2.4 HYDROLOGIC ENGINEERING

This section of the U.S. EPR FSAR is incorporated by reference with the following departures and supplements.

2.4.1 Hydrologic Description

The U.S. EPR FSAR includes the following COL Item for Section 2.4.1:

> A COL applicant that references the U.S. EPR design certification will provide a site-specific description of the hydrologic characteristics of the plant site.

This COL Item is addressed as follows:

{This section identifies the interface of BBNPP with the hydrosphere. It also identifies the hydrologic causal mechanisms that will establish the design basis with respect to floods and water supply requirements. Information on surface water and groundwater uses that may be affected by plant operation is also included in this section.

References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

Sections 2.4.1.1 through 2.4.1.3 are added as a supplement to the U.S. EPR FSAR.

2.4.1.1 Site and Facilities

2.4.1.1.1 BBNPP Site Description

The proposed BBNPP site is located in Salem Township, Luzerne County, Pennsylvania (PA), on the west side of the North Branch of the Susquehanna River (NBSR) (within the Middle Susquehanna Sub-basin), as shown on Figure 2.4-1. The proposed BBNPP site is situated in the Walker Run watershed, which is has a drainage area of 4.32 mi^2 (11.16 km^2). The BBNPP Property is also adjacent to Susquehanna Steam Electric Station (SSES) Units 1 and 2 in an area of open deciduous woodlands, interspersed with cultivated fields and orchards. The BBNPP property sits on a relatively flat upland area, 219 ft (66.8 m) above the nominal Susquehanna River level, as shown in Figure 2.4-2. The BBNPP site is approximately:

- 1.7 mi (2.7 km) north-northeast of the confluence of Walker Run and the NBSR,
- 22 mi (35 km) downstream of Wilkes-Barre, PA,
- 5 mi (8 km) upstream of Berwick, PA, and
- 70 mi (113 km) north-northeast of Harrisburg, PA.

Portions of the BBNPP site area are covered by glacial deposits, as the site area was subjected to both glacial and periglacial events during the Quaternary Epoch. Much of the specific plant site is largely devoid of glacial deposits. The overburden is composed predominantly of residual soil that formed from weathering of the underlying shale with glacial till occurring only in sparse locations. Devonian bedrock lies beneath the overburden. Erosion and down cutting from the Susquehanna River and its tributary streams have dissected the overburden, leaving many exposed bedrock outcrops throughout the site area. Topographic relief within a 5 mi (8 km) radius around the BBNPP site varies from just under 500 ft (152 m) on the floodplain of the NBSR, to greater than 1,700 ft (518 m) along Nescopeck Mountain (see Figure 2.4-2).

The NBSR flows from north to south past the SSES and makes a broad, 90 degree angle turn (i.e., Bell Bend) to the west before reaching Berwick, PA. The proposed BBNPP Intake Structure is approximately 22 miles (35 km) downstream of Wilkes-Barre, PA and 5 miles (8 km) upstream of Berwick, PA. The site of the BBNPP Intake Structure is the reference for the BBNPP site with respect to distances along the NBSR. The NBSR ultimately receives all surface water that drains from the BBNPP site.

Two hills extend from east to west along the north side of the BBNPP property, and Walker Run stream runs through the valley that they form (see Figure 2.4-3). Walker Run is a relatively small stream but is the largest in the immediate vicinity of the BBNPP site. Walker Run flows southward along the western side of the BBNPP, and there is a considerable drop in elevation from the hill tops within the Walker Run watershed to the Susquehanna River. Table 2.4-1 shows the approximate runoff flow path lengths and slopes within the Walker Run watershed sub-basins. An unnamed tributary to Walker Run shown in Figure 2.4-3 as Unnamed Tributary 1 flows along the eastern and southern BBNPP protected area boundary and enters Walker Run on the southwest side of the BBNPP property. A second unnamed tributary shown in Figure 2.4-3 as Unnamed Tributary 2 flows southeastward through the BBNPP property and empties into Unnamed Tributary 1. The Walker Run watershed has a drainage area of 4.32 mi^2 (11.61 km^2). Based on the runoff of these streams and the proposed Site Utilization Plant Layout (see Figure 2.4-5), the Walker Run watershed can be divided into eleven sub-basins as illustrated in Figure 2.4-3.

SSES is located approximately 1 mi (1.6 km) from the BBNPP Nuclear Island, on the west bank of the NBSR on a relatively flat plain of gently rolling hills. The grading of the SSES was designed to direct storm water away from the safety related buildings by a system of culverts, surface drainage channels, and underground storm drains towards the NBSR (PPL, 1999b). The SSES plant grade elevation is approximately 670 ft (204.2 m) msl, which is approximately 49 ft (14.9 m) below the BBNPP finished plant grade elevation of 719 ft (219.2 m) NAVD 88. Due to its distance from the SSES and the difference in elevation, runoff from the SSES property would not impact the BBNPP property. Runoff from the BBNPP is directed towards infiltration basins and detention basins located throughout the BBNPP property (see Figure 2.4-102), which help preserve the pre-development hydrologic conditions and allow runoff to discharge naturally to the surrounding wetlands and drain south via Unnamed Tributary-1, Unnamed Tributary-2 and Walker Run to the NBSR. Therefore, runoff from the BBNPP property would not impact the existing SSES property. Furthermore, the SSES is located outside of the Walker Run watershed (see Figure 2.4-3). Figure 2.4-4 illustrates the BBNPP site grading plan and runoff flow paths. All runoff will be routed through drainage (or infiltration) basins and detention basins based on the site drainage system as shown on Figure 2.4-102. Site drainage areas were established based on the direction in which surface runoff is routed to each infiltration basin and detention basin. The result was seven distinct drainage areas, which are shown on Figure 2.4-103. The site grading plan, which is also presented in Figure 2.4-103, is supplementary to the site drainage system design. When analyzing the effects of local intense precipitation at the site in Section 2.4.2, the Powerblock area (i.e., Basin 10.4; see Figure 2.4-4) was divided into additional areas in order to evaluate ponding effects in the vicinity of the safety-related structures: Basin 10.4A includes the area that is is occupied by all safety-related facilities at elevation 718 ft NAVD 88 (top of soil reflecting 12 inches of crushed stone below elevation 719 ft NAVD 88) based on the site grading plan, Basin 10.4B receives the overflow from Basin 10.4A and conveys all runoff away from the site, and Basin 10.4C (which is located immediately west of the safety-related ESWEMS Retention Pond) acts as a catch basin by collecting overflow from the Wetland Area. Figure 2.4-4 shows the nine site drainage areas that were considered when evaluating the effects of local intense precipitation using U.S.

Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC)-Hydrologic Modeling System (HMS) Version 3.1.0 software (USACE, 2006), which is discussed in detail in Section 2.4.2.

2.4.1.1.2 BBNPP Facilities

The BBNPP will be a U.S. Evolutionary Power Reactor (EPR). The U.S. EPR is a pressurized water reactor design. The BBNPP design is a four-loop, pressurized water reactor, with a reactor coolant system composed of a reactor pressure vessel that contains the fuel assemblies, a pressurizer including ancillary systems to maintain system pressure, one reactor coolant pump per loop, one steam generator per loop, associated piping, and related control systems and protection systems.

The Reactor Building is surrounded by the Fuel Building, four Safeguard Buildings, two Emergency Diesel Generator Buildings, the Nuclear Auxiliary Building, the Radioactive Waste Processing Building and the Access Building. Figure 2.4-5 shows the layout for BBNPP, depicting main features: BBNPP Property Boundary, water intake, discharge pipelines, and switchyard.

The BBNPP Reactor Building is a cylindrical reinforced concrete vertical structure, capped with a reinforced \ enclosed spherical dome ceiling. The Reactor Building is approximately 186 ft (56.7 m) in diameter with an overall height of about 240 ft (73.2 m). The finished plant grade for BBNPP will be at an elevation of approximately 719 ft (219.2 m) NAVD 88. With the bottom of the Reactor Building foundation 35 ft (11 m) below grade, the new Reactor Building will rise 205 ft (62.5 m) above grade. The top of the Reactor Building will be at an elevation of approximately 924 ft (281.6 m).

Safety-related facilities for the BBNPP are located at the finished plant grade elevation of 719 ft (219.2 m) NAVD 88. The safety-related structures in the BBNPP Powerblock area include the following: reactor complex (consisting of the reactor, fuel, and safeguards buildings), emergency diesel generator buildings, and the ESWS cooling towers.

The BBNPP will have a closed-loop cooling system. The BBNPP Cooling Towers will be round concrete structures with a diameter of approximately 350 ft (107 m) at the base and an approximate height of 475 ft (145 m). Other BBNPP buildings will be concrete or steel with metal siding.

The BBNPP Intake Structure will be located on the NBSR downstream from the existing SSES Units 1 and 2 intake structure as shown in Figure 2.4-10. The makeup water for the ESWS cooling towers will normally be supplied from the non-safety-related Raw Water Supply System, located in the BBNPP Intake Structure. It withdraws water from the NBSR. ESWS cooling tower basins will also serve as the Ultimate Heat Sink (UHS) cooling water storage volumes for use during design basis accidents (DBA). ESWS cooling tower basin inventory will provide cooling water for safety-related heat removal for the first 72 hours during DBA conditions. The ESWS makeup water after the first 72 hours under DBA conditions will be supplied directly from the ESWEMS Retention Pond.

2.4.1.1.3 BBNPP Flood Design Basis

The design basis flood elevation for the BBNPP site was determined by considering a number of different flooding possibilities. These include the Probable Maximum Flood (PMF) on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami, and ice effect flooding. Each of these flooding scenarios was investigated in conjunction with other flooding and meteorological events, such as wind generated waves, in accordance with guidelines presented in ANSI/ANS 2.8-1992 (ANS, 1992). Adequate drainage capacity will be provided to prevent flooding of safety-related facilities and to convey storm water runoff from the roofs and buildings away from the plant. Detailed discussions on each of these flooding events and how they were estimated are found in Section 2.4.2 through Section 2.4.8.

The most significant flood event on record is the 1972 flood which resulted from Hurricane Agnes and occurred throughout the Mid-Atlantic region of the United States. On June 25, 1972, a river crest of 517.35 ft (157.7 m) msl was observed near the SSES Units 1 and 2 intake structure (Ecology III, 1986). Discussion of peak stream flow is presented in Section 2.4.1.2.1.7.

The finished plant grade elevation will be 719 ft (219.2 m) NAVD 88 (Section 2.5.4). The elevation of the Susquehanna River 100-year (yr) floodplain is approximately 513 ft (156 m) National Geodetic Vertical Datum of 1929 (NGVD 1929) (Federal Emergency Management Agency (FEMA), 2008) or 512.3 ft (156.1 m) NAVD 88. Thus, the BBNPP is approximately 206.7 ft (63.0 m) above the Susquehanna River 100-yr floodplain. The Susquehanna River PMF peak discharge and water surface elevation near the BBNPP site were estimated by following the procedures provided in the United States Nuclear Regulatory Commission (NRC) Regulatory Guide 1.59 (NRC, 1977) and the American National Standards Institute (ANSI)/American Nuclear Society (ANS) 2.8 (ANS, 1992), respectively. The PMF peak discharge was estimated as 1.13 million cfs (31,998 m^3/s) resulting in a peak water surface elevation (WSE) of approximately 548 ft (167.0 m) NAVD 88 at the location of the proposed BBNPP Intake Structure. The BBNPP finished plant grade elevation is approximately 171 ft (52.1 m) above the estimated Susquehanna River PMF elevation.

The maximum water level due to local intense precipitation, or the local Probable Maximum Precipitation (PMP), at the BBNPP site is estimated and discussed in Section 2.4.2. The safety-related structures in the Powerblock area (i.e., Basin 10.4A; see Figure 2.4-4) consist of two ESWS Cooling Towers located in the northwest corner, Emergency Diesel Generator Buildings located north and south of the Nuclear Island and the Reactor complex, which consists of the Reactor, Fuel and Safeguards Buildings. The locations of the buildings are shown on Figure 2.4-5. The entrances to each of these structures are located at or above the finished floor grade elevation 720 ft (219.5 m) NAVD 88. The maximum water level in the Powerblock is elevation 718.36 ft (218.96 m) NAVD 88, which is 1.64 ft (0.50 m) below the reactor complex finished floor grade at elevation 720 ft (219.5 m) NAVD 88.

The estimation of the PMF water levels on Walker Run and tributary creeks located near the proposed BBNPP are discussed in detail in Section 2.4.3. Section 2.4.3 describes the Walker Run watershed models that were developed to determine the runoff hydrographs, peak flows, and the resulting flood stage elevations. The scope of this analysis includes the HEC-HMS 3.1.0 evaluation of the all-season Probable Maximum Storm (PMS) to develop the runoff hydrographs and peak flows, and the HEC-RAS 4.1 evaluation to determine the resulting flood stage elevations in the vicinity of the proposed BBNPP. The PMF evaluation of local streams (i.e., Walker Run, Unnamed Tributary-1 and Unnamed Tributary-2) near the BBNPP indicate a maximum PMF water surface elevation of 715.03 ft (217.94 m) NAVD 88 along Unnamed Tributary-2, which is approximately 3.97 ft (1.21 m) below the finished plant grade elevation of 719 ft (219.2 m) NAVD 88 as shown on Figure 2.4-33.

The safety-related ESWEMS Retention Pond is located southeast of the Powerblock area, as shown on Figure 2.4-5. Grading around the ESWEMS Retention Pond is sloped to keep surface stormwater from entering the pond. To prevent an overflow caused by malfunction of the makeup system or by rainfall accumulation in the ESWEMS Retention Pond, a spillway (elevation of 698 ft (212.75 m) NAVD 88) is provided to drain excess storage. A general arrangement figure of the ESWEMS area is provided on Figure 2.4-36. The top of the dike of the ESWEMS Retention Pond is at elevation 700 ft (213.4 m) NAVD 88 and the grade level of the ESWEMS Pump House is at elevation 700.5 ft (213.5 m) NAVD 88. Assuming no losses, the maximum water level resulting from local intense precipitation in the ESWEMS Retention Pond was estimated to be 698.36 ft (212.86 m) NAVD 88 as presented in Section 2.4.2. Wave run up within the ESWEMS Retention Pond during the local intense precipitation event was analyzed and discussed in Section 2.4.8. The wave action elevation resulting from the 1,000 year wind event, assuming that the initial water surface elevation within the ESWEMS Retention Pond is equivalent to 698.36 ft (212.86 m) NAVD 88, was estimated to be 699.83 ft (213.31 m) NAVD 88. Therefore, there is 0.17 ft (0.05 m) of freeboard to the top of the dike embankment at elevation 700 ft (213.4 m) NAVD 88 and 0.67 ft (0.20 m) of freeboard to the grade level of the ESWEMS at elevation 700.5 ft (213.5 m) NAVD 88.

Section 2.4.4 discusses the water control structures within the Susquehanna River Basin and potential flood impacts to the safety-related facilities on site that would occur in the event of simultaneous dam failures. The peak flow resulting from the dam break discharges on the Susquehanna River near the project site is estimated to be 244,000 cfs (6,909 m^3/s). The resulting peak flow is less than the peak flow on record from Hurricane Agnes (345,000 cfs (9,769 m^3/s) at Wilkes-Barre on June 24th 1972 and 363,000 cfs (10,279 m^3/s) at Danville on June 25th, 1972 (USGS, 2008a)(USGS,2008b)), during which a river crest of 517.35 ft (157.69 m) msl was observed near the SSES Units 1 and 2 intake structure (Ecology III, 1986). Therefore, the water level from the simultaneous failure of upstream dams is significantly below the finished plant grade elevation of 719 ft (219.2 m) NAVD 88, and the estimated flow of 244,000 cfs (6909 m^3/s) will not impact the BBNPP site.

The BBNPP site lies approximately 107 mi (172 km) inland from the Chesapeake Bay, which is downstream from the BBNPP site. Because the plant site is more than 100 mi (161 km) from the nearest coast, the elevation of the plant is 206 ft (62.8 m) above the 100-yr floodplain of the Susquehanna River, and there are no major water bodies adjacent to the BBNPP property, potential tsunami flooding and storm surge and seiches flooding are not applicable considerations for this site and are not factors which could cause flooding. Further discussion is presented in Section 2.4.5 and Section 2.4.6.

2.4.1.2 Hydrosphere

2.4.1.2.1 Hydrological Characteristics

Two hills extend from the east to west along the north side of the BBNPP property, and Walker Run flows through the valley that they form (see Figure 2.4-3). The highest ground surface elevation within the Walker Run watershed is approximately 1,160 ft (353.6 m) NAVD 88. Surface elevations decrease to the east and south toward the NBSR. Surface runoff from the Walker Run watershed drains via small streams southward toward the NBSR. These streams include one named stream (Walker Run) and two small unnamed streams (Unnamed Tributary-1 and Unnamed Tributary-2); note that the Unnamed Tributary-3 discharges directly to the NSBR and is located outside of the Walker Run watershed. In addition, several small ponds are located within the Walker Run watershed (see Figure 2.4-3).

There is a considerable drop in elevation from the hill tops within the Walker Run watershed to the Susquehanna River. Table 2.4-1 shows the approximate runoff flow path lengths and slopes within the Walker Run watershed sub basins.

2.4.1.2.1.1 Susquehanna River

The Susquehanna River is approximately 444 mi (715 km) in length. The Susquehanna River has its headwaters at Cooperstown, Otsego County, located in upstate New York (NY). The Susquehanna River profile is shown in Figure 2.4-6.

The Susquehanna River Basin has a delineated area of 27,510 mi^2 (71,251 km^2) (SRBC, 2008b). The location and extent of the Susquehanna River Basin and its six (6) sub-basins are shown in Figure 2.4-1. More than three-quarters of the entire Susquehanna River Basin lies in Pennsylvania (PADEP, 2008e).

In New York, several headwater tributaries discharge into the Susquehanna River including the Unadilla, the Chenango, the Otselic and the Tioughnoiga rivers (PADEP, 2008g). To the west, the Chemung River is formed by Cohocton, Canisteo, Cowanesque and Tioga rivers. The Chemung River joins the Susquehanna in Bradford County, Pennsylvania. In total, 6,275 mi^2 (16,252 km^2) of New York drain to the Susquehanna River (PADEP, 2008g).

In Pennsylvania, the Susquehanna River flows south and east before turning southwest above Wilkes-Barre. The branch of the Susquehanna River upstream from Sunbury is unofficially referred to as the NBSR. From Sunbury, the river flows south towards Harrisburg, being joined north of Harrisburg by another large tributary, the Juniata. Beyond Harrisburg, the Susquehanna River again turns southeast forming the boundary between York and Lancaster counties before entering Maryland (PADEP, 2008g). At its mouth, it empties into the northern end of the Chesapeake Bay at Havre de Grace, Hartford County, Maryland (MD), at an elevation of 0 ft (0 m) msl.

The BBNPP site is located within the Middle Susquehanna River sub-basin. The Middle Susquehanna River Sub-Basin covers an area of 3,771 mi^2 (9,767 km^2).

2.4.1.2.1.2 North Branch of the Susquehanna River (NBSR)

The branch of the Susquehanna River upstream from Sunbury is unofficially referred to as the NBSR. The NBSR flows southeast through high, flat-topped plateaus separated by steep-sided valleys. As it flows downstream the NBSR is joined by the Lackawanna River where it turns southwest and flows towards Sunbury, PA (SRBC, 2008a).

The NBSR flows through 8 counties in Pennsylvania, while receiving drainage from areas within 14 counties in Pennsylvania.

The NBSR is utilized to supply makeup to the Circulating Water System and Raw Water Supply System. It does not serve as the ultimate heat sink. The NBSR is not utilized for any safety-related purposes. Low water levels in the NBSR are investigated in Section 2.4.11.

2.4.1.2.1.3 Walker Run & Unnamed Tributary-1

Walker Run flows towards the south until it converges with the NBSR, at approximately River Mile 164 (264 km). Walker Run collects runoff from the area surrounding the BBNPP site and areas north, west, and southwest of the BBNPP site. The drainage area for the Walker Run watershed is approximately 4.32 mi^2 (11.16 km^2) (Figure 2.4-3). Walker Run has a difference in elevation of approximately 290 ft (88.4 m) over its entire length with an overall slope of 1.5% .

Unnamed Tributary-1 (also known as the East Branch of Walker Run) flows along the eastern and southern protected area boundary of BBNPP and discharges into Walker Run on the southwest side of the BBNPP protected area boundary (see Figure 2.4-3).

2.4.1.2.1.4 Unnamed Tributary-2

A second unnamed tributary (Unnamed Tributary-2) flows southeastward through the BBNPP property and empties into Unnamed Tributary-1 (see Figure 2.4-3).

2.4.1.2.1.5 Unnamed Tributary-3

A third unnamed tributary (Unnamed Tributary-3) flows southeastward below the BBNPP property and empties into the NBSR about 0.8 mi (1.3 km) upstream from the Walker Run confluence. Its drainage area is not part of the Walker Run watershed (see Figure 2.4-3).

2.4.1.2.1.6 Gauging Stations

There are no gauging stations within the Walker Run watershed. The NBSR gauging stations in Pennsylvania that gauge both surface water elevation and water flow and are located close to the BBNPP site, include the United States Geological Survey (USGS) gauging stations at Wilkes-Barre, PA (Station No. 01536500), and Danville, PA (Station No. 01540500). These stations are located upstream, and downstream of the proposed BBNPP Intake Structure, respectively (Figure 2.4-7).

