or farm machinery, while clearance over railroad lines would equal or exceed 37 ft (11 m) phase-to-ground. The two circuits will be constructed in such a manner to provide sufficient physical separation to minimize the risk of simultaneous failure. The two lines will be constructed in accordance with established National Electric Safety Code (NESC) standards, PJM procedures and State and Local regulations. Detailed design of the transmission interconnection will be done as part of the PJM Interconnection process per PJM's Open Access Transmission Tariff.

Environmental impacts are limited to the proposed plant and construction area on the BBNPP site. No new corridors, or crossings over main highways, primary roads, waterways, or railroad lines are required.

5.6.3.2 Structural Design Parameters

As described in Section 3.7, the number and location of the transmission towers between the existing Susquehanna 500 kV Yard, the new Susquehanna 500 kV Yard 2, and the BBNPP switchyard will conform with PPL EU and PJM design standards. The BBNPP switchyard would occupy an 850 ft (259 m) by 300 ft (91 m) tract of land approximately 900 ft (274 m) east of the BBNPP containment. The BBNPP switchyard would be electrically integrated with the existing Susquehanna 500 kV Yard, the new Susquehanna 500 kV Yard 2 by constructing two 500 kV, 4,260 MVA, lines on individual towers. The two circuits will be constructed in such a manner to provide sufficient physical separation to minimize the risk of simultaneous failure. The two lines will be constructed in accordance with established National Electric Safety Code (NESC) standards, PJM procedures and State and Local regulations. Detailed design of the transmission interconnection will be done as part of the PJM Interconnection process per PJM's Open Access Transmission Tariff. The existing 500 kV transmission towers are designed and constructed to National Electric Safety Code (NESC) and PJM Transmission and Substation Design Subcommittee Technical Requirements. The new towers added to support BBNPP will also conform to these criteria. The new towers will be steel tubular or lattice designs, and will provide minimum clearances in accordance with the aforementioned standards (Section 3.7). The two circuits connecting the existing Susquehanna 500 kV Yard, the new Susquehanna 500 kV Yard 2, and the BBNPP switchyard, will be carried on separate towers. All structures will be grounded with a combination of ground rods, foundation grounds and a ring counterpoise system.

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5.6.3.3 Maintenance Practices

The transmission lines and towers for BBNPP are located entirely within the boundaries of the BBNPP project area. Environmental impacts would be limited to the proposed project plant and construction area. Thus, no new corridors and associated vegetation buffer zones would be required to minimize visual impacts along roadways.

The use of pesticides and herbicides for vegetation control is described in the PPL EU vegetation management procedures.

5.6.3.4 Aircraft Visibility

The Federal Aviation Administration (FAA) normally requires that structures that exceed a height of 200 ft (61 m) above ground level be marked and/or lighted for "increased conspicuity to ensure safety to air navigation" (FAA, 2000). If any transmission structures exceed a height of 200 ft (61 m) above ground surface Federal Aviation Administration permits will be required.

Helicopters, however, may land periodically at the BBNPP site and the design of the transmission towers and lines will include lights and markers, where appropriate, to alert helicopter traffic to potential hazards created by the proposed structures. For example, lighting may be incorporated into tower design and painted spherical markers may be attached to overhead lines for increased conspicuity to ensure air safety (FAA, 2000).

Aesthetic impacts are also considered in the design of the new transmission structures. Buildings and equipment will be painted to blend with the existing facilities and will not significantly increase the visual impact of the BBNPP site. While the transmission towers will be of sufficient height to avoid safety impacts on the ground, the towers will not be excessively high such that aircraft safety is compromised or unnecessary visual impacts result from excessive tower height.

5.6.3.5 Electric Field Gradients

The maximum electric field gradients for the proposed transmission lines can be predicted through calculation. While there are no specific criteria for maximum electric field gradients, induced currents resulting from high electric fields created by overhead transmission lines are a concern and must be considered in the system design in accordance with the NESC.

As part of the design process, the transmission lines will be analyzed to determine electrical field strengths and to verify conformance with NESC requirements on line clearance to limit shock from induced currents. The minimum clearance to the ground, for lines having voltages exceeding 98 kV alternating current, must limit the potential induced current due to electrostatic effects to 5 milliamperes if the largest anticipated truck, vehicle, or other equipment were short-circuited to ground. For this determination, the NESC specifies that the lines be evaluated assuming a final unloaded sag at 120°F (49°C). The calculation is a 2-step process in which the average field strength at 1.0 m (3.3 ft) above the ground beneath the minimum line clearance is calculated, and then the steady-state current value is determined. The 500 kV lines to be constructed between the BBNPP switchyard, the existing Susquehanna 500 kV Yard, and the new Susquehanna 500 kV Yard 2, will be designed to meet the NESC.

5.6.3.6 Proposed Transmission Corridors

The transmission lines to support BBNPP will be constructed within the BBNPP site, thus no new offsite corridors or widening of existing offsite corridors is required to connect BBNPP to the existing electrical grid. The existing two 500 kV circuits from the SSES site, the

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Susquehanna-Wescosville-Alburtis line to the Alburtis substation and the Sunbury-Susquehanna #2 line, are shown on the map in Figure 3.7-1 (Section 3.7). The site topography and generalized route for the transmission lines on the BBNPP site are also shown in Figure 3.7-1 (Section 3.7). The onsite transmission lines are anticipated to cross over a construction road and laydown areas associated with the project. Since these lines are not expected to be energized until the end of the project, exposure of the construction phase work force to field gradients would be minimal. Areas under the transmission lines will be cleared of any vegetation that might pose a safety threat. Any maintenance access roads are not anticipated to increase the public's exposure to electric field gradients. The anticipated reestablishment of native grasses and shrub vegetation, rather than tall trees, in the corridor will also limit wildlife exposure for smaller animal species.

5.6.3.7 Impacts to Communication Systems

Generally, the cause of radio or television interference from transmission lines is from corona discharge from defective insulators or hardware. Complaints regarding electromagnetic interference with radio or television reception that occur are investigated for cause and, as necessary, defective components replaced to correct the problem. The existing BBNPP transmission lines are designed and constructed to minimize corona. The lines supporting BBNPP will also be designed and constructed to minimize corona. As such, it is expected that radio and television interference from these new lines will be minimal.

5.6.3.8 Grounding Procedures for Stationary Objects

The structures and equipment on the BBNPP site will be adequately grounded in the course of designing and constructing the BBNPP. There are no new offsite lines and associated rights-of-way required for BBNPP. No new offsite rights-of-way and associated grounding of stationary objects is required.

5.6.3.9 Electric Shock Potentials to Moving Vehicles

There is minimal potential for electric shock in moving vehicles such as buses or cars since the vehicles are insulated from ground by their rubber tires. As a result, occupants in cars and buses are generally safe from potential shock from overhead high voltage lines. In addition, since the vehicle is moving, there is little opportunity for the vehicle to become "capacitively charged" due to immersion in a transmission line's electrical field. In the unlikely event that a moving vehicle becomes charged, it is also unlikely that a grounded person outside the moving car or bus will touch the vehicle, thereby discharging a current through the person's body.

5.6.3.10 Noise Levels

Corona discharge is the electrical breakdown of air into charged particles caused by the electrical field at the surface of the conductors, and is increased by ambient weather conditions such as humidity, air density, wind, and precipitation and by irregularities on the energized surfaces. During wet conditions audible noise from the corona effect can exceed 50 dBA for a 500 kV line. Corona noise for a 500 kV line may range between 59 and 64 dBA during a worst case rain with heavy electrical loads (SCE, 2007). For reference, normal speech has a sound level of approximately 60 dBA and a bulldozer idles at approximately 85 dBA.

There were no state or county noise ordinances found for the BBNPP site area. Salem Township has a qualitative noise standard in Section 318 of the Zoning Ordinance. The Standard states "Noise which is determined to be objectionable because of volume, frequency or beat shall be muffled or otherwise controlled."

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BBNPP transmission lines are designed and constructed with hardware and conductors that have features to eliminate corona discharge. Nevertheless, during wet weather, the potential for corona discharge increases, and nuisance noise could occur if insulators or other hardware have any defects. Corona induced noise along the existing transmission lines is very low or inaudible, except possibly directly below the line on a quiet, humid day. Such noise does not pose a risk to humans. Complaints on transmission line noise are monitored but reports of nuisance noise have not been received from members of the public.

As shown in Figure 3.7-1, the BBNPP switchyard, the transmission lines connecting the BBNPP switchyard to the existing Susquehanna 500 kV Yard and the new Susquehanna 500 kV Yard 2, will be constructed entirely on the BBNPP site. Switchyards include transformer banks and circuit breakers that create “hum,” normally around 60 dBA, and occasional instantaneous sounds in the range of 70 to 90 dBA during activation of circuit breakers (CA, 2006). The new BBNPP switchyard, the expansion to the existing Susquehanna 500 kV Yard, and the new Susquehanna 500 kV Yard 2, will introduce these new noise sources (transformers and circuit breakers) to its location.

A leaf off noise survey was conducted at the SSES with measurements taken at the nearest residential locations to the proposed BBNPP. There are switchyards and transmission lines associated with SSES. Absolutely no sounds from the plant were detectable during attended measurement for normal operation on February 29, 2008. Sound pressure levels were below 60 dB. SSES Unit 1 was shut down on March 3, 2008. Noise from the plant, presumed to be construction or maintenance sources, was readily audible during the March 14, 2008 attended measurement survey, but sound pressure levels remained below 60 dB (HAI, 2008). Therefore, in the absence of construction and maintenance activities, all measured ambient sound levels can be attributed to normal, current environmental sources, such as traffic noise, high wind and rain and are not related to the existing SSES plant.

The noise levels surrounding the substation would likely be close to 60 dBA near the substation fence, but would be significantly reduced near the site boundary, approximately 2,800 ft (850 m) to the south. According to NUREG-1437, noise impacts from currently operating nuclear power plants have been found to be small and generally not noticed by the public. Noise levels below 60 to 65 decibels are considered to be of small significance (NRC, 1996).

5.6.3.11 References

CA, 2006. Southern California Edison’s Devers-Palo Verde 500 kV Project (Application Number A.05-04-015), Final Environmental Impact Report/Environmental Impact Statement, Section D.8 Noise, California Public Utilities Commission, October 2006, Website: http://www.cpuc.ca.gov/Environment/info/aspen/dpv2/feir/d08_noise.pdf, Date accessed: June 2008.

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SCE, 2007. Southern California Edison, Application 05-04-015, Opinion Granting A Certificate of Public Convenience and Necessity, IV.C.2. Corona Noise Impacts, January 2007, Website: http://docs.cpuc.ca.gov/published/FINAL_DECISION/64017-05.htm, Date accessed: June 2008.

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5.7 URANIUM FUEL CYCLE IMPACTS

This section discusses the environmental impacts from the uranium fuel cycle for the U.S. EPR. The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposal of fuel for nuclear power reactors.

The regulations in 10 CFR 51.51(a) (CFR, 2007a) state that:

> Every environmental report prepared for the construction permit stage of a light water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

NRC Table S-3 is used to assess environmental impacts. Its values are normalized for a reference 1,000 MWe light water reactor (LWR) at an 80% capacity factor. The 10 CFR 51.51(a), Table S-3 (CFR, 2007a) values are reproduced as the "Reference Reactor" column in Table 5.7-1. A typical U.S EPR unit has been evaluated operating at a 95% capacity factor. The results of this evaluation are also included in Table 5.7-1.

Specific categories of natural resource use are included in NRC Table S-3 (and duplicated in Table 5.7-1). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high level and low level wastes, and radiation doses from transportation and occupational exposure. In developing NRC Table S-3, the NRC considered two fuel cycle options, which differed in the treatment of spent fuel removed from a reactor. "No recycle" treats all spent fuel as waste to be stored at a Federal waste repository; "uranium only recycle" involves reprocessing spent fuel to recover unused uranium and return it to the system. Neither cycle involves the recovery of plutonium. The contributions in NRC Table S-3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the two fuel cycles ("uranium only recycle" and "no recycle"); that is, the identified environmental impacts are based on the cycle that results in the greater impact.

Because the U.S. does not currently reprocess spent fuel, only the "no recycle" option is considered here. Natural uranium is mined from either open-pit or underground mines or by an in-situ leach solution process. In-situ leach mining, the primary form used in the U.S. today, involves injecting a lixiviant solution into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The in-situ leach solution containing uranium is transferred to mills where it is processed to produce uranium oxide (UO2) or "yellowcake". A conversion facility prepares the uranium oxide from the mills for enrichment by converting it to uranium hexafluoride, which is then processed to separate the non-fissile isotope uranium-238 from the fissile isotope uranium-235. At a fuel fabrication facility, the enriched uranium, which is approximately 4-5 percent uranium-235, is converted to UO2. The UO2 is pelletized, sintered, and inserted into tubes to form fuel assemblies. The fuel assemblies are placed in the reactor to heat water to steam which turns turbines which produce power. The nuclear reaction reduces the amount of uranium-235 in the fuel. When the uranium-235 content of the fuel reaches a point where the nuclear reaction becomes inefficient, the fuel assemblies are withdrawn from the reactor. After onsite storage for a time sufficient to allow the short-lived fission products to decay thus reducing the heat generation

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rate, the fuel assemblies would be available for transfer to a permanent waste disposal facility for internment. Disposal of spent fuel elements in a repository constitutes the final step in the "no recycle" option.

The following assessment of the environmental impacts of the fuel cycle for a U.S. EPR at the Bell Bend Nuclear Power Plant (BBNPP) site is based on the values in NRC Table S-3 and the NRC's analysis of the radiological impacts from radon-222 and technetium-99 provided in NUREG-1437 (NRC, 1996). NUREG-1437 (NRC, 1996) and Supplement 1 to the Generic Environmental Impact Statement to NUREG-1437 (NRC, 1999a) provide a detailed analysis of the environmental impacts from the uranium fuel cycle. Although these references are specific to impacts related to license renewal, the information is relevant to this review because the U.S. EPR design uses the same type of fuel.

The fuel impacts in NRC Table S-3 are based on a reference 1,000 MWe LWR operating at an annual capacity factor of 80% for a net electric output of 800 MWe. As discussed in Section 1.1, BBNPP is being proposed to be located near the Susquehanna Steam Electric Station (SSES) site. The proposed unit will be located west of the existing SSES Units 1 and 2. The U.S. EPR standard configuration of 4,590 MWt with a gross electrical output of 1,710 MWe is used to evaluate uranium fuel cycle impacts relative to the reference reactor. In the following evaluation of the environmental impacts of the fuel cycle, a standard configuration and a capacity factor of 95% for a total gross electric output (i.e., 1,710 MWe) of approximately 1,625 MWe for the U.S. EPR is used. The U.S. EPR output is approximately twice the output used to estimate impact values in NRC Table S-3 (reproduced here as the first column of Table 5.7-1) for the reference reactor. Analyses presented here are scaled from the 1,000 MWe reference reactor impacts to reflect the output of a single U.S. EPR.

Recent changes in the fuel cycle may have some bearing on environmental impacts. As discussed below, the contemporary fuel cycle impacts are bounded by values in NRC Table S-3 even considering that the generating capacity of the U.S. EPR would be 100% higher than the NRC Table S-3 reference 1,000 MWe LWR.

The NRC calculated the values in NRC Table S-3 from industry averages for the performance of each type of facility or operation associated with the fuel cycle. The NRC chose assumptions so that the calculated values would not be under-estimated. This approach was intended to ensure that the actual values are less than the quantities shown in NRC Table S-3 for all LWR nuclear power plants within the widest range of operating conditions. Since NRC Table S-3 was promulgated, changes in the fuel cycle and reactor operations have occurred. For example, the estimate of the quantity of fuel required for a year's operation of a nuclear power plant can now reasonably be calculated assuming a 60 year lifetime (40 years of initial operation plus a 20 year license renewal term). This is described in NUREG-1437 (NRC, 1996), for both BWRs and PWRs, and the highest annual requirement, 35 MTU made into fuel for a BWR, was used as the basis for the reference reactor year.

However, Table 5.7-2 shows that the U.S. EPR requires slightly more than 35 MTU per year. It also shows the fuel cycle requirements assuming it is scaled to the net (i.e., 1,000 MWe with an 80% capacity factor) generating capacity of the reference 1,000 MWe LWR. The uranium requirements slightly exceed 35 MTU because the generating capacity is significantly greater than any of the reactor designs that were considered when NUREG-1437 (NRC, 1996) was issued. The U.S. EPR is sized for significantly higher generating capacity than its predecessors to achieve the benefit of the economy of scale offered by a larger plant. Nearly two of the reference 1,000 MWe LWRs would be required to provide the generating capacity of a single U.S. EPR.

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Also, a number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and enrichment requirements, reducing annual fuel requirements. For example, the U.S. EPR is expected to employ such improvements as axial blankets to reduce axial neutron leakage which will reduce uranium-235 enrichment requirements, and consequently the quantity of uranium required for the U.S. EPR.

Therefore, NRC Table S-3 remains a reasonably conservative estimate of the environmental impacts of the fuel cycle fueling nuclear power reactors operating today.

Another change is the elimination of the restrictions in the U.S. on the importation of foreign uranium. The economic conditions of the uranium market now and in the foreseeable future favor full utilization of foreign uranium at the expense of the domestic uranium industry. These market conditions have forced the closing of most uranium mines and mills in the U.S., substantially reducing the environmental impacts from these activities although with the recent dramatic increase in the price of uranium, there is likely to be some recovery of the uranium mining industry. However, the NRC Table S-3 estimates have not been adjusted accordingly so as to ensure that these impacts, which have been experienced in the past and may be fully experienced in the future, are considered.

With the recent sharp increase in price of uranium it is likely there will be a reduction in the uranium enrichment tails assay. The uranium tails assay can best be described as the degree of depletion of uranium-235 in the depleted uranium waste that remains following the enrichment process. It is a parameter that can be adjusted to economical needs, depending on the cost of natural uranium and enrichment. As the price of uranium increases, it is generally more cost effective to remove more of the uranium-235 isotope from the natural uranium even though more separative work is required to do so. There is also some environmental gain to the extent that there are fewer uranium tails to dispose with the lower tails assay. Thus, with a lower tails assay less uranium is required reducing the effect of mining and milling operations on the environment. Although an increase in the amount of separative work is required, it is likely that the gaseous diffusion process will be replaced by centrifuge enrichment, and the overall impact on the environment will be less.