The Wilkes-Barre gauging station is located approximately 24 mi (38.6 km) upstream from the BBNPP site. The drainage area of the NBSR at Wilkes-Barre is approximately 9,960 mi^2 (25,796 km^2) (USGS, 2008b), and the average annual flow calculated from the mean daily streamflow data recorded at the USGS gauging station for a 108-yr period (1899-2006) is 13,641 cfs (386 m^3/s) (USGS, 2008i). At Wilkes-Barre, the maximum streamflow was recorded on June 24th, 1972 and noted as 345,000 cfs (9,769 m^3/s) and the daily minimum streamflow noted was 532 cfs (15.1 m^3/s), recorded on September 27th, 1964 (USGS, 2008i). The maximum recorded flood level was 551.77 ft (168.18 m) NAVD 88, recorded on June 24, 1972 (USGS, 2008i). Temperature data has not been recorded for this station.

Peak annual streamflow recorded at the Wilkes-Barre gauging station is presented in Table 2.4-2 (USGS, 2008b). Monthly streamflows and mean, maximum and minimum daily streamflows at Wilkes-Barre, PA, are presented in Table 2.4-3 through Table 2.4-6, respectively (USGS, 2008i). Mean streamflow discharges at Wilkes-Barre are also presented in Figure 2.4-8 along with maximum and minimum monthly average values.

The USGS gauge at Danville, PA (Station No. 01540500) has been in continuous operation since April 1905 (USGS, 2008a). The Danville gauging station is located approximately 28 mi (45 km) downstream from the BBNPP Site. The drainage area of the NBSR at Danville is approximately 11,200 mi^2 (29,008 km^2) (USGS, 2008a). The average annual flow calculated from the mean daily data recorded during the 102-year period (1905-2006) is 15,483 cfs (438 m^3/s) (USGS, 2008a). At Danville, the maximum streamflow at this station was 363,000 cfs (10,279 m^3/s) (USGS, 2008h), which was recorded on June 25, 1972, during Hurricane Agnes. The maximum flood level, 462.69 ft (141.03 m) NAVD 88, was recorded on the same date (June 25, 1972) and the daily minimum streamflow noted was 558 cfs (15.8 m^3/s), recorded on September 24th, 25th and 27th in 1964 (USGS, 2008h).

Peak annual streamflow recorded at the Danville gauging station is presented in Table 2.4-7 (USGS, 2008a). Monthly streamflows and mean, maximum and minimum daily streamflows at Danville, PA, are presented in Table 2.4-8 through Table 2.4-11 (USGS, 2008h), respectively.

Mean streamflow discharges at Danville are also presented in Figure 2.4-9 along with maximum and minimum monthly values.

2.4.1.2.1.7 Periods of Peak Streamflow

Hurricane Agnes caused the maximum flood on record within the area that was defined previously as the North Branch of the Susquehanna River (NBSR). The critical factor affecting the record flooding was the near continuous nature of rainfall during the hurricane. From June 21-25, an average of 6-10 inches (15-25 cm) of rain fell over the Mid-Atlantic region (NOAA, 2008). These high rainfalls produced record flooding on the Susquehanna River, equaling or exceeding flood recurrence intervals of 100 years along portions of the Susquehanna River (NOAA, 2008). Hurricane Agnes generated peak stream flows of 345,000 cfs (9,769 m^3/s) at Wilkes-Barre on June 24th and 363,000 cfs (10,279 m^3/s) at Danville on June 25th (USGS, 2008a)(USGS, 2008b).

On June 25, 1972 a river crest of 517.35 ft (157.7 m) msl was observed near the SSES intake structure (Ecology III, 1886). The BBNPP finished plant grade will be at approximately elevation 719 ft (219.2 m) NAVD 88, which is approximately 202 ft (61.6 m) above the recorded peak flood elevation.

2.4.1.2.1.8 Bathymetry of the North Branch of the Susquehanna River (NBSR)

The bathymetry of the NBSR near the BBNPP Intake Structure is illustrated in Figure 2.4-10. Streambed elevations in the vicinity of the BBNPP Intake Structure range from 473 to 490 ft (144 to 149 m) NAVD 88. The BBNPP Intake Structure draws water from the NBSR through a 9 ft (3 m) opening from 474 to 483 ft (144 to 147 m) NAVD 88. The design basis low water level elevation is 484 ft (148 m) NAVD 88. As a result, the bathymetry of the NBSR will not be affected by the intake system.

2.4.1.2.1.9 Floodplain of the North Branch of the Susquehanna River (NBSR)

The elevation of the NBSR, 100-yr floodplain is approximately 513 ft (156 m) National Geodetic Vertical Datum of 1929 (NGVD 29) (FEMA, 2008), or 512.3 ft (156.1 m) NAVD 88, and the floodplain illustrated in Figure 2.4-13 and Figure 2.4-14, is approximately 0.44 mi (0.71 km) wide in this area. The FEMA Flood Insurance Rate Map in the vicinity of the BBNPP property (Figure 2.4-11 through Figure 2.4-14) shows that the predicted Susquehanna River flooding that will occur during a 500-yr recurrence interval extends up to elevation 514 ft (157 m) NGVD 29, or 513.3 ft (156.5 m) NAVD 88, near the BBNPP Intake Structure. Figure 2.4-11 through Figure 2.4-14 show the 100-yr and 500-yr Susquehanna River flooding impacts in the vicinity of the BBNPP site. The BBNPP finished plant grade elevation will be 719 ft (219.2 m) NAVD 88, thus the BBNPP property is approximately 206 ft (62.8 m) above the NBSR 100-yr floodplain and 205.7 ft (62.7 m) above the NBSR 500-yr floodplain

Figure 2.4-11 and Figure 2.4-12 illustrates the predicted 100-yr and 500-yr flood levels in the Walker Run watershed and the Susquehanna River. The 100-yr and 500-yr flood on Walker Run brings water levels to elevations 658 ft (200.6 m) and 659 ft (201 m) NGVD 29, or 657.3 ft (200.3 m) and 658.3 ft (200.6 m) NAVD 88, respectively. The BBNPP finished plant grade will be at elevation 719 ft (219.2 m) NAVD 88. Thus, flooding from a 100-yr or a 500-yr storm should be at least 60 or 61 ft (18.3 or 18.6 m) below the plant grade.

2.4.1.2.2 Dams and Reservoirs

A total of 492 water control structures are located on tributaries that drain into the Susquehanna River upstream of the site (Figure 2.4-15). However, there are no dams on the main stem of the Susquehanna River upstream from the BBNPP site. Only select upstream dams identified on Figure 2.4-15 were considered in Section 2.4.4 when evaluating the effects of potential dam failures. All available information in reference to these selected upstream dams, including pool elevations and storage volumes, is presented in Table 2.4-12.

Figure 2.4-15 also shows dams located downstream from BBNPP. The Adam T. Bower Memorial Dam is the world's largest inflatable dam and the first dam downstream from the site of the BBNPP Intake Structure. The Adam T. Bower Memorial Dam was completed in 1970 and creates a 3,060-acre (1238-ha) lake during summer months (DCNR, 2008). The dam and lake are part of the Shikellamy State Park in Snyder County, PA.

2.4.1.2.3 Surface Water Users

In the Susquehanna River Basin, water use is regulated by the Susquehanna River Basin Commission (SRBC). Water use in Pennsylvania, is registered with and reported to the Pennsylvania Department of Environmental Protection (PADEP).

The Water Resources Planning Act (Act 220) requires the PADEP to conduct a statewide water withdrawal and use registration and reporting program (PADEP, 2008a). Each public water supply agency, each hydropower facility (irrespective of the amount of withdrawal), and each person who withdraws or uses more than 10,000 gallons of water per day (gpd) (37,854 liters per day (lpd)) over any 30-day period, must register their withdrawal or withdrawal use.

The SRBC, was created by a compact between the Federal government and the three states within which the Susquehanna River Basin lies. Operations subject to the SRBC are those that exceed the consumption rate of 20,000 gpd (75,708 lpd) over a 30-day average (SRBC, 2007) or that exceed an average withdrawal (groundwater, surface water or combined) of 100,000 gpd (378,541 lpd) over a 30-day period. Consumption rates less than the 20,000 gpd (75,708 lpd) fall under the Water Resources Planning Act (Act 220).

The Middle Susquehanna sub-basin (Figure 2.4-1) is 3,755 mi^2 (9,725 km^2) in area and has a population representing 16% of the total Susquehanna River Basin. Total water consumption (surface water and groundwater) in the sub-basin is: 40.7% for power generation, 37.6% for municipal use, 15.2% for industrial use, 4.1% for agriculture, and 2.4% for domestic use (SRBC, 2008a).

Surface water use data for Luzerne County were obtained from the PADEP (PADEP, 2008f). Figure 2.4-16 illustrates the registered surface water withdrawal locations reported by major water users in Luzerne County (PADEP, 2008a). This figure does not include public water supplies, because the state does not publish the locations of public water supplies for security reasons. Table 2.4-13 identifies active surface water users (not including the public water supplies) within Luzerne County (PADEP, 2008f); these withdrawals are mainly used for irrigation and industrial purposes. Figure 2.4-17 shows the locations of the surface water intakes portrayed in Figure 2.4-16, but includes only those which are within a 5 mi (8 km) radius of the BBNPP site. SSES Units 1 and 2 are the largest water user in the vicinity of the BBNPP site. Presently, Walker Run is not among the listed sources of water for agricultural, domestic, or industrial purposes.

Water usage at SSES Units 1 and 2 is regulated by SRBC under Docket No. 19950301-1. SSES Unit 1 and 2 reported an average withdrawal of 58.3 million gallons per day (MGD) (220 million lpd). The maximum allowable withdrawal rate is 66 MGD (250 million lpd). The peak daily consumptive water allowed is 48 MGD (182 million lpd).

Table 2.4-14 shows the consumptive water use pattern by SSES Units 1 and 2 from 2001 to 2006 (PPL, 2008). During that period, the highest total monthly consumptive use was 1,175 million gallons per month (4,448 million liters per month) in July 2002, and an annual average consumptive use (from 2001 to 2006) of 909.5 million gallons per month (3,443 million liters per month).

Between 1961 and 2002, the Susquehanna River had an annual mean flow of 14,586 cfs (413 m^3/s) (NRC, 2006) (USEPA, 2008a). The SRBC works with local, state, and federal agencies to augment and protect in stream water needs during times of low flow. As part of this low flow management, activities such as the low flow augmentation for the existing SSES Units 1 and 2 were achieved by an agreement between Pennsylvania Power and Light Company (PPL) and the U.S. Army Corps of Engineers (USACE). USACE manages the Cowanesque Reservoir located in Lawrenceville, PA, to provide water supply storage and releases during low flow periods to replace the consumptive water use by SSES Units 1 and 2. In addition, the SRBC dictates that if the surface-water withdrawal impact is minimal in comparison to the natural or continuously augmented flows of a stream or river, no further mitigation is necessary (SRBC, 2002).

Currently, the SRBC is studying existing reservoirs to identify additional water storage capacity that might be released during low flow in the Susquehanna River.

Major public water Suppliers within Luzerne and Columbia Counties are presented in Table 2.4-15 (USEPA, 2008b) (PADEP, 2008d). Water sources for Luzerne and Columbia counties include lakes, rivers, reservoirs, and their tributaries, but does not include water withdrawal directly from the Susquehanna River.

Surface and wastewater discharges at SSES Units 1 and 2 are regulated through the National Pollutant Discharge Elimination System (NPDES). In Pennsylvania, these are issued and enforced by the PADEP Bureau of Water Management. The SSES Units 1 and 2 current NPDES permit (Permit No. PA0047325) was effective beginning on September 1, 2005, and is valid through August 31, 2010. Table 2.4-16 shows the average and maximum monthly SSES cooling tower blowdown discharge rates from 2000 through 2007 (PPL, 2008). The highest recorded monthly maximum discharge (17.78 MGD, or 67 million lpd) occurred in 2003.

Figure 2.4-18 illustrates water pollution control facilities locations within a 5-mile (8-km) radius from BBNPP and Figure 2.4-19 shows their locations within Luzerne County. Table 2.4-17 lists the water pollution control facilities located within Luzerne County. PADEP has recorded 159 outfalls in Luzerne County and 1,723 outfalls within a 50-mile (80-km) radius of the BBNPP site (PADEP, 2008c). Since each individual permit may have more than one outfall, the number of actual permits is less than the number of outfalls quoted above.

2.4.1.2.4 Groundwater Characteristics

The local and regional groundwater characteristics are described in Section 2.4.12. A detailed list of current groundwater users, groundwater well locations, and the withdrawal rates in the vicinity of the BBNPP site is presented in Section 2.4.12.2.

The water source to meet the water demand requirements during operation of the BBNPP is the Susquehanna River. All cooling makeup water will be obtained from the Susquehanna River. All water for drinking and several other smaller uses will be obtained from a public water supply (Luzerne County). Construction water needs are expected to be satisfied by obtaining water from the nearby township. Additional information regarding the use of groundwater at the BBNPP site is presented in Section 2.4.12.1.4.

2.4.1.3 References

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2.4.2 Floods

The U.S. EPR FSAR includes the following COL Item in Section 2.4.2:

> A COL applicant that references the U.S. EPR design certification will identify site-specific information related to flood history, flood design considerations, and effects of local intense precipitation.

This COL Item is addressed as follows:

{This section identifies historical flooding at the site and in the region of the site. It summarizes and identifies individual flood types and combinations of flood producing phenomena in establishing the flood design basis for safety-related plant features. This section also covers the potential effects of local intense precipitation. Although topical information is discussed in

Section 2.4.3 through Section 2.4.7 and Section 2.4.9, the types of events considered and the controlling event are reviewed in this section.

References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

Section 2.4.2.1 through Section 2.4.2.4 are added as a supplement to the U.S. EPR FSAR.

2.4.2.1 Flood History

The BBNPP site is located on a relatively flat upland area 219 ft (66.8 m) above the North Branch of the Susquehanna River (NBSR) water level. The proposed BBNPP Intake Structure is approximately 22 mi (35 km) downstream of Wilkes-Barre, PA and 5 mi (8 km) upstream of Berwick, PA. The BBNPP site is situated in the Walker Run watershed, which has a drainage area of 4.32 mi^2 (11.16 km^2). Walker Run flows along the western side of the BBNPP Property Boundary and discharges into the Susquehanna River at approximately river mile 164 (264 km). The "Unnamed Tributary 1" (see Figure 2.4-3) flows along the south/southeast boundary of the site and discharges into Walker Run south of the BBNPP. Flood potential from Walker Run is discussed in Section 2.4.3.

The closest gauging station to the BBNPP site in the Susquehanna River is the United States Geological Society (USGS) station at Bloomsburg, PA (number 01538700). However, this gauging station has only been in service since 1994 and the available USGS reports include gauge height only (USGS, 2009).

The closest gauging stations to the BBNPP in the Susquehanna River that report both surface water elevation and water flow are USGS stations at Wilkes-Barre, PA (number 1536500) and Danville, PA (number 1540500), which are upstream and downstream of river mile 164 (264 km) (the confluence of Walker Run), respectively (see Figure 2.4-7).

Gauging of the Susquehanna River on a continuous basis began in 1900 at Wilkes-Barre and 1905 at Danville. The 1972 flood that occurred throughout the Mid-Atlantic United States as a result of Hurricane Agnes is the most significant flood event on record. The critical factor affecting the record flooding was the near continuous nature of rainfall during Hurricane Agnes. From June 20-25, 1972 an average total of 6-10 inches (15-25 cm) of rain fell over the Mid-Atlantic region (NOAA, 2008). These high rainfalls produced record flooding on the Susquehanna River, equaling or exceeding 100 year flood recurrence intervals along portions of Susquehanna River (NOAA, 2008). The 1972 flood generated peak stream flows of 345,000 cfs (9,769 m^3/s) at Wilkes-Barre on June 24th and 363,000 cfs (10,279 m^3/s) at Danville on June 25th (USGS, 2008a)(USGS,2008b). On June 25, 1972 a river crest of 517.36 ft (157.69 m) mean sea level (msl) and mean daily flow of 329,837 cfs (9,340 m^3/s) was recorded near the SSES intake structure (Ecology III, 1986).

At Wilkes-Barre, the maximum recorded flood level was 40.91 ft (12.47 m) (elevation 551.77 ft, 168.18 m) NAVD 88, recorded on June 24, 1972. In Danville, the maximum flood level, 32.16 ft (9.80 m) (elevation 462.69 ft, 141.03 m) NAVD 88, was recorded on June 25, 1972. Maximum stream flow records are presented and discussed for both stations in Section 2.4.1.
Figure 2.4-20 shows the recorded peak streamflow for Wilkes-Barre and Danville gauging stations (USGS, 2008a and 2008b).

Susquehanna River flooding is primarily the result of runoff from the large contributing drainage area due to heavy rainfall and snowmelt during the spring and early summer seasons. During a large flood, the Susquehanna River spills over its banks onto the broad floodplain areas of the valley. Aylesworth Creek Dam and Stillwater Dam are the only significant water control structures with flood control storage capacity within the Middle Susquehanna Sub-basin. There are no dams present in the Walker Run watershed.

As discussed in Section 2.4.7, ice sheets have formed on the Susquehanna River on more than one occasion. Despite the formation of ice on the Susquehanna River, there have been no instances of ice jams or ice induced flooding at the existing Susquehanna SES Units 1 and 2 intake. Further details of historic ice sheets and ice effects are discussed in Section 2.4.9.

Landslides (submarine or subaerial) have occurred in the vicinity of the BBNPP site but have not caused any flooding impacts at the existing SSES Units 1 and 2. Landslide impacts are further discussed in Section 2.4.3 and Section 2.4.9.

2.4.2.2 Flood Design Considerations

The design basis flood elevation for the BBNPP site is determined by considering a number of different flooding possibilities. The possibilities applicable and investigated for the site include the Probable Maximum Flood (PMF) on streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami, and ice effect flooding. Each of these flooding scenarios was investigated in conjunction with other flooding and meteorological events, such as wind generated waves, as required in accordance with the guidelines presented in ANSI/ANS 2.8-1992 (ANS, 1992). Detailed discussions on each of these flooding events and how they were estimated are found in Section 2.4.3 through Section 2.4.8. Adequate drainage capacity will be provided to prevent flooding of safety-related facilities due to local intense rainfall and to convey storm water runoff from the roofs and buildings away from the plant. Stormwater from the roof drains will be drained through the downspouts for each of the plant buildings and will be collected and routed into the drainage system.

The estimation of the PMF water levels on Walker Run and tributary creeks located near the BBNPP site are discussed in detail in Section 2.4.3. Section 2.4.3 describes the Walker Run watershed models that were developed to determine the runoff hydrographs, peak flows, and resulting flood stage elevations. The scope of this analysis includes the HEC-HMS 3.1.0 evaluation of the all-season Probable Maximum Storm (PMS) to develop the runoff hydrographs and peak flows, and the HEC-RAS 3.1.3 evaluation to determine the resulting flood stage elevations in the vicinity of the site.

As noted above, on June 25,1972 a river crest of 517.36 ft (157.69 m) msl was recorded near the SSES intake structure (Ecology III, 1986). The BBNPP plant grade elevation is 719 ft (219.2 m) NAVD 88. Therefore, Susquehanna River flooding similar to the maximum recorded events will not affect the plant.

Section 2.4.4 discusses the water control structures within the Susquehanna River Basin and potential flood impacts to the safety-related facilities on site that would occur in the event of simultaneous dam failures.

Probable maximum surge and seiche flooding on the Susquehanna as a result of the probable maximum hurricane is discussed in Section 2.4.5. Because of the location of the BBNPP site relative to the nearest coast and the elevation of the plant relative to the Susquehanna River, storm surge and seiche flooding considerations are not applicable for this site.

Section 2.4.6 describes the derivation of the Probable Maximum Tsunami (PMT) flooding. The potential of Tsunami events that could affect the BBNPP site caused by local or distant seismic activities is negligible. The BBNPP site is too far inland from the coastal line (approximately 107 mi (172 km) inland from the nearest coast which is the Chesapeake Bay) to suffer from any tsunami flooding. Thus, the PMT does not pose a flood risk to the BBNPP site.

The maximum water level due to local intense precipitation or the local Probable Maximum Precipitation (PMP) is estimated and discussed in Section 2.4.2.3. The maximum water level in the Power Block area due to the local 1 hour 1 mi^2 PMP event is at elevation 718.36 ft (218.96 m) NAVD 88. This water level becomes the design basis flood elevation for all safety-related facilities in the Power Block area. All safety-related building entrances in the Power Block are located above this elevation at an elevation of 720 ft (219.5 m) NAVD 88.

2.4.2.3 Effects of Local Intense Precipitation

All runoff will be routed through drainage (or infiltration) basins based on the site drainage system as shown on Figure 2.4-102. Site drainage areas were established based on the direction in which surface runoff is routed to each drainage basin and detention basin. The result was seven distinct drainage areas, which are shown on Figure 2.4-103. The site grading plan, which is also presented in Figure 2.4-103, is supplementary to the site drainage system design. Local intense precipitation was evaluated at the site using U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC)-Hydrologic Modeling System (HMS) Version 3.1.0 software (USACE, 2006). The parameters needed to construct the HEC-HMS 3.1.0 model are as follows:

1. Specified hyetograph for the rainfall event
2. Drainage areas
3. Soil Conservation Service (SCS) Loss Parameters
    - SCS Curve Number
    - Initial Abstraction
    - Percentage of drainage area that is impervious
4. SCS Unit Hydrograph Transformation
    - Lag Time
5. Reservoir Element Input: elevation-area / elevation-storage curves for the drainage areas, the assumed starting water surface elevations and the discharge structure lengths, elevations, and coefficients
6. Reach Element Input: reach lengths, cross-sections, slopes and Manning's n coefficients.

The 1-hour, 1 square mile Probable Maximum Precipitation (PMP) event is the worst-case scenario when analyzing the site drainage areas containing all safety-related structures since the intense rainfall over a short duration allows more water to accumulate within the drainage areas before draining when compared to a longer duration PMP of less temporal intensity. Note that the peak incremental rainfall over a 5-minute duration is 5.90 inches during the 1-hour PMP but only 1.60 inches during the 72-hour PMP. Under the assumption that no losses occur, the 72-hour PMP event for a 10 square mile area at the location of the proposed site is the worst-case scenario when analyzing the ESWEMS Pond since it generates more total rainfall than the 1-hour PMP event. The design basis for local intense precipitation is the all-season Probable Maximum Storm (PMS) as obtained from the U.S. National Weather Service (NWS) Hydro-meteorological Report Number 52 (HMR-52) (NOAA, 1982). The cumulative storm hyetograph for the 1-hour PMP event was generated by using ratio analysis to obtain the 5-minute, 15-minute and 30-minute PMP from the Hydrometeorological Report Number 52 (HMR-52) once the 1-hour PMP was determined (NOAA, 1982). The 1-hour cumulative rainfall hyetograph was used as the time-series input when conducting the site drainage system Probable Maximum Flood (PMF) analysis in HEC-HMS 3.1.0. Table 2.4-18 shows the PMP depths obtained from the HMR-52 for the 1-hour storm event. The 72-hour cumulative rainfall hyetograph was determined over the Walker Run Watershed drainage area using the HMR-52 computer program. The 72-hour cumulative rainfall hyetograph was used as the time-series input when conducting the ESWEMS Pond PMF analysis in HEC-HMS 3.1.0 (USACE, 2006). Table 2.4-19 shows the PMP depths obtained from the HMR-51 report for the 72-hour storm event (NOAA, 1978).

As stated previously, there are seven site drainage areas (see Figure 2.4-103) that were defined based on the site drainage system design. When analyzing the effects of local intense precipitation at the site, the Power Block area (i.e., Basin 10.4; see Figure 2.4-103) was divided into additional areas in order to evaluate ponding effects in the vicinity of the safety-related structures: Basin 10.4A includes the area that is occupied by all safety related structures at elevation 718 ft NAVD 88 (top of soil reflecting 12 inches of crushed stone below elevation 719 ft NAVD 88) based on the site grading plan, Basin 10.4B receives the overflow from Basin 10.4A and conveys all runoff away from the plant, and Basin 10.4C (which is located immediately west of the safety-related ESWEMS Pond) acts as a catch basin by collecting overflow from the Wetland Area. The nine drainage areas that are considered in the HEC-HMS 3.1.0 model are shown on Figure 2.4-104 and presented in Table 2.4-20.

Both SCS basin loss and hydrograph transformation methods were applied since the site drainage areas are small (tens of acres) and fully developed. SCS procedures are applicable in small watersheds, especially urbanized watersheds, in the United States (USDA, 1986). SCS loss method parameters representing a worst-case scenario in which all rainfall is converted to runoff were used when modeling the effects of local intense precipitation at the site: the curve number (CN) was assumed to be 98, the initial abstraction was assumed to be 0 inches, and the site was assumed to be 100 percent impervious. The runoff lag time ($\mathbf{T_{lag}}$) needed to be determined for each of the nine site drainage areas shown on Figure 2.4-104 when using the SCS unit hydrograph transformation method for developing peak discharges within the site drainage areas in HEC-HMS 3.1.0. The runoff time of concentration ($\mathbf{T_c}$) was estimated for each site drainage area under the assumption that all runoff acts as shallow concentrated flow (USDA, 1986). Figure 2.4-105 shows the drainage area flow paths that were used to estimate $\mathbf{T_c}$. Once $\mathbf{T_c}$ was estimated, $\mathbf{T_{lag}}$ was calculated using the following equation (USACE, 2000):

$\mathbf{T_{lag} = 0.6 * T_c}$ (Equation 2.4.2-1)

Note that the ESWEMS Pond catchment, Basin 10.4A and Basin 10.4C were assumed to store runoff with no time lag ($\mathbf{T_{lag}}$ = 0); therefore, no runoff transform method was used. Table 2.4-70 shows the estimated $\mathbf{T_c}$ and $\mathbf{T_{lag}}$ for each site drainage area.

All overflow pipes, culverts and drainage basins are assumed to be clogged as a result of ice or debris blockage when modeling the effects of local intense precipitation at the site, and all drainage ditches are assumed to be full in order to simulate the "worst-case-scenario" site drainage condition. Therefore, all site drainage areas were simply modeled as storage reservoirs in HEC-HMS 3.1.0. A schematic of the site drainage HEC-HMS 3.1.0 model is provided on Figure 2.4-21. The storage capacity of each reservoir element within the HEC-HMS 3.1.0 model (see Figure 2.4-21) was defined within the model using the "Elevation-Area" and "Elevation-Storage" methods. Reservoir element overflow was modeled using the "Outflow Structures" routing method in HEC-HMS 3.1.0; all site drainage area overflow was modeled as a broad-crested weir assuming a weir coefficient (C) of 2.63 for all discharge structure lengths greater than 15 ft (Brater and King, 1976) and a weir coefficient (C) of 2.65 for the 6-foot long ESWEMS Pond spillway (Brater and King, 1976). Note that the discharge structure length for the "Basin 10.4A" reservoir element, which was modeled as a spillway, was conservatively reduced by 20 percent which is an effective reduction in the length of the reservoir element. This was done in order to take into account the drainage effects resulting from a potential blockage of flow through the security fence along the perimeter of the Power Block.

Based on the grading plan, Basin 10.1 conveys excess stormwater runoff by way of open channel flow down and away from the plant. Therefore, one reach element (Basin 10.1 Reach) was incorporated into the site drainage HEC-HMS 3.1.0 model (see Figure 2.4-21). The Muskingum-Cunge method and eight-point method were used in HEC-HMS 3.1.0 to define the routing characteristics of the reach and the geometry of the reach, respectively. The Basin 10.1 reach and cross-section location is shown on Figure 2.4-106, and the eight-point cross-section for the Basin 10.1 reach is shown on Figure 2.4-107. The Manning's n coefficient was assumed to be 0.011, which is representative of smooth surfaces such as concrete, asphalt, gravel, or bare soil (USDA, 1986).

The safety-related structures in the Power Block area (i.e., Basin 10.4A) consist of two ESWS Cooling Towers located in the northwest corner, two ESWS Cooling Towers located in the southeast corner, Emergency Diesel Generator Buildings located north and south of the Nuclear Island and the Reactor complex, which consists of the Reactor, Fuel and Safeguards Buildings. The locations of the buildings are shown on Figure 2.4-4. The entrances to each of these structures are located at or above the finished floor grade elevation 720 ft (219.5 m) NAVD 88. Table 2.4-21 gives the entrance elevations at the various safety-related facilities and compares them with the water levels resulting from local intense precipitation (i.e., HEC-HMS 3.1.0 site drainage model results for the 1-hour PMP event) near those facilities. The maximum water level in the Power Block is elevation 718.36 ft (218.96 m) NAVD 88, which is 1.64 ft (0.50 m) below the reactor complex finished floor grade at elevation 720 ft (219.5 m) NAVD 88.

The ESWEMS Pond facility must be operational at all times the plant is in operation since it is classified as a safety-related facility under Nuclear Regulatory Commission (NRC) Regulatory Guide 1.27 (NRC, 1976). The maximum water level resulting from local intense precipitation (72-hour PMP event) in the ESWEMS Pond is elevation 698.36 ft (212.86 m) NAVD 88, which is 1.64 ft (0.50 m) below the top of the dike at elevation 700 ft (213.4 m). Basin 10.4C (which is located immediately west of the ESWEMS Pond) acts as a catch basin by collecting overflow from the Wetland Area. It was determined that the peak water surface elevation within Basin 10.4C is 694.77 ft (211.77 m) NAVD 88 during the 1-hour PMP storm event, which is 5.23 ft (1.59 m) below the ESWEMS Pond dike at El. 700 ft (213.4 m) NAVD 88. Although there is a peak outflow of 282.39 cfs (8.00 m3/s) from Basin 10.4C during the 1-hour PMP storm event, this outflow is conveyed away from the plant. The ESWEMS Pond is located within Basin 12, and it was determined that the peak water surface elevation within Basin 12 is 695.62 ft (212.02 m) NAVD 88 during the 1-hour PMP storm event, which is 4.38 ft (1.34 m) below the ESWEMS Pond dike. The finished floor grade elevation of the ESWEMS Pump House is 700.5 ft

(213.5 m) NAVD 88, which is 2.14 ft (0.65 m) above the peak water level in the ESWEMS Pond. Possible overtopping of the ESWEMS Pond dike due to wind generated waves during the local intense precipitation event is discussed in Section 2.4.8. A schematic layout of the ESWEMS is shown on Figure 2.4-36.

Based on the Power Block grading, entrance locations, and peak PMP water levels in each sub-basin, all safety-related facility entrances are located above the peak water levels resulting from local intense precipitation at the site.

2.4.2.4 References

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2.4.3 Probable Maximum Flood (PMF) on Streams and Rivers

The U.S. EPR FSAR includes the following COL Item in Section 2.4.3:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information to describe the probable maximum flood of streams and rivers and the effect of flooding on the design.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

The proposed Bell Bend Nuclear Power Plant (BBNPP) site is located in Salem Township, Luzerne County, Pennsylvania on the west side of the North Branch of Susquehanna River as shown on Figure 2.4-22. The source of potential flooding at the proposed site is local intense precipitation directly over the site. This section discusses the Probable Maximum Flood (PMF) on streams and rivers as a result of the Probable Maximum Precipitation (PMP) over the watershed.

All runoff from the BBNPP enters the North Branch Susquehanna River at the mouth of Walker Run. The BBNPP Powerblock sits on a relatively flat upland area about 219 ft (66.8 m) elevation above the nominal Susquehanna River level. The site is 22 mi (35 km) downstream of Wilkes-Barre, PA and 5 mi (8 km) upstream of Berwick, PA. The BBNPP site is situated in the Walker Run watershed, which is within the Middle Susquehanna River Sub-basin and has a drainage area of 4.32 mi^2 (11.16 km^2). Walker Run Stream flows along the western side of the BBNPP property. An Unnamed Tributary (Unnamed Tributary-1; see Figure 2.4-3) to Walker Run flows along the eastern and southern sides of the BBNPP protected area boundary and enters Walker Run on the southwest side of the BBNPP property. A second Unnamed Tributary (Unnamed Tributary-2; see Figure 2.4-3) flows through the BBNPP property and enters Unnamed Tributary-1 on the southern side of the BBNPP property.

The 1972 flood that occurred throughout the Mid-Atlantic United States as a result of Hurricane Agnes is the most significant flood event on record. The critical factor affecting the record flooding was the near continuous nature of rainfall during Hurricane Agnes. From June 20 through June 25, an average of 6-10 in (15-25 cm) of rain fell over the Mid-Atlantic region (NOAA, 2008). These high rainfalls produced record flooding on the Susquehanna River, equaling or exceeding flood recurrence intervals of 100 years along portions of Susquehanna River (NOAA, 2008).

The 1972 flood generated peak stream flows of 345,000 cfs (9,769 m^3/s) at Wilkes-Barre on June 24th and 363,000 cfs (10,279 m^3/s) at Danville on June 25th (USGS, 2008a)(USGS,2008b). On June 25, 1972 a river crest of 517.36 ft (157.7 m) mean sea level (msl) and mean daily flow of 329,837 cfs (9,340 m^3/s) was recorded near the SSES intake structure (Ecology III, 1986).

The Susquehanna River PMF peak discharge and water surface elevation near the BBNPP site were estimated by following the procedures provided in the United States Nuclear Regulatory

Commission (NRC) Regulatory Guide 1.59 (NRC, 1977) and the American National Standards Institute (ANSI)/ American Nuclear Society (ANS) 2.8 (ANS, 1992), respectively.

The PMF peak discharge was determined using the maps presented in Figures B.2 through B.7 of NRC Regulatory Guide 1.59 (NRC, 1977) Appendix B, which contains enveloping PMF isolines for index drainage areas of 100, 500, 1000, 5000, 10000, and 20000 square miles, respectively, for drainage areas of those sizes east of the 103rd meridian. As discussed in Appendix B of NRC Regulatory Guide 1.59 (NRC, 1977), the maps may be used to determine PMF Peak discharge as follows:

a. Locate the BBNPP site on the 100-square-mile map.

b. Read and record the 100-square-mile PMF peak discharge by straight-line interpolation between the isolines.

c. Repeat Steps (a) and (b) for 500, 1000, 5000, 10000, and 20000 square miles.

d. Plot the six PMF peak discharges so obtained versus drainage area on a log-log scale chart.

e. Select a trendline that best represents the plotted data.

f. Using the equation of the trendline selected in Step (e), calculate the PMF peak discharge for the BBNPP site using the area of the Susquehanna River Basin upstream from the BBNPP intake structure location.

The PMF peak discharge was estimated to be 1.13 million cfs (31,998 m^3/s) using the above procedure established in NRC Regulatory Guide 1.59 (NRC, 1977).

ANSI/ANS 2.8-1992 defines a flood-dry site as a site where "safety-related structures are so high above potential flood sources that safety from flooding is obvious or can be documented with minimum analysis" (ANS, 1992). Given that the proposed final plant grade elevation of the BBNPP Nuclear Island (719 ft [219.2 m] NAVD88) and ESWEMS Retention Pond (700 ft [213.4 m] NAVD 88) are 217 ft (66.1 m) and 198 ft (60.4 m), respectively above the Susquehanna River bank elevation of 502 ft (153.0 m) NAVD88, the BBNPP site can be classified as a flood-dry site. A PMF approximation procedure that is applicable for flood-dry sites is provided in Section 5 of ANSI/ANS 2.8 (ANS, 1992) as follows:

a. Estimate PMF peak discharge on the basis of drainage area relationships to discharge derived from available PMF studies in the region.

b. Estimate river stage using Manning's equation, average river channel bottom slope, river cross sections, and conservative friction factors.

c. Elevation should be tested for sensitivity to potential errors in estimated values.

Step (a) was accomplished by using the PMF relationships provided in NRC Regulatory Guide 1.59 (NRC, 1977) as discussed previously, yielding a PMF peak discharge estimation of 1.13 million cfs (31,998 m^3/s). The river stage corresponding to this PMF peak discharge was estimated using Manning's equation in accordance with Step (b). After taking the potential errors in estimated values into consideration per Step (c), the river stage was estimated to be

548 ft (167.0 m) NAVD 88 at the location of the proposed BBNPP intake structure. The BBNPP finished plant grade elevation is 719 ft (219.2 m) NAVD 88, which is 171 ft (52.1 m) above the PMF elevation of 548 ft (167.0 m) NAVD 88.

Walker Run and the Unnamed Tributaries 1 & 2 adjacent to the BBNPP protected area boundary were analyzed for the Probable Maximum Flood (PMF) due to their proximity to the plant. The analysis was based on the post construction topography to reflect the post-construction site layout as displayed on Figure 2.4-5. Walker Run flows towards the south until it converges with the Susquehanna River at approximately river mile 164 (km 264). Walker Run and Unnamed Tributaries 1 & 2 collect runoff from the area surrounding the plant and also areas northwest, west, and southwest of the plant. The total collection area for the Walker Run watershed is approximately 4.32 mi^2 (11.16 km^2), and all Walker Run sub-basin areas (see Figure 2.4-3) are provided in Table 2.4-22. Walker Run has a difference in elevation of approximately 290 ft (88.4 m) over its entire length with an overall slope of 1.5 percent. Walker Run and the Unnamed Tributaries 1 & 2 adjacent to the BBNPP protected area boundary were modeled together using the stream junction feature available within the Hydrologic Engineering Center's River Analysis System Version 4.1 (HEC-RAS 4.1) All safety-related structures, systems, and components within the BBNPP Power Block are located at a finished plant grade elevation of 719 ft (219.2 m) NAVD 88.

The results of the PMF analysis indicate a maximum PMF water surface elevation of 675.69 ft (205.95 m) NAVD 88 at cross section 12,764.15 along Walker Run, 672.34 ft (204.93 m) NAVD 88 at cross section 1614.092 along Unnamed Tributary 1, and 715.03 ft (217.94 m) NAVD 88 at cross section 1645.505 along Unnamed Tributary 2 in the vicinity of the NPP (see Figure 2.4-31). The grade elevation for the proposed BBNPP is 719 ft (219.2 m) NAVD 88, which provides a minimum elevation difference of 3.97 ft (1.21 m) below the finished plant grade along Unnamed Tributary-2 and an elevation difference of 43.31 ft (13.20 m) below the plant grade at Walker Run.

Section 2.4.3.1 through Section 2.4.3.7 are added as a supplement to the U.S. EPR FSAR.

2.4.3.1 Probable Maximum Precipitation (PMP)

The PMP was developed according to procedures outlined in the Hydrometeorological Report (HMR) Numbers 51 and 52 (NOAA, 1978; NOAA,1982). The PMP depths obtained from the isohyetal charts in the HMR-51 for an area of ten square miles are presented in Table 2.4-28. The PMP hyetograph has been estimated based on the size, shape, and geographic location of the Walker Run watershed in accordance with the procedures outlined in the HMR-52 (USACE, 1984). The Walker Run watershed covers an area of 4.32 mi^2 (11.16 km^2). The delineation of the watershed was manually digitized and is shown in Figure 2.4-3.

The distribution of the PMP storm was estimated using the procedures in HMR Numbers 51 and 52 (NOAA, 1978; NOAA,1982). Precipitation depth data is obtained from isohyetal charts presented in the HMR-51. This data, along with the watershed boundary coordinates and other parameters from the HMR-52 such as storm orientation and rainfall duration data, were input into the HMR-52 computer model (USACE, 1984) and the PMP was computed. In determining the hyetograph for the site, HMR-52 composes 5-minute incremental precipitation depths for the input depth-duration curves and then arranges them in a pre-selected order. The maximum incremental depth is placed at the middle of the storm duration, with the remaining incremental depths arranged in descending order, alternating before and after the central incremental depth.

The HEC-HMS 3.1.0 model, developed by the U.S. Army Corps of Engineers (USACE, 2006), was used to simulate the routing of increased stream flow generated by the PMP in the Walker Run watershed. A schematic of the Walker Run watershed HEC-HMS 3.1.0 model is provided on Figure 2.4-23. Only maximum all-season PMP distributions were considered, i.e., maximum fair weather, rainfall only distributions. The site is located within the 4.32 mi^2 (11.16 km^2) Walker Run watershed, so the short-duration intense summer rainfall storms would govern maximum runoff considerations. Table 2.4-25 provides the PMF peak flow results from the Walker Run watershed HEC-HMS 3.1.0 model were used as HEC-RAS 4.1 model input to determine PMF flood stage elevations near the proposed site. In addition, the PMF hydrographs corresponding to the hydrologic elements identified in Table 2.4-25 that are closest to the site (see Figure 2.4-29) are shown in Figure 2.4-25 through Figure 2.4-28. Typically, snowmelt floods are critical for very large watersheds of thousands of square miles. Based on the historical snowfall information for the BBNPP site region in Section 2.3, snowmelt does not make a significant contribution to flooding situations. Therefore, antecedent snow-pack conditions have not been considered in the PMF analysis.

2.4.3.2 Precipitation Losses

Precipitation losses for the Walker Run watershed are determined using the Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), runoff methodology (USDA, 1986). For this method, a composite runoff curve number (CN) is assigned to each sub-basin in the watershed (Table 2.4-23). The CN is used to describe the sub-basin's capacity to absorb and retain precipitation or produce runoff. Runoff curve numbers range from about 30 to 100, with higher numbers producing more runoff and lower numbers producing more infiltration. Each composite CN is determined based on the sub-basin's surface soils (SSURGO, 2008), land cover (PAMAP, 2005), and average antecedent moisture conditions. Percentages of impervious areas were selected based on cover conditions (Table 2.4-23). Impervious areas include open water bodies, roads, buildings, and the BBNPP.

2.4.3.3 Runoff and Stream Course Models

A schematic of the HEC-HMS 3.1.0 computer model for the Walker Run watershed is shown on Figure 2.4-23. The Clark unit hydrograph method (Clark, 1945)(Straub 2000) was used to transform rainfall to runoff by calculating discharge hydrographs for each sub-basin. There are no stream gages located within the watershed, so the methods of Straub (Straub, 2000) were used to estimate the Clark parameters for all sub-basin hydrographs (Table 2.4-24).

There are no historical records available to verify the results of the runoff analysis. However, the Clark unit hydrograph method is accepted in many regions of the United States, including the Mid-Atlantic Region, to estimate basin runoff and peak discharges from precipitation events.