For the enrichment operation, the gaseous diffusion process is largely being replaced with the centrifuge process. NUREG-1437 (NRC, 1996) addresses this issue and notes that the centrifuge process uses 90% less energy than gaseous diffusion. Since the major environmental impacts for the entire fuel cycle are from the emissions from the fossil fueled plants needed to supply the energy demands of the gaseous diffusion plants, this reduction in energy requirements results in a fuel cycle with much less environmental impact. A transition to centrifuge enrichment will also result in a significant reduction in the cooling water discharges associated with the use of the fossil fuel plants as well as the large amount of cooling water required for the gaseous diffusion plant process equipment.

Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those in NRC Table S-3. Section 6.2 of NUREG-1437 (NRC, 1996) discusses the sensitivity of these changes in the fuel cycle on the environmental impacts.

Finally, the "no recycle" option might not always be the only option for spent fuel disposition in this country. The Energy Policy Act of 2005 (PLN, 2005) directs the Department of Energy (DOE) to conduct an advanced fuel recycling technology research, development, and demonstration program to evaluate proliferation-resistant fuel recycling and transmutation technologies. DOE has reported to Congress on a plan to begin limited recycling of fuel with current reactors by

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2025, and transitional recycling with current reactors by 2040 (DOE, 2005). Therefore, it is possible that recycling may be available during the 40 year initial term of the license to operate the U.S. EPR in the U.S. However, many actions will be required by the federal government before this research and development concept becomes a technological reality. For this reason, it has been concluded that this option is too speculative to warrant further consideration for the U.S. EPR.

5.7.1 LAND USE

The total annual land requirements for the fuel cycle supporting a U.S. EPR (as scaled up from the reference reactor and provided in Table 5.7-1) is approximately 229 acres (93 hectares). Approximately 26 acres (11 hectares) is permanently committed land, and 203 acres (82 hectares) is temporarily committed. A "temporary" land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following decommissioning, the land could be released for unrestricted use. "Permanent" commitments represent land that may not be released for use after decommissioning.

In comparison, a coal plant of 1,600 MWe (1,520 MWe net) capacity using strip-mined coal requires about 370 acres (150 hectares) per year for fuel alone. As a result, the impacts on land use for the U.S. EPR are deemed so minor as to not warrant mitigation.

5.7.2 WATER USE

Principal water use for the fuel cycle is that required to remove waste heat from the power stations supplying electricity to the enrichment process. Scaling from NRC Table S-3, Table 5.7-1 shows that of the total annual water use of 2.310×10^{10} gal (8.7×10^{10} l) for the U.S. EPR fuel cycle, about 2.252×10^{10} gal (8.5×10^{10} l) is required for the removal of waste heat. Evaporative losses from fuel cycle process cooling are approximately 3.2×10^{8} gal (1.2×10^{9} l) per year and mine drainage is approximately for 2.6×10^{8} gal (9.8×10^{8} l) per year.

Although the water use associated with the fuel cycle for the U.S. EPR would be greater than for the reference reactor, on a comparative basis obtained by scaling the reference reactor to the U.S. EPR, the Table S-3 data are applicable to the U.S. EPR.

NUREG-1437 (NRC, 1996) indicates that on a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the reference 1,000 MWe LWR using once-through cooling. The consumptive water use is about 2% of that from the model 1,000 MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of that of the model 1,000 MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible, and as a result do not warrant mitigation.

Further, as noted earlier in this application, with the likelihood that centrifuge enrichment will be used for the U.S. EPR, water use will decline significantly because less than 10% of the energy used for the gaseous diffusion process will be required for the centrifuge enrichment.

5.7.3 FOSSIL FUEL IMPACTS

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents about 5% of the annual electric power production of the reference 1,000 MWe LWR. The original analysis (AEC, 1974) shows that the environmental impacts are almost totally from the electrical generation needed for the gaseous diffusion process. These impacts result from the emissions from the electrical

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generation that is assumed to be from coal plants, the water needed to cool the coal plants and the water needed to cool the gaseous diffusion plant equipment.

However, the process used for enrichment is undergoing a transition from gaseous diffusion to centrifuge enrichment. Centrifuge enrichment technology requires less than 10% of the energy needed for the gaseous diffusion process.

In the U.S., Louisiana Energy Services (LES), and the United States Enrichment Corporation (USEC) are in the process of constructing new centrifuge enrichment plants. LES broke ground for a new centrifuge enrichment plant at a site near Eunice, New Mexico in August 2006. The USEC centrifuge enrichment plant license was issued by the NRC in April 2007.

By the time enrichment services are required for the U.S. EPR, it is possible that the majority of U.S. supplied enrichment services will utilize centrifuge technology. As such, the environmental impacts associated with the electrical generation would be correspondingly less for the U.S. EPR.

Process heat is primarily generated by the combustion of natural gas. As concluded in NUREG-1437 (NRC, 1996), this gas consumption, if used to generate electricity, is less than 0.4% of the electrical output from the reference reactor. As a result, the direct and indirect consumption of electrical energy for fuel cycle operations are deemed to be minor relative to the power production of the U.S. EPR.

The natural gas consumption associated with the fuel cycle for the U.S. EPR will be greater than for the reference reactor since the U.S. EPR has a significantly higher generating capacity. However, if a comparative basis is established by scaling the reference reactor to the U.S. EPR, it is anticipated that this figure will remain at less than 0.4% of the U.S. EPR output.

5.7.4 CHEMICAL EFFLUENTS

The quantities of liquid, gaseous and particulate discharges associated with the fuel cycle processes are given in NRC Table S-3 (Table 5.7-1) for the reference 1,000 MWe LWR. The quantities of effluents for a U.S. EPR is approximately twice those in NRC Table S-3 (Table 5.7-1). The principal effluents are SOx, NOx, and particulates. Based on the Environmental Protection Agency Latest Findings on National Air Quality, 2002 Status and Trends (EPA, 2003), the U.S. EPR emissions constitute a very small fraction of the national sulfur and nitrogen oxide annual emissions.

Liquid chemical effluents produced in the fuel cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. All liquid discharges into navigable waters of the U.S. from facilities associated with fuel cycle operations are subject to requirements and limitations set by a National Pollutant Discharge Elimination System (NPDES) regulatory discharge permit, thus assuring minimum impact.

As concluded in NUREG-1555 (NRC, 1999b) tailing solutions and solids are generated during the milling process, but are not released in quantities sufficient to have a significant impact on the environment.

Impacts from the above listed chemical effluents for the U.S. EPR, therefore, are minor and will not warrant mitigation.

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5.7.5 RADIOACTIVE EFFLUENTS

Radioactive gaseous effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle are set forth in NRC Table S-3 as shown in Table 5.7-1. From these data the 100 year environmental dose commitment to the population in the U.S. is calculated for one year of the fuel cycle for the U.S. EPR (excluding reactor releases and dose commitments due to radon-222 and technetium-99). The dose commitment to the population is approximately 800 person-rem (8 person-Sv) per year of operation of the U.S. EPR based on scaling up the referenced 1,000 MWe LWR.

The additional whole body dose commitment to the population from radioactive liquid wastes effluents due to all fuel cycle operations other than reactor operation is approximately 400 person-rem (4 person-Sv) per year of operation. Thus, the estimated 100 year environmental dose commitment to the population from the fuel cycle for radioactive gaseous and liquid effluents is approximately 1,200 person-rem (12 person-Sv) to the whole body per reactor-year for the U.S. EPR.

The radiological impacts of radon-222 and technetium-99 releases are not included in NRC Table S-3. However, Section 6.2 of NUREG-1437 (NRC, 1996), estimates radon-222 releases from mining and milling operations, and from mill tailings for a year of operation of the reference 1,000 MWe LWR. The estimated releases of radon-222 for one U.S. EPR reactor year are 11,500 Ci (4.3×10^5 GBq). Of this total, about 78% is from mining, 15% from milling, and 7% from inactive tails before stabilization. Radon releases from stabilized tailings were estimated to be 2.0 Ci (74 GBq) per year for the U.S. EPR. This is twice the NUREG-1437 (NRC, 1996) estimate for the reference reactor year. The major risks from radon-222 are from exposure to the bone and lung, although there is a small risk from exposure to the whole body. The organ-specific dose weighting factors from 10 CFR 20 (CFR, 2007b) were applied to the bone and lung doses to estimate the 100 year dose commitment from radon-222 to the whole body.

NUREG-1437 (NRC, 1996) considers the potential health effects associated with the releases of technetium-99. The estimated release for the U.S. EPR is 0.015 Ci (0.55 GBq) from chemical processing of recycled uranium hexafluoride before it enters the isotope enrichment cascade or centrifuge plant and 0.011 Ci (0.39 GBq) into ground water from a high level waste repository. The major risks from technetium are from exposure of the gastrointestinal tract and kidneys, and a small risk from whole-body exposure. The total-body 100 year dose commitment from technetium-99 is estimated to be 222 person-rem (2.22 person-Sv) for the U.S. EPR.

Although radiation can cause cancer at high doses and high dose rates, no data unequivocally establish a relationship between cancer and low doses or low dose rates, below about 10,000 mrem (100 mSv). However, to be conservative, radiation protection experts assume that any amount of radiation may pose some risk of cancer, or a severe hereditary effect, and that higher radiation exposures create higher risks. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detrimental effects. Based on this model, risk to the public from radiation exposure can be estimated using the nominal probability coefficient (730 fatal cancers, non-fatal cancers or severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv)) provided in the International Commission of Radiological Protection Publication 60 (ICRP, 1991). This coefficient, multiplied by the sum of the estimated whole-body population doses of approximately 3,500 person-rem/yr (35 person-Sv per year) provided above for the U.S. EPR, estimates that the population in the U.S. could incur a total of approximately 2.6 fatal cancers, non-fatal cancers or severe hereditary effects from the annual fuel cycle for the U.S. EPR.

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This risk is small compared to the number of fatal cancers, non-fatal cancers and severe hereditary effects that are estimated to occur in the population annually from exposure to natural sources of radiation using the same risk estimation methods.

Based on these analyses, the environmental impacts of radioactive effluents from the fuel cycle for the U.S. EPR are deemed to be minor and, therefore, will not warrant mitigation.

5.7.6 RADIOACTIVE WASTES

For low level waste disposal at land burial facilities, Table S-3 indicates that there will be no significant radioactive releases to the environment. The basis for this conclusion is that only shallow land burial is considered. The U.S. EPR operates at a cleaner level than the reference LWR discussed in NUREG-0116 (NRC, 1976) as evidenced by lower volumes of low level radioactive waste discussed in Section 3.5. Improvements in fuel integrity and differences in fuel form are responsible for contributing to both a lower level of waste generated during operation and less overall contamination to be managed during the decontamination and decommissioning process. The plants with higher thermal efficiency would produce less heavy metal waste. The main radionuclides identified for low level waste are Co-60 and Fe-55 with half-lives of 5.26 years and 2.73 years, respectively. Based on these half-lives, after about 20 years, the activity would be less than the reference LWR.

Federal Law requires that high level and transuranic wastes are to be buried at a repository and no release to the environment is expected to be associated with such disposal because it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are no longer present at the time of disposal of the waste. In NUREG-0116 (NRC, 1976), which provides background and context for the high level and transuranic Table S-3 values, the NRC indicated that these high level and transuranic wastes will be buried and will not be released to the environment.

The NRC has already concluded that for applicants seeking an Early Site Permit (ESP), these impacts are acceptable, and would not be sufficiently large to require a NEPA conclusion that the construction and operation of a new nuclear unit at the sites should be denied.

5.7.7 OCCUPATIONAL DOSE

The annual occupational dose for the Reference 1,000 MWe reactor attributable to all phases of the fuel cycle is about 600 person-rem (NRC, 1996). Since the fuel cycle for the U.S. EPR is similar to the fuel cycle of the Reference Reactor, the annual occupational dose for all phases of the fuel cycle can be determined by normalizing the rated power of the U.S. EPR to the Reference Reactor. Doing this the annual occupational dose for all phases of the fuel cycle is approximately 1,220 person-rem or approximately a factor of 2 larger than the reference reactor S-3 value. However, on a per MWe basis, the dose would be the same. The environmental impact from this occupational dose is considered minor compared to the dose of 5 rem/yr (0.05 Sv/yr) to any individual worker permitted under 10 CFR Part 20 (CFR, 2007b).

5.7.8 TRANSPORTATION

The transportation dose to workers and the public totals about 2.5 person-rem (0.025 person-Sv) annually for the Reference 1,000 MWe LWR per Table S-3. Scaling the data for the U.S. EPR, this corresponds to a dose of approximately 5.1 person-rem (0.051 person-Sv). For comparative purposes, the estimated collective dose from natural background radiation to the U.S. population is 90 million person-rem/yr (900,000 person-Sv/yr) (NCRP, 1987). On the basis of this comparison, environmental impacts of transportation will be negligible.

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5.7.9 FUEL CYCLE

As previously, only the "no recycle" option is considered here because the U.S. does not currently reprocess spent fuel. The data provided in Table S-3, however, include maximum recycle option impact for each element of the fuel cycle (NRC, 1999b). As a result, the analysis of the uranium fuel cycle performed and the environmental impacts described, as compared to Table S-3 impacts, are not affected by whether a specific fuel cycle is selected ("no recycle" or "uranium only recycle").

5.7.10 REFERENCES

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Table 5.7-1—NRC Table S-3 of Uranium Fuel Cycle Environmental Data[a] Compared to the U.S. EPR Configuration (Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116))

(Page 1 of 3)

	Reference Reactor	U.S. EPR
MWe	1,000	1,710
Capacity Factor	0.8	0.95
MWe (Net)	800	1624.5
Environmental Considerations		
NATURAL RESOURCE USE		
Land (acres)(hectares)		
Temporarily committed[b]	100 (40)	203 (82)
Undisturbed area	79 (32)	160 (65)
Disturbed area	22 (9)	45 (18)
Permanently committed	13 (5)	26 (11)
Overburden moved (millions of MT)(millions of tons)	2.8 (3.1)	5.7 (6.3)
Water (millions of gallons)(millions of liters)		
Discharged to air	160 (606)	320 (1,211)
Discharged to water bodies	11,090 (41,980)	22,520 (85,247)
Discharged to ground	127 (481)	258 (977)
Total	11,377 (43,067)	23,102 (87,450)
Fossil fuel		
Electrical energy (thousands of MW-hour)	323	656
Equivalent coal (thousands of MT (thousands of tons))	118 (130)	240 (265)
Natural gas (millions of scf)(millions of cubic meters)	135 (3.82)	274 (7.76)
EFFLUENTS-CHEMICALS (MT)(tons)		
Gases (including entrainment) [c]		
SO_X	4,400 (4,849)	8,935 (9,849)
NO_X[d]	1,190 (1,311)	2,416 (2,663)
Hydrocarbons	14 (15.4)	28 (31)
CO	29.6 (32.6)	60 (66)
Particulates	1,154 (1,272)	2,343 (2,583)
Other gases		
F	0.67 (0.74)	1.36 (1.50)
HCl	0.014 (0.015)	0.028 (0.031)
Liquids		
SO_4	9.9 (10.9)	20.1 (22.2)
NO_3	25.8 (28.4)	52.4 (57.8)
Fluoride	12.9 (14.2)	26.2 (28.9)
Ca^{++}	5.4 (5.95)	11 (12.1)
Cl^-	8.5 (9.4)	17.3 (19.1)
Na^+	12.1 (13.3)	24.6 (27.1)
NH_3	10.0 (11.0)	20.3 (22.4)
Fe	0.4 (0.4)	0.8 (0.9)
Tailings solutions (thousands of MT (thousands of tons))	240 (264)	487.4 (537.3)

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Table 5.7-1—NRC Table S-3 of Uranium Fuel Cycle Environmental Data[a] Compared to the U.S. EPR Configuration (Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116))

(Page 2 of 3)

	Reference Reactor	**U.S. EPR**
Solids	91,000 (100,282)	185,000(203,928)
EFFLUENTS-RADIOLOGICAL (CURIES)(GBq)		
Gases		
Rn-222[e]	Note e	
Ra^{226}	0.02 (0.74)	0.04 (1.48)
Th^{230}	0.02 (0.74)	0.04 (1.48)
Uranium	0.034 (1.258)	0.069 (2.553)
Tritium (thousands)	18.1 (669.7)	36.8 (1,361.6)
C^{14}	24 (888)	48.7 (1,801.9)
Kr^{85} (thousands)	400 (14,800)	812.3 (30,055.1)
Ru-106	0.14 (5.18)	0.28 (10.36)
I-129	1.3 (48.1)	2.6 (96.2)
I-131	0.83 (30.71)	1.69 (62.53)
Tc-99[e]	Note (e)	
Fission products and TRU[f]	0.203 (7.511)	0.412 (15.244)
Liquids		
Uranium and daughters	2.1 (77.7)	4.3 (159.1)
Ra-226	0.0034 (0.1258)	0.0069 (0.2553)
Th-230	0.0015 (0.0555)	0.003 (0.111)
Th-234	0.01 (0.37)	0.02 (0.74)
Fission and activation products	5.9E-06 (2.18E-04)	1.20E-05 (4.44E-04)
Solids		
Other than HLW[f] (shallow)	11,300 (418,100)	22,900 (848,750)
TRUf and HLW[f] (deep)	1.1E+07 (4.07E+08)	2.2E+07 (8.26E+08)
Effluents - thermal (billions of Btu (billions of Joules))	4,063 (4,286,465)	8,250 (8,701,600)
Transportation (person rem)(Sv)	12.1(0.121)	24.6 (0.246)
Exposure of workers and the general public	2.5 (0.025)	5.1 (0.051)
Occupational exposure	22.6 (0.226)	45.9 (0.459)

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Table 5.7-1—NRC Table S-3 of Uranium Fuel Cycle Environmental Data[a] Compared to the U.S. EPR Configuration (Normalized to Model LWR Annual Fuel Requirement (WASH-1248) or Reference Reactor Year (NUREG-0116))

(Page 3 of 3)

	Reference Reactor	U.S. EPR

Notes:

a. In some cases where no entry appears in NRC Table S-3 it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the table. NRC Table S-3 does not include health effects from the effluents described in the table, or estimates of releases of radon-222 from the uranium fuel cycle or estimates of technetium-99 released from waste management or reprocessing activities. Radiological impacts of these two radionuclides are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," dated May 1996, and it was concluded that the health effects from these two radionuclides posed a small significance.