The 8-point Muskingum-Cunge Method was used for stream/floodplain routing through the stream network to the watershed outlet (Miller, 1975) (Ponce 1978). Base flow in Walker Run, which is on the order of 1 to 10 cfs (0.03 to 0.30 m^3/s), is considered negligible for these calculations.

2.4.3.4 Probable Maximum Flood Flow

To account for changes in flow due to contributing subwatersheds and flow accumulation downstream, flow change locations were specified within the HEC-RAS 4.1 model when incorporating the PMF peak discharge results as estimated in HEC-HMS 3.1.0 in order to determine stream flood profiles and water surface elevations. All flow change locations (i.e. river stations in HEC-RAS 4.1 model), as well as the corresponding HEC-HMS 3.1.0 model junctions/ outlets and PMF peak discharge rates, are reported in Table 2.4-25. Runoff hydrographs at flow change locations near the proposed site are shown on Figure 2.4-25 through Figure 2.4-28.

2.4.3.5 Water Level Determination

Maximum water levels along Walker Run and Unnamed Tributaries 1 & 2 were determined utilizing the standard step backwater method for natural channels as implemented in the HEC-RAS 4.1 computer program developed by the U.S. Army Corps of Engineers (USACE, 2010). Required input for HEC-RAS 4.1 includes geometric cross section data, flow rates, expansion and contraction coefficients, roughness data, boundary conditions, and major obstructions such as bridges, culvert, and weirs. HEC-GeoRAS Version 4.2.93 was used for the preparation of geometric cross-section data and for extraction of Manning roughness values for import into the HEC-RAS 4.1 model.

The cross-section data was constructed using Light Detection and Ranging (LiDAR) data (horizontal ground resolution of 3.2 feet) of Luzerne County (PADCNR, 2006) for existing areas outside of the BBNPP site layout. For areas within the BBNPP property boundary, grading plans were used to depict post-construction conditions. For the ungraded area within the proposed BBNPP property boundary, (existing wetlands), a combination of pre and post-construction topography was used to represent future conditions.

The HEC-RAS 4.1 computer model cross section locations for Walker Run and Unnamed Tributaries 1 & 2 are shown on Figure 2.4-29. Cross-section locations near the vicinity of the proposed site are shown on Figure 2.4-31.

Manning's roughness coefficients for the stream channel and floodplain were estimated based on the intersection of cross-sections with land use polygons and procedures outlined by the USGS (USGS, 1990). For areas outside the boundaries of the BBNPP property, coefficients were estimated with HEC-GeoRAS 4.2.93 (USACE, 2009) using a land use feature class with Manning's n values stored for different land use types. For areas within the BBNPP property boundary, Manning roughness values were manually altered to reflect the post-construction site layout. Roughness coefficient values of 0.051 for the main channel, 0.032 for the main channel and overbank areas through the project area, 0.141 for the forest floodplain areas, and 0.066 for the farming/pasture floodplain areas were used in the HEC-RAS 4.1 model. Figure 2.4-30 shows the locations of the bridges and culverts that were included in the HEC-RAS 4.1 model. Flow over the bridge and culvert decks is considered as a broad-crested weir flow with a weir coefficient of 2.6 (USACE, 2008).

Since Walker Run discharges into the Susquehanna River, the estimated PMF water surface elevation at the confluence of Walker Run and Susquehanna River for the Susquehanna River PMF flow profile was used as a downstream boundary condition. The PMF water surface elevation at the confluence point was calculated to be 536.81 ft (163.62 m) NAVD 88. This water level was used as a downstream boundary condition.

The PMF flow rates at the flow change locations listed in Table 2.4-25 are input into the HEC-RAS 4.1 model at the indicated cross section locations (see Figure 2.4-29). The mixed flow option, which computes both sub-critical and super-critical flow regimes, was used to model the PMF profiles.

In addition to the standard PMF analysis, three additional scenarios were modeled: 1) PMF assuming all bridges are blocked by debris and sedimentation (see Figure 2.4-30), 2) PMF assuming a slope failure which blocks the stream channel, approximately 4,000 feet downstream (following the channel route) of the proposed plant (see Figure 2.4-30), 3) PMF with all bridges blocked and a slope failure blocking the Walker Run channel (i.e., scenario-1 + scenario-2; see Figure 2.4-30). There was only a small difference in water surface elevations between all four scenarios. The maximum water surface elevation at the BBNPP site which would affect the safety related structures was a result of the standard PMF peak discharge for Walker Run and the standard PMF peak discharge with bridges blocked and a slope failure (i.e., scenario 3) for Unnamed Tributary-1. The maximum water surface elevation near the vicinity of the BBNPP site for Unnamed Tributary-2 is the same in all the cases. All bridge locations and the location of the hypothetical landslide are shown on Figure 2.4-30.

The computed water surface elevations near the vicinity of the site for Walker Run and Unnamed Tributaries 1 &2 are summarized in Table 2.4-26 and Table 2.4-27, respectively. The Walker Run, Unnamed Tributary-1, and Unnamed Tributary-2 water surface profiles are shown on Figure 2.4-24, Figure 2.4-32, Figure 2.4-33, respectively.

From Table 2.4-26, the maximum water level in the area of the BBNPP site during the PMF event from Walker Run is elevation 675.69 ft (205.95 m) NAVD 88 at cross section 12,764.15 (see Figure 2.4-31). This is approximately 43.31 ft (13.20 m) below the finished plant grade elevation of 719 ft (219.15 m) NAVD 88.

From Table 2.4-27, the maximum water level in the area of the BBNPP site during the PMF event from Unnamed Tributary-1 is elevation 672.34 ft (204.93 m) NAVD 88 at cross section 1614.092 (see Figure 2.4-31). This is approximately 46.66 ft (14.22 m) below the finished plant grade elevation of 719 ft (219.15 m) NAVD 88.

From Table 2.4-27, the maximum water level in the area of the BBNPP site during the PMF event from Unnamed Tributary-2 is elevation 715.03 ft (217.94 m) NAVD 88 at cross section 1645.505 (see Figure 2.4-31). This is approximately 3.97 ft (1.21 m) below the finished plant grade elevation of 719 ft (219.15 m) NAVD 88.

The top roadway of the assumed culvert at Unnamed Tributary-2 was established at elevation 695 ft (211.8 m) NAVD 88 (access road elevation). As reported in Table 2.4-27, the water surface elevation at the inlet of this culvert is at 696.38 ft (212.26 m) NAVD 88, which is 3.62 ft (1.10 m) below the top elevation of the ESWEMS Pond dike at elevation 700 ft (213.4 m) NAVD 88, and 4.12 ft (1.26 m) below the ESWEMS Pump House at elevation 700.5 ft (213.5 m) NAVD 88.

2.4.3.6 Coincident Wind Wave Activity

Due to the high flow velocity of Walker Run perpendicular to the direction of the wind activity and the relatively short duration of high water elevation during a PMF event, the wind wave activity is negligible. Wind wave activity calculations are typical for standing water and are not applicable for relatively shallow, moving water with a short fetch. Thus, wave height estimation was not performed during the PMF evaluation of Walker Run.

2.4.3.7 References

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2.4.4 Potential Dam Failures

The U.S. EPR FSAR includes the following COL Item for Section 2.4.4:

> A COL applicant that references the U.S. EPR design certification will verify that the site-specific potential hazards to safety-related facilities due to the failure of upstream and downstream water control structures are within the hydrogeologic design basis.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

The proposed Bell Bend Nuclear Power Plant (BBNPP) site is located in Salem Township, Luzerne County, Pennsylvania to the northwest of the North Branch of the Susquehanna River (NBSR) as shown in Figure 2.4-22. Potential flooding at the proposed BBNPP site due to local intense precipitation falling directly onto the site and the resulting Probable Maximum Flood (PMF), as well as the PMF of nearby Walker Run, Unnamed Tributary-1, and Unnamed Tributary-2, were discussed in Section 2.4.2 and Section 2.4.3 respectively. The safety risks associated with the potential dam failures upstream in the NBSR Basin must also be assessed. This section discusses the water control structures within the Susquehanna River Basin and potential impacts to the safety-related facilities on site that would occur in the event of simultaneous dam failures.

The site sits on a relatively flat upland area, with finished plant grade elevation 219 ft (66.8 m) above the Susquehanna River nominal water level. The BBNPP Intake Structure is approximately 22 mi (35 km) downstream of Wilkes-Barre, PA and approximately 5 mi (8 km) upstream of Berwick, PA. The BBNPP site is situated in the Walker Run watershed, which has a drainage area of 4.32 mi^2 (11.16 km^2). All watershed and sub-basin areas that are referred to in this section, as well as all upstream and downstream distances taken relative to the BBNPP site, were obtained using ArcGIS software (ESRI, 2007; SRBC, 2006a; SRBC, 2006b; NID, 2008; USGS, 1984). Walker Run flows along the western side of the BBNPP property. The Unnamed Tributary-1 (see Figure 2.4-3) to Walker Run flows along the eastern and southern sides of the BBNPP protected area boundary and enters Walker Run on the southwest side of the BBNPP property, and Unnamed Tributary-2 (see Figure 2.4-3) flows through the BBNPP property and enters Unnamed Tributary-1 on the southern side of the BBNPP protected area boundary.

All safety-related facilities for BBNPP are located at approximately elevation 719 ft (219.2 m). The most significant flood event on record is the 1972 flood which resulted from Hurricane Agnes and occurred throughout the Mid-Atlantic region of the United States. It generated peak stream flows of 345,000 cfs (9,769 m^3/s) at Wilkes-Barre on June 24th 1972 and 363,000 cfs (10,279 m^3/s) at Danville on June 25th, 1972. (USGS, 2008a)(USGS, 2008b) On June 25, 1972 a river crest of 517.35 ft (157.69 m) msl was observed near the SSES Units 1 and 2 intake structure (Ecology III, 1986). This is approximately 202 ft (61.6 m) below the finished plant grade elevation 719 ft (219.2 m).

Walker Run and the Unnamed Tributaries 1 & 2 adjacent to the BBNPP were analyzed for the Probable Maximum Flood (PMF) due to their proximity to the BBNPP. The analysis was based on the post-construction topography to reflect the post-construction site layout as displayed on Figure 2.4-5. Walker Run flows towards the south until it converges with the Susquehanna River at approximately river mile 164 (km 264). Walker Run and Unnamed Tributaries 1 & 2 collect runoff from the area surrounding the plant and also areas northwest, west, and southwest of the plant. The total collection area for the Walker Run watershed is approximately 4.32 mi^2 (11.16 km^2). Walker Run has a difference in elevation of approximately 290 ft (88.4 m) over its entire length with an overall slope of 1.5 percent. Walker Run and the Unnamed Tributaries 1 & 2 adjacent to the BBNPP protected area boundary were modeled together using the stream junction feature available within the Hydrologic Engineering Center's River Analysis System Version 3.1.3 (HEC-RAS 3.1.3). All safety-related structures, systems, and components within the BBNPP Power Block are located at an approximate elevation of 719 ft (219.2 m) NAVD 88. The results of the PMF analysis indicate a maximum PMF water surface elevation of 675.69 ft (205.95 m) NAVD 88 at cross section 12,764.15 along Walker Run, 672.34 ft (204.93 m) NAVD 88 at cross section 1614.092 along Unnamed Tributary-1, and 715.03 ft (217.94 m) NAVD 88 at cross section 1645.505 along Unnamed Tributary-2 in the vicinity of the NPP (see Figure 2.4-31). The finished plant grade elevation for the proposed BBNPP is 719 ft (219.2 m) NAVD 88, which provides a minimum elevation difference of 46.66 ft (14.22 m) below finished plant grade along Unnamed Tributary-1, 3.97 ft (1.21 m) below the finished plant grade along Tributary-2 and an elevation difference of 43.31 ft (13.20 m) below the finished plant grade along Walker Run.

The Susquehanna River Basin has a delineated area of 27,501 mi^2 (71,227 km^2) (SRBC, 2006a). The location and extent of the Susquehanna River Basin and its six sub-basins are shown in Figure 2.4-1. Although many water control structures are located within the Susquehanna

River Basin upstream from the site, several multipurpose dams are positioned on tributaries within the Susquehanna River Basin. There are no dams on the main stem of the Susquehanna River upstream from the BBNPP site. Only select upstream dams identified in Figure 2.4-15 were considered in this section regarding potential dam failures. There are no significant dams that provide flood control storage capacity on the Susquehanna River upstream from the BBNPP site. All available information in reference to the selected upstream dams, including pool elevations and storage volumes, is presented in Table 2.4-12.

Stillwater Dam is the only significant multipurpose water control structure that provides flood protection within the Middle Susquehanna Sub-basin. The Middle Susquehanna Sub-basin covers an area of 3,771 mi^2 (9,763 km^2) (SRBC, 2006b). Stillwater Dam is located approximately 65 mi (105 km) upstream from the BBNPP site. The flood control storage volume for the Stillwater Dam is approximately 5.23E8 ft^3 (1.48E7 m^3) (USGS, 2008c).

All other significant upstream dams are located in different sub-basins relative to the BBNPP site: the Cowanesque, Hammond and Tioga Dams are located within the Pennsylvania portion of the Chemung Sub-basin, Almond Dam is in the New York portion of the sub-basin; all other dams are located in New York in the Upper Susquehanna Sub-basin (Figure 2.4-15). Among all the dams in the Chemung Sub-basin, the Cowanesque Dam is closest to the site with an approximate distance of 164 mi (264 km) upstream. Whitney Point Dam is the closest from the Upper Susquehanna Sub-basin with an approximate distance of 176 mi (283 km) upstream from the BBNPP site.

Impact of a simultaneous failure of the major dams located upstream of the BBNPP site was evaluated. This calculation estimates the outflow hydrographs resulting from the failure of 31 dams (Figure 2.4-15) and the subsequent effects of routing the hydrographs through the river network to a location on the Susquehanna River near the BBNPP site. HEC-HMS version 3.3 was used to model the effect of the potential dam breaks routed through tributaries and down the Susquehanna River past the BBNPP site. HEC-HMS is capable of modeling dam breaches and calculating an outflow hydrograph from a breached reservoir according to various parameters, and routing the flow through reaches of a defined geometry. The inclusion of such features such as spillway and dam top overflow, dam break simulation, and reach routing, make this software suitable for this calculation. A simplified routing technique, 8-point Muskinghum-Cunge, is used; therefore, the model is only reliable for estimating river flows at selected points in the network and is not intended for any accurate estimation of flood rise elevations or inundation delineation.

For these analyses, the dam failure is considered to be triggered by a seismic event that instantaneously fails all the dams. As such, there is no rainfall specified, and a fair weather or "sunny day" breach scenario is analyzed. The reaches were delineated based on the significance of the channel. Only reaches of the main channel and its significant branches were delineated as separate sub-basins. In several cases, a single reach was split into multiple reaches in order to accurately route the reservoir discharge to the appropriate junction. For all reaches, the Muskingum-Cunge routing method with an 8-point geometry (channel with floodplains) was used. No rainfall modeling is performed; however, drainage areas are delineated for defining base flow to the primary river reaches in this model.

The reservoirs included in the model were chosen based on their ability to generate large dam break outflow hydrographs that could produce an appreciable impact at the Susquehanna River near the site. The criteria used were dams over 50 feet (15.2m) in height with a storage volume greater than 1000 acre-feet (1.23E6 m^3).

Peak flow associated with dam break discharges in the Susquehanna River near the project site is estimated to be 244,000 cfs (6,909 m^3/s). This discharge rate is significantly less than the 345,000 cfs (9769 m^3/s) and 363,000 cfs (10,279 m^3/s) peak flows from Hurricane Agnes recorded at Wilkes-Barre and Danville, Pennsylvania, respectively, on June 24 and June 25, 1972 (USGS, 2008a) (USGS, 2008b). During Hurricane Agnes, a river crest of 517.35 ft (157.69 m) was observed near the SSES Units 1 and 2 intake structure (Ecology III, 1986). The estimated dam break discharge of 244,000 cfs (6,909 m^3/s) is equated with a lower river crest estimate, only 514.5 ft (156.8 m) in the vicinity of the proposed BBNPP intake structure location. The 514.5 ft (156.8 m) river crest, determined from the same stage-discharge relationship used to estimate Susquehanna River PMF water levels (see Section 2.4.3), is also well below the finished plant grade elevation at the Site, 719 ft (219.2 m). It is therefore concluded that the estimated dam break flow of 244,000 cfs (6909 m^3/s) will not impact the BBNPP.

There are no dams within the Walker Run watershed. Although many water control structures are located within the Susquehanna River Basin upstream from the site, several multipurpose dams are positioned on tributaries within the Susquehanna River Basin. Since all of these dams are far upstream relative to the BBNPP site (see Figure 2.4-15), there will be no impacts due to sedimention at the BBNPP Intake Structure following a simultaneous dam failure event. Since the plant is located above the floodplain of the Susquehanna River, the safety-related structures and functions would not be affected by sedimentation.

Since there will be a significant amount of freeboard between the BBNPP and the maximum dam failure water level, no flooding will occur at the site.

The ESWEMS Retention Pond is the only waterbody located near the Power Block. The ESWEMS Retention Pond will be excavated such that the required water volume is below site grade. Therefore, dam break analysis is not necessary. Flooding resulting from the failure of these storage structures will not impact the safety-related structures.

The first dam downstream from the BBNPP site on the Susquehanna River is the Adam T. Bower Memorial Dam, which is a temporary (or seasonal) inflatable dam that is used for recreational purposes. Failure of the Adam T. Bower Memorial Dam would not affect the water supply at the BBNPP site upstream since it does not have a large storage capacity.

2.4.4.1 References

Ecology III, 1986. Pre-Operational Studies of the Susquehanna River in the Vicinity of the Susquehanna Steam Electric Station, 1971-1982. Ecology III, Inc. December 1986.

ESRI, 2007. Street Map Pro [CD-ROM], 2007 State and County Boundaries, Roads, and Streams/Rivers, ESRI 2007.

NID, 2008. National Inventory of Dams (NID). Website: http://crunch.tec.army.mil/nidpublic/webpages/nid.cfm, Date accessed: February 2008.

SRBC, 2006a. 2006 Susquehanna River Basin Boundary, Website: http://www.pasda.psu.edu/data/srbc/srb.zip, Date accessed: February 2008.

SRBC, 2006b. Subbains of the Susquehanna River, Website: http://www.pasda.psu.edu/data/srbc/subbasins.zip, Date accessed: February 2008.

USGS, 1984. Williamsport quadrangle, Pennsylvania (map). 1:100,000. 7.5 Minute Series. Reston, Virginia: USGS, 1984.

USGS, 2008a. Peak Streamflow for Pennsylvania USGS 01540500 Susquehanna River at Danville, PA, U.S. Geological Survey, Website: http://nwis.waterdata.usgs.gov/pa/nwis/peak?site_no=01540500&agency_cd=USGS&format=html, Date accessed: January 25, 2008.

USGS, 2008b. Peak Streamflow for Pennsylvania USGS 01536500 Susquehanna River at Wilkes-Barre, PA, U.S. Geological Survey, Website: http://nwis.waterdata.usgs.gov/pa/nwis/peak?site_no=01536500&agency_cd=USGS&format=html, Date accessed: January 25, 2008.

USGS, 2008c. USGS 01534180 Stillwater Lake, PA, U.S. Geological Survey, Website: http://waterdata.usgs.gov/pa/nwis/uv/?site_no=01534180&PARAmeter_cd=00062, Date accessed: April, 4, 2008.

2.4.5 Probable Maximum Surge and Seiche Flooding

The U.S. EPR FSAR includes the following COL Item for Section 2.4.5:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information on the probable maximum surge and seiche flooding and determine the extent to which safety-related plant systems require protection. The applicant will also verify that the site-specific characteristic envelope is within the design maximum flood level, including consideration of wind effects.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

Sections 2.4.5.1 through 2.4.5.6 are added as a supplement to the U.S. EPR FSAR.

2.4.5.1 Probable Maximum Winds and Associated Meteorological Parameters

The BBNPP site is located in Salem Township, Luzerne County, northeastern Pennsylvania. It lies on a relatively flat upland terrace, approximately 1.8 miles (2.9 km) west of the NBSR. The plant grade elevation will be 719 ft (219.2 m) NAVD 88 (FSAR Section 2.5.4). The elevation of the Susquehanna River 100-yr floodplain, near the BBNPP Intake Structure, is approximately 513 ft (156 m) National Geodetic Vertical Datum of 1929 (NGVD 29) (Federal Emergency Management Agency (FEMA, 2008)) or 512.3 ft (156.1 m) NAVD 88. Thus, the BBNPP Powerblock is approximately 206.7 ft (63.0 m) above the Susquehanna River 100-yr floodplain (Figure 2.4-2). There are no major water bodies (e.g., greater than 10 acres (4 hectares)) directly adjacent to or within the BBNPP Property Boundary (except for the Susquehanna River south of US RT 11) .

Site-specific characteristics of the regional climatology, including wind speeds and wind direction, are discussed in FSAR Section 2.3.

The BBNPP site lies approximately 107 mi (172 km) inland from the Chesapeake Bay, which is downstream from the BBNPP Intake Structure. Because the plant site is more than 100 mi (161 km) from the nearest coast, and the elevation of the BBNPP Powerblock is 206.7 ft (63.0 m) above the 100-yr floodplain of the Susquehanna River, and there are no major water bodies adjacent to or within the BBNPP Property Boundary (except for the Susquehanna River south of US RT 11) , potential storm surges or seiche flooding are not applicable considerations for this site and are not factors which could cause flooding.

Between 1851 and 2009, there have been 285 reported hurricanes that reached landfall on the continental U.S. (NOAA, 2010). The 1972 (June 21-24) flood that occurred throughout the Mid-Atlantic region as a result of Hurricane Agnes is known to be one of the most significant floods in recorded history of the area. The critical factor affecting the record flooding was the near continuous nature of rainfall during Hurricane Agnes. From June 21-25, an average of 6-10 inches (15-25 cm) of rain fell over the Mid-Atlantic region (NOAA, 2008). These high rainfalls produced record flooding on the Susquehanna River, equaling or exceeding flood recurrence intervals of 100 years along portions of the Susquehanna River (NOAA, 2008). Hurricane Agnes generated peak stream flows of 345,000 cfs (9,769 m^3/s) at Wilkes-Barre on June 24th and 363,000 cfs (10,279 m^3/s) at Danville on June 25th (USGS, 2010a)(USGS, 2010b). On June 25, 1972 a river crest of 517.35 ft (157.7 m) mean sea level (msl) and mean daily flow of 329,837 cfs (9,340 m^3/s) was recorded near the SSES Units 1 and 2 Intake Structure (Ecology III, 1986). Potential flooding caused by hurricane and major storm events (i.e., flooding caused by heavy rainfall and runoff) is discussed in FSAR Section 2.4.2.

2.4.5.2 Surge and Seiche Water Levels

2.4.5.2.1 Historical Surges

Two hundred and eighty-five hurricanes have been reported to reach the coast of the continental U.S. between 1851 and 2009 (NOAA, 2010). Because the BBNPP site is located approximately 107 mi (172 km) inland from the Chesapeake Bay, recorded storm surge and seiche water levels are not a factor which could cause flooding at the proposed BBNPP site.

2.4.5.2.2 Estimation of Probable Maximum Storm Surge

The probable maximum storm surge (PMSS) at the BBNPP site can be estimated by considering the most severe combination of the components of primary surge height, cross wind effects, 10 percent exceedance high tide, and sea level anomaly.

In the U. S. Army Corps of Engineers (USACE) 1986 computation of wind waves over the continental shelf from the entrance to the Chesapeake Bay has been reported. In this computation, the water depths were also assumed to include the storm surge and astronomical tide over the shelf area.

Based on the USACE calculations, it is safe to conclude that due to the disance of 107 miles (172 km) inland from the nearest coast and the elevation of the BBNPP Powerblock of 206.7 ft (63.0 m) above the 100-yr floodplain, storm surges and seiche flooding are not applicable considerations for this site.

2.4.5.3 Wave Action

The only body of water within the BBNPP Property Boundary (except for the Susquehanna River south of US RT 11) is the Essential Service Water Emergency Makeup System (ESWEMS) Retention Pond. The BBNPP ESWEMS Retention Pond at normal water level of 695 ft (212 m), has a volume of about 76.6 acre-feet (98,823 m^3). An unisolatable overflow spillway has a crest at elevation of 698 ft (212.8 m) msl. The graded ground elevation around the ESWEMS Retention Pond provides a 4 ft (1.2 m) minimum freeboard at normal pond water level. In addition, the plant yard is graded away from the pond to prevent plant runoff from entering the pond. The excavated pond slopes are covered with riprap for protection against wave action (Black & Veatch, 2010). The ESWEMS Retention Pond is a small body of water and is not subject to significant surge and seiches. Regulatory Guide 1.59 (NRC, 1977) defines the design basis considerations, with respect to flooding, for the ESWEMS Retention Pond. The derivation of probable maximum winds and wave runup are evaluated in FSAR Section 2.4.8.

2.4.5.4 Resonance

The BBNPP site lies approximately 107 mi (172 km) inland from the Chesapeake Bay , which is downstream from the BBNPP site. Because the plant site is more than 100 mi (161 km) from the nearest coast, and the elevation of the BBNPP Powerblock is 206.7 ft (63.0 m) above the 100-yr floodplain of the Susquehanna River, and there are no major water bodies adjacent to the BBNPP site, potential storm surges or seiche flooding are not applicable considerations for this site and are not factors which could cause flooding. Resonance of seiche oscillation will not occur because a seiche is not an applicable consideration at the BBNPP site.

2.4.5.5 Protective Structure

Flood protection measures for the ESWEMS Pump House are discussed in FSAR Section 2.4.10.

Because the BBNPP Powerblock is located on an elevated river terrace, approximately 206.7 ft (63.0 m) above the Susquehanna River floodplain and approximately 1.8 miles (2.9 km) west of the floodplain, progressive floodplain erosion will have no impact on the BBNPP site.

Erosion has occurred throughout the Susquehanna River basin over the past 13,000 years (i.e. since the last glacial advance) and will continue to happen.

2.4.5.6 References

Black and Veatch, 2010. Black and Veatch Drawing, 161642-1EMS-S1102, Plant Arrangement ESWEMS Pond Sections and Details, Revision 2, 2010.

Ecology III, 1986. Pre-Operational Studies of the Susquehanna River in the Vicinity of the Susquehanna Steam Electric Station, 1971-1982. December 1986.

FEMA, 2008. Flood Insurance Map, Luzerne County, Federal Emergency Management Agency, Website: http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1, Date accessed: March 27, 2008.

NOAA, 2008. Middle Atlantic River Forecast Center, Hurricane Agnes - National Oceanic and Atmospheric Administration. Website: http://ahps.erh.noaa.gov/marfc/Flood/agnes.html, Date accessed: February 7, 2008.

NOAA, 2010. List of Hurricanes Landfalling in the Continental United States, National Oceanic and Atmospheric Administration, Website: http://www.aoml.noaa.gov/hrd/hurdat/ushurrlist18512009.txt, Date accessed: September 29, 2010.

NRC, 1977. Regulatory Guide 1.59, Design Basis Floods for Nuclear Power Plant, Revision 2, U.S. Nuclear Regulatory Commission, 1977.

USACE, 1986. Storm Surge Analysis and Design Water Level Determinations, EM 1110-2-1412, U.S. Army Corps of Engineers, April 15, 1986.

USGS, 2010a. Peak Streamflow for Pennsylvania USGS 01540500 Susquehanna River at Danville, PA, U.S. Geological Survey. Website: http://nwis.waterdata.usgs.gov/pa/nwis/peak?site_no=01540500&agency_cd=USGS&format=html Date accessed: September 10, 2010.

USGS, 2010b. Peak Streamflow for Pennsylvania USGS 01536500 Susquehanna River at Wilkes-Barre, PA, U.S. Geological Survey. Website: http://nwis.waterdata.usgs.gov/pa/nwis/peak?site_no=01536500&agency_cd=USGS&format=html Date accessed: September 10, 2010.

2.4.6 Probable Maximum Tsunami Flooding

The U.S. EPR FSAR includes the following COL Item in Section 2.4.6:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information and determine the extent to which the plant safety-related facilities require protection from tsunami effects, including Probable Maximum Tsunami Flooding.

This COL Item is addressed as follows:

{This section develops the geohydrological design basis to ensure that any potential hazards to the structures, systems, and components important to safety due to the effects of a probable maximum tsunami are considered in the plant design.

Section 2.4.6.1 through Section 2.4.6.8 are added as a supplement to the U.S. EPR FSAR.

2.4.6.1 Probable Maximum Tsunami

The BBNPP site is located in Salem Township, Luzerne County, northeastern Pennsylvania. It lies on a relatively flat upland terrace, approximately 1.8 miles (2.9 km) west of the North Branch of the Susquehanna River. The plant grade elevation will be 719 ft (219.2 m) NAVD 88 (Section 2.5.4). The elevation of the Susquehanna River 100-yr floodplain, near the BBNPP Intake Structure, is approximately 513 ft (156 m) National Geodetic Vertical Datum of 1929 (NGVD 29) (Federal Emergency Management Agency (FEMA), 2008) or 512.3 ft (156.1 m) NAVD 88. Thus, the BBNPP Powerblock is approximately 206.7 ft (63.0 m) above the Susquehanna River 100-yr floodplain. There are no major water bodies (e.g., greater than 10 acres (4 hectares in area) directly adjacent to or within the BBNPP Property Boundary (except for the Susquehanna River south of US RT 11) . Figure 2.4-34 shows the locations of geo-seismic tsunami source generators around the earth (NASA, 2008). Table 2.4-29 lists several recorded historical tsunamis in the Atlantic Ocean from 1755 to 2004 (NOAA, 2010). The BBNPP site lies approximately 107 mi (172 km) inland from the Chesapeake Bay, which is downstream from the BBNPP site.

Because the plant site is more than 100 mi from the nearest coast, the elevation of the plant site is 206.7 ft (63.0 m) above the 100-yr floodplain of the Susquehanna River, and there are no major water bodies adjacent or within the BBNPP Property Boundary (except for the Susquehanna River south of US RT 11), potential tsunami events are not applicable considerations for this site and are not factors which could cause flooding.

The potential that tsunami events, caused by local or distant seismic activities, could affect the BBNPP site is negligible.

2.4.6.2 Historical Tsunami Record

A review of the National Geophysical Data Center (NGDC), indicates there are no records of major tsunamis in the USA with significant flooding impacts.

2.4.6.3 Tsunami Source Generators Characteristics

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.4 Tsunami Analysis

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.5 Tsunami Water Levels

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.6 Hydrography and Harbor or Breakwater Influences on Tsunami

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.7 Effects on Safety Related Facilities

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.8 Hydrostatic and Hydrodynamic Forces

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.9 Debris and Water-Borne Projectiles

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.10 Effects of Sediment Erosion and Deposition

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.11 Consideration of other Site-Related Evaluation Criteria

This section is not applicable as there is no risk of tsunami flooding at the site.

2.4.6.12 References

FEMA, 2008. Flood Insurance Rate Map, Luzerne County. Website: http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1, Date accessed: March 27, 2008.}

NASA, 2008. Digital Tectonic Activity Map, Website: http://denali.gsfc.nasa.gov/ dtam/, Date accessed: May 06, 2008.

NOAA, 2010. NOAA / WDC Historical Tsunami Database at NGDC; East Coast of the USA and Canada, Website: http://www.ngdc.noaa.gov/hazard/ tsu_db.shtml, Date accessed: September 29, 2010.

2.4.7 Ice Effects

The U.S. EPR FSAR includes the following COL Items for Section 2.4.7:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information regarding ice effects and design criteria for protecting safety-related facilities from ice-produced effects and forces with respect to adjacent water bodies.

> A COL applicant that references the U.S. EPR design certification will evaluate the potential for freezing temperatures that may affect the performance of the

ultimate heat sink makeup, including the potential for frazil and anchor ice, maximum ice thickness, and maximum cumulative degree-days below freezing.

These COL Items are addressed as follows:

{As discussed in Section 2.4.1, the BBNPP site is located in Northeast Pennsylvania near Berwick, PA in the township of Salem. The Susquehanna River lies about 1.5 miles (2.4 km) south and 1.8 miles (2.9 km) east of BBNPP site. Figure 2.4-2 indicates the location of the site.

Reference to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), values unless otherwise stated.

2.4.7.1 Ice Conditions

Ice at a nuclear power plant site could occur in any one of the following forms:

- Surface ice and its associated forces
- Anchor ice formation on components
- Frazil ice that could clog intake flow passages
- Ice jams that could affect the flow path to the water supply intake
- Breach of ice jams causing flooding at site
- Ice accumulation on roofs of safety-related structures and components
- Ice blockage of the drainage system causing flooding
- Ice accumulation causing reduction in water storage volume

Historical data characterizing ice conditions at the BBNPP site have been collected and the effects evaluated for the operation of BBNPP. These data include ice cover and thickness observations in the Susquehanna River, ice jam records, and air temperature measurements from the SSES Units 1 and 2 meteorological tower (PPL, 2008). There are no safety-related structures facilities that could be affected by ice-induced low flow of the Susquehanna River.

To assure the BBNPP safety-related Essential Service Water Emergency Makeup System (ESWEMS) would not be affected by surface ice, the possibility of ice jam formation and the potential for frazil ice were examined by estimating the maximum surface ice thickness that could form during the worst icing condition expected at the site. Ice-induced forces are accounted for in the design of the BBNPP Intake Structure.

The storage capacity of the pond has been sized to accommodate more than the 27-day minimum requirement of makeup water including a conservative evaluation for water loss to ice cover. As a result, ice formation on the ESWEMS Retention Pond surface has been accounted for in determining, the minimum volume required during emergency operations.

2.4.7.2 Description of the Cooling Water Systems

The BBNPP Circulating Water System (CWS) is a closed-cycle using natural draft cooling towers for the heat sink. Makeup water to the cooling tower basins will be supplied from the BBNPP Intake Structure located along the Susquehanna River east of the BBNPP site. BBNPP cooling tower blowdown effluent is delivered to the Susquehanna River through a permitted discharge line.

The BBNPP also has a safety-related Essential Service Water System (ESWS) to provide cooling water to the Component Cooling Water System heat exchangers and to the emergency diesel generator heat exchangers to dissipate heat. The ESWS is a closed-cycle system that uses mechanical draft cooling towers for heat removal. These cooling towers provide the Ultimate Heat Sink (UHS) function.

The basins of the ESWS cooling towers are sized to provide sufficient water to permit the ESWS to perform its safety-related heat removal function for up to 3 days (72 hours) post accident under the worst anticipated environmental conditions without replenishment. Beyond the 72 hour post accident period, makeup water is supplied from the ESWEMS Retention Pond, a safety related structure located southeast of the Nuclear Island. Blowdown from the ESWS cooling towers is routed to the Combined Waste Water Retention Pond via discharge lines connected to the natural draft cooling towers common blowdown effluent line. Water in the Combined Waste Water Retention Pond is released to the Susquehanna River via an overflow weir.

2.4.7.3 Intake and Discharge Structures

The BBNPP Intake Structure will supply makeup water to the natural draft cooling tower basins for the non-safety-related CWS. The Raw Water Supply System (RWSS) supplies makeup water to the safety-related ESWEMS Retention Pond. Both systems are housed in the BBNPP Intake Structure.

River gauge records show that freezing on the Susquehanna River between Wilkes-Barre and Danville gauging stations can be expected during winter months. However, it is not anticipated to cause ice flooding that exceeds the high water elevation of 525 ft (160 m) NAVD 88 established for final design of the BBNPP Intake Structure.

Plant effluent going back to the Susquehanna River from BBNPP consists of cooling tower blowdown from the CWS cooling towers and the ESWS cooling towers, and miscellaneous low volume wastewater streams from the Power Block. The blowdown line extends approximately 310 ft (95 m) into the Susquehanna River below the design minimum water level of 484 ft (148 m) NAVD 88. Ice or ice flooding will be unlikely to occur at the discharge structure, as the warm discharge water will serve to keep the outfall open.

2.4.7.4 Historical Ice Formation

The climate of Pennsylvania is generally considered to be a humid continental type of climate. Daily air temperatures measured at the SSES Units 1 and 2 meteorological tower indicate that below freezing temperatures occur typically between the months of November and March (PPL, 2008). However, maximum accumulated freezing degree-days, as defined in Section 2.4.7.6, occur mostly in December, January and February.

Based on air temperature data summaries collected at the SSES Units 1 and 2 meteorological tower from 2001 through 2007 (PPL, 2008), the monthly average air temperature in the region ranges from about 28.6°F (-2°C) in January to 71.3°F (22°C) in July, while the monthly average minimum air temperature for December is 16.9°F (-8°C), January is 12.6°F (-11°C) and for February is 15.3°F (-9°C). In the recent years (2001-2007) the average minimum temperature during winter months (December, January, and February) has been around 14.9°F (-10°C).

Flooding due to ice break-up that results in ice jams can be a problem during the winter months. A search of the "Ice Jam Database" maintained by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL) reveals 13 recorded instances of ice jams near Wilkes-Barre in the Susquehanna River. Figure 2.4-35 illustrates ice jams within a 50-mile (80 km) radius of the BBNPP site (ESRI, 2007). The most recent ice movement and ice jamming occurred on March 3, 2004 in the vicinity of Wilkes-Barre. Approximately 4.0 ft (1.2 m) of backwater was observed at the Wilkes-Barre USGS gauging station (USACE, 2008).

Ice accumulation on the transmission towers and switchyard of existing SSES Units 1 and 2 has sporadically occurred during freezing rainfall. To date, events such as these have not affected the operation of SSES Units 1 and 2 and ice accumulation on transmission towers is not anticipated to affect operation of BBNPP.

2.4.7.5 Frazil Ice

Research on the properties of frazil ice indicates that the nature and quantities of ice produced depend on the rate of cooling within a critical temperature range. Frazil ice forms when the water temperature is below 32°F (0°C), the rate of super cooling is greater than 0.018°F (-17.8°C) per hour in turbulent flows, and there is no surface ice sheet to prevent the cooling (USACE, 1991) (Griffen, 1973). This type of ice, which is in the shape of discoids and spicules (Griffen, 1973), typically forms in shallow flowing water, such as in rivers and lakes, when the flow velocity is approximately 2 ft/s (0.6 m/s) or higher (IAHR, 1970).

Under the unlikely scenario that frazil ice forms in the ESWEMS Retention Pond, the analysis focused on the potential for mixing of frazil ice crystals formed at the surface to sufficient depths to cause a concern for the ESWEMS intake system. In this analysis, the mixing depth was calculated based on several wind speed recurrence intervals. The mixing depth was estimated by calculating a wave base which can be defined as the depth below the mean water surface where the fluid motion as a result of the waves is considered negligible.

Based upon the calculated wave base, the maximum mixing depth as a result of the 1,000-yr recurrence wind speed (118 mph; 53.0 m/s) is limited to 4.82 ft (1.47 m). The top of the ESWEMS water intake system is approximately 13.42 ft (4.09 m) below the ESWEMS Retention Pond normal water surface elevation of 695 ft (211.8 m) NAVD 88. Therefore, under the most extreme wind recurrence interval, the sustained speeds are not sufficient to provide a deep enough mixing zone to mix frazil ice to the depth of the ESWEMS intake system.

The ESWEMS Retention Pond arrangement with pump intakes approximately 13.42 ft (4.09 m) below the ESWEMS Retention Pond normal water surface elevation of 695 ft (211.8 m) NAVD 88 prevents any interruption of emergency water supply to the ESWS.

Furthermore, neither frazil ice nor anchor ice have been observed in the intake structure of the existing SSES Units 1 and 2 since the start of operation. There is no public record of frazil or anchor ice obstructing other water intakes in the Susquehanna River. As a result, frazil ice or anchor ice is unlikely to occur to an extent that will affect the function of the makeup water intakes.

2.4.7.6 Surface Ice Sheet

Ice may form on the surface of the BBNPP ESWEMS Retention Pond during severe winter periods. Ice formation, however, does not affect the operation of the ESWEMS Retention Pond because the top of the ESWEMS water intake system is approximately 12.50 ft (3.81 m) below the ice formation. Sufficient water volume is provided in the pond to preclude ice from reaching the pump intake during post-accident operation. This arrangement prevents any interruption of emergency water supply to the ESWS. Thus, there is no possibility for pump blockage by ice.

Plant Technical Specifications in COLA Part 4, defines surveillance requirements (SR) regarding the ESWEMS Retention Pond. Plant Technical Specifications include a surveillance on a 24-hour basis to assure that the average water temperature of the ESWEMS Retention Pond is less than or equal to 95 °F (35 °C). In addition, Plant Technical Specifications include a surveillance on a 24-hour basis to verify that the water level of the ESWEMS Retention Pond is greater than or equal to 690 ft (210 m) NAVD 88. Both of these surveillance requirements will ensure that the ESWEMS Retention Pond remains operable.

The pond structures at the water surface are in contact with surface ice that can form during prolonged subfreezing periods. Ice expansion and wind drag on the ice surface exert forces on these structures. The following sections address the approach used in evaluating the ice thickness and the forces on the ESWEMS Pump House and the pond outlet structure caused by the presence of ice.

Determination of the ice thickness in the ESWEMS Retention Pond is based on the analysis of monthly Accumulated Freezing Degree-Days (AFDD), defined as the summation of the difference between 32°F (0°C) and all recorded daily air temperatures below freezing (or the average daily temperature obtained from hourly data on record) for the months of December, January, and February.

The BBNPP Intake Structure draws water from the North Branch of the Susquehanna River (NBSR) through a 9 ft (3 m) opening from 474 to 483 ft (144 to 147 m) NAVD 88. The design basis low water elevation is 484 ft (148 m) NAVD 88. Therefore, the BBNPP Intake Structure will not be impacted by surface ice formation. Detailed information about the layout of the BBNPP Intake Structure is provided in Section 10.4.5.

The maximum ice thickness that could form in the Susquehanna River and the ESWEMS Retention Pond was estimated using historic air temperature data from the nearby SSES Unit 1 and 2 meteorological tower for the period of 2001 through 2007 (PPL, 2008).