   Data supporting NRC Table S-3 are addressed in WASH-1248, "Environmental Survey of the Uranium Fuel Cycle," dated April 1974; NUREG-0116, "Supplement 1 to WASH-1248, Environmental Survey of Reprocessing and Waste Management Portions of the LWR Fuel Cycle," dated October, 1976; NUREG-0216 "Supplement 2 to WASH-1248, Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," dated March 1977; and in the record of final rule making pertaining to "Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3." The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only recycle and no recycle). The contribution from transportation excluded transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in NRC Table S-4 of 10 CFR 51.20(g). The contributions from the other steps of the fuel cycle are given in Columns A through E of NRC Table S-3A of WASH-1248.

b. The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

c. Estimated effluents based upon combustion of coal for equivalent power generation.

d. 1.2% from natural gas use and processes.

e. Radiological impacts of radon-222 and technetium-99 are addressed in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," dated May 1996. The Generic Environmental Impact Statement concluded that the health effects from these two radionuclides pose a small risk.

f. TRU means transuranic; HLW means high level waste.

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Table 5.7-2—Average Nominal Annual Fuel Cycle Requirements (U.S. EPR Scaled to the 1,000 MWe Reference LWR)

	U_3O_8 kg (lbs)	Natural UF_6 kg U (lbs U)	SWUs	Enriched UF_6 kg U (lbs U)
U.S. EPR	393,000 (867,000)	332,000 (732,100)	201,000	35,800 (78,900)
Scaled to the Reference Reactor	194,000 (427,000)	163,000 (360,000)	99,000	17,600 (39,000)

NOTES:

a. U.S. EPR 1,710 MWe; capacity factor 95% = 1,624.5 Net MWe
b. Reference Reactor 1,000 MWe; capacity factor 80% = 800 Net MWe
c. Adjustment factor 1,000 x 800/1,624.5 = 0.492
d. U.S. EPR tails assay is assumed to be 0.3%
e. U.S. EPR average enrichment is 4.3% uranium-235

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5.8 SOCIOECONOMIC IMPACTS

5.8.1 PHYSICAL IMPACTS OF STATION OPERATION

This section addresses the direct physical impacts of plant operation on the surrounding community. The impacts evaluated include the effects from noise, odors, exhausts, thermal emissions, and visual intrusion. The discussion evaluates how these impacts should be treated and whether mitigation is needed. As a result of regulatory permits and controls and the remoteness of the site, direct physical impacts from plant operation on the surrounding community are expected to be SMALL.

5.8.1.1 Plant Layout

Potential physical impacts will be controlled through compliance with applicable regulations and woodland screening. The plant layout is provided in Figure 2.2-1. As described in Section 2.1, the area of the proposed facility is largely deciduous woodlands, interspersed with grasslands and orchards. It is a rural area, relatively remote from population and community centers. Its location is approximately 5 mi (8 km) from Berwick, the nearest population center.

The plant layout is provided in Figure 3.1-1 and its structures are described in Section 3.1. The BBNPP site boundary would encompass approximately 424 ac (172 ha) within the Owner Controlled Area of 882 ac (357 ha) adjacent to the existing Susquehanna Steam Electric Station (SSES) Units 1 and 2.

5.8.1.2 Distribution of Community Population, Buildings, Roads and Recreational Facilities

The total residential population within 1 mi (1.6 km) is an estimated 280 persons based on the 2000 U.S. Census (Table 2.5-6). The number of residents within the 3 mi (4.8 km) Low Population Zone (LPZ) was estimated to be 2,733 persons (Section 2.5.1). No residential properties are located within the BBNPP site boundary. Furthermore, there are no nursing homes, hospitals, prisons, or schools within the LPZ.

Table 2.5-6 presents population distributions, by residential population and transient population in 2000, within each of the sixteen geographic directional sectors at radii of 0 to 1 mi (0 to 2 km), 1 to 2 mi (2 to 3 km), 2 to 3 mi (3 to 5 km), 3 to 4 mi (5 to 6 km), 4 to 5 mi (6 to 8 km) and 5 to 10 mi (8 to 16 km) from the BBNPP site.

Besides the residential or farm buildings to the west and south, Berwick is located southwest of the BBNPP site and has commercial buildings in the town center. Figure 2.2-7 shows roads/highways that are in the vicinity of the BBNPP site.

The major recreational facility in the immediate area near the BBNPP site is the 401 ac (162 ha) Riverlands Recreational Area, which is part of the land owned by SSES. This recreational area is located east of the BBNPP and SSES sites along the Susquehanna River, as denoted in Figure 2.1-3. Three additional Commonwealth owned game lands are located within the 6 mi (10 km) radius of the BBNPP site. The two largest game lands total approximately 5,557 ac (2,249 ha). Two smaller privately owned land trust conservancy lands are also located within the 6 mi (10 km) radius.

5.8.1.3 Noise

The principal noise sources associated with operation of the new plant are the switchyard, transformers, and CWS and ESWS cooling towers. As noted in Section 2.7.7, a recent baseline ambient noise survey documents that there was no observed, offsite, audible noise from the

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existing SSES plant, day or night over two separate test periods encompassing leaf-off and leaf-on conditions. Similar results would be expected for BBNPP, as it relates to general plant noise, including the switchyard and transformers. Additional noise would occur from the two BBNPP CWS and four ESWS cooling towers.

The estimated noise generated from the BBNPP cooling towers operation has been modeled to assess the impact to the nearby community. Figure 5.8-1 shows the estimated sound contours from the anticipated cooling tower noise during operation. Table 5.8-1 shows the estimated sound levels from anticipated cooling tower noise during operation. As illustrated, the sound levels beyond the BBNPP site boundary, regardless of the season, are below both the EPA and HUD acceptable outdoor level of 55 dB(A) (USEPA, 1974) (CFR, 2007d). Results suggest that the CWS cooling tower noise levels would be imperceptible at the offsite locations. There are two residences to the west of the plant that appear to be within the 50 dBA sound contour, where noise would be perceptible during quiet periods of the day and imperceptible at other times. The typical noise level from the two cell mechanical draft ESWS cooling tower is estimated to be approximately 54 dBA at 800 ft (244 m). The nearest residences are approximately 900 feet (274 m) from the ESWS cooling towers, so the noise level at these locations would be expected to be less than the EPA and HUD acceptable outdoor level of 55 dBA. Thus, the impact of noise from operation of BBNPP to nearby residences and recreational areas is anticipated to be SMALL.

Noise generated from traffic would increase due to a larger plant workforce and more BBNPP site deliveries and offsite shipments. The traffic noise, however, would be limited to normal weekday business hours. In addition, traffic control and administrative measures, such as staggered shift hours would diminish traffic noise during the weekday business hours. Traffic noise during evenings and weekends would be substantially reduced because only a small fraction of the weekday workforce will be onsite. The potential noise impacts to the community, therefore, are expected to be temporary during shift change and manageable. Thus, the impact from noise from traffic due to operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.

The noise levels would be controlled by compliance with regulatory criteria. For worker protection, the Occupational Safety and Health Administration (OSHA) noise-exposure limits identified in 29 CFR 1910.95 (CFR, 2007b) would be met. For residential areas, the EPA and HUD guidelines would be met, specifically, the acceptable outdoor decibel sound level of 55 dB(A) (USEPA, 1974) (CFR, 2007d).

5.8.1.4 Air and Thermal Emissions

The principal air emission sources associated with operation of BBNPP are standby diesel generators. BBNPP would have four diesel generators (EDGs) as part of the Emergency Power Supply System, and two Station Blackout (SBO) diesel generators. Section 3.6.3 quantifies the anticipated annual diesel generator air emissions, which include particulate matter (PM), sulfur oxides (SOx), hydrocarbons (HC), and nitrogen oxides (NOx). Each EDG would be tested for approximately 4 hours every month, plus an additional 24 to 48 hours once every 2 years. Testing of the SBO diesels would occur for approximately 4 hours every quarter plus an additional 12 hours every year, and for an extended period of about 12 hours every 18 months.

Air emissions would be controlled by compliance with the Commonwealth of Pennsylvania permit requirements and Federal Air Quality Standards 40 CFR 89.112 (CFR, 2007c). The diesel generators would be required to meet the applicable emission limits in effect at the time of plant startup, with additional air pollution controls as required.

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Air emissions sources not otherwise permitted will also be administratively controlled to comply with Occupational Safety and Health Standards. In particular, 29 CFR 1910.1000 (CFR, 2007a) places limits on certain vapors, dusts, and other air contaminants. Dust suppression methods such as watering areas that have been reseeded will minimize dust emissions. Thus, the impact from air emissions from operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.

Another air emission is deposition from water droplets leaving the top of the CWS cooling towers. As the droplets evaporate, the solids would precipitate and fall to the ground. Thermal air emission impacts are addressed separately in Section 5.3.3.1. Potential impacts include the plume visibility, fogging, icing, and water deposition. Maximum solids deposition in the form of salts carried by plume water droplets is expected to be within NUREG-1555 criteria for protection of vegetation. No fogging or icing associated with the tower plumes is predicted.

Thermal emission impacts are addressed separately in Section 5.3, Cooling System Impact. The thermal discharge from BBNPP would return blowdown from the CWS and ESWS cooling towers and site wastewater streams to the Susquehanna River. Pennsylvania guidelines for thermal discharges limit the maximum allowable temperature increase for critical periods during the year to 2°F (1.3°C) during any one hour period (PADEP, 2003). This limit would be administered through the National Pollutant Discharge Elimination System (NPDES) permit. Thermal plume modeling indicates that the BBNPP thermal plume would meet applicable Commonwealth criteria for the designated use in this reach of the Susquehanna River, which is Warm Water Fishes (WWF). Additional information is provided in Section 5.3.2. Based on its small size and relative distribution, impacts of the BBNPP thermal plume to aquatic communities are expected to be SMALL. (PADEP, 2003)

5.8.1.5 Visual Intrusion

The CWS cooling towers, and to a lesser extent the containment building, would be visible depending on viewpoints and the general topography of the site. Ridges to the north should help to minimize the impacts to viewpoints from that direction. Proximity to Market Street and Beach Grove Road would likely make the CWS cooling towers, and in some instances the containment building, visible from those nearby locations. Site surroundings contain stands of deciduous forest that will minimize visual intrusion from ground level for most other structures. To the extent the CWS cooling towers rise above the tree line, they generally would be visible yet consistent with the viewpoints of SSES. The BBNPP intake and discharge structures would be visible from the Susquehanna River, as they would be located along the shoreline near existing SSES structures. The BBNPP structures, other than the CWS cooling towers, would not be visible from the river due to the tree line along its eastern bank (Section 3.1 and Section 5.3.3.1).

The water vapor plume from the CWS cooling towers would also be noticeable, given the heights to which the plume might rise, especially during the winter months, as discussed in Section 5.3.3.1. The frequency of the plume direction, its height, and its extent would vary, depending on the season and wind direction. The average length of the plume is expected to range from 0.274 mi (0.440 km) in the summer to 0.615 mi (0.990 km) in the spring. The annual average plume length is estimated to be approximately 0.372 mi (0.559 km). The average plume height would range from 776 ft (236 m) during the summer to 961 ft (293 m) during the winter. As a result, potential visual intrusion from the plume would vary according to the viewpoint and season, yet would be consistent with existing site uses. Thus, the visual impact from the plumes from the CWS cooling towers due to operation of BBNPP to nearby residences and recreational areas is anticipated to be SMALL.

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5.8.1.6 Standards for Noise and Gaseous Pollutants

The noise levels will be controlled by compliance with regulatory requirements. For worker protection, the Occupational Safety and Health Administration (OSHA) noise-exposure limits identified in 29 CFR 1910.95 (CFR, 2007b) will be met. For residential areas, the EPA and HUD guidelines would be met.

Air emissions will be controlled by compliance with regulatory requirements, (CFR, 2007c), and where applicable, air emission permits for construction and operating equipment would be obtained and adhered to.

Air emissions sources not otherwise permitted will also be administratively controlled to comply with Occupational Safety and Health Standards. In particular, 29 CFR 1910.1000 (CFR, 2007a) places limits on certain vapors, dusts, and other air contaminants.

5.8.1.7 Proposed Methods to Reduce Visual, Noise and Other Pollutant Impacts

A traffic impact analysis (TIA) was completed and discussed in Section 4.4.1, which showed that the conditions during BBNPP operations would have no significant effect on the operating level of service along U.S. Highway 11. Thus, the impact from traffic from operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.

As discussed in Section 5.8.1.3 through Section 5.8.1.6, the impacts due to noise, air pollutants, and visual impacts are expected to be SMALL. Outdoor noise levels would comply with EPA and HUD guidelines and OSHA noise exposure limits for workers outside of the buildings. Excessive noise inside the buildings would require protective equipment to be worn by workers. Thus, the impact from noise to plant workers from operation of BBNPP is anticipated to be MODERATE inside the buildings requiring hearing protection, and SMALL outside of those buildings and inside other buildings that do not require hearing protection.

Air emissions would comply with the Commonwealth and Federal requirements through administration of applicable permits. The diesel generators would be required to meet the applicable emission limits in effect at the time of plant startup, with additional air pollution controls as required. OSHA standards would be adhered to for onsite exposure to vapors, dusts, and other air contaminants for workers. Thus, the impact from air emissions to plant workers from operation of BBNPP is anticipated to be MODERATE inside the buildings, requiring breathing apparatus, and SMALL outside of the buildings and inside other buildings that do not require breathing apparatus.

Thermal discharges would be controlled through the National Pollutant Discharge Elimination System (NPDES) permit process for plant discharges to surface waters including the Susquehanna River. Thus, the impact from thermal impacts from operation of BBNPP to the Susquehanna River is anticipated to be SMALL. The BBNPP intake and discharge structures would be visible from the Susquehanna River given their location adjacent to the SSES structures along the river bank. The BBNPP containment building and CWS cooling towers would be visible from certain locations within the viewshed but would be consistent with that of SSES Units 1 and 2. The plumes from the CWS cooling towers would be visible from these same vantage points. The impact of these visual intrusions, however are expected to be SMALL because the BBNPP site is already aesthetically altered by the presence of the existing SSES structures. As a result, no mitigation is required.

5.8.1.8 References

CFR, 2007a. Title 29, Code of Federal Regulations, Part 1910.1000, Air Contaminants, 2007.

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CFR, 2007b. Title 29, Code of Federal Regulations, Part 1910.95, Occupational Noise Exposure, 2007.

CFR, 2007c. Title 40, Code of Federal Regulations, Part 89.112, Oxides of Nitrogen, Carbon Monoxide, Hydrocarbon, and Particulate Matter Exhaust Emission Standards, 2007.

CFR, 2007d. Title 24, Code of Federal Regulations, Part 51, Subpart B Noise Abatement and Control, 2007.

PADEP, 2003. Implementation Guidance for Temperature Criteria, PA DEP ID# 391-2000-017. October 3, 1997 with minor changes made through December 18, 2003.

USEPA, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, PB 550/9-74-004.

5.8.2 SOCIAL AND ECONOMIC

This section describes the potential demographic, housing, employment and income, tax revenue generation, land value, and public facilities and services impacts of station operations. The comparative geographic area, for the evaluation of socioeconomic impacts extends in a 50 mi (80 km) radius from the proposed BBNPP. Luzerne County and Columbia County have been defined as the region of influence (ROI), because 87% of the existing SSES operational workforce resides there, and it is assumed that the operational workforce for BBNPP would also primarily reside in and impact this geographic area.

As shown in Table 5.8-2, it is estimated that a total of 363 employees would be added to the onsite workforce to operate BBNPP. An estimated 316 workers (87%) and their families (i.e., households) would likely reside in the ROI. In addition, an estimated 244 of the indirect jobs located in the ROI that would be created by the BBNPP operation would be filled by the spouses of the direct workforce. A total of 1,366 people would migrate into the ROI as a result of the operation of BBNPP, assuming a worst-case scenario that all indirect jobs would be filled by new in-migrants rather than by existing unemployed or underemployed residents, representing a 0.4% increase in the total of 383,401 people in the two counties in 2000. It is concluded that the impacts to population levels in the ROI would be SMALL, and would not require mitigation.

5.8.2.1 Demography

5.8.2.1.1 50 Mile (80 km) Comparative Geographic Area

The operational workforce would likely be hired from throughout the northeast United States, including major population centers in the vicinity of the study area such as: the Scranton, Pittsburgh, and Philadelphia, Pennsylvania areas; the New York City metropolitan area; and the Baltimore, Maryland and Washington, D.C. areas. Some of the operational workforce is likely to be drawn from the construction workforce, which would permanently move to the ROI. Because of the relatively small size of the BBNPP operational workforce, and the estimated population decrease in the ROI from 383,401 in 2000 to 378,034 in 2006 (5,367 or 1.4%), the changes in population within the 50 mi (80 km) comparative geographic area would be SMALL, and would not require mitigation (USCB, 2006a) (USCB, 2006b) (USCB, 2000c) (USCB, 2000d).

5.8.2.1.2 Two-County Region of Influence

As stated earlier, because 87% of the existing SSES operational workforce resides in Luzerne County (42.3%) and Columbia County (44.8%), it is assumed that the direct and indirect

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operational workforce for BBNPP would reflect the existing SSES employee demographic pattern and be permanent in-migrants primarily residing in and impacting this geographic area.

An additional workforce of up to 1,000 workers may be required for a 15-day period, once every 18 months, to support planned plant outages during refueling and other specialized tasks. This group likely would represent only temporary visitors to the area and would either commute on a weekly basis or for the duration of the tasks, and would reside in area hotels and motels. The scheduled outage for BBNPP would be planned around similar schedules for SSES, so that they do not overlap.

Because of the relatively small size of the BBNPP operational workforce, the changes in population within the ROI would be SMALL, and would not require mitigation.

5.8.2.2 Housing

The construction workforce would be significantly larger than the operational workforce (Section 4.4.2). Construction would be of sufficient duration that the housing and support services required during BBNPP operation would already be in place so that any incremental BBNPP operational impacts would be SMALL. Thus, the operational workforce would either rent or purchase existing homes in the ROI, or would purchase acreage on which to build new homes. Of the estimated 550 direct and indirect households migrating into the ROI as a result of operating BBNPP, assuming a worst-case scenario that all indirect jobs would be filled by new in-migrants rather than by existing unemployed or underemployed residents, it is estimated that 268 households (49%) would reside in Luzerne County and 284 (51%) would reside in Columbia County. The total number of housing units needed within the ROI would represent 3.3% of the total 16,817 vacant units located in the ROI in 2000 (USCB, 2000c) (USCB, 200d)

In addition, scheduling planned outages for BBNPP at times other than when they would occur for SSES Units 1 and 2 should minimize the impacts of the availability and cost for hotel/motel rooms and other short-term accommodations.