Surface ice thickness (t_i) can be estimated as a function of Accumulated Freezing Degree-Days (AFDD) using the modified Stefan equation (USACE, 2004), where C is a coefficient, usually ranging between 0.3 and 0.6 and AFDD is in °F days. For the Susquehanna River, a coefficient of 0.15 was used to provide a conservative estimation of the ice thickness ("Average River with Snow Condition;" Table 1; USACE, 2004). A value of 0.7 was used to estimate the ice thickness in the ESWEMS Retention Pond ("Average Lake with Snow Condition;" Table 1; USACE, 2004).

$$t_i = C\,(AFDD)^{0.5}$$

Accumulated Freezing Degree-Days are obtained for each winter month (December, January, and February) by summing the Freezing Degree-Days (FDD) for each month, which is the difference between the freezing point (32°F (0°C)) and the average daily air temperature (T_a):

$$FDD = (32 - T_a)$$

Table 2.4-30 summarizes the average accumulated Freezing Degree-Days for each winter month and the corresponding ice thickness estimate from 2001 to 2007 for the Susquehanna

River. Table 2.4-31 summarizes the AFDD and estimated ice thickness from 2001 to 2007 for the ESWEMS Retention Pond. As indicated in Table 2.4-30, the monthly average AFDD is 190.4°F occurring in January with the corresponding ice thickness estimated to be 2.07 in (5.26 cm). Table 2.4-31 shows that the ESWEMS Retention Pond average ice thickness occurring in January is estimated to be 9.66 in (24.54 cm).

Effects of surface ice on Walker Run will not impact operation of the BBNPP, as Walker Run is not used a source of water for the plant.

2.4.7.7 Ice Accumulation on the BBNPP Intake Structure and ESWS Cooling Tower Basins and Preventive Measures

The BBNPP Intake Structure and water discharge structures on the Susquehanna River are not safety-related structures. Even though the Susquehanna River is subject to ice formation during winter months, the BBNPP Intake Structure is not impacted. The BBNPP Intake Structure draws water from the NBSR through a 9 ft (3 m) opening from 474 to 483 ft (144 to 147 m) NAVD 88, and the design basis low water level elevation is 484 ft (148 m) NAVD 88. This design would not be subject to ice blockage or ice formed in the Susquehanna River.

Ice will not affect the discharge structure, as the warm discharge water will keep the outfall open.

For the ESWS cooling tower basins, measures will be taken to ensure that the basins underneath the cooling tower cells have a minimum of 72 hours water supply without the need for any makeup water during a design basis accident. As indicated in Section 2.4.7.2, any makeup water to the basin needed beyond the 72 hour, post accident period will be supplied from the BBNPP ESWEMS. In order to assure the availability of a minimum of 72 hours water supply in the ESWS cooling tower basins, the minimum volume in each basin will be established considering: (a) losses due to evaporation and drift under design basis accident conditions and design environmental conditions; (b) minimum submergence to avoid formation of harmful vortices at the pump suction; and (c) the operational range for basin water levels. During extreme cold weather conditions, operational controls will be implemented, as required, to assure the availability of the required volume. Tower operations during cold weather will mitigate ice buildup consistent with vendor recommendations (e.g., periodic fan operation in the reverse direction). Therefore, operational controls, together with system design features, will prevent ice formation in the ESWS Cooling Tower Basins as discussed in Section 9.2.5.

2.4.7.8 Effect of Ice on High and Low Water Levels and Potential for Ice Jam

Because the operating floor of the ESWEMS Pump House is at elevation 700.5 ft (213.5 m) NAVD 88, 5.5 ft (1.7 m) above the design normal water level of 695 ft (211.8 m) NAVD 88, and because the water will be drawn at a minimum of 0.42 ft (0.13 m) above finish grade of elevation 670 ft (204.2 m) NAVD 88, ice-induced low and high water levels will not affect the operation of the ESWEMS Pump House. The impacts of ice in the ESWEMS Retention Pond is described in Section 2.4.7.6 and the ESWS cooling tower basins are discussed in Section 2.4.7.7.

In addition, BBNPP surface runoff from the site vicinity drains into small streams which discharge into the Susquehanna River. Streams close to the site have small drainage areas and would not pose the potential of ice flooding at the site.

2.4.7.9 Effect of Ice and Snow Accumulation on Site Drainage

Air temperature measurements at the SSES Units 1 and 2 meteorological station indicate that mean daily temperatures at the site had periodically fallen below freezing for multiple consecutive days in winter (PPL, 2008). This introduces the possibility of ice blockage of small catch basins, storm drains, culverts and roof drains. The flood protection design of the BBNPP safety-related facilities assumes that all catch basins, storm drains, and culverts are blocked by ice, snow or other obstructions, rendering them inoperative during a local probable maximum precipitation (PMP) event; this assumption is conservative insofar as a PMP is unlikely to occur during freezing conditions. Details of the local PMP analyses and flood protection requirements for the site are discussed in Section 2.4.2 and Section 2.4.10. Therefore, temporary blockage of site drainage areas due to ice will not affect the operation of safety-related facilities.

2.4.7.10 Ice and Snow Roof Loads on Safety Related Structures

Acceptable roofing structure performance for each safety-related roof is described in Section 2.3.1.

2.4.7.11 References

ESRI, 2007. Street Map Pro [CD-ROM], 2007 State and County Boundaries, Roads, and Streams/Rivers, Environmental Systems Research Institute, 2007.

Griffen, 1973. The Occurrence and Prevention of Frazil Ice at Water Supply Intakes, Research Branch Publication Number W43, Toronto Ministry of the Environment, A. Griffen, 1973.

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USACE, 1991. Cold Regions Research and Engineering Laboratory, Frazil Ice Blockage of Intake Trash Racks, Technical Digest Number 91-1, U.S. Army Corps of Engineers, S. Daly, March 1991.

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USACE, 2008. Ice Jam Database, Cold Regions Research and Engineering Laboratory (CRREL). Website: https://rsgis.crrel/usace.army.mil/icejam/ Date accessed: December 26, 2007.}

2.4.8 Cooling Water Canals and Reservoirs

The U.S. EPR FSAR includes the following COL Item for Section 2.4.8:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information and describe the design basis for cooling water canals and reservoirs used for makeup to the UHS cooling tower basins.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless otherwise stated.

Section 2.4.8.1 through Section 2.4.8.3 are added as a supplement to the U.S. EPR FSAR.

2.4.8.1 Cooling Water Design

The BBNPP does not include any safety-related canals used to transport water. The non-safety-related BBNPP Intake Structure is located on the North Branch of the Susquehanna River and water is conveyed to the BBNPP power block via pipelines. The safety-related Essential Service Water Emergency Makeup System (ESWEMS) for BBNPP will be located to the southeast of the power block area.

The volume of water stored in the ESWEMS Retention Pond that comprises part of the UHS will be sufficient to meet all safety-related water supply requirements after accounting for loss in storage capacity due to seepage, sedimentation, evaporation, ice sheet formation, and other causes. The makeup to the ESWEMS Retention Pond is from the filtered Raw Water Supply System (RWSS), therefore, sedimentation will not affect the pond capacity. In addition, the pond will be below the finished site grade and only precipitation or pumped in water will fill the ESWEMS Retention Pond, further limiting sedimentation. The interior slopes are protected with rip-rap and the exterior slopes are seeded; therefore, erosion will not affect the pond capacity. The volume of water required with associated margins for losses is discussed in U.S. EPR FSAR Section 9.2.1 and Section 9.2.5.

The natural soils are primarily granular, therefore, cohesive fill will be utilized for the ESWEMS Retention Pond to limit seepage. Geotechnical properties of the fill are discussed in Section 2.5.4. The original design assumed the pond bottom would consist of a compacted clay liner of approximately 3 ft (1 m). The cohesive fill will actually go down to bedrock, which in all cases is at a lower elevation than the bottom of the 3 ft (1 m) thick clay liner.

The seepage characteristics will be confirmed during construction when the permeability of the cohesive fill used to construct the pond can be determined.

The ESWEMS Retention Pond will be excavated and built up using cohesive fill to ensure the required water volume is below the finished site grade in the vicinity of the pond. Although the required volume will be below site grade and a slope failure will not present a hazard to downstream residents, a slope failure may rupture the clay liner, resulting in loss of the ESWEMS Retention Pond.

Therefore, the ESWEMS Retention Pond slopes will have adequate safety factors for end of construction, steady state seepage, sudden drawdown, and earthquake loading conditions, as discussed in Section 2.5.5.

The ESWEMS Retention Pond design must ensure that the capability to perform its safety-related function is maintained during the most severe credible natural phenomena in combination with normal operations, anticipated operational occurrences, or accident condition. With respect to the most severe natural occurrences, design with respect to storm surges and seiches is discussed in Section 2.4.5, design with respect to tsunami hazards is discussed in Section 2.4.6, and design with respect to ice hazards is discussed in Section 2.4.7.

2.4.8.2 Reservoirs

The ESWEMS Retention Pond is the only proposed reservoir on the site. In the event of a design basis accident, the ESWEMS Retention Pond provides water for the post-accident period beyond the first 72 hours. The ESWEMS Retention Pond is 22.5 ft (6.9 m) deep from the top of the dike with side slopes of 3 horizontal to 1 vertical. The storage capacity of the pond at the normal water level of elevation 695 ft (211.83 m) NAVD 88 is 76.6 acre-feet (98,823 m^3). During post accident conditions, the ESWEMS Retention Pond is utilized to supply makeup water to the ESWS cooling towers. Figure 2.4-36 shows the schematic layout of the ESWEMS Retention Pond.

A description of the BBNPP ESWEMS Retention Pond is provided in Section 9.2.5 and Section 3.8. Hydrologic conditions during PMP and coincident wind wave activities are discussed in Section 2.4.8.2.1. Consideration of probable maximum wind is discussed in Section 2.4.8.2.2. These conditions were evaluated at a water level corresponding to elevation 695 ft (211.83 m) NAVD 88 to minimize the possibility of inadvertent discharges through the outlet structure.

2.4.8.2.1 Probable Maximum Flood Design Considerations

Site grading at the ESWEMS Retention Pond will prevent surface water from outside of the ESWEMS Retention Pond from entering the ESWEMS Retention Pond; therefore, the ESWEMS Retention Pond spillway discharge capacity and freeboard will be designed for the PMP as provided in Section 2.4.2. For the ESWEMS Retention Pond with an initial water level of elevation 695 ft (211.83 m) NAVD 88, the probable maximum water level due to a 72-hour PMP on the ESWEMS Retention Pond and outflow over the 6-foot (2 m) wide, broad-crested weir spillway reaches elevation 698.36 ft (212.86 m) NAVD 88. This is delineated in Table 2.4-32, as discussed in Section 2.4.8.2.2 (NOAA, 1978). Several wind scenarios were analyzed (Table 2.4-33) coincident with the probable maximum water level of elevation 698.36 ft (212.86 m) NAVD 88 to ensure that the ESWEMS Retention Pond does not overtop. Results of these scenarios are presented in Table 2.4-34. The highest annual wind speed of 57 mph (92 km/hr) results in a freeboard requirement of 0.68 ft (0.21 m), corresponding to an ESWEMS water level of elevation 699.04 ft (213.07 m) NAVD 88. For the 1,000 yr recurrence interval, the freeboard is 1.47 ft (0.45 m) corresponding to a water level at the ESWEMS Retention Pond of elevation 699.83 ft (213.31 m) NAVD 88, as discussed in Section 2.4.8.2.2.1

2.4.8.2.2 Water Level Determination

The ESWEMS Retention Pond's hydrologic design is controlled by the PMP and its associated water level. The 72-hour PMP on the ESWEMS Retention Pond is distributed as shown in Table 2.4-32, utilizing Hydrometeorological Report Number 51 (NOAA, 1978). The resulting rainfall is converted to equivalent inflow to the pond to determine the maximum resulting water level. The outlet structure, which is a 6.0 ft (1.8 m) wide broad-crested spillway, has a crest elevation of 698 ft (212.75 m) NAVD 88. The discharge coefficient used in the weir equation is 2.65 (Brater, 1976). Flood routing indicates that the probable maximum water level in the pond, during the 72-hr PMP, will reach elevation 698.36 ft (212.86 m) NAVD 88 with a peak outflow of 3.42 cfs (0.10 m^3/s) based upon an initial water level corresponding to 695 ft (211.83 m) NAVD 88. The energy of this outflow from the ESWEMS Retention Pond is dissipated at the base of the spillway channel before being routed through a channel lined with rip-rap, which then discharges to a swale that conveys surface runoff down and away from the site.

Under the assumption that no losses occur, the 72-hour PMP event for a 10 square mile area at the location of the proposed site is the worst-case scenario when analyzing the ESWEMS Retention Pond since it generates more total rainfall than the 1-hour PMP event. The 1-hour

PMP storm event provides intense rainfall over a short duration compared to the 72-hour PMP, which provides more total rainfall, allowing the surface water level to rise higher under the assumption that there are no losses. Therefore, the water level in the ESWEMS Retention Pond resulting from the 72-hour PMP event is greater when compared to the rise in water level resulting from a 1-hour PMP. A detailed discussion of the 72-hour PMP event and the 1-hour PMP event is provided in Section 2.4.2.3.

2.4.8.2.2.1 Coincident Wind Wave Activity

Discussion of wind wave activities is limited to the ESWEMS Retention Pond since it is the only safety-related hydrologic element at the site that is subject to wind wave activity.

As a conservative approach, the highest wind speeds with a mean recurrence interval of 2, 10, 25, 50, 100, and 1,000 years were taken into account as occurring coincidentally with the probable maximum water level at its peak elevation (Thom, 1968). At this evaluated water level of 698.36 ft (212.86 m) NAVD 88, the ESWEMS Retention Pond has a water surface length (or fetch length) of 690.16 ft (210.36 m), a width of 390.16 ft (118.92 m), and a depth of 20.86 ft (6.36 m). The designed dimensions at the top of the BBNPP ESWEMS Retention Pond dike are 22.5 ft (6.9 m) deep from the top of the dike with side slopes of 3 horizontal to 1 vertical and surface dimensions of 700 ft (213 m) by 400 ft (122 m).

Wind setup is calculated by following U.S. Army Corps of Engineers (USACE,1997) guidance.

$$S = \frac{U^2 F}{1400D} \qquad \text{Equation 2.4.8-1}$$

Where U is average wind velocity in miles per hour, F is wind tide fetch in miles, and D is the average depth in feet. The wind tide fetch F is usually taken to be twice the distance of the maximum effective fetch F_e, which is the distance over which wind can travel unobstructed across a body of water. F_e was estimated to be the maximum water surface length of 690.16 ft (210.36 m). The maximum fetch distance was doubled to obtain the wind tide fetch F. Table 2.4-33 shows the wind speed, effective fetch, wind tide fetch, average depth and wind setup for each of the scenarios.

Several hydrometeorological events were considered in the analysis occurring coincidentally with the probable maximum water level at elevation 698.36 ft (212.86 m) NAVD 88.

The calculation of wave runup involves finding the significant wave height and period based on fetch length and wind speed. Then, the determination of the wave runup is based on the characteristics of the wave and embankment slope. Coastal Engineering Manual, EM 1110-2-1100, (USACE, 2006) provides guidance for this process. EM 1110-2-1100 describes the following procedure for calculation of shallow water wave heights and periods:

1. Determine the straight line fetch and over water wind speed;

2. Using the fetch and wind speed from (1), estimate the wave height and period from deepwater nomograms;

3. Compare the predicted wave period from (2) to the shallow water limit as per:

$$T_p \approx 9.78\left(\frac{d}{g}\right)^{\frac{1}{2}}$$ Equation 2.4.8-2

Where, T_p is the wave period, d is the average depth of the ESWEMS Retention Pond, and g is the gravitational acceleration (9.81 m/s^2)

a. If the predicted wave is greater than the limiting value, reduce the predicted wave period to the limiting value. The wave height may be found by noting the dimensionless fetch associated with the limiting wave period and substituting this fetch for the actual fetch in the wave growth calculation.

b. If the predicted wave period is less than the limiting value, retain the deepwater values from (2).

c. If the wave height exceeds 0.6 times the depth, the wave height should be limited to 0.6 times the depth.

Wave runup was then calculated using equations and suggested coefficients from EM 1110-2-1100 (USACE, 2006). Table 2.4-34 shows the resulting wind setup, wave runup and freeboard requirement values.

The freeboard requirement is defined as the height above the still water surface that the wind setup combined with the wave runup will impact. Note that $R_{u2\%}$ is the wave runup that 2 percent of the waves will exceed, which is the most conservative value that can be calculated using EM 1110-2-1100 (USACE, 2006).

Based on the results shown in Table 2.4-34, the overflow protection is adequate during the PMP and wave action does not adversely affect the ESWEMS Retention Pond embankments.

2.4.8.2.3 Probable Maximum Wind Design Considerations

2.4.8.2.3.1 Probable Maximum Winds

Using the method of Thom (Thom, 1968), the annual highest wind speed at the BBNPP site at different recurrence intervals is indicated in Table 2.4-35. The annual highest wind speeds are computed at 30 ft (9 m) above ground level. The Thom method assumes that:

a. Surface friction is uniform for a fetch of 25 mi (40 km);

b. Extreme winds result only from extratropical cyclones or thunderstorms; and

c. Extreme winds from tornados are not included in this analysis.

Maximum winds in the site area are associated mainly with thunderstorms and squall lines rather than hurricanes or other cyclonic storms. Although these winds are usually considered local in nature, they can cause wind setup and generate large waves in water bodies.

The probable maximum wind was determined based on the method of Thom (Thom, 1968). Thom used meteorological data collected over a 21-year period from 150 monitoring stations to provide isotachs of the 0.50, 0.10, 0.04, 0.02, and 0.01 quantiles for the annual highest wind speed for the United States. Thom then provides an empirical method to use these data to determine the highest wind speed for other quantiles at any U.S. location. This method was used to determine the highest wind speed likely to occur at the 0.001 quantile, or the 1,000-year mean recurrence interval. Table 2.4-35 shows the highest mile wind speed at different recurrence intervals obtained from Thom (Thom, 1968).

A wind speed with a return period of 1,000 years constitutes a conservative design basis for safety-related elements. Based on Thom's model, this design wind speed applicable to the site was computed to be 118 mph (190 km/hr) with duration of 1-minute.

Because Thom's isotachs and statistics are based on a specific 21-year database, more recent data can not be taken into account, except as a comparison of actual extreme wind speeds with those predicted by Thom (Thom, 1968).

The highest wind speed of 57 mph (92 km/hr) was recorded in 2006, at Susquehanna Steam Electric Station (SSES) Units 1 & 2 meteorological tower, based on available data from 2001 to 2007 (PPL, 2008).

As an example, this 57 mph (92 km/hr) compares with Table 2.4-35 values determined from Thom's method of 60 mph (97 km/hr) (10-year recurrence interval) and 70 mph (113 km/hr) (25-yr recurrence interval).

2.4.8.2.3.2 Wave Action

To ensure that the ESWEMS Retention Pond does not overtop, several recurrence intervals were considered coincident with the probable maximum water level of elevation 698.36 ft (212.86 m) NAVD 88. Results of these scenarios are presented in Table 2.4-34.

In the analysis of wave action, an extreme wind speed with a 1,000-year recurrence interval occurring coincidentally with the probable maximum water level corresponding to an elevation of 698.36 ft (212.86 m) NAVD 88 is considered to be a conservatively postulated combination of hydrometeorological events. This design wind for a 1,000 year return interval, as discussed in Section 2.4.8.2.2.1, has the highest wind speed of 118 mph (190 km/hr).

Wave runup results using the methods described in Section 2.4.8.2.2.1 are shown in Table 2.4-34. At the 1,000 year wind event and for a rip-rapped slope of 3 horizontal to 1 vertical designed to resist this wave action, the maximum wave runup ($R_{u2\%}$) is calculated to be 1.35 ft (0.41 m). Including the wind setup value (S) of 0.12 ft (0.04 m), the total runup (S +$R_{u2\%}$) would be 1.47 ft (0.45 m) and would reach elevation 699.83 ft (213.31 m) NAVD 88. The rip-rap design is also based on the wave runup analysis.

2.4.8.2.3.3 Design Basis for ESWEMS Retention Pond

Based on the regional climatology and the 1,000 yr recurrence maximum wave runup result of 1.35 ft (0.41 m), wind generated waves at the normal water level will not exceed 4 ft (1 m); therefore, the rip-rap has been sized for a 4 ft (1 m) wave.

The rip-rap consists of dumped stone - hard, durable, and angular in shape. The specification for the stone requires a percentage loss of not more than 40 after 500 revolutions as tested by ASTM C 535, Resistance to Abrasion of Large Size Coarse Aggregate by Use of the Los Angeles Machine (ASTM, 2003a). The stone sizes vary from a maximum of approximately 18 in (46 cm) to a minimum of 1 in (3 cm) (to fill voids), and have a 50-percent size of 12 in (30 cm). The maximum stone weight is 500 lbs (227 kg), and the specific gravity is greater than 2.60.

The fine bedding layer is placed on the prepared embankment slope in a single lift. The fine bedding gradation satisfies the requirements of ASTM C 33, Concrete Aggregates (ASTM, 2007).

The coarse bedding layer is placed in a single lift on top of the finished fine bedding layer, which has a surface free from mounds or windrows. The coarse bedding gradation shown on Section 9.2.5 satisfies the requirements of ASTM D 448, Standard Sizes of Coarse Aggregate for Highway Construction, Size No. 467 (ASTM, 2003b).

Stone for rip-rap is placed on the surface of the finished coarse aggregate bedding layer in a manner which produces a reasonably well-graded mass of stone with the minimum practicable percentage of voids. Rip-rap is placed to its full course thickness in one operation to avoid displacing the underlying material. All material comprising the rip-rap is placed and distributed such that there are no large accumulations of either the larger or smaller sizes of stone.