Thus, the overall ROI, and each county within it, have enough housing units available to meet the needs of the direct and indirect operational workforces. Because significantly more units are available than would be needed, the in-migrating workforces alone should not result in an increase in housing prices or rental rates. Thus, it is concluded that the impacts to area housing would be SMALL, and would not require mitigation.

5.8.2.3 Employment and Income

As stated earlier, it is estimated that a total of 363 direct employees would be added to the onsite workforce to operate BBNPP, and a maximum of 690 indirect job opportunities would be created in the state assuming a worst-case scenario that all indirect jobs would be filled by new in-migrants rather than by existing unemployed or underemployed residents. As stated above, of this total an estimated 316 direct workers (87%) and 601 indirect workers would reside within the Luzerne and Columbia County region of influence. The 917 direct and indirect ROI jobs would result in a noticeable, but SMALL, impact to the area economy, representing a 0.5% increase in the 151,869 total labor force in Luzerne County in 2000 and the 32,403 total labor force in Columbia County (USCB, 2000b).

It is estimated that PPL Bell Bend, LLC would spend $28 million annually on salaries (in 2005 dollars, an average of $77,135/year/worker for direct labor, excluding benefits). The BBNPP estimated average annual salary is significantly greater (over 47% more) than the $52,370 mean

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earnings in Luzerne County in 2006 (USCB, 2006a) and 59% more than the $48,437 mean earnings in Columbia County (USCB, 2006b). If income is distributed similar to the direct workforce in-migration pattern, Luzerne County would experience an estimated $11.8 million increase in annual income and Columbia County would receive an estimated $12.5 million annually.

Assuming that the indirect workforce would have annual salaries of $52,370 (based on the 2006 mean earnings in Luzerne County (USCB, 2006a), the 292 indirect workforce migrating into Luzerne County would generate over $15.3 million in income and the 309 indirect workforce migrating into Columbia County would generate $16.2 million in household income. This additional income would result in additional expenditures and economic activity in the ROI. However, it would represent a small percentage of overall total income in the ROI. Thus, it is concluded that the impacts to employment and income would be SMALL, and would not require mitigation (USCB, 2006a)

5.8.2.4 Tax Revenue Generation

5.8.2.4.1 50 Mile (80 km) Comparative Geographic Area

Additional state income taxes would be generated by the in-migrating residents, although the amount cannot be estimated because of the variability of investment income, retirement contributions, tax deductions taken, applicable tax brackets, and other factors. It is estimated that the 50 mi (80 km) radius and the Commonwealth would experience a $28 million increase in annual wages from the direct workforce and $36.1 million in indirect workforce wages ($52,370 annual salary multiplied by 690 total indirect jobs in Pennsylvania), for a total of $64.1 million. Relative to the existing total wages for the Commonwealth and 50 mi (80 km) radius area, it is concluded that the potential increase in Commonwealth income taxes represent a SMALL economic benefit.

Additional sales taxes also would be generated by the power plant and the in-migrating residents. It is estimated that PPL BBNPP, LLC would spend about $9 million annually (in 2005 dollars) on materials, equipment, and outside services (excluding costs for planned outages), which would generate additional Commonwealth sales and income taxes. The amount of increased sales tax revenues generated by the in-migrating residents would depend upon their retail purchasing patterns, but would only represent a SMALL benefit to this revenue stream for the Commonwealth and the 50 mi (80 km) radius area.

Overall, although all tax revenues generated by the BBNPP and the related workforce would be substantial in absolute dollars, as described above, they would be relatively small compared to the overall tax base in 50 mi (80 km) area and the Commonwealth of Pennsylvania. Thus, it is concluded that the overall beneficial impacts to Commonwealth tax revenues would be SMALL.

5.8.2.4.2 Two-CountyRegion of Influence

Starting in 2018, PPL Bell Bend, LLC, estimates that BBNPP will generate approximately $ [Proprietary Information - Withheld Under 10 CFR 2.390(a)(4) - See Part 9 of this COL Application] a year in real estate taxes (in 2008 dollars). When compared to the total real estate taxes paid by PPL Susquehanna, LLC, in 2008, i.e., approximately $4 million, this sum will represent a significant increase in revenues for Salem Township, the Berwick Area School District, and Luzerne Country. These increased real estate tax revenues would either provide additional revenues for existing public facility and service needs or for new needs generated by the power plant and associated workforce. The increased revenues could also help to maintain

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or reduce future taxes paid by existing non-project related businesses and residents, to the extent that project-related payments provide tax revenues that exceed the public facility and service needs created by BBNPP. It is concluded that these increased power plant real estate tax revenues would be a LARGE economic benefit to Salem Township and Luzerne County.

Additional local income taxes would be generated by the in-migrating residents, although the amount cannot be estimated because of the variability of investment income, retirement contributions, tax deductions taken, applicable tax brackets, and other factors. It is estimated that Luzerne County would experience an $11.8 million increase in annual wages from the direct workforce and $15.3 million in indirect workforce wages, for a total of $27.1 million. Columbia County would experience an estimated annual increase of $12.5 million from the direct workforce and $16.2 million in indirect workforce wages, for a total of $28.7 million. Relative to the existing total wages for the ROI, it is concluded that the potential increase in local income taxes represent a SMALL economic benefit to the jurisdictions.

Overall, although all tax revenues generated by the BBNPP and the related workforce would be substantial in absolute dollar terms as described above, they would be relatively small compared to the overall tax base in the ROI. Thus, it is concluded that the overall beneficial impacts to tax revenues would be SMALL.

5.8.2.5 Land Values

Studies have found varying impacts to residential and commercial land values for facilities that are visible and have greater perceived risks such as nuclear power plant sites, potentially less visible but also greater perceived risks of contaminated and brownfield sites, highly visible but lower perceived risk sites such as transmission lines, and for highly visible but low perceived human risk sites such as windfarm energy facilities.

Other studies of potential impacts to property values have had varied results, depending on the type of facility being studied, including facilities that are more visible and could have greater risks such as nuclear power plants, facilities that are potentially less visible but also have greater risks such as landfills and hazardous waste sites, and highly visible facilities but with potentially less perceived risk such as electrical transmission lines and windfarm facilities. For instance, a Maryland Department of Natural Resources (MDNR, 2006) study of the effects of large industrial facilities showed that residential property values were not adversely affected by their proximity to the Calvert Cliffs Nuclear Power Plant site. Overall, Maryland power plants have not been observed to have negative impacts on surrounding property values. Similarly, studies of the property value impacts of the Three Mile Island nuclear power plant accident showed that nearby residences were not significantly affected by the accident (Gamble, 1982) (RESI, 2004) (MDNR, 2006).

However, studies of the impacts to residential property values from low-level radioactive waste landfills in Ohio (Smolen, 1992), from leaks at a nuclear facility in Ohio (Miller,1992; as cited by Reichert, 1997), and along potential nuclear shipment routes in Nevada (UER, 2002) show that these facilities and activities have a negative impact on housing values within a limited distance from the facility, typically within 3 mi (4.8 km). Even within this limited distance, the impacts on property values decrease rather quickly as one gets farther from the facility.

Evaluations of potentially less visible but also perceived greater risk facilities such as hazardous waste and Superfund sites (e.g., underground storage tanks, existing and former manufacturing facilities, and so forth) generally show similar results. A study of underground storage tanks in Ohio showed that proximity to non-leaking or unregistered leaking tanks did not affect property values, but registered leaking tanks affected property values within 300 feet

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of the sites (Simons, 1997). Studies of Superfund sites in Ohio (Reichert, 1997), Texas (Kohlhase, 1991; as cited by Reichert, 1997) (Dale, 1997) (McCluskey, 1999), Pennsylvania (Erickson, 2001), and the southeastern U.S. (Ho and Hite, 2004) showed that property values were negatively affected by the facilities. The negative impacts were particularly noticeable during periods with significant media coverage and public concern, with the properties close to the facilities most affected. Again, the greater the distance from the facilities, the less the impacts on property values. Also, once there was a reduction in media attention and public concern, or after site cleanup, property values sometimes recovered from their losses. Similar results were found for landfills in Ohio (Hite, 2001; as cited by Ho and Hite, 2004) and Maryland (Thayer et al., 1992) (Hite, 2001; as cited by Ho, 2004) (Simons, 1997) (Reichert, 1997) (Kohlhase, 1991) (Dale, 1997) (McCluskey, 1999) (Erickson, 2001).

Electrical transmission lines and windfarm facilities can be highly visible but might have a smaller perceived risk to area residents than nuclear and hazardous waste facilities. Although three early studies (Blinder, 1979) (Brown, 1976) (Kinnard et al., 1984; as cited by Delaney and Timmons, 1992) found that tall electrical transmission lines did not affect nearby residential or agricultural property values, later studies (Colwell and Foley, 1979; as cited by Delaney and Timmons, 1992) showed that they did have a negative effect on property values. The most common reason given by one study was the visual impact of the transmission line, followed by the perceived health risk (Delaney, 1992). One study (Colwell, 1990) showed that over time the negative impacts to property values decreased, indicating a reduced concern about the facilities.

Studies of potential impacts to property values from windfarm facilities have had mixed results. A study of an existing windfarm in New York (Hoen, 2006) and a potential windfarm facility in Illinois (Poletti, 2007) showed that there was no impact to nearby residential property values. However, another study (Sterziner et al., 2003) of impacts at existing facilities showed that property values increased faster near the facilities than in control areas, likely because of the perception that they represented "green" benefits to the environment.

Overall, these studies show that the impacts of various types of facilities can have a negative impact on residential property values, typically within 1 to 3 mi (1.6 to 4.8 km) of a facility. However, they also show that the impacts might be less where other facilities already exist, and over time these negative impacts could decrease. Because there is an existing nuclear power plant next to the BBNPP site that has been there for a number of years; and the BBNPP will not be highly visible to area residents or recreational users, depending on their location, and will be located over a mile away from most residents; the impacts to land values likely would be minimal and not require mitigation. Thus, it is concluded that the impacts to land values would be SMALL, and would not require mitigation.

5.8.2.6 Public Facilities

As discussed in Section 4.4.2, the size of the construction workforce, the excess capacity of housing and public facilities in the ROI, and actions taken to meet unforeseen needs would result in enough public facility capacity to meet the smaller direct operational workforce needs. As discussed above, there is a sufficient quantity of vacant housing units in Luzerne County and Columbia County to meet the housing needs of the in-migrating direct and indirect operational workforces for BBNPP, so no new housing units would likely be required. Thus, water and sewage services would not be affected and would continue to be adequate to meet the needs of the workforces. Although an increase in the population would likely place additional demands on area transportation and recreational facilities, the facilities appear to have enough capacity to accommodate the increased demand and impacts would likely be SMALL. Area

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highways and roads would have increased traffic levels, particularly during shift changes at the BBNPP, resulting in a SMALL traffic impact.

5.8.2.6.1 Transportation

As indicated for the construction phase of BBNPP, any replacement heavy equipment and reactor components could be taken by railroad during plant operation and maintenance activities, thereby reducing potential regional highway/road impacts. These materials would then be transported from the railroad, on the BBNPP access road, to the site (Section 4.1.1).

As shown in Table 5.8-3, under the future without construction of BBNPP scenario, levels of service (LOS) would be “A” (i.e., the best level of service on a scale of A to F) for the intersection of Route 11 and Main Street and for the intersection of Route 11 and LaSalle Street. All other intersections analyzed would have LOS levels of “B.” Under the future build scenario with the BBNPP projected 363 operational workers, these service levels could be maintained by implementing mitigation that would only entail optimizing the signal timing plan at the Route 11 and Orange Street intersection (KLD, 2008). If this improvement was made prior to operation of the power plant, it would accommodate the commuting patterns of the BBNPP operational workforce. Thus, it is concluded that the impacts to transportation would be SMALL, and no additional mitigation would be required.

5.8.2.6.2 Area-Wide and Recreational Aesthetics

The BBNPP site is currently partly forested and partly cleared land. The BBNPP would be located primarily in the cleared area where many of the facilities, and particularly the tallest structures (e.g., the Reactor Building, vent stack, and the CWS cooling towers) would be visible from three adjacent residential properties about 1,400 feet (426 m) or more to the west and south at ground level. The tallest structures associated with construction of BBNPP include the Reactor Building that would rise about 204 ft (62 m) above grade, the vent stack that would rise 211 ft (64 m), and the two natural draft CWS cooling towers that would rise 475 ft (145 m) above grade.

BBNPP would be built west of SSES Units 1 and 2, at least 1,400 ft (426 m) from the nearest residential properties and 1.5 mi (2.5 km) west of the Susquehanna River shoreline. The tallest structures would include the Reactor Building that would rise about 204 ft (62 m) above grade, the vent stack that would rise 211 ft (64 m), and the two natural draft CWS cooling towers that would rise 475 ft (145 m) above grade. Thus, these structures would be visible from some locations, but the exterior finishes of the new plant buildings would be compatible in color and texture to those of the existing plant buildings. This would provide a consistent, overall appearance, architecturally integrating the two plants. Thus, the visual impacts of these structures to area residents and transportation facilities (e.g., U.S. Highway 11 providing access to the site and the elevated State Route 93 North located south/southwest of the site and across the Susquehanna River) would be SMALL, to the extent that those offsite facilities are used.

SSES Units 1 and 2 have cooling towers, so visible water vapor plumes are currently created. The plume generated by the BBNPP cooling towers would be visible to area residents, recreational users in the surrounding area, travelers along U.S. Highway 11, and to travelers along State Route 93 North, an elevated roadway located south/southwest of the BBNPP site across the Susquehanna River. It is estimated that the average plume length would range from 0.274 mi (0.440 km) in the summer to 0.615 mi (0.990 km) in the winter, and its average height would range from 776 ft (236 m) in the summer to 961 ft (293 m) in the winter. Thus, the plumes

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would not introduce a new element to the visual landscape, so the additional visual impacts from BBNPP would be SMALL.

Because only existing off-site transmission corridors, or proposed transmission corridors that are unrelated to the project's construction, would be used to accommodate the increased generation from BBNPP, no new off-site transmission lines would be built to service the plant and only new, short on-site interconnections or line relocations would be required.

Because no new housing units or developments would likely be built to meet BBNPP operational workforce needs, there would be no visual impacts to existing residents or users in the ROI from these facilities.

Because of the minimal visual impacts of the BBNPP structures, access roads, water intake, outfall, transmission lines, and the water vapor plumes, it is concluded that the impacts to area-wide and recreational aesthetics would be SMALL, and would not require mitigation.

5.8.2.7 Public Services

An increase in population levels from the BBNPP operational workforces would not likely place additional demands on area doctors and hospitals, police services, fire suppression and EMS services, and schools because the area has experienced a 1.4% population decline from 2000 to 2006. As shown in Section 2.5.1, population levels in the ROI without the BBNPP project are estimated to decline by 11,928 people from 2000 to 2010, and another 6,727 people from 2010 to 2020, thus somewhat reducing the need for public services. This loss of population would be offset somewhat by the potential total direct and indirect in-migration of 1,366 people into the ROI for operation of BBNPP. Also, because the addition of BBNPP-related population is so much less than the general projected out-migration of population, there should still be an overall reduced need for public services. Thus, these services should have enough capacity to accommodate the increased demand and impacts would likely be SMALL.

5.8.2.7.1 Police, EMS, and Fire Suppression Services

As described in Section 2.5.2 and Section 4.4.2, Luzerne County and Columbia County have large volunteer fire departments that are meeting the needs of their respective residents. Because additional needs would be met during the construction phase of the power plant, no additional police, EMS or fire suppression services would likely be required for the operational phase, the impact would be SMALL, and no mitigation would be required.

A Salem Township Volunteer Fire Company representative suggested that an increased number of calls would be anticipated, but additional equipment and personnel are needed regardless of the operation of the new facility. In addition, a Berwick Fire Department representative suggested the need for specialized equipment for the rescue operations, such as confined space entry or high rope rescue materials. However, these fire and emergency response departments would be supplemented by a BBNPP onsite emergency response team, which would include a fire brigade. The BBNPP staff would also include an onsite emergency response team and emergency medical technician (EMT) responders. An emergency management plan would be developed for BBNPP, similar to that which already existing for SSES Units 1 and 2. The plan would address PPL Bell Bend, LLC and agency responsibilities, reporting procedures, actions to be taken, and other items should an emergency occur at BBNPP.

For additional unforeseen service needs that might arise, as described in Section 5.8.2.4 above, the significant new tax revenues generated in Luzerne County by operation of BBNPP would

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provide additional funding to expand or improve services and equipment to meet the additional daily demands created by the plant. Columbia County would also experience increased revenues from operation of the power plant, but to a much lesser extent. Detailed discussions about non-radiological accidents can be found in Section 5.12.2 and radiological impacts are discussed in Section 5.4 and Section 7.0. Thus, it is concluded that there would be a SMALL impact on some fire and law enforcement departments, and no mitigation would be required.

5.8.2.7.2 Educational System

As described above, an estimated 268 new households would migrate into Luzerne County as a result of the operation of BBNPP with an estimated 130 mostly school-aged children (assuming 0.48 children per household). This would represent a 0.3% increase in the 2005-2006 student enrollment of 42,000 in Luzerne County. In 2018, PPL Bell Bend, LLC estimates that BBNPP will pay the Berwick School District approximately $ [Proprietary Information - Withheld Under 10 CFR 2.390(a)(4) - See Part 9 of this COL Application] a year. When compared to the taxes paid to the Berwick Area School District by PPL Susquehanna, LLC, in 2008, i.e., approximately $2.8 million, this sum will represent a significant increase in funds available to meet the educational needs for children in the in-migrating operational work force. Thus, it is concluded that the impacts to the Luzerne County Public School System would be SMALL, and would not require mitigation.

The in-migration of an estimated 284 new households into Columbia County, with an estimated 135 children, as a result of the operation of the BBNPP would similarly place greater demands on the County educational system. This would represent a 1.3% increase in the 2005-2006 student enrollment of 10,800 in Columbia County. Although the school district could receive some additional funding from property taxes generated by these new households (likely to be minimal because adequate housing units are already available in the county and those units are already being taxed), it would not receive additional funding directly from the power plant, because BBNPP does not pay property taxes to Columbia County. Because the number of in-migrating operational households is small, and the educational system already would likely have been expanded to meet the in-migrating construction workforce needs, the impacts of the power plant on the Columbia County School District would likely be SMALL and would not require mitigation.