The BBNPP ESWEMS Retention Pond is the source of water for the ESWS. Capacity of the ESWEMS Retention Pond is designed in accordance with Regulatory Guide 1.27 (NRC, 1976) to ensure that after 72 hours of an accident, the ESWEMS Retention Pond holds 27 days of water supply.

The plant water requirements discussed in Section 2.4.11 are supplied from the Susquehanna River. The low flow conditions discussed in Section 2.4.11 do not influence the dependability of the ESWEMS Retention Pond.

2.4.8.2.3.4 Resonance

As a conservative approach, wind wave activity within the ESWEMS Retention Pond was evaluated coincident with the probable maximum water level at its peak elevation. At the evaluated water level of 698.36 ft (212.86 m) NAVD 88, the ESWEMS Retention Pond has a water surface length (or fetch length) of 690.16 ft (210.36 m), a width of 390.16 ft (118.92 m), and a depth of 20.86 ft (6.36 m). The ESWEMS Retention Pond side slopes are covered with rip-rap which acts as a wave energy absorber. For these reasons, resonance of the pond is not anticipated.

2.4.8.3 References

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2.4.9 Channel Diversions

The U.S. EPR FSAR includes the following COL Item for Section 2.4.9:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information and demonstrate that in the event of diversion or rerouting of the source of cooling water, alternate water supplies will be available to safety-related equipment.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

BBNPP is located adjacent to the North Branch of the Susquehanna River (NBSR). The geology of the Susquehanna River Basin, from its headwaters in Cooperstown, New York to its mouth in the Chesapeake Bay, changes as you proceed south. The river is approximately 444 mi (715 km) long, making it the longest river on the East Coast of the United States, and flows through New York, Pennsylvania and Maryland. From the headwaters to southern New York, the geology of the land surrounding the river is mostly glacial till underlain by sandstones and shales. Glacial till is a mixture of all sizes of sediments from boulders (glacial erratic) to silt and clay (very fine) sized sediments. In Pennsylvania, the glacial debris ends and sedimentary rocks are the predominant bedrock. The sedimentary rocks include sandstones and shales and also include carbonates such as limestones. Farther south from the BBNPP site, towards the Chesapeake Bay, sedimentary rocks are dominant, however, metasedimentary rocks, such as schists and slates, are also present. The BBNPP site and surrounding areas are shown in Figure 2.4-2. Section 2.4.9.1 through Section 2.4.9.8 are added as a supplement to the U.S. EPR FSAR.

2.4.9.1 Historical Channel Diversions

Section 2.5.1 provides further description and discussion of geological processes that lead to the formation of the Susquehanna River. This section briefly describes the formation of the Susquehanna River.

The Susquehanna River will be used to supply makeup water to the safety-related ESWEMS and non-safety-related Circulating Water System (CWS) as described in Section 2.4.1.1. Municipal water provided by the PA American Water Company (PAW) will be used to satisfy the demands of potable, sanitary and miscellaneous plant systems. The Susquehanna River is described as "an extremely ancient river, the existence of which can be traced back (at least) to the opening of the Atlantic following the Late Triassic/Jurassic rifting of eastern North America from NW Africa. During its long history, the Susquehanna has incised many hundreds of meters into the folded structure of the Appalachians, creating spectacular examples of superimposed drainage. Early studies of this landscape also revealed a number of 'peneplains', some of which are now known to be capped by fluvial deposits of the Susquehanna that pre-date this river's relatively recent entrenchment into its present narrow gorge" (Westaway, 2007). The Susquehanna River has also been subjected to multiple periods of glaciation. Four main periods of continental glaciation occurred in Pennsylvania with three glacial periods directly impacting the BBNPP site region. These glacial events occurred in the following order from oldest to youngest; Early Pleistocene, Early Middle Pleistocene, Middle Pleistocene, and Late Pleistocene. The oldest glaciation extended the farthest south, with each subsequent glacial event never advancing past the previous one, as shown on Figure 2.4-37. These older glacial advances are more difficult to identify due to the eroding attributes of more recent glaciers. The area south of the Late Pleistocene glacial limit is characterized by extensive colluvial deposits and other features of periglacial origin (Braun, 2004) including frost riving and congelifluction (Sevon, 1999). The limit of the Late Pleistocene glacial event, also known as the Late Wisconsinan (17,000-22,000 years), is marked by heads-of-outwash in the valleys with an 'indistinct' moraine on adjacent hillsides (Braun, 2004) and is labeled as Olean Till on Figure 2.4-37. The overall trend of the late Wisconsinan margin across northeastern Pennsylvania is N60°W. Hilltop striae on the Appalachian and Pocono Plateaus, within 30 miles (48 km) of the margin, indicate a regional ice flow direction of North-South to S20 °W (Braun, 1988). The Late Illinoian (132,000-198,000 years) glacial event advanced only a few miles from the more recent Late Wisconsinan event, as shown in Figure 2.4-37, and is identified by heads-of-outwash in the valleys and discontinuous patches of till or colluvium derived from till (Braun, 1988). Pre-Illinoian glaciations advanced approximatley 20-40 mi (32-64 km) beyond the Late Illinoian limit, as shown on Figure 2.4-37. Glacial lake sediments and two belts of ”markedly thicker glacial deposits” suggest that Pre-Illinoian era northeastern Pennsylvania was subjected to two glacial events (Braun, 2004). During periods of Pleistocene Glaciation, the Susquehanna River flowed an additional approximate 248 mi (399 km), 186 mi (299 km) of which is now submerged beneath the Chesapeake Bay and another 62 miles (100 km) flowed over the continental shelf (Westaway, 2007). During glacial retreats, large volumes of glacial melt-waters formed broad, high energy streams including the Susquehanna River, and other neighboring rivers such as the Delaware and Potomac Rivers that incised deep canyons into the continental shelf.

Approximately 7.5 mi (12 km) northeast of the BBNPP site, is the location of one of the largest landslides in Pennsylvania. Approximately 4 Ka ago, a rock block landslide on the south side of Schickshinny Mountain in which 20,260,000-27,450,000 yd^3 (15,490,000-21,000,000 m^3) moved 1,250 ft (381 m) onto the Susquehanna River floodplain and extended in, and partially diverted, the Susquehanna River (Inners, 1988). A rock block slide is "a translational slide in which the moving mass consists of a single unit that is not greatly deformed" (Varnes, 1978). Another, much smaller, landslide was witnessed in 1947 in which rainfall, that deposited 6 inches (15 cm) of rain within 2 hours, likely caused approximately 122,000 yd^3 (93,300 m^3) to move downslope within a minute or two (Inners, 1988). Including the aforementioned landslides, thirteen rock block slides have been mapped between Nanticoke, Pennsylvania and Shickshinny, Pennsylvania (a distance of approximately 9 mi (14.5 km)) along the south side of Schickshinny Mountain, with a total volume of about 56,000,000 yd^3 (42,800,000 m^3) (Inners, 1988). All of these landslides, with the exception of the 1947 landslide, are prehistoric, having a maximum age of approximately 11 Ka, and were the likely results of a combination of the dipslope of Shickshinny Mountain being ultimately underlain by a weak mudstone, a relatively low dipping angle of the rock beds on the slope (approximately 20°), and the undercutting of the sandstone-mudstone bedding planes by the Susquehanna River. Even though porewater pressure, as a result of high moisture conditions in the area, was the most likely cause of many of these historic rock block slides, the larger landslides probably required a longer 'wet' season and/or multiple year high-moisture conditions. (Inners, 1988)

The highest land feature within a 5 mi (8 km) radius of the site is Nescopeck Mountain, to the southeast of the site, which reaches an elevation of about 2,368 ft (722 m) msl. The Susquehanna River elbows around the BBNPP site area to the east and south and is approximately 8,300 ft (2,530 m) from the site (at the closest point). The average elevation of the NBSR 100-yr floodplain is approximately 513 ft (156 m) National Geodetic Vertical Datum of 1929 (NGVD 1929) (FEMA, 2008), or 512.3 ft (156.1 m) NAVD 88, with an average width of approximately 0.75 mi (1.2 km). The finished floor grade elevation of the ESWEMS Pump House is at elevation 700.5 ft (213.51 m) NAVD 88.

Given the seismic, topographical, and geologic evidence in the region (Section 2.5.1 and Section 2.5.2), and despite the historic landslides of the region mentioned above, the limited potential for upstream diversion or rerouting of the Susquehanna River (due to channel migration, river cutoffs, or subsidence) could not adversely impact safety-related facilities at the BBNPP site.

2.4.9.2 Regional Topographic Evidence

The BBNPP does not rely on the Susquehanna River for safe shutdown since the ESWEMS contains sufficient storage volume under emergency conditions. The non-safety-related BBNPP Intake Structure for BBNPP will be located on the Susquehanna River, about 300 ft (100 m) south of the existing SSES Units 1 and 2 intake structure. The Susquehanna River is channeled by two ridges, Lee Mountain and Shickshinny Mountain, northeast of the site while Nescopeck Mountain borders the south side of the Susquehanna River south and southeast of the BBNPP site. Within the 5 mi (8 km) radius of the site, the Susquehanna River flows over very competent bedrock, thus limiting erosion of the riverbed. Erosional deposits of stratified drift on the river banks, typically sand and gravel (as shown in Figure 2.4-37), were primarily deposited during deglaciation of the site area, but continues today at a significantly decreased rate.

The BBNPP site lies within the Middle Susquehanna Subbasin portion of the Susquehanna River Basin, which drains an area of approximately 3,755 mi^2 (9,725 km^2) (SRBC, 2008c). Water usage, and permitting of dams and reservoirs, throughout the entire Susquehanna River Basin, is closely governed and regulated by the Susquehanna River Basin Commission (SRBC) in connection with varying other government agencies. More information on the dams and reservoirs of the Susquehanna River Basin is provided in Section 2.4.4. Because the Susquehanna River is regulated, the possibility of river diversions is very unlikely.

2.4.9.3 Diversions Caused By Ice

A review of the Pleistocene history of the Susquehanna River shows the river underwent significant changes. During the Pleistocene pre-historic period, the Susquehanna River flowed several hundreds of miles longer, through the current day Chesapeake Bay and down the continental slope (Westaway, 2007). During the pre-historic Pre-Illinoian cold stage, part of the

Susquehanna River, mainly the West Branch, was dammed near Montoursville, Pennsylvania by ice and resulted in the flooding and overflowing of the West Branch of the Susquehanna River into a nearby tributary, the Juniata River (Westaway, 2007). The approximate location of this ice dam is over 40 mi (64.4 km) west from the BBNPP site. Due to the distance from the site and intense cold conditions during this occurrence that are no longer experienced within the state (Sevon, 1999), a similar ice damming is highly unlikely to adversely affect the safety related structures at the site.

Even though the Susquehanna River is subject to varying amounts of floating ice during the winter months, the BBNPP Intake Structure, a non-safety related structure, is not impacted. The BBNPP Intake Structure draws water from the NBSR through a 9 ft (3 m) opening from 474 to 483 ft (144 to 147 m) NAVD 88, which is below the design basis low water level elevation of 484 ft (148 m) NAVD 88. Therefore, the function of the Intake Structure is not expected to be impacted by low water conditions. This design would not be subject to ice blockage or ice formed in the Susquehanna River.

Furthermore, the Susquehanna River freezing is not anticipated to cause ice flooding, since a design high water elevation of 525 ft (160 m) NAVD 88 was considered in the final design of the intake system. Ice, or ice flooding, will not cause a problem at the plant discharge, as the warm discharge water will keep the outfall open. A further discussion on the formation of surface ice and the potential for an ice jam is provided in Section 2.4.7.

Flooding due to ice jams as a result of ice break-up can be a problem during the winter months. For instance, jamming may occur at locations where floating ice is retained at bridges. There are 13 recorded instances of ice jams near Wilkes-Barre in the Susquehanna River based on a search of the "Ice Jam Database" maintained by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (CRREL). Figure 2.4-35 illustrates ice jams within a 50-mile (80 km) radius. The most recent ice movement and ice jamming occurred on March 3, 2004 in the vicinity of Wilkes-Barre. Approximately 4.0 ft (1.2 m) of backwater was observed at the Wilkes-Barre USGS gauging station (USACE, 2008).

2.4.9.4 Site Flooding Due to Channel Diversion

Channel diversion resulting from scenarios such as a hypothetical landslide along Walker Run, and complete blockage of bridge openings along Walker Run and the culvert along Unnamed Tributary-2, were evaluated when analyzing Probable Maximum Flood (PMF) on local streams in Section 2.4.3 (see Figure 2.4-30). Based on these analyses, safety-related structures located within the Powerblock at a finished plant grade elevation of 719 ft (219.2 m) NAVD 88 will not be affected by flooding due to channel diversion (see Section 2.4.3). Furthermore, the finished floor grade elevation of the ESWEMS Pump House at 700.5 ft (213.5 m) NAVD 88 will not be exceeded as a result of flooding due to channel diversion (see Section 2.4.3).

All safety-related facilities within the BBNPP Powerblock are located at a finished plant grade elevation of 719 ft (219.2 m) NAVD 88; the finished floor grade elevation of the ESWEMS Pump House is 700.5 ft (213.5 m) NAVD 88. The highest flood on record for the Susquehanna River was the 1972 flood that occurred throughout the Mid-Atlantic as a result of Hurricane Agnes. This 1972 flood recorded a peak stream flow of approximately 345,000 cfs (9,769 m^3/s) at Wilkes-Barre and 363,000 cfs (10,279 m^3/s) at Danville (USGS, 2008a) (USGS, 2008b). On June 25, 1972 a river crest of 517.36 ft (157.7 m) mean sea level (msl) and a mean daily flow of 329,837 cfs (9,340 m^3/s) was recorded near the SSES intake structure (Ecology III, 1986). The Susquehanna River PMF peak discharge and water surface elevation near the BBNPP site were estimated by following the procedures provided in the United States Nuclear Regulatory

Commission (NRC) Regulatory Guide 1.59 (NRC, 1977) and the American National Standards Institute (ANSI)/American Nuclear Society (ANS) 2.8 (ANS, 1992), respectively. The PMF peak discharge was estimated as 1.13 million cfs (31,998 m^3/s) resulting in a peak water surface elevation (WSE) of approximately 548 ft (167.0 m) NAVD 88 at the location of the proposed BBNPP Intake Structure. The BBNPP finished plant grade elevation is 719 ft (219.2 m) NAVD 88, which is 171 ft (52.1 m) above the PMF elevation of 548 ft (167.0 m) NAVD 88.

Therefore, the plant site is dry with respect to PMF flooding on the Susquehanna River and local streams (i.e., Walker Run, Unnamed Tributary-1 and Unnamed Tributary-2) as discussed in Section 2.4.3. Although the estimated Susquehanna River PMF only considers a localized probable maximum precipitation (PMP) storm (i.e., channel diversion scenarios such as a hypothetical landslide impeding flow along the Susquehanna River were not evaluated), it is anticipated that no dams or obstructions on the Susquehanna River would be permitted by the PADEP, SRBC, and USACE that would create flooding or problems for the BBNPP without adequate redress.

2.4.9.5 Human-Induced Channel Flooding

Human-induced channel flooding of the Susquehanna River is not anticipated because the Susquehanna River flooding is monitored and controlled by the SRBC and the U.S. Army Corps of Engineers. There are no reported federal projects to channel or dam any portion of the Susquehanna River. FSAR Section 2.4.3 discusses the PMF on streams and rivers as a result of the PMP over the watershed. On Walker Run, no dams or obstructions would be permitted to be constructed that would cause flooding at the BBNPP site.

There are no dams within the Walker Run watershed. Several water control structures are located within the Susquehanna River Basin upstream from the site, some of which are positioned on significant tributaries that drain into the Susquehanna River (Figure 2.4-15). During an upstream (from the proposed BBNPP Intake Structure) dam failure event, flooding resulting from the failure of these storage structures will not impact the safety-related structures. Section 2.4.4 provides an in depth discussion of the dam failure analysis.

Human induced, temporary flow cut off can occur on the Susquehanna River due to coffer damming for construction of a new bridge for example. In this case the CWS supply may be reduced or shutdown which could impact operation of the BBNPP. It is highly unlikely that flow cutoff would be so severe it would affect normal plant operations; however, in this unlikely event, the BBNPP emergency water supply would continue to be effective until river flow could be restored.

2.4.9.6 Alternate Water Sources

An alternate water source is not required for the BBNPP design. Following a postulated accident, the emergency safety-related water supply to the ESW System is initially supplied from basins that are located beneath each of the four ESWS cooling towers. Each of the four cooling tower basins holds sufficient volume of water to supply the ESW System for 72 hours. After the initial 72 hours, the ESWEMS Retention Pond supplies makeup water to the ESWS cooling tower basins for use by the ESWS during the following 27 days of the postulated accident duration. There is no potential of blockage of the safety-related ESWEMS Pump House due to channel diversions. Non-safety related water sources, such as water from the non-safety related CWS Makeup Water System, Raw Water Supply System, and municipal water system are also available, if needed.

2.4.9.7 Other Site-Related Evaluation Criteria

The potential for channel diversion from seismic or severe weather events is not considered to result in a loss of cooling water supply. Seismic Category I structures are designed for a seismic event and will be situated at finished plant grade elevation 719 ft (219.2 m) NAVD 88 at the Powerblock and 700.5 (213.5 m) NAVD 88 at the ESWEMS Pump House, which are not exceeded by site flooding due to channel diversions as discussed previously in Section 2.4.9.4. Due to the limited likelihood of a seismic event at or within the site area and because the sides of the new forebay will be protected by vertical sheet pile walls, no additional measures are necessary to protect against a potential channel diversion due to seismic events. A collapse of the shoreline to the northeast and east of the BBNPP site during a seismic or severe weather event is assumed to not result in silt depositing in the forebay to such an extent that it would cause a loss of cooling water supply. A seismic event would result in the bulk of the collapsed material being deposited at the shoreline location of the failure. Normal waves and flow of the river would disperse this material slowly over a wide area. A severe storm could relocate shoreline sands and soils but is, again, dispersed over a wide area. A severe storm or collapse of nearby shoreline may result in the need for maintenance dredging of the Susquehanna River.

2.4.9.8 References

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2.4.10 Flooding Protection Requirements

The U.S. EPR FSAR includes the following COL Item in Section 2.4.10:

> A COL applicant that references the U.S. EPR design certification will use site-specific information to compare the location and elevations of safety-related facilities, and of structures and components required for protection of safety-related facilities, with the estimated static and dynamic effects of the design basis flood conditions.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88) unless stated otherwise.

This section discusses the locations and elevations of safety-related facilities to identify the structures and components exposed to flooding. The safety-related facilities are compared to design basis flood conditions to determine if flood effects need to be considered in plant design or in emergency procedures.

The BBNPP plant grade elevation is 719 ft (219.2 m) NAVD 88. The highest flood of record on the Susquehanna River took place in 1972 during Hurricane Agnes. This 1972 flood recorded a peak stream flow of about 345,000 cfs (9,769 m^3/s) at Wilkes-Barre, PA on June 24th, 1972 and 363,000 cfs (10,279 m^3/s) at Danville on June 25th, 1972 (USGS, 2008a) (USGS, 2008b). On June 25, 1972 a river crest of 517.36 ft (157.7 m) mean sea level (msl) and mean daily flow of 329,837 cfs (9,340 m^3/s) was recorded near the SSES intake structure (Ecology III, 1986). Therefore, the BBNPP Powerblock is approximately 202 ft (61.6 m) higher than the June 25, 1972 river crest at the SSES Intake Structure, (Ecology III, 1986).

The Susquehanna River Probable Maximum Flood (PMF) peak discharge and water surface elevation near the BBNPP site were estimated by following the procedures provided in the United States Nuclear Regulatory Commission (NRC) Regulatory Guide 1.59 (NRC, 1977) and the American National Standards Institute (ANSI)/American Nuclear Society (ANS) 2.8 (ANS, 1992), respectively. The PMF peak discharge was estimated as 1.13 million cfs (31,998 m^3/s) resulting in a peak water surface elevation of approximately 548 ft (167.0 m) NAVD 88 at the BBNPP Intake Structure. The BBNPP plant grade elevation is 719 ft (219.2 m) NAVD 88, which is 171 ft (52.1 m) above the estimated PMF elevation of 548 ft (167.0 m).

Therefore, it is anticipated that the Susquehanna River flooding will not affect the plant. The BBNPP site is dry with respect to major flooding on the Susquehanna River, and only a localized Probable Maximum Precipitation (PMP) storm was considered for flood design protection of safety-related facilities.

The safety-related structures in the Powerblock consist of two ESWS Cooling Towers located in the northwest corner, two ESWS Cooling Towers located in the southeast corner, Emergency Diesel Generator Buildings located north and south of the Nuclear Island and the Reactor Complex, which consists of the Reactor, Fuel, and Safeguards Buildings. The locations of the buildings are shown on Figure 2.4-5. The BBNPP plant grade elevation is 719 ft (219.2 m) NAVD 88, and the entrances to each of these structures are located at or above the finished floor grade elevation 720 ft (219.5 m) NAVD 88.