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5.8.3 ENVIRONMENTAL JUSTICE IMPACTS

This section describes the potential disproportionate adverse socioeconomic, cultural, environmental, and other impacts that operation of BBNPP could have on low-income and

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minority populations within two geographic areas. The first geographic area is a 50 mi (80 km) radius, where there is a potential for disproportionate employment, income, and radiological impacts, compared to the general population (NRC, 1999). This analysis also evaluates potential impacts within the region of influence (ROI), most of which is encompassed within a 20 mi (32 km) radius of the power plant site, where more localized potential additional impacts could occur to housing, employment, aesthetics, recreation, and other resources, compared to the general population. It also highlights the degree to which each of these populations would disproportionately benefit from operation of the proposed power plant, again compared to the entire population.

Section 2.5.1 provides details about the general population characteristics of the study area and Section 2.5.4 provides details about the number and locations of minority and low-income populations within a 50 mi (80 km) radius of the BBNPP site, and subsistence uses. Potential radiological impacts to the general public are described in Section 5.4 and Section 7.1.

5.8.3.1 50 Mile (80 km) Comparative Geographic Area

As stated in Section 2.5.1 and Section 2.5.4, the greatest concentrations of minority populations within the comparative geographic area, but outside of the ROI, primarily reside toward the edges of the 50 mi (80 km) radius (Section 2.5.4) in: Lehigh County, which is located southeast of the BBNPP site with 54 aggregate minority census block groups; Lycoming County, which is located west-northwest of the site with 8 aggregate groups; Lackawanna County, which is located northeast of the site with 6 aggregate groups; and Monroe County, which is located east of the site with 6 aggregate groups. Similarly, the greatest concentrations of low-income populations are located in: Lehigh County with 13 census block groups; Lycoming County with 9 census block groups; Monroe County with 9 census block groups; Lackawanna County with 6 census block groups; and Northumberland County, which is located southwest of the BBNPP site with 5 census block groups (Section 2.5.4). Thus, because of the distances from the BBNPP site, there are no unique minority or low-income populations within the comparative environmental impact area that would likely be disproportionately adversely impacted by operation of the power plant, because they reside outside of the area where environmental impacts (e.g., noise, air quality, water quality, changes in habitat, aesthetic, etc.) would likely occur.

However, that proportion of low-income and minority operational workers from the comparative geographic area that are currently employed, but would be willing to move or commute to the power plant site, could realize increased income levels. Because there would not be disproportionate direct physical impacts to minority and low-income populations, and some might benefit from increased employment opportunities and income levels, the impacts would be SMALL and would not require mitigation.

5.8.3.2 Two-County Region of Influence

5.8.3.2.1 Employment and Income

As described in Section 5.8.2, there would be an estimated 363-person workforce operating the BBNPP power plant from 2018 to 2058. An estimated 154 workers (42.3%) would reside in Luzerne County and 163 (44.8%) would reside in Columbia County. In addition, as described in Section 5.8.2, 601 indirect job opportunities (using a ROI-only multiplier of 1.9011) would be created in the ROI in support of the direct workforce. Minority and low-income residents of these census block groups might benefit from employment at BBNPP, to the extent that they are currently unemployed or underemployed, and to the extent that they have the skills required to fill the operational workforce positions. This beneficial impact is likely to be SMALL,

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would not be disproportionate compared to the general population, and would not require mitigation.

As discussed in Section 5.8.2, it is estimated that PPL Bell Bend, LLC would spend $28 million annually in salaries (an average of $77,135/year/worker for direct labor, excluding benefits). The BBNPP estimated average annual salary is 47% greater than the mean earnings of $52,370 in Luzerne County in 2006 (USCB, 2006a) and 59% more than the $48,437 in mean earnings in Columbia County in 2006 (USCB, 2006b). Again, minority and low income residents might benefit from employment at BBNPP, to the extent that they can switch from lower paying to higher paying jobs. Given the small number of higher paying jobs created, the beneficial impacts for low-income and minority populations would be SMALL, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.2.2 Housing

As described in Section 2.5.2 and Section 5.8.2, there are far more vacant housing units available in the ROI (a total of 20,796 or 11.8% in 2006, of which 16,390 or 9.3% are year-around units (USBC, 2006c) (USBC, 2006d) than would be needed to house the direct and indirect operational workforces for BBNPP. Also, because significantly more units are available than would be needed, the in-migrating direct and indirect workforces alone should not result in an increase in housing prices or rental rates.

In addition, scheduling planned outages with as many as 1,000 additional staff for BBNPP every 18 months, at times other than when they would occur for SSES Units 1 and 2, should minimize the impacts of the availability and cost for hotel/motel rooms and other short-term accommodations (Section 5.8.2). Again, as indicated in Section 2.5.2, there were 49 hotels, motels, and bed and breakfast facilities with almost 2,300 units in Luzerne County in 2008, 47 facilities with about 1,300 units available in Columbia County, and numerous other facilities were available outside of the ROI, but within a reasonable commuting distance. Thus, BBNPP should not affect the availability or cost of housing for low-income and minority populations. Because the operational workforce would not require significant amounts of vacant housing or hotel/motel rooms and, thus, would not affect housing or rental prices, the power plant would have a SMALL impact on housing, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.2.3 Tax Revenues

Starting in 2018, PPL Bell Bend, LLC, estimates that BBNPP will generate approximately $ [Proprietary Information - Withheld Under 10 CFR 2.390(a)(4) - See Part 9 of this COL Application] a year in real estate taxes (in 2008 dollars). When compared to the total real estate taxes paid by PPL Susquehanna, LLC, in 2008, i.e., approximately $4 million, this sum will represent a significant increase in revenues for Salem Township, the Berwick Area School District, and Luzerne Country.

PPL Bell Bend, LLC also would spend about $9 million annually on materials, equipment, and outside services (excluding costs for planned outages), which would generate additional sales taxes for the Commonwealth of Pennsylvania (Section 5.8.2).

The BBNPP operational workforce would generate increased income tax, sales tax, and property tax revenues where they live and where they spend their incomes. Low-income and minority populations might benefit somewhat from these increased tax revenues, either because they might help to avoid some future tax increases or they might fund improvements to, or the creation of, new public facilities or services. However, the benefits of these additional

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tax revenues, facilities, or services would be SMALL, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.2.4 Subsistence

Existing or traditional subsistence harvesting activities would not likely be affected by the operation of BBNPP, because these activities do not occur directly on the BBNPP site. Also, BBNPP would not likely affect the surrounding environment where subsistence and other harvesting activities might occur, and thus should not affect harvest rates. Thus, impacts to subsistence uses would be SMALL, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.2.5 Transportation

The BBNPP operations will have no effect on the currently available modes of transportation provided for low income or minority populations, including public transport and personal cars. Impacts to roads from the additional construction or operations workforce have been discussed in Section 4.4.1.5 and Section 5.8.2.6.1. Impacts from the 363 new workers on the roads are SMALL and are limited to the area in the direct vicinity of BBNPP site, which is approximately 5 mi (8 km) or more from the closest minority or low income census tract. Thus, impacts to minority or low income groups would be SMALL, would not be disproportionate compared to the general population, and would not require mitigation.

5.8.3.3 References

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Table 5.8-1—Estimated Cooling Tower Sound in A-weighted Levels at Seven Community Receptors

Location	Estimated Cooling Tower LAeq	Leak-Off Ambient LA50	Leak-On Ambient LA50	Leak-On Ambient LAeq	Leaf-On Ambient LAeq
1 (onsite)	52	NA	NA	NA	NA
2	34	33	34	35	36
3	33	33	34	36	38
4	40	33	31	36	35
5	33	39	37	53	41

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Table 5.8-2—Estimates of In-Migrating Operational Workforces in Luzerne County and Columbia County, from 2018 to 2058

In-migration Characteristics	Luzerne County	Columbia County	Total ROI
Direct Workforce:			
Maximum Direct Workforce			363
Percent of Current SSES Units 1 and 2 Workforce Distribution	42.3%	44.8%	87.1%
Estimated In-migrating Direct Workforce	154	163	316
In-migrating Direct Workforce Population (@2.48 people/ household)	381	403	784
Indirect Workforce:			
Estimated Distribution of Peak Direct Workforce	154	163	316
Peak Indirect Workforce (@1.9011 multiplier)	292	309	601
Indirect Workforce Needs Met by Direct Workforce Spouses/Others (@52.2% working females 16 years old and older)	119	126	244
Remaining, Unmet Indirect Workforce Need	173	184	357
Number of Indirect Households Meeting Unmet Need (@ 1.522 Workers/Household)	114	121	234
In-migrating Indirect Workforce Population (@2.48 people / household)	282	299	581
Total In-migrating Direct and Indirect Workforce People:	663	702	1,366

Notes:

Maximum direct operational workforce estimates were provided by UniStar (2006).

The BEA estimated an operational multiplier of 1.9011 for the two county ROI.

U.S. Census Bureau (USCB, 2000a) census data indicates that the Commonwealth of Pennsylvania had 2.48 people per household.

U.S. Census Bureau (USCB, 2000b) census data indicates that, within the Commonwealth of Pennsylvania, 52.2% of households had a working female 16 years old or older (assumed to be a spouse for this analysis).

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Table 5.8-3—Intersection LOS: Future Build Conditions

Intersection	Type	Future No-Build		Future Build	
		AM	PM	AM	PM
RT11 & Union Street	Signalized	B	B	B	B
RT11 & Main Street	Signalized	A	A	A	A
RT11 & PPL	Unsignalized	B	B	B	B
RT11 & Bell Bend Entrance	Unsignalized			B	B
2nd Street & Market Street	Signalized	B	B	B	B
Front Street & Market Street	Signalized	B	B	B	B
RT11 & LaSalle Street	Signalized	A	A	A	A
RT11 & Orange Street	Signalized	B	B	B	B
RT11 & Poplar Avenue	Signalized	B	B	B	B

Notes:
A = Free Flow
B = Resonably Free Flow
C = Stable Flow
D = Approaching Unstable Flow
E = Unstable Flow
F = Forced or Breakdown Flow

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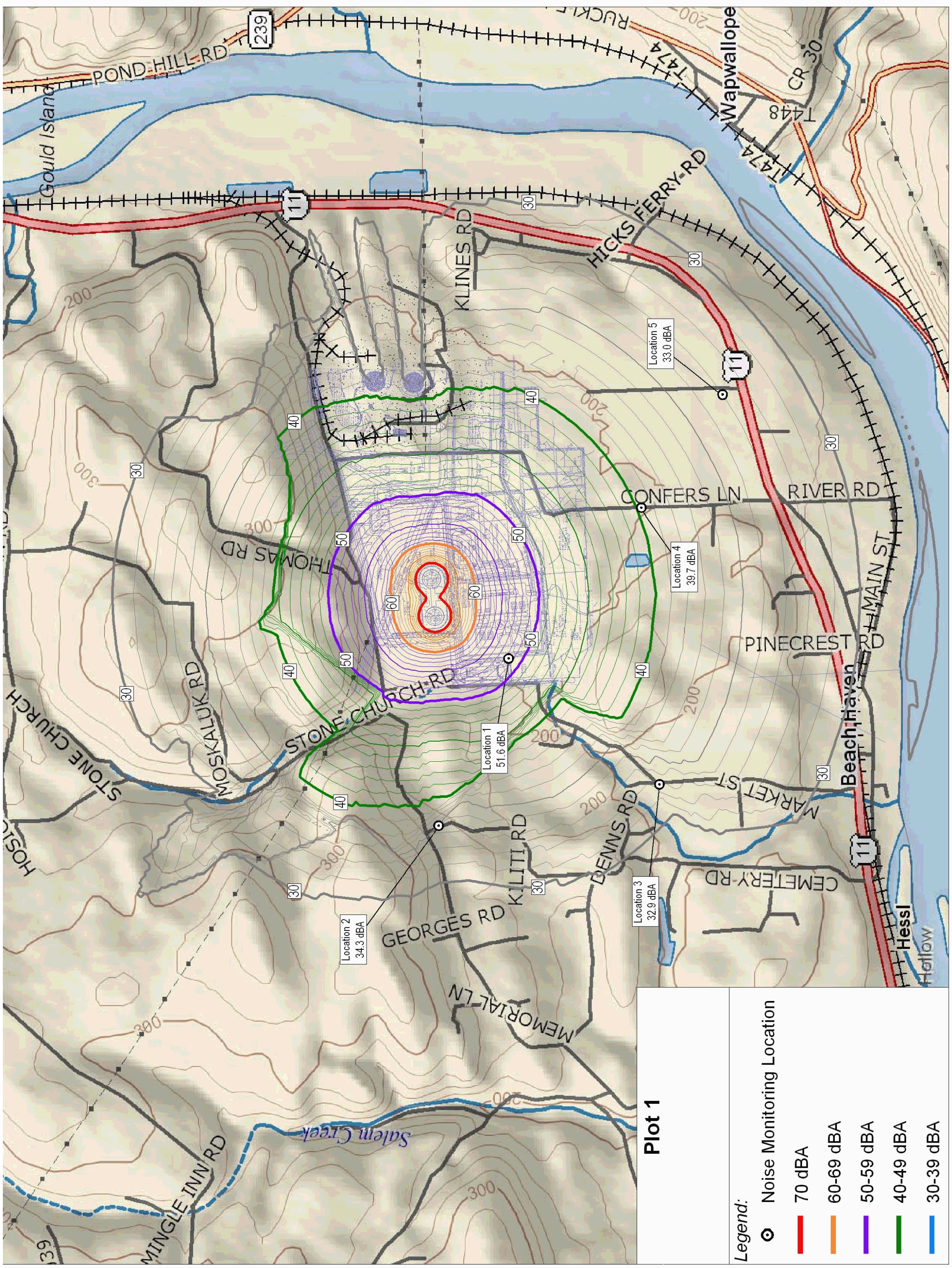
Figure 5.8-1—Predicted Sound Contours (dBA) of the Cooling Towers During BBNPP Operation



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5.9 DECOMMISSIONING

5.9.1 NRC GENERIC ENVIRONMENTAL IMPACT STATEMENT REGARDING DECOMMISSIONING

As indicated in Appendix A of Section 5.9 of NUREG-1555 (NRC, 2000), studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those considered in the Final Generic Environmental Impact statement (GEIS) on Decommissioning (NRC, 2002). The GEIS evaluates the environmental impact of the following three decommissioning methods:

- DECON - The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

- SAFSTOR - The facility is placed in a safe stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel has been removed from the reactor vessel and radioactive liquids have been drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement.

- ENTOMB - This alternative involves encasing radioactive structures, systems, and components in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

NRC regulations do not require a COL applicant to select one of these decommissioning alternatives or to prepare definite plans for decommissioning. These plans are required by 10 CFR 50.82 (CFR, 2007a) after a decision has been made to cease operations. Therefore, general decommissioning environmental impacts are summarized in this section, since detailed plans or a selection of alternatives is not required for a COL applicant.

Decommissioning of a nuclear facility that has reached the end of its useful life has a positive environmental impact. The major environmental impact, regardless of the specific decommissioning option selected, is the commitment of small amounts of land for waste burial in exchange for the potential re-use of the land where the facility is located.

Radiological doses during decommissioning with appropriate work procedures, shielding, and other occupational dose control measures (e.g., remote controlled equipment) similar to those used during plant operation will be controlled. To date, experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance when it is operational. While each potential decommissioning alternative would have radiological impacts from the transport of materials to their disposal sites, the expected impact from this transportation activity would not be significantly different from normal operations.

5.9.2 DECOMMISSIONING COST ANALYSIS SUMMARY

While NRC regulations do not require the applicant to submit detailed decommissioning plans (e.g., no detailed analysis of decommissioning is necessary), COL applicants, in accordance with 10 CFR 52.77 (CFR, 2007b), must include as part of their application a report containing a certification that financial assurance for decommissioning will be provided in an amount that may be more, but not less, than the amount stated in the table in 10 CFR 50.75 (CFR, 2007c)

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paragraph (c)(1). Based on this decommissioning funding report, financial assurance, using a parent guarantee, will be provided in the amount of $398.6 million (2008 $) consistent with the minimum funding amount established by 10 CFR 50.75 (CFR, 2007c) paragraph (c) and NUREG-1307 (NRC, 2007). This financial assurance will be provided via an acceptable instrument in accordance with 10 CFR 50.75 (CFR, 2007c) paragraph (e) and the guidance provided in Regulatory Guide 1.159 (NRC, 2003). The decommissioning funding report for BBNPP is provided in Part 1, "General Information" of this COL application.

5.9.3 REFERENCES

CFR, 2007a. Title 10, Code of Federal Regulations, Part 50.82, Termination of License, 2007.

CFR, 2007b. Title 10, Code of Federal Regulations, Part 52.77, Contents of Applications; General Information, 2007.

CFR, 2007c. Title 10, Code of Federal Regulations, Part 50.75, Reporting and Recordkeeping for Decommissioning Planning, 2007.

NRC, 2000. Standard Review Plans for Environmental Reviews for Nuclear Power Plants, NUREG-1555, U.S. Nuclear Regulatory Commission, March, 2000.

NRC, 2002. Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, NUREG-0586, U.S. Nuclear Regulatory Commission, 1988 and Supplement 1, November 2002.

NRC, 2003. Assuring the Availability of Funds for Decommissioning Nuclear Reactors, Regulatory Guide 1.159, Revision 1, Nuclear Regulatory Commission, October, 2003.

NRC, 2007. Report on Waste Burial Charges, NUREG-1307, Rev. 12, Nuclear Regulatory Commission, NMSS, February, 2007.

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5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION

This section summarizes the measures and controls to be implemented during the operation of BBNPP to limit potential adverse impacts.

5.10.1 IMPACTS DURING OPERATION

In general, potential impacts will be mitigated through compliance with applicable Federal, Pennsylvania, and local laws and regulations enacted to prevent or minimize adverse environmental impacts that may be encountered such as air emissions, noise, storm water pollutants, and spills. Principal among these will be the NPDES Permit to protect water quality and compliance with 10 CFR Parts 50, Appendix I, (CFR, 2007a), 10 CFR 51.52(b) (CFR, 2007b) and 40 CFR Part 190 (CFR, 2007c) to minimize radiation. Also included will be required plans such as a Storm Water Pollution Prevention Plan (SWPPP) and associated Best Management Practices (BMPs) to minimize sediment erosion as well as administrative actions such as a site Resource Management Plan. ER Section 1.3 lists the various applicable Federal, Pennsylvania, and local laws, regulations, and permits.

Table 5.10-1 lists the potential impacts associated with the operation of BBNPP described in Sections 5.1 through 5.9 as well as Sections 5.11 and 5.12. The table identifies, from the categories listed below, which adverse impact may occur as a result of operation and its relative significance rating (i.e., [S]mall, [M]oderate, or [L]arge) following implementation of associated measures and controls. NUREG-1437, Supplemnt 37 (NRC, 2008) wasalso used to evaluate potential impacts. Table 5.10-1 also includes a brief description, by section, of each potential impact and the measures and controls to mitigate the impact, if needed.

- Erosion and Sedimentation
- Air Quality (dust, air pollutants)
- Wastes (effluents, spills, material handling)
- Surface Water
- Ground water
- Land Use
- Water Use and Quality
- Terrestrial Ecosystems
- Aquatic Ecosystems
- Socioeconomic
- Aesthetics
- Noise
- Traffic
- Radiation Exposure

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- Other (site specific)

Based on existing site conditions, SSES Units 1 and 2 programs and procedures, proposed measures and controls, the potential adverse impacts identified from the operation of BBNPP are anticipated to be SMALL for all categories evaluated.

5.10.2 REFERENCES

CFR, 2007a. Title 10, Code of Federal Regulations, Part 50, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, 2007.

CFR, 2007b. Title 10, Code of Federal Regulations, Part 51.52, Environmental Effects of Transportation of Fuel and Waste-Table S-4, 2007.

CFR 2007c. Title 40, Code of Federal Regulations, Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations, 2007.

NRC, 2008. Generic Environmental Impact Statement for License Renewal of Nuclear Plants Regarding Susquehanna Steam Electric Station, Units 1 and 2 (NUREG-1437, Supplement 37) Draft Report for Comment, April 2008.

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation

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ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
5.1 Land Use Impacts	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
						S		S	S						S	
5.1.1 The Site and Vicinity	Presence of new permanent structures. (L) (TE) (AE) (O)															BBNPP footprint would be wholly contained on a dedicated nuclear power plant site; onsite land is not used for farmland nor is it considered prime or unique.
	Solids deposition from cooling tower drift. (TE) (AE)															Solids deposition (assumed as salt) rates below NUREG-1555 significance level, with drift eliminator in place.
	Release of fuel, oils, or other chemicals. (L)															Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan
	Regional land use increase due to settlement of new workforce in region. (AE)															Settlement of the new work force in the region is expected to be SMALL.
5.1.2 Transmission Corridors and Offsite Areas	No new offsite transmission lines or rights-of-way disturbance (the existing/independently planned transmission lines have sufficient capacity to carry the total output of existing SSES Units 1 and 2, as well as new BBNPP). (L)															Continue existing transmission corridor maintenance policies and practices to protect terrestrial and aquatic ecosystems.
	New onsite transmission facilities. (L) (TE)															Continue existing onsite transmission maintenance policies and practices and use site Resource Management Plan and Best Management Practices (BMPs) to protect and mitigate resources such as forested wetlands in the vicinity to the extent practicable.

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation

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ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
5.1.3 Historic Properties and Cultural Resources	Disturbance of potentially eligible archaeological resources for National Register of Historic Places listing. (L)															Based on the Phase 1a assessments and review of applicable State and Federal databases, adverse impacts to historic or cultural resources from operations are unlikely given efforts to identify potential onsite resources and the development of measures to limit impacts during operational maintenance activities.-Complete Phase 1b Cultural Resource Survey Report and receive State Historic Preservation Office (SHPO) consutation in order to identify measures to avoid, minimize, or mitigate any adverse effects.
5.2 Water-Related Impacts	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
	S			S	S		S		S							
5.2.1 Hydrologic Alterations and Plant Water Supply	Storm water runoff from onsite buildings, utilities, and roads. (ES) (SW) (W) (AE)															Implement Storm Water Pollution Prevention Plan (SWPPP), including erosion and sediment plan, as part of the National Pollutant Discharge Elimination System (NPDES) permit requirements.
	River water withdrawal for closed-loop Circulating Water System. (SW) (W) (AE)															Evaluate Clean Water Act 316(b) rule applicability. Install Best Available Technology (BAT) intake design.
	Ground water withdrawal impact. (GW)															Ground water withdrawals will not be used to support operation of BBNPP. Use offsite water supply, as needed.
	Disturbance of wetlands and surface water systems in vicinity. (ES) (SW) (AE)															Use site Resource Management Plan and BMPs to protect resources such as wetlands and surface water systems in vicinity.
	Periodic maintenance dredging. (SW) (W) (AE)															Obtain individual Corps of Engineers 404 Permit; comply with BMP and Pennsylvania requirements.

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.2.2 Water-Use Impacts	Reduced navigational or recreational use. (W) (AE)	No effect on fisheries, navigation, or recreational use in the Susquehanna River is expected.
	River water withdrawal and consumptive use for closed-loop Circulating Water System. (SW) (W)	Comply with Susquehanna River Basin Commission requirements.
	Reduction in available pervious (infiltration) areas. (SW) (GW)	Implement SWPPP, including erosion and sediment plan, as part of the NPDES permit requirements.
	Disturbance of wetlands and surface water systems in vicinity. (ES) (SW) (AE)	Use site Resource Management Plan and BMPs to protect resources such as wetlands and surface water systems in vicinity.
	Ground water withdrawal impact. (GW)	Ground water withdrawals will not be used to support operation of BBNPP. Use offsite water supply, as needed.
5.2.3 Water Quality Impacts	Effluent releases from plant and cooling tower to the Susquehanna River. (SW) (W) (AE)	Obtain Pennsylvania Department of Environmental Protection (PADEP)-issued NPDES permit and comply with applicable state water quality standards.
	Onsite erosion and sediment build up. (ES)	Implement SWPPP, including erosion and sediment plan, as part of the NPDES permit requirements.
	Temporary increase in turbidity and silt from periodic dredging. (SW) (W) (AE)	Obtain individual Corps of Engineers 404 Permit; comply with BMP and Pennsylvania requirements.
	Release of fuel, oils, or other chemicals. (SW) (GW)	Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.
5.3 Cooling System Impacts	Erosion/Sediment (ES): S Air Quality (AQ): S Wastes (WS): Surface Water SW): S Ground water (GW): Land Use (L): Water Use & Quality (W): Terrestrial Ecosystems (TE): S Aquatic Ecosystems (AE): S Socioeconomic (S): Aesthetics (A): S Noise (N): S Traffic (T): Radiation Exposure (R): Other (site specific) (O):	
5.3.1 Intake System		

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.3.1.1 Hydrodynamic Descriptions and Physical Impacts	Alteration of Susquehanna River hydrology. (GW)	Water withdrawal for BBNPP is comparable to SSES Units 1 and 2. Water withdrawal is not expected to significantly alter the flow pattern of the Susquehanna River as it travels past the intake.
	Sediment deposition increase. (AE) (ES)	Low intake velocity design. Perform periodic dredging, as needed.
5.3.1.2 Aquatic Ecosystems	Entrainment increase. (AE)	Perform 316(b) evaluation. Conduct entrainment impact study. Use BAT (Best Available Technology) intake design.
	Impingement increase. (AE)	Water withdrawal comparable to SSES Units 1 and 2; hence, the resultant impacts are expected to be comparable. CWS Makeup Water Intake Structure design incorporates features to reduce impingement SSES fisheries studies suggest no adverse effect to fisheries population. Conduct impingement impact study.
5.3.2 Discharge System		
5.3.2.1 Thermal Description and Physical Impacts	Ambient temperature increase. (AE)	Use closed-cycle system, incorporating a subsurface, multi-port diffuser. Thermal modeling results demonstrate that the thermal plume will meet comply with Pennsylvania Water Quality Standards (Pa. Code, Chapter 93, § 93.9k) for Warm Water Fishes (WWF) for thermal compliance criteria.

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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.3.2.2 Aquatic Ecosystems	Attraction of fish to thermal plume. (AE)	All effects studied extensively at SSES Units 1 and 2, which collectively demonstrate the absence of harm due to present plant operation.
	Heat shock. (AE)	Thermal modeling results show a very small area exposed to elevated temperatures, which is expected to have minimum, if any, impact.
	Blockage to migration. (AE)	Thermal modeling results show a very small area exposed to elevated temperatures, which is expected to have minimum, if any, impact.
	Chemical effects of biocides. (AE)	Discharge concentrations of these constituents will be limited by the NPDES permit issued by the PADEP. Chemical effects of the BBNPP discharge to the aquatic biota will be minimal.
	Turbulence from diffuser jets. (AE) (SW)	The action of the jets quickly mixes the heated water and limits the potential for fishes to be attracted to the area. The turbulence will not harm aquatic organisms.
	Changes to benthic species composition. (AE)	No loss or alteration of unique habitat is expected or reduction in density, species composition, or community structure of the aquatic community.
5.3.3 Heat-Discharge System		
5.3.3.1 Heat Dissipation to the Atmosphere	Visible cooling tower plume. (AQ) (A)	Seasonal/Annual Cooling Tower Impacts (SACTI) modeling results show plumes occur in all directions, whose lengths and heights vary seasonally, but judged to have small impact and not require mitigation.
	Increase in ground-level fogging and icing. (AQ)	SACTI cooling tower modeling results show that no fogging and icing would occur for the BBNPP natural draft cooling towers.
	Solids deposition from cooling tower drift. (TE) (A)	SACTI cooling tower modeling results show solids deposition (assumed as salt) rates below NUREG-1555 significance level, with a drift eliminator in place.
	Plume (cloud) shadowing, humidity, and precipitation. (AQ) (A)	SACTI cooling tower modeling results show cloud shadowing and humidity impacts are small. Precipitation increases do not occur.
	Noise generated from cooling towers. (N)	Noise levels from CWS and ESWS cooling towers are expected to be below both the EPA and HUD acceptable outdoor guideline of 55 dBA.

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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.3.3.2 Terrestrial Ecosystems	Plant community (vegetation and trees) disturbance due to. -fogging, high humidity, and icing, -solids deposition (assumed as salt). (TE)	Natural vegetation is already adapted to frequent fogging, high humidity, and icing.
		Vegetation damage from drift-based salt deposition originating from natural draft cooling towers has been shown to be minor.
		Impacts of salt drift on terrestrial ecology would be small, and would not warrant mitigation; similarly, potential impacts from slight increases in ground level humidity and from infrequent icing events are small and do not require mitigation.
	Noise from human and vehicular activity; noise from cooling tower operation. (N)	Potential adverse impacts to terrestrial wildlife caused by cooling tower noise is expected to be small and not require mitigation.
	Avian collisions with man-made structures. (TE) (A)	Strobe lights installed on cooling towers expected to reduce the possibility of collision by eagles or raptors migrating along the Susquehanna River corridor and minimize attraction of nocturnal migrating birds.
5.3.4 Impacts to Members of the Public	Release of thermophilic bacteria from within the cooling system. (AE)	Biocide treatment of makeup water prior to entering the cooling towers should minimize the propagation of micro-organisms. As a result, pathogenic thermophilic organisms are not expected to propagate within the BBNPP condenser cooling tower system and should not create a public health issue.
	Noise from cooling tower operation. (N)	Computer modeled noise contours show noise at the owner controlled area boundary is between 40 and 50 dBA (Section 5.8.1). There are two residences within th e50dBA contour. The levels from the ESWS cooling tower at the nearest residence, approximately 900 ft (274 m) away, are less than 54 dBA. The noise levels from operation of the CWS and ESWS coling towers are less than the EPA and HUD aceptable outdoor guideline at the nearest residence.

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ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
5.4 Radiological Impacts of Normal Operation	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
		S		S	S			S	S					S		
5.4.1 Exposure Pathways	Liquid and gaseous pathway. (AQ) (TE) (AE) (R) (SW) (GW)															Calculated doses for all exposure pathways less than guidelines established in 10 CFR Part 50, Appendix I, and regulatory limits set in 40 CFR Part 190.
																Comply with requirements and design to maintain dose ALARA. Implement radiological monitoring program, including ground water.
	Direct radiation. (TE) (R)															Calculated doses for all exposure pathways less than guidelines established in 40 CFR Part 190.
																Comply with requirements and design to maintain dose ALARA. Implement radiological monitoring program.
5.4.2 Radiation Doses to Members of the Public	Liquid and gaseous pathway. (AQ) (R) (SW) (GW)															Calculated doses for all exposure pathways are less than guidelines established in 10 CFR Part 50, Appendix I, and regulatory limits set in 40 CFR Part 190.
																Comply with requirements and design to maintain dose ALARA. Implement radiological monitoring program.
	Direct radiation. (R)															Calculated doses for all exposure pathways less than guidelines established in 40 CFR Part 190.
																Comply with requirements and design to maintain dose ALARA. Implement radiological monitoring program.

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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.4.3 Impacts to Members of the Public	Liquid and gaseous pathway. (AQ) (R) (SW) (GW)	Calculated doses for all exposure pathways less than guidelines established in 10 CFR Part 50, Appendix I, and regulatory limits set in 40 CFR Part 190.
		Comply with requirements and design to maintain dose ALARA. Implement radiological monitoring program.
	Direct radiation. (R)	Calculated doses for all exposure pathways less than guidelines established in 40 CFR Part 190.
		Comply with requirements and design to maintain dose ALARA.
		Implement radiological monitoring program.
5.4.4 Impacts to Biota Other than Members of the Public	Liquid and gaseous pathway. (TE) (AE) (R) (SW) (GW)	Calculated doses for all exposure pathways less than regulatory limits set in 40 CFR Part 190, which is conservative for biota. (Section 5.4.4.3)
		Comply with requirements and design to maintain dose ALARA.
		Implement radiological monitoring program.
	Direct radiation. (R)	Calculated doses for all exposure pathways less than regulatory limits set in 40 CFR Part 190, which is conservative for biota. (Section 5.4.4.3)
		Comply with requirements and design to maintain dose ALARA.
		Implement radiological monitoring program.

ER Reference Section	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	Proposed Measures and Controls or Mitigating Circumstances
5.5 Environmental Impact of Waste		S	S	S		S	S		S							

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation

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<table>
<tr><th>ER Reference Section</th><th colspan="15">Potential Impact Category and Description</th><th>Proposed Measures and Controls or Mitigating Circumstances</th></tr>
<tr><td rowspan="2">5.5.1 Nonradioactive Waste System Impacts</td><td colspan="15">Solid waste generation including hazardous waste.
(WS)</td><td>Reuse, recycle and reclaim solid waste and liquids as appropriate; otherwise, use approved transporters and offsite disposal facilities.</td></tr>
<tr><td colspan="15">Chemical and other pollutant discharges, including liquid and gaseous effluents.
(WS) (AQ) (W) (AE)</td><td>Comply with applicable State and Federal hazardous waste and air quality regulations. Comply with NPDES permit, including implementing a SWPPP.</td></tr>
<tr><td rowspan="2">5.5.2 Storage and Disposal of Mixed Waste Impacts</td><td colspan="15">Chemical and radiation exposure.
(WS) (SW) (W) (AE)</td><td>BBNPP annual quantities expected to be similar to SSES Units 1 and 2, which are minimal.</td></tr>
<tr><td colspan="15">Accidental releases and cleanup.
(SW) (W) (L)</td><td>Implement storage, shipment and emergency response procedures.</td></tr>
<tr><td rowspan="2">5.6 Transmission System Impacts</td><td>Erosion/Sediment (ES)</td><td>Air Quality (AQ)</td><td>Wastes (WS)</td><td>Surface Water SW)</td><td>Ground water (GW)</td><td>Land Use (L)</td><td>Water Use & Quality (W)</td><td>Terrestrial Ecosystems (TE)</td><td>Aquatic Ecosystems (AE)</td><td>Socioeconomic (S)</td><td>Aesthetics (A)</td><td>Noise (N)</td><td>Traffic (T)</td><td>Radiation Exposure (R)</td><td>Other (site specific) (O)</td><td rowspan="2"></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>S</td><td>S</td><td></td><td>S</td><td>S</td><td></td><td></td><td>S</td></tr>
<tr><td rowspan="5">5.6.1 Terrestrial Ecosystems</td><td colspan="15">Effects from maintenance of offsite transmission lines and corridors.
(TE) (O)</td><td>Existing/independently planned offsite transmission lines and corridors will be used for BBNPP; mitigation of potential impacts to offsite terrestrial ecosystems would be unchanged.</td></tr>
<tr><td colspan="15">Loss of onsite vegetation and existing habitat as well as forest cover.
(TE) (O)</td><td>Use site Resource Management Plan and BMPs to protect resources, e.g., Indiana bat.</td></tr>
<tr><td colspan="15">Disturbance to important terrestrial species.
(TE) (O) (N)</td><td>Use site Resource Management Plan and BMPs to protect resources, e.g., Indiana bat.</td></tr>
<tr><td colspan="15">Effects from maintenance of onsite transmission lines and corridors.
(TE)</td><td>Implement onsite routine transmission system maintenance policy and procedures, including vegetation control, erosion control, and important species protection.</td></tr>
<tr><td colspan="15">Use of biocides.
(TE) (AE)</td><td>Biocides will be used sparingly, if ever, in response to highly selective problems, and away from water.</td></tr>
</table>

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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.6.2 Aquatic Ecosystems	Effects from maintenance of offsite transmission lines and corridors. (AE) (O)	Existing/independently planned offsite transmission lines and corridors will be used for BBNPP; mitigation of potential impacts to offsite aquatic ecosystems would be unchanged.
	Disturbance of onsite wetlands and streams in vicinity. (AE)	Use site Resource Management Plan and BMPs to protect resources, e.g., wetlands and surface water systems.
	Disturbance to important aquatic species. (AE) (N)	Use site Resource Management Plan and BMPs to protect resources.
	Effects from maintenance of onsite transmission lines and corridors. (AE)	Implement onsite routine transmission system maintenance policy and procedures, including vegetation control (runoff of defoliants and herbicides), erosion control, and important species protection.
5.6.3 Impacts to Members of the Public	Public exposure to noise, electric shock, and electric field gradients. (N)	Existing/independently planned offsite transmission lines and corridors will be used for the new unit; mitigation of potential impacts from noise, electric shock, and EMF would be unchanged.
	Public exposure to noise, electric shock, and electric field gradients. (N)	Onsite exposure expected to be similar or less than existing transmission system due to smaller onsite footprint and distance to public areas.
	Visibility to aircrafts. (O)	Transmission structures will meet Federal Aviation Administration (FAA) requirements if any exceed the maximum height criteria of 200 ft. Transmission towers and lines will include lights and markers, where appropriate, to alert helicopter traffic to potential hazards created by the proposed structures.
	Aesthetic impacts related to new transmission structures. (A)	Paint exteriors of structures, where practicable, with a compatible color of the surrounding area.

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ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
5.7 Uranium Fuel Cycle		S	S	S		S	S							S		
	Uranium mining and milling. (L) (R) (W) (AQ) (SW) (WS)															Comparison of the EPR reactor, which was normalized for a reference 1,000 MWe LWR, to Table S-3 values (Table 5.7-1) shows that the impacts evaluated (land use, water use, fossil fuels, chemical effluents, radioactive effluents and wastes, occupational exposure, and transportation), would all be minor and require no action to warrant mitigation.
	Production of uranium conversion. (L) (R) (W) (AQ) (SW) (WS)															Likely use of centrifuge process in lieu of gaseous diffusion process, which significantly reduces energy use and resultant environmental effects.
	Transportation of radioactive materials. (L) (R) (W) (AQ) (SW) (WS)															The dose to workers and public for the Reference 1,000 MWe LWR was compared to natural background radiation to the U.S. population, and found that environmental impacts of transportation will be negligible.
	Management of low- and high-level radioactive wastes. (L) (R) (W) (AQ) (SW) (WS)															For low level waste at land burial facilities, Table S-3 indicates that there will be no significant radioactive releases to the environment. No release to the environment from high level and transuranic wastes is expected at disposal because it has been assumed that all of the gaseous and volatile radio includes contained in the spent fuel are no longer present at the time of disposal of the water.

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
5.8 Socioeconomic Impacts	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
		S								S	S	S	S			
5.8.1 Physical Impacts	Noise increase due to plant operation, including the switchyard and transformers. (N) (S) (A) (T)															SMALL, if any, offsite audible operation noise is anticipated based on existing plant baseline noise survey results .
	Noise increase due to cooling tower operation. (N) (S) (A) (T)															CWS and ESWS cooling tower noise levels are expected to be below both the EPA and HUD acceptable outdoor guideline of 55 dBA.
	Noise increase due to local worker traffic and deliveries. (N) (S) (A) (T)															Traffic noise limited to normal weekday, business hours.
	Air emissions related to diesel generators. (AQ)															Compliance with applicable EPA and Pennsylvania air quality regulations and permits.
	Local traffic increase. (N) (S) (T)															A traffic impact analysis (TIA) was completed and showed that the conditions during BBNPP operations for all shifts will have no significant effect on the operating level of service along Route 11. The impact from traffic operation of the new unit to nearby residences and recreational areas is anticipated to be SMALL.
	Plant visibility and physical impacts, e.g., intake and discharge structures, containment, cooling tower and related plume. (N) (S) (A) (T)															Limited visibility of site from north and east due to topography. Existing visibility of cooling tower from south and west expected to remain the same.
																Site physical impacts would be controlled through compliance with applicable regulations and plant siting.
																Plume rise varies and is temporary, depending on the season, wind direction, and viewpoint location.

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation
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ER Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.8.2 Social and Economic Impacts	Operation work force increase. (S) (T)	Operation work force expected to reside in the ROI, which has enough housing to meet the need.
		Indirect work force job increase will be a benefit.
		Spending on materials, products, and services, including payroll, expected to occur inside the ROI.
	Spending and tax revenue increase. (S)	Minor aggregate socioeconomic impacts inside ROI anticipated (e.g., increase needs of schools, public services and facilities), but mitigation unnecessary due to sufficient capacity.
	Increased traffic levels. (AQ) (T)	Facilities appear to have enough capacity to accommodate the increased demand and impacts would likely be small.
	Public services need (housing, schools, EMS, land use) increase. (S) (T)	Minor aggregate socioeconomic impacts inside ROI anticipated (e.g., increase needs of schools, public services and facilities), but mitigation unnecessary due, in general, to sufficient capacity. Low income housing not affected due to sufficient vacant housing inside ROI to meet the need.
5.8.3 Environmental Justice Impacts	No disproportionate adverse impacts to minority or low-income populations. (S)	None necessary.

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation

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ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
5.9 Decommissioning	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
		S	S				S	S	S	S		S	S	S	S	
	Radiation exposure related to onsite decommissioning activities and transport of waste materials to disposal sites. (R) (T) (N) (WS)															Radiation exposure anticipated to be comparable or less than during operation per NUREG-0586.
	Socioeconomic effects due to demands on and contributions to the community by workers. (S) (N)															Socioeconomic effects less than during plant construction or operation because level of activity and releases are expected to be smaller per NUREG-0586.
	Environmental effects due to ecology, air quality, and water quality. (AQ) (W) (TE) (AE)															Environmental effects less than during operation because level of activity and releases are expected to be smaller per NUGREG-5086.
	Sufficient funding to complete decommissioning. (O)															Guarantee of certified amount for financial assurance for decommissioning will be provided.
5.11 Transportation of Radioactive Materials, Incident-Free	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
														S		
	General public exposure to radiation during incident-free transport of fuel and wastes. (R)															Performed detailed analysis in accordance with 10 CFR 51.52(b), yielding conservative results.
	Worker exposure to radiation during incident-free transport of fuel and wastes. (R)															Performed detailed analysis in accordance with 10 CFR 51.52(b), yielding conservative results.

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Table 5.10-1—The Summary of Measures and Controls to Limit Adverse Impacts During Operation

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ER Reference Section	Potential Impact Category and Description															Proposed Measures and Controls or Mitigating Circumstances
5.12 Nonradiological Health Impacts	Erosion/Sediment (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water SW)	Ground water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomic (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	Other (site specific) (O)	
		S										S			S	
	Public exposure to air emissions, noise, pathogenic organisms, and electric shock (O) (AQ) (N)															Comply with federal and state air quality requirements or permits.
																BBNPP predicted offsite noise levels are 50 dBA or lower.
	Occupational accidents or illnesses from exposures to noise, toxic chemicals or organisms. (O) (AQ) (N)															Implement site-wide Safety and Medical Program, including safety policies, safe work practices, as well as general and topic-specific training.
																BBNPP is anticipated to have similar OSHA incident rate of recordable cases as SSES Units 1 and 2, which is less than national and state average.

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5.11 TRANSPORTATION OF RADIOACTIVE MATERIALS

The NRC evaluated the environmental effects of transportation of fuel and waste for light water reactors in the Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants (AEC, 1972) and Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1 (NRC, 1975) and found the impacts to be SMALL. These NRC analyses provided the basis for Table S-4 in 10 CFR 51.52 (CFR, 2007a) which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor.

The NRC regulations in 10 CFR 51.52 state that:

> Every environmental report prepared for a light-water-cooled nuclear power reactor shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions in paragraph (b) of this section.

The U.S. EPR design varies from the conditions of 10 CFR 51.52(a). Specifically,

- The reactor has a core thermal power level exceeding 3,800 MWth,
- The reactor fuel has a uranium-235 enrichment that may exceed 4% by weight, and the uranium dioxide pellets are not encapsulated in zircaloy rods,
- The average level of irradiation of the irradiated fuel from the reactor will exceed 33,000 MWd/MTU.

Because the EPR does not satisfy all of the conditions of 10 CFR 51.52(a), a full description and detailed analysis of transportation environmental impacts is required in accordance with 10 CFR 51.52(b).

This section summarizes the detailed analysis for normal conditions performed for the EPR incident-free environmental impacts for the transportation of fuel and radioactive wastes transported to and from the BBNPP site. The detailed analysis for accident conditions is summarized in Section 7.4.

The parameters evaluated in Section 5.11 are from the environmental impacts listed in 10 CFR 51.52(c), Table S-4, and the fuel cladding requirement in 10 CFR 51.52(a)(2), as follows:

- Fuel cladding,
- Heat (per irradiated fuel cask transit),
- Traffic density, and
- Incident-free dose for transportation workers, general public (onlookers and along route).

These evaluated impacts will be compared to the respective criteria in 10 CFR 51.52. Fuel cladding and heat will be discussed in separate sections. Traffic density and dose will be discussed in the same section since the calculation of dose is partly a function of traffic density.

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The impact of shipment weight as described in Table S-4 is governed by other restrictions and is unaffected by the U.S. EPR variation from 10 CFR 51.52(a). Table 5.11-1 presents information from Table S-4 of 10 CFR 51.52 (CFR, 2007a).

In addition, an evaluation for the Maximally Exposed Individual is performed based on the following conservative exposure scenarios:

- Truck crew member,
- Inspectors,
- Resident,
- Individual stuck in traffic, and
- Person at a truck service station.

5.11.1 FUEL CLADDING ENVIRONMENTAL IMPACT

10 CFR 51.52 describes the use of Zircaloy as fuel rod cladding material. More recently, the NRC has also specified, through rule-making, ZIRLO as an acceptable fuel cladding in 10 CFR 50.46 (CFR, 2007b). BBNPP will use AREVA's M5 Advanced Zirconium (M5) fuel rod cladding material.

Several NRC licensees have received approval to use M5 fuel rod cladding with a finding of "no significant impact." For example, NRC approved Davis-Besse Nuclear Power Station, Unit 1 use of M5 cladding, and concluded that the cladding presents no significant environmental impact during transportation (FR, 2000):

> With regard to the potential environmental impacts associated with the transportation of the M5 clad fuel assemblies, the advanced cladding has no impact on previous assessments determined in accordance with 10 CFR 51.52.

Further, in 2003, the NRC found M5 fuel rod cladding generally acceptable for use in license applications by compliance with the conditions specified in, and reference to AREVA's Topical Report (TR) (NRC 2003):

> The staff has completed its review of the subject TR and finds it is acceptable for referencing in licensing applications to the extent specified and under the limitations delineated in the report and in the associated safety evaluation (SE).

As described above, the use of M5 fuel cladding has been previously evaluated and determined to not result in significant transportation environmental impact at existing facilities. The use of M5 fuel cladding at BBNPP will be equivalent to the M5 fuel cladding previously evaluated at the existing facilities. Therefore, it is concluded that the use of M5 cladding at BBNPP will result in no environmental impact during transportation.

5.11.2 HEAT (IRRADIATED FUEL CASK IN TRANSIT) ENVIRONMENTAL IMPACT

This section addresses the decay heat generated in irradiated fuel casks during shipment to a repository. 10 CFR 51.52(c), Table S-4 (CFR, 2007c) concludes that heat generation of up to 250,000 Btu/hr (73 kW) within a cask is an acceptable environmental impact.

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An irradiated fuel cask has not yet been designed for U.S. EPR fuel; however in NUREG-1811, NUREG-1815, and NUREG-1817 the NRC described and addressed future irradiated fuel casks that may carry up to 1.8 MTU (4000 lbs U) (NRC, 2004; NRC, 2006a; and NRC, 2006b).

Each U.S. EPR fuel assembly contains up to 0.536 MTU (1200 lbs U). ORIGEN2.1 was used to calculate the decay heat from an U.S. EPR fuel assembly using the information provided in Table 5.11-6 (ORNL, 1991). Based on these calculations, an U.S. EPR irradiated fuel assembly will generate 5524 Btu/hr (1.6 kW) of decay heat following 5 years of onsite storage after removal from the reactor core (Table 5.11-2).

Therefore, an irradiated fuel cask designed consistent with that described in the referenced NUREGs could carry up to 3.36 irradiated assemblies (1.8 MTU / 0.536 MTU/assembly.) The total cask decay heat generation would then be 18,553 Btu/hr (5450 kW) (3.36 assemblies times 5524 Btu/hr per assembly.)

An alternative analysis is to assess the maximum number of irradiated fuel assemblies per cask that could be shipped while complying with the 250,000 Btu/hr (73 kW) condition in Table S-4. This method addresses future potential cask designs that could be used to transport greater numbers of assemblies per cask.

The maximum number of U.S. EPR irradiated fuel assemblies based on this evaluation would be 45 assemblies (250,000 Btu/hr / 5524 Btu/hr per assembly). The largest postulated irradiated fuel transfer cask designs have capacities of about half this number and their use for transportation of irradiated U.S. EPR fuel would result in proportionally lower heat generation, well below the Table S-4 value (NRC, 2000b).

Therefore, the decay heat generated by the U.S. EPR fuel per irradiated fuel cask in transit is bounded by 10 CFR 51.52(c), Table S-4 and will not result in significant environmental effects during transportation under normal conditions.

5.11.3 INCIDENT-FREE DOSE AND TRAFFIC DENSITY IMPACT ANALYSIS

This section summarizes the incident-free transportation environmental impacts during the 40 year normal operations for BBNPP. Transportation categories include;

- Transport of unirradiated fuel (new fuel) from fuel fabrication facilities to the BBNPP site,
- Transport of irradiated fuel from the BBNPP site to a monitored retrievable storage facility or permanent repository, and
- Transport of radioactive waste (radwaste) from the BBNPP site to off-site disposal facilities.

TRAGIS (ORNL, 2003) and RADTRAN (SNL, 2006) computer codes were used to calculate incident-free dose. Code inputs for each category are presented in Table 5.11-3. The results are summarized in Table 5.11-5.

The results presented in Table 5.11-5 provide a comparison to the reference reactor using an analysis that is consistent with the methodology used previously in the Environmental Impact Statements NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b).

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5.11.3.1 Impact of Unirradiated Fuel (New Fuel)

The radiological dose for the environmental impacts of incident-free new fuel shipments to the BBNPP site was calculated from the farthest (most conservative) new fuel fabrication facility near Richland, WA to the BBNPP site.

RADTRAN 5.6 was used to model the BBNPP location specific environmental impact. The model used TRAGIS (ORNL, 2003) generated BBNPP location specific route data to yield dose per shipment. The postulated stop duration was 5.9 hours based on the TRAGIS calculated 2628 mi (4230 km) commercial highway route distance and the 0.0023 hr/mi (0.0014 hr/km), consistent with the stop model assumption used in NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b).

The RADTRAN 5.6 model calculated radiological impact results per shipment are shown in Table 5.11-5.

The dose per shipment was multiplied by the average number of annual shipments to calculate the average dose per reactor year. New fuel shipments during the life of a reactor are expected to total 298 over the 40 year license period for an average of 7.5 shipments per reactor year. This is consistent with the condition described in Table S-4, which indicates that less than one shipment will occur per day.

At an average of 7.5 shipments per year, the average annual radiological impact from new fuel shipments will be as shown in Table 5.11-5.

5.11.3.2 Impact of Irradiated Fuel

The postulated radiological dose from the incident-free shipment of irradiated fuel from the BBNPP site to the proposed Yucca Mountain Repository located in Nevada was evaluated by multiplying conservative dose estimates per shipment by the average annual number of shipments.

A RADTRAN 5.6 model was developed using TRAGIS Highway Route Controlled Quantity distance and demographic data specific to the reactor site. Model conservatism is similar to that found in the irradiated fuel RADTRAN 5 models from NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b). The bounding commercial route distance calculated with TRAGIS was approximately 2541 mi (4090 km) with stop duration of 4.5 hours.

The RADTRAN 5.6 model conservatively calculated radiological impact results per shipment are presented in Table 5.11-5.

Shipping cask capacity assumptions are approximations based on current shipping cask designs. The U.S. EPR will require an average of 21 shipments of irradiated fuel per year assuming an irradiated fuel cask capacity of 1.8 MTU (4000 lbs U) consistent with NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b) and using the highest annual reload for the U.S. EPR of 37.5 MTU (83,000 lbs U), This is consistent with the condition described in Table S-4 of less than 1 shipment per day.

The postulated average annual radiological impact from an average of 21 irradiated fuel shipments per year to the proposed Yucca Mountain Repository is provided in Table 5.11-5.

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5.11.3.3 Impact of Radioactive Waste (Radwaste)

The transportation dose of the incident-free radwaste shipments from the BBNPP site was calculated using the same RADTRAN 5.6 inputs and assumptions as described in 5.11.3.2 above including a bounding disposal location for the BBNPP site. TRAGIS was used to evaluate the highway route to the Hanford, WA commercial low level waste disposal repository. This site is currently not available to Pennsylvania waste generators, but was used because it is bounding (farthest distance) compared to other existing disposal and processing sites. Other sites evaluated were Clive, UT; Beatty, NV; Barnwell, SC; and processors near Oak Ridge and Memphis, TN.

Using the same input parameters as the irradiated fuel model ensured a conservative model and is justified by the similar route demographics and conservatively chosen maximum package and vehicle surface dose rates. Conservative parameters such as using the maximum vehicle dose-rate allowed by law provides for maximally exposed individuals.

The bounding commercial route distance calculated with TRAGIS was approximately 2640 mi (4248 km) with stop duration of 5.0 hours.

The RADTRAN 5.6 conservatively calculated radiological impact results per shipment are provided in Table 5.11-5.

The U.S. EPR average of 15 radwaste shipments per year was derived using current shipping container volume estimates of 55-gallon (0.21 m^3) drums and 90 ft^3 (2.55 m^3) high integrity containers for process wastes and 1000 ft^3 (28.32 m^3) SEALAND containers for dry active waste, similar to the analyses in NUREG-1811, NUREG-1815, and NUREG-1817 (NRC, 2004; NRC, 2006a; and NRC, 2006b). Commercially available containers were matched to the appropriate waste type to determine the total number of containers generated per year. The number of shipments was then determined by dividing the number of containers postulated to be generated by an assumed number of containers that can be transferred per shipment. Table 5.11-4 shows the U.S. EPR container generation rates, realistic container per shipment assumptions, and the subsequent annual number of shipments. The calculated 15 shipments per year is consistent with the condition in Table S-4 which describes less than one shipment per day.

At this average of 15 shipments per year, the average annual radiological impact from radwaste shipments to the bounding disposal site at Hanford, WA is shown in Table 5.11-5.

5.11.3.4 Comparison with Table S-4 and Conclusion

Table 5.11-6 summarizes the incident-free transportation environmental impacts per reactor year. The table included consideration of:

- Transport of unirradiated fuel (new fuel) from fuel fabrication facilities to the BBNNP site,
- Transport of irradiated fuel from the BBNNP site to a monitored retrievable storage facility or permanent repository, and
- Transport of radioactive waste (radwaste) from the BBNNP site to offsite disposal facilities.

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The cumulative doses shown in Table 5.11-5 were calculated based on the product of thousands of potentially exposed individuals and the very low doses that each of the could receive.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses below about 10 rem (100 mSv) or at low dose rates. The individual doses and dose rates calculated to occur during normal transportation are many orders of magnitude less than either of these.

Radiation protection experts conservatively assume that any amount of radiation exposure may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures, i.e., linear, no-threshold dose response model is used to describe the relationship between radiation dose and detriments such as cancer induction. This model has been accepted as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably over-estimates those risks.

The NRC staff estimates the risk to the public from radiation exposure using the nominal probability coefficient for total detriment of 730 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv) from ICRP Publication 60 (ICRP, 1991).

All the population doses presented in Table 5.11-5 are less than 100 person-rem/yr (one person-Sv/yr); therefore, the total detriment estimates associated with these postulated doses would all be less than 0.1 fatal cancers, nonfatal cancers, and severe hereditary effects per year.

These risks are very small compared to the fatal cancers, nonfatal cancers, and severe hereditary effects that would occur annually in the same population from exposure to natural sources of radiation.

Based on this the environmental impacts during normal transportation environmental do not represent a significant environmental impact.

5.11.3.5 Maximally Exposed Individual Impact

The maximally exposed individual impact is the potential dose for individuals exposed to any one shipment given the maximum exposure for all pathways. The shipment dose is independent of source, and is based on the maximum potential package dose rate allowed and postulated exposure scenarios. An analysis of incident-free doses to MEI was performed based on NUREG-1815 (NRC, 2006a), Section 6.2.1.1, which in turn references the DOE's Final Environmental Impact Statement (FEIS) for Yucca Mountain (DOE, 2002). An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the reactor site.

The analysis is based on assumptions about exposure times, dose rates, and the number of times an individual may be exposed to an off-site shipment. It was assumed that the shipment dose rate is 10 mrem/hr (0.1 mSv/hr) at 6.6 ft (2m) from the side of the transport vehicle, the maximum dose rate allowed by DOT regulations (49 CFR 173.441). The average annual shipment frequency is based on the total of irradiated fuel and radioactive waste (assuming the dose rate from the unirradiated fuel shipments is negligible repective to MEI). The analysis is described below for several different categories of individuals.

Truck Crew Member:

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Truck crew members are trained radition workers, and would receive the highest radiation doses during the incident-free transport because of their proximity to the loaded shipping container for an extended period of time. Although unlikely, it is assumed that the maximum exposure for a crewmember could occur. For irradiated fuel shipments, the the crew member doses are limited to 2 rem (0.02 Sv) per year, which is the DOE administrative control level (DOE, 2005). The limit is anticipated to apply to spent nuclear fuel shipments to a disposal facility, as DOE will take title to the spent fuel at the reactor site. For radwaste shipments, the crew member doses are limited to 5 rem (0.05 Sv) per year, which is the NRC limit for occupational exposures (10 CFR 20). Since the NRC limit is higher, a MEI could receive a potential 5 rem/yr (0.05 Sv/yr).

Non-radiation workers, or the general public would receive much less exposure, as demonstrated below.

Inspectors:

Radioactive shipments are inspected by Federal or state vehicle inspectors, for example, at state ports of entry. NUREG-1815 assumed that inspectors would be exposed for 1 hour at a distance of 3.3 ft (1 m) from the package. The dose rate at 3.3 ft is assumed at 14 mrem/hr (0.14 mSv/hr) (Table 5.11-3), so the dose per shipment is 14 mrem (0.14 mSv).

For the EPR, based on 21 annual irradiated fuel shipments (as noted in Section 5.11.3.2) and 15 annual radwaste shipments (as noted in Section 5.11.3.3) (36 total), the annual dose to vehicle inspectors is calculated to be 500 mrem/yr (5 mSv/yr), assuming the same person inspects all shipments of fuel and waste:

> MEI annual dose = (21 irradiated fuel + 15 radwaste) shipments/yr x 14 mrem/shipment (0.14 mSv) = 504 mrem/yr (5 mSv/yr).

Resident:

NUREG-1815 used the DOE FEIS assumption of a resident living 100 ft (30 m) from shipments that are traveling 15 mi/hr (24 km/hr) for all shipments along a particular route. The FEIS also assumed a resident would be exposed to 5000 (mostly legal-weight) shipments over 24 years. The dose to the resident over 24 years was estimated at 6 mrem (0.06 mSv) (DOE, 2002). Therefore, the dose per shipment is 0.0012 mrem (0.000012 mSv/yr).

For the EPR with an average of 36 annual shipments, the potential dose to the MEI resident is 0.0432 mrem/yr (0.000432 mSv/yr).

> MEI annual dose = 6 mrem (0.06 mSv) / 5000 shipments x 36 shipments/yr = 0.0432 mrem/yr (0.000432 mSv/yr).

Individual stuck in traffic:

NUREG-1815 used the DOE FEIS assumption that, for one time only, an individual could become stuck in traffic next to a loaded shipment for one hour at a distance of 4 ft (1.2 m). Similar to a resident, it was assumed the individual would be exposed to 5,000 (mostly legal-weight) shipments over 24 years. The dose to the resident over 24 years was estimated at 16 mrem (0.16 mSv) (DOE, 2002). Therefore, the dose per shipment is 0.0032 mrem (.000032 mSv).

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For the EPR with an average of 36 annual shipments, the potential dose to the MEI stuck in traffic is 0.115 mrem/yr (0.00115 mSv/yr).

MEI annual dose = 16 mrem (0.16 mSv) / 5000 shipments x 36 shipments/yr = 0.115 mrem/yr (0.00115 mSv/yr).

Person at a truck service station:

NUREG-1815 used the DOE FEIS assumption that an employee at a service station where all truck shipments from the advanced reactors would stop could be exposed for 49 minutes at a distance of 52 ft (16 m) from the loaded shipment. This results in a dose estimate of 0.07 mrem/shipment (0.0007 mSv/shipment).

For the EPR with an average of 36 annual shipments, the potential dose to the MEI at a truck service station is 2.52 mrem/yr (0.252 mSv/yr).

MEI annual dose = 0.07 mrem (0.0007 mSv)/shipment x 36 shipments/yr = 0.252 mrem/yr (0.0252 mSv/yr).

5.11.4 SUMMARY AND CONCLUSION

A conservative and detailed analysis of the environmental impacts for the transportation of unirradiated fuel, irradiated fuel, and radioactive waste to and from BBNPP has been performed in accordance with 10 CFR 51.52(b) (CFR, 2007c). The use of M5 cladding has been previously evaluated and determined not to result in significant environmental impact during normal conditions of transportation. The decay heat generated by U.S. EPR fuel in transit is bounded by 10 CFR 51.52(c), Table S-4 (CFR, 2007c) and will not result in significant environmental effects during transportation under normal conditions. The dose and traffic impact analysis of the incident free transportation of U.S. EPR fuel and radioactive waste generated at the new facility will not result in significant environmental effects during transportation under normal conditions.

Based on this, the U.S. EPR design variation from the conditions of 10 CFR 51.52(a) will not result in significant environmental effects during transportation activities associated with the operation of BBNPP. As a result, the impacts would be SMALL.

5.11.5 REFERENCES

AEC, 1972. Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, WASH-1238, Atomic Energy Commission, December, 1972.

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Table 5.11-1—Summary of Environmental Impacts of Transportation of Fuel and Waste to and from One Light Water Reactor, taken from 10 CFR 51.52 Table S-4

Normal Conditions of Transport			
		Environmental Impact	
Heat (per irradiated fuel cask in transit)		250,000 Btu/hr (73 kW)	
Weight (governed by Federal or State Restrictions)		73,000 lbs. (33000 kg) per truck; 100 tons (91 MT) per cask per rail car	
Truck		Less than 1 per day	
Rail		Less than 3 per month	
Exposed Population	Estimated Number of Persons Exposed	Range of Doses to Exposed Individuals (per reactor year)	Cumulative Dose to Exposed Population (per reactor year)
Transportation Workers	200	0.01 to 300 mrem (1e-4 to 3 mSv)	4 person rem (40 mSv)
General Public			
Onlookers	1,100	0.003 to 1.3 mrem (0.03 to 13 μSv)	3 person rem (30 mSv)
Along Route	600,000	1E-4 to 6E-2 mrem (1E-3 to 0.6 μSv)	No number provided in 10 CFR 51.52 Table S-4

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Table 5.11-2—Decay Heat for EPR Irradiated Fuel Assembly

Decay Time (year)	Decay Heat per Assembly (Btu/hr)			
	GWd/MTU 62	GWd/MTU 52	GWd/MTU 40	GWd/MTU 10
4.75	7.32E+03		4.01E+03	9.17E+02
5.00	7.09E+03	5.52E+03	3.88E+03	8.83E+02
6.34	5.89E+03		3.17E+03	6.95E+02

Note 1: Linear regression used to determine 5 year decay heat at 62, 40, 10 (GWd/MTU).
Note 2: Polynomial Regression used to determine 52 GWd/MTU decay heat at 5 years:
(5.52E+03 = 0.896*(52)^2+54.96*(52)+243)

Note 3: 4.75 and 6.34-yr data (divided by 241 assemblies) from TRAGIS User's Manual, Table 5-3 (ORNL, 2003)

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Table 5.11-3—RADTRAN & TRAGIS Model Input Parameters

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Parameter	New Fuel	Spent Fuel	Radwaste
TRAGIS Input:			
Route Mode	Commercial	HRCQ	Commercial
Route Origin	Richland, WA	BBNPP	BBNPP
Route Destination	BBNPP	Yucca Mt, NV	Hanford, WA
RADTRAN Input TRAGIS:			
Total Shipping Distance, mi (km)	2628.4 (4229.9)	2541.2 (4089.5)	2639.7 (4248.0)
Travel Distance - Rural, mi (km)	2078.8 (3345.4)	2017.4 (3246.7)	2077.5 (3343.4)
Travel Distance - Suburban, mi (km)	505.7 (813.8)	469.8 (756.0)	506.9 (815.7
Travel Distance - Urban, mi (km)	44.1 (70.9)	54.0 (87.0)	55.5 (89.2)
Population Density - Rural, person/mi^2 (person/km^2)	29.6 (11.4)	28.7 (11.1)	29.5 (11.4)
Population Density - Suburban, person/mi^2 (person/km^2)	745.8 (288.0)	765.9 (295.7)	785.8 (303.4)
Population Density - Urban, person/mi^2 (person/km^2)	5850.2 (2258.8)	6082.0 (2348.3)	5975.1 (2307.0)
Stop Time, hr/trip	5.9[(b)]	4.5[(c)]	5.0[(d)]

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Table 5.11-3—RADTRAN & TRAGIS Model Input Parameters

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Parameter	New Fuel	Spent Fuel	Radwaste
RADTRAN Input from NRC Models[(a)]			
Vehicle Speed, mi/hr (km/hr)	55 (88.49)	55 (88.49)	55 (88.49)
Traffic Count - Rural, vehicles/ hr	530	530	530
Traffic Count - Suburban, vehicles/ hr	760	760	760
Traffic Count - Urban, vehicles/hr	2400	2400	2400
Dose Rate at 3.3 ft (1 m) from Vehicle, mrem/hr (mSv/hr)	0.1 (0.001)	14 (0.14)	14 (0.14)
Packaging Length, ft (m)	23.9 (7.3)	17.1[(e)] (5.2)	17.1 (5.2)
Number of Truck Crew	2	2	2
Population Density at Stops (radii: 3.3 to 32.8 ft (1 to10 m)), person/mi^2 (person/km^2)	166,536 (64,300)	77699.6 (30,000)	77699.6 (30,000)
Population Density at Stops (radii: 32.8 to 2624 ft (10 to 800 m)), person/mi^2 (person/km^2)	NA	880.6 (340)	880.6 (340)
Shielding Factor at Stops (radii: 3.3 to 32.8 ft (1 to 10 m))	1	1	1
Shielding Factor at Stops (radii: 32.8 to 2624 ft (10 to 800 m))	NA	0.2	0.2

Notes:

(a) From Nureg-1815 [Appendix C]
(b) Based on 0.0014 hour/km [NUREG-1815, Table G-2]
(c) Based on TRAGIS output: 9 stops at 30 minutes each.
(d) Based on TRAGIS output: 10 stops at 30 minutes each.
(e) Cylinder of 3.3 ft (1 m) diameter.

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Table 5.11-4—Annual EPR Solid Radioactive Waste

Waste Type	Annual Max Quantity ft^3 (m^3)	Container Internal Volume ft^3 (m^3)	Maximum Number of Containers	Containers per Shipment	Number of Shipments
Evaporator Concentrates	140 (4.0)	7.3 (0.21 (a))	19.2	40	1
Spent Resins (other)	90 (2.5)	90 (2.55 (b))	1.0	1	1
Spent Resins (Rad Waste Demineralizer System)	140 (4.0)	90 (2.55 (b))	1.6	1	2
Wet Waste from Demineralizers	8 (0.2)	90 (2.55 (b))	0.1	1	1
Waste Drum for Solids Collection from Centrifuge System	8 (0.2)	7.3 (0.21 (a))	1.1	40	1
Filters (quantity)	120 (3.4)	90 (2.55 (b))	1.3	1	2
Sludge	35 (1.0)	90 (2.55 (b))	0.4	1	1
Mixed Waste	2 (0.1)	7.3 (0.21 (a))	0.3	40	1
Non-Compressible Dry Active Waste (DAW)	70 (2.0)	1000 (28.32 (c))	0.1	1	1
Compressible DAW	1415 (40.1)	1000 (28.32 (c))	1.4	2	1
Combustible DAW	5300 (150.1)	1000 (28.32 (c))	5.3	2	3
Overall Totals	(208)				15

Notes: First two columns from Table 3.5-10
(a) 7.3 ft^3, 55 gallon drum.
(b) 90 ft^3, medium size container such as an 8 to 120 HIC.
(c) 1000 ft^3, 20 ft. SEALAND container.

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Table 5.11-5—Summary of Annual Transportation Radiological Dose Impact for the EPR

	New Fuel	Irradiated Fuel	Radwaste	Total	S-4
Worker Dose, person-rem (person-Sv)	1.7E-02 (1.7E-04)	2.1E+00 (2.1E-02)	1.6E+00 (1.6E-02)	3.7E+00 (3.7E-02)	4.0E+00 (4.0E-02)
Public, Onlooker Dose, person-rem (person-Sv)	6.5E-02 (6.5E-04)	6.7E+00 (6.7E-02)	5.3E+00 (5.3E-02)	1.2E+01 (1.2E-01)	3.0E+00 (3.0E-02)
Public, Along Route Dose, person-rem (person-Sv)	1.2E-03 (1.2E-05)	1.7E-01 (1.7E-03)	1.3E-01 (1.3E-03)	3.0E-01 (3.0E-03)	3.0E+00 (3.0E-02)

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Table 5.11-6—ORIGEN2.1 Decay Heat Input Parameters for EPR Irradiated Fuel

PARAMETER		VALUE
US EPR core thermal power for design-basis applications	Nominal	4590 MWt
	Measurement Uncertainty	22 MWt (0.48%)
	Total (design-basis)	4612 MWt
Number of fuel assemblies in core		241
Fuel enrichment		5 $^{w}/_{o}$ U-235
Mass of U metal in fuel assembly		535.917 kg
Total mass of U metal in core		1.2916E+05 kg
Fuel isotopic composition (based on ORNL/TM-12294/V4)	U-234	4.423E-02 $^{w}/_{o}$
	U-235	5.000E+00 $^{w}/_{o}$
	U-236	2.300E-02 $^{w}/_{o}$
	U-238	9.493E+01 $^{w}/_{o}$
	Total	1.00E+02 $^{w}/_{o}$
Irradiation time interval	5 GWd/MTU	140.026 days
Irradiation times to yield the selected burnups	10 GWd/MTU	280.05 days
	40 GWd/MTU	1120.21 days
	62 GWd/MTU	1736.32 days
Decay time array		0 to 1.0E+09 sec (31.69 yrs)
Computer code and cross-section libraries (RSIC CCC-371, and ORNL/TM-11018)(ORNL, 1991)		ORIGEN-2.1 PWRUE

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5.12 NONRADIOLOGICAL HEALTH IMPACTS

5.12.1 PUBLIC HEALTH

Nonradiological health impacts and risks to members of the public due to operation of the new power plant and associated new transmission lines are those previously identified.

The impacts to the public from pathogenic organisms in the heated effluent from the plant are addressed in Section 5.3.4, "Impacts to Members of the Public (Cooling System Impacts)".

The impacts to the public from operation of the transmission system due to induced currents in metal fences and vehicles beneath transmission lines are addressed in Section 5.6.3, "Impacts to Members of the Public (Transmission System Impacts).

The impacts and risks due to the transport of nonradiological air emissions and dust and noise propagation offsite through the atmosphere to nearby residences and businesses are addressed in Section 5.8.1 "Physical Impacts of Station Operations".

5.12.2 OCCUPATIONAL HEALTH

Personnel at an operational power generation unit could be susceptible to industrial accidents (e.g., falls, electric shock, burns), or occupational illnesses due to noise exposure, exposure to toxic or oxygen replacing gases, exposure to thermophilic organisms in the condenser bays, and other caustic agents.

During the operations phase of BBNPP a safety and medical program with associated personnel to promote safe work practices and respond to occupational injuries and illnesses will be provided. The safety and medical program will utilize an industrial safety manual providing a set of work practices with the objective of preventing accidents due to unsafe conditions and unsafe acts. These safe work practices address hearing protection, confined space entry, personal protective equipment, respiratory protection, heat stress, electrical safety, excavation and trenching, scaffolds and ladders, fall protection, chemical handling, storage, and use, and other industrial hazards. The safety and medical program provides for employee training on safety procedures. Site safety and medical personnel are provided to handle industrial accidents and occupational illnesses.

The Bureau of Labor Statistics maintains records of a statistic known as total recordable cases (TRC), which are a measure of work-related injuries or illnesses that include death, days away from work, restricted work activity, medical treatment beyond first aid, and other criteria. The incidence rate of recordable cases at Susquehanna Steam Electric Station (SSES) for its workforce (excluding outage onsite workers) for 2005 through 2007, as calculated from OSHA documentation, averaged 0.24 cases per 100 workers or 0.24%. This compares favorably to the nationwide TRC rate for electrical power generation workers of 3.1% nationwide (BLS, 2008) and to the Commonwealth of Pennsylvania for utility workersof 3.17% (PDLI, 2007). It is estimated that 363 onsite employees would be added for BBNPP. An additional workforce of up to 1000 workers is estimated during a 15-day period once every 18 months to support plant outages.

The number of total recordable cases per year for BBNPP can be estimated as the number of workers times the TRC rate. The estimated TRC incidences would be:

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Number of Workers	TRC Incidence at US Rate	TRC Incidence at PA Rate	TRC Incidence at SSES Units 1 and 2 Rate
363 (normal)	11	12	1
1000 (outage)	1 (per outage event)	1 (per outage event)	0

The estimated total recordable cases for the operations workforce based on the rate for SSES Units 1 and 2 is well under the U.S. and Commonwealth of Pennsylvania rates, showing that SSES's safety program is effective. This same program would be used to guide safe operations at the proposed unit to ensure that employees work in a safe manner and recordable cases are prevented as much as possible.

5.12.3 REFERENCES

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