The effects of local intense precipitation at the BBNPP site are analyzed and discussed in Section 2.4.2, and the maximum water level in the Powerblock during the 1-hour PMP event was estimated to be 718.36 ft (218.96 m) NAVD 88 which is 1.64 ft (0.50 m) below the reactor complex finished floor grade at elevation 720 ft (219.5 m) NAVD 88. Walker Run and Unnamed Tributaries 1 & 2 adjacent to the BBNPP protected area boundary were analyzed for PMF in Section 2.4.3. The results of the PMF analysis indicate a maximum PMF water surface elevation of 675.69 ft (205.95 m) NAVD 88 at cross section 12,764.15 along Walker Run, 672.34 ft (204.93 m) NAVD 88 at cross section 1614.092 along Unnamed Tributary-1, and 715.03 ft (217.94 m) NAVD 88 at cross section 1645.505 along Unnamed Tributary-2 in the vicinity of the BBNPP (see Figure 2.4-31). The plant grade elevation for BBNPP is 719 ft (219.2 m) NAVD 88, which provides a minimum elevation difference of 46.66 ft (14.22 m) below the plant grade along Unnamed Tributary-1, 3.97 ft (1.21 m) below the plant grade along Unnamed Tributary-2, and 43.31 ft (13.20 m) below the plant grade along Walker Run.

The maximum estimated water surface elevations resulting from all design basis flood considerations are below the entrance and grade slab elevations for the Powerblock safety-related facilities. Therefore, flood protection measures are not required in the Powerblock area.

The safety-related ESWEMS Retention Pond is located southeast of the Powerblock area, as shown on Figure 2.4-36. Grading around the ESWEMS Retention Pond is sloped to keep surface stormwater from entering the pond. To prevent an overflow caused by malfunction of the makeup system or by rainfall accumulation in the ESWEMS Retention Pond, a spillway at elevation 698 ft (212.75 m) NAVD 88 is provided to drain excess storage . A schematic layout of the ESWEMS is provided in Figure 2.4-36.

The top of the dike of the ESWEMS Retention Pond is at elevation 700 ft (213.4 m) NAVD 88 and the grade level of the ESWEMS Pump House is at elevation 700.5 ft (213.5 m) NAVD 88. Assuming no losses, the maximum water level resulting from local intense precipitation

(72-hour PMP event) in the ESWEMS Retention Pond was estimated to be 698.36 ft (212.86 m) NAVD 88 as presented in Section 2.4.2. The crest elevation of the ESWEMS Retention Pond spillway is 698 ft (212.75 m) NAVD 88, resulting in a peak outflow of 3.42 cfs (0.10 m^3/s) during the 72-hour PMP event. As stated previously, the energy of this outflow from the ESWEMS Retention Pond is dissipated at the base of the spillway channel before being routed through a channel lined with rip-rap, which then discharges to a swale that conveys surface runoff down and away from the site. Wave run up within the ESWEMS Retention Pond during the local intense precipitation event was analyzed and discussed in Section 2.4.8. The wave action elevation resulting from the 1,000 year wind event, assuming that the initial water surface elevation within the ESWEMS Retention Pond is equivalent to 698.36 ft (212.86 m) NAVD 88, was estimated to be 699.83 ft (213.31 m) NAVD 88. Therefore, there is 0.17 ft (0.05 m) of freeboard to the top of the dike embankment at elevation 700 ft (213.4 m) NAVD 88 and 0.67 ft (0.20 m) of freeboard to the grade level of the ESWEMS Pump House at elevation 700.5 ft (213.5 m) NAVD 88.

The possibility of flood elevations outside the ESWEMS Retention Pond overflowing the ESWEMS Retention Pond dike embankment at elevation 700 ft (213.4 m) NAVD 88 and flooding the ESWEMS Pump House at elevation 700.5 ft (213.5 m) NAVD 88 were also evaluated in Section 2.4.2 and Section 2.4.3. When evaluating the effects of local intense precipitation in the proposed site in Section 2.4.2, it was determined that the dike does not overflow with the highest peak water surface elevation of 695.62 ft (212.02 m) NAVD 88. When evaluating PMF on nearby streams in Section 2.4.3, the top roadway of the culvert at the wetlands outlet along Unnamed Tributary-2 was established at elevation 695 ft (211.8 m) NAVD 88 (access road elevation). As reported in Table 2.4-27, the water surface elevation near the inlet of this proposed culvert is 696.38 ft (212.26 m) NAVD 88. Therefore, the PMF water level is 3.62 ft (1.10 m) below the top elevation of the ESWEMS Retention Pond dike at elevation 700 ft (213.4 m) NAVD 88 and 4.12 ft (1.26 m) below the ESWEMS Pump House at elevation 700.5 ft (213.5 m) NAVD 88.

The BBNPP Intake Structure at the Susquehanna River is not a safety-related facility. However, the BBNPP Intake Structure will be designed to take into account the flood elevation of 525 ft (160 m) msl.

In summary, the safety-related facilities are designed to withstand the combination of flooding conditions and wave-run up, including both static and dynamic flooding forces, associated with the flooding events discussed in Section 2.4.2 through Section 2.4.8.

2.4.10.1 References

ANS, 1992. Determining Design Basis Flooding at Power Reactor Sites, ANSI/ ANS-2.8-1992, American National Standard Institute/American Nuclear Society, July 1992.

Ecology III, 1986. Pre-Operational Studies of the Susquehanna River in the Vicinity of the Susquehanna Steam Electric Station, 1971-1982. December 1986.

NRC, 1977. Regulatory Guide 1.59, Design Basis Floods for Nuclear Power Plants, Revision 2, Nuclear Regulatory Commission, August 1977.

USGS, 2008a. Peak Streamflow for Pennsylvania USGS 01540500 Susquehanna River at Danville, PA. Website: http://nwis.waterdata.usgs.gov/pa/nwis/peak?site_no=01540500&agency_cd=USGS&format=html, Date accessed: February, 2008.

USGS, 2008b. Peak Streamflow for Pennsylvania USGS 01536500 Susquehanna River at Wilkes-Barre, PA. Website: http://nwis.waterdata.usgs.gov/pa/nwis/peak?site_no=01536500&agency_cd=USGS&format=html, Date accessed: February, 2008.}

2.4.11 Low Water Considerations

The U.S. EPR FSAR includes the following COL Item in Section 2.4.11:

> A COL applicant that references the U.S. EPR design certification will identify natural events that may reduce or limit the available cooling water supply, and will verify that an adequate water supply exists for operation or shutdown of the plant in normal operation, anticipated operational occurrences, and in low water conditions.

This COL Item is addressed as follows:

{This section investigates natural events that may reduce or limit the available cooling water supply to ensure that an adequate water supply exists to shut down the plant under conditions requiring safety-related cooling. Specifically, events resulting in a low water level in the Susquehanna River are investigated in this section.

References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

Section 2.4.11.1 through Section 2.4.11.7 are added as a supplement to the U.S. EPR FSAR.

2.4.11.1 Low Flow in Rivers and Streams

The BBNPP sits on a relatively flat upland area, with the plant grade above the nominal Susquehanna River level. Figure 2.4-2 shows the location of the BBNPP in relation to the existing SSES Units 1 and 2, the Susquehanna River, and Walker Run. The BBNPP site is approximately 21.4 mi (38.6 km) downstream of the U.S. Geological Service (USGS) gauge located at Wilkes-Barre, and approximately 5 mi (8 km) upstream of Berwick.

BBNPP relies on the Susquehanna River to supply water for safety-related and non-safety-related purposes. BBNPP does not draw water from any other streams or creeks located in the vicinity of the site; thus, low water conditions resulting from the low flow in these water bodies have no adverse impact on BBNPP.

The minimum daily mean discharge of 532 cfs (15 m^3/s) reported at Wilkes-Barre on September 27, 1964 (USGS, 2008a) has a recurrence interval of 109 years based on the Weilbull frequency distribution of daily mean flow data at the Wilkes-Barre gauge station (refer to Section 2.4.11.3) Using the depth-level-flow relationship of the Susquehanna SES Environmental Laboratory, a discharge of 532 cfs (15 m^3/s) results in a water surface elevation of approximately 485.3 ft (147.9 m) msl near the BBNPP Intake Structure (Soya, 1991).

The BBNPP Intake Structure draws water from the NSBR through a 9 ft (3m) opening from 474 to 483 ft (144 to 147 m) NAVD 88, and the design basis low water level elevation for the BBNPP Intake Structure is 484 ft (148 m) NAVD 88.

The estimated low water level of 485.3 ft (147.9 m) msl (Soya, 1991) is above the design basis low water level for the BBNPP Intake Structure. Therefore, the function of the non-safety related makeup water intake for the Circulating Water System (CWS) and Raw Water Supply

System (RWSS) will not be affected by the estimated low water level. Furthermore, the SRBC has the authority to release water from the Cowanesque Reservoir to supplement river flow if drought conditions occur: this release is initiated by a flow of 868 cfs (25 m^3/s) at the Wilkes-Barre gauging station, and for this reason there is little chance of ever having water levels less than 485.72 ft (148.05 m) msl near the BBNPP Intake Structure (Soya, 1991).

2.4.11.2 Low Water Resulting from Surges, Seiches, Tsunamis, or Ice Effects

Since the effect from seiches and tsunamis on the site are negligible, as described in Section 2.4.5 and Section 2.4.6 respectively, these effects are not taken into account for the low water consideration. Section 2.4.7 includes a description of cases of ice formation or ice-jams that may result in low water level. However, as concluded in Section 2.4.7, the possibility of ice jam formation on the Susquehanna River will not adversely affect the ability of the safety related Essential Service Water Emergency Makeup System (ESWEMS) to function properly.

2.4.11.2.1 Storm Surge Effect

Since the plant grade elevation of BBNPP is approximately 207 ft (63 m) above the 100-yr floodplain of the Susquehanna River, there are no effects due to storm surges or seiche flooding that would impact the site's safety-related facilities. Details of the storm surge effects are given in Section 2.4.5.

2.4.11.2.2 Tsunami Effect

Any effect from a tsunami-like wave is not credible. Details of the tsunami effects are given in Section 2.4.6.

2.4.11.3 Historical Low Water

Table 2.4-36 lists the location and period of record for USGS gauging stations at Wilkes-Barre and Danville, which are located upstream and downstream of the BBNPP site on the Susquehanna River, respectively (USGS, 2008a) (USGS, 2008b). The minimum annual water level and streamflow measurements in the Susquehanna River and their corresponding stages on the Susquehanna River at Danville and Wilkes-Barre are listed in Table 2.4-37 and Table 2.4-38. Table 2.4-39 shows the low calculated annual flow statistics for the Wilkes-Barre and Danville USGS gauging stations based on almost 106 years of recorded flow data.

Figure 2.4-38 shows the mean monthly minimum flow variations for Wilkes-Barre and Danville gauging stations. The minimum water level in the Susquehanna River measured at Wilkes-Barre was 509.13 ft (155.18 m) NAVD 88 on September 22, 1964 (USGS, 2008f). The lowest river stage measured at Danville was 432.12 ft (131.71 m) NAVD 88 on September 25, 1900 (USGS, 2008e). The minimum daily mean discharge in the Susquehanna River was 532 cfs (15 m^3/s) at Wilkes-Barre on September 27, 1964 (USGS, 2008a) and 558 cfs (16 m^3/s) at Danville, on September 27, 1964 (USGS, 2008b) These flows may be considered as the probable minimum flows in the Susquehanna River at these respective stations.

Statistical methods were used to determine the recurrence interval associated with Susquehanna River low flow events (Linsley, 1992). Frequency analysis methods such as Weilbull, Gumbel and Log Pearson Type III distributions were used to estimate flood frequency events. However, by adjusting the procedure slightly to accommodate low flow events when calculating the Weilbull recurrence intervals to establish an estimated frequency distribution, and by calculating the probability that the flow is less than (as opposed to greater than or equal to) a flow event of a given magnitude, all three (3) methods mentioned above can be used effectively to estimate the frequencies of low flow events. Plots comparing the three (3) calculated frequency distributions, as well as the extrapolation of Log Pearson Type III distributions at the Danville (USGS, 2008b) and Wilkes-Barre (USGS, 2008a) gage stations, can be found on Figure 2.4-39 and Figure 2.4-40, respectively.

Table 2.4-40 summarizes the recurrence intervals calculated for the record low flows at Wilkes-Barre and Danville gauging stations. Figure 2.4-41 and Figure 2.4-42 illustrate the state-discharge curves for Danville and Wilkes-Barre, respectively.

Using the drainage area ratio transfer method developed by the US Geological Survey (USGS), in cooperation with the Pennsylvania Department of Environmental Protection (PADEP), low flow statistics were interpolated for the ungaged water supply intake located at Susquehanna River Mile 165 based on statistics that were developed using the data recorded at the upstream (Wilkes-Barre; USGS, 2008a) and downstream (Danville; USGS, 2008b) gauging stations (USGS, 2008g). When applying this method using the low flow statistics calculated at the Wilkes-Barre gage station, the 1-day, 10-year average low flow (Q1,10) was estimated as 818 cfs (23 m^3/s) (Table 2.4-39). The 7-day, 10-year low flow condition (Q7,10) estimated at Wilkes-Barre as the design low flow condition is 850 cfs (24 m^3/s).

Regulatory Guide 1.206 (NRC, 2007) does not provide guidance regarding the specific return period for the extreme low water level, but does recommend the use of the 100-year drought as a design basis for non-safety related facilities. The 100-year low water level is the appropriate design level for the non-safety-related makeup water intake for the Circulating Water System (CWS) and Raw Water Supply System (RWSS), or the BBNPP Intake Structure.

As shown in Table 2.4-38, the minimum water level in the Susquehanna River at the Wilkes-Barre was 509.13 ft (155.18 m) NAVD 88 in 1964 (USGS, 2008f).

The minimum flow is based on the historical flow data (from 1900 to 2006) at the Wilkes-Barre station, located upstream from the BBNPP site. The minimum daily mean flow of 532 cfs (15 m^3/s) reported at Wilkes-Barre on September 27, 1964 (USGS, 2008a), which has an estimated recurrence interval of 109 years based on the Weilbull frequency distribution, results in a water level of 485.3 ft (147.9 m) msl near the BBNPP Intake Structure after applying the depth-flow-level relationship of the Susquehanna River at the SSED Environmental Laboratory (Soya, 1991). Soya (Soya, 1991) also reports that flows ranging from 380 to 600 cfs (11 to 17 m^3/s) result in a water level near the SSES Environmental Laboratory, which is approximately 1,620 ft (402 m) up river from the existing SSES river intake, of about elevation 485.1 to 485.5 ft (147.9 to 148.0 m) msl (Soya, 1991). These water levels are higher then tha BBNPP Intake Structure's design low water level of 484 ft (148 m) NAVD 88 and thus will not impact withdrawal of water from the Susquehanna River.

Susquehanna River Basin Drought

The PADEP is responsible for the drought monitoring and management. The PADEP uses drought indicators (i.e. stream flow, soil moisture and precipitation) to provide timely identification of developing drought conditions. Stream flows have been widely used as an indicator of a developing drought. For this evaluation, 30-day average stream flow values computed by the USGS (USGS, 2008c) (USGS,2008d) were used to evaluate drought status based on stream flow percentiles. Figure 2.4-43 and Figure 2.4-44 shows the 30-day moving average for 2007 and 2008 stream flow for Danville and Wilkes-Barre USGS gauging stations, respectively. For stream flows, the 25, 10 and 5 percentile color bands are used as indicators for drought watch, warning, and emergency, respectively.

When drought conditions occur, the SRBC commission has the authority to release water from the Cowanesque Reservoir to augment the Susquehanna River flow. Currently, this release is initiated by a flow of less than or equal to 868 cfs (25 m^3/s) at the USGS Wilkes-Barre gauging station (Soya, 1991).

2.4.11.4 Future Controls

There are no future controls that could create or exacerbate low flow conditions, or that could affect the ability of potential BBNPP safety-related facilities to function adequately.

2.4.11.5 Plant Requirements

2.4.11.5.1 Minimum Safety-Related Cooling Water Flow

In terms of plant requirements, the ESWS provides flow for normal operating conditions, for shutdown/cool down and for Design Basis Accident (DBA) conditions. The ESWS pump in each train obtains water from the ESWS cooling tower basin of that train and circulates the water through the ESWS. Heated cooling water returns to the ESWS cooling tower to dissipate its heat load to the environment. Makeup water is required to compensate for ESWS cooling tower water inventory losses due to evaporation, drift, and blowdown associated with cooling tower operation. Water to the ESWS cooling tower basins under normal operating conditions and shutdown/cool down conditions is provided by the Raw Water Supply System (RWSS). Water is stored in the ESWS cooling tower basin, which provides at least 72 hours of makeup water for the ESWS cooling tower following a DBA. After 72 hours have elapsed under DBA conditions, emergency makeup water to the tower basins is provided by the safety-related ESWEMS Retention Pond. Refer to Section 9.2.1 and ER Section 3.3 for more information regarding the ESWS.

During DBA conditions, the ESWS cooling tower basins contain sufficient water to accommodate 72 hours of operation without makeup. Four trains of ESWS are assumed to be in operation to respond to an accident. After 72 hours of post-accident operation, makeup flow will be supplied by the ESWEMS Retention Pond (or Ultimate Heat Sink [UHS]) to the four operating ESWS cooling tower basins. The required makeup flow rate will reduce over time as heat loads get lower. Post-accident makeup to the ESWS cooling tower basins is pumped from the ESWEMS Retention Pond using pumps located in the safety-related ESWEMS Pump House. Refer to Section 9.2.5 and ER Section 3.3 for more information regarding the UHS.

Technical Specifications (TS) and bases for the ESWEMS Retention Pond (or Ultimate Heat Sink [UHS]), TS 3.7.19, is discussed in COLA Part 4. Surveillance requirements (SR) for the ESWEMS Retention Pond are identified, including verification of the water level and average water temperature on a 24-hour basis, to ensure that the ESWEMS remains operable and capable of performing its safety-related function (i.e., provide the 27-day post-accident water supply) during DBA conditions.

2.4.11.5.2 Minimum Normal Operating Water Flow

Plant Requirements

The normal BBNPP plant water demand will be approximately 25,729 gpm (97,384 lpm). This water will be drawn from the Susquehanna River through the BBNPP Intake Structure.

2.4.11.5.2.1 Susquehanna River Flow

Water Supply Intake and Pumphouse Structure

The estimated low water level of 485.3 ft (147.9 m) msl (Soya, 1991) is above the design basis low water level of 484 ft (148 m) NAVD 88 for the BBNPP Intake Structure. Therefore, the function of the non-safety-related makeup water intake for the Circulating Water System (CWS) and Raw Water Supply (RWSS) will not be affected by the estimated low water level. Furthermore, the SRBC has the authority to release water from the Cowanesque Reservoir to supplement river flow if drought conditions occur; this release is initiated by a flow of 868 cfs ($25 m^3/s$) at the Wilkes-Barre gauging station, and for this reason there is little chance of ever having water levels less than 485.72 ft (148.05 m) msl near the BBNPP Intake Structure (Soya, 1991).

Water treatment will be required for both influent and effluent water streams. The Circulating Water Treatment System provides treated water for the CWS and consists of three phases: makeup treatment, internal circulating water treatment and blowdown treatment. The RWSS Water Treatment System provides treated water for the ESWS and power plant makeup. Detailed information regarding the water treatment process is described in ER Section 3.3.2

Circulating Water System

Under normal plant operating conditions, BBNPP uses the CWS to dissipate heat from the turbine condenser and Closed Cooling Water System. A closed-cycle, wet cooling system is used for BBNPP similar to the existing SSES cooling system. Makeup water to the CWS cooling tower is required due to evaporation, drift and blowdown. Refer to Section 10.4.5 and ER Section 3.3 for more information regarding the CWS.

2.4.11.5.3 Plant Water Effluent

The plant water effluent will consist mainly of the blowdown from the CWS and ESWS cooling towers. The blowdown from the CWS and ESWS cooling towers and miscellaneous low volume waste are directed to the Combined Waste Water Retention Pond. The discharge velocity will be sufficient to mix the effluent with the river water for a 7-day, 10-year low flow condition estimated at Wilkes-Barre as the design low flow condition (850 cfs ($24 m^3/s$)), in order to minimize thermal effects. These anticipated discharge conditions meet the existing Pennsylvania Water Quality standards.

2.4.11.6 Heat Sink Dependability Requirements

The normal source of water for the CWS and ESWS is the BBNPP Intake Structure on the Susquehanna River. The ESWEMS Retention Pond will be the emergency source of water for the ESWS. The low flow conditions in the Susquehanna River do not influence the dependability of the ESWEMS Retention Pond since the ESWEMS Retention Pond is designed to provide a 27 day supply of water.

Design basis heat loads for various plant modes are provided in Section 9.2.5 and U.S. EPR FSAR Section 9.2.5.

2.4.11.7 References

Linsley, 1992. Probability Concepts in Planning, Water-Resources Engineering, B.J. Clark and E. Castellano, ed., McGraw-Hill, Inc., New York, pp. 140-144 and pp. 808-809 (Table A-5).

NRC, 2007. Combined License Applications for Nuclear Power Plants (LWR Edition), Regulatory Guide 1.206, Revision 0, U.S. Nuclear Regulatory Commission, June 2007.

Soya, 1991. Depth -Level-Flow Relationship of the Susquehanna River at the Susquehanna SES Environmental Laboratory. Ecology III, Inc. October 1991.

USGS, 2008a. National Water Information System, Wilkes-Barre, PA: Web Interface, Website: http://waterdata.usgs.gov/nwis/dv/?site_no=01536500&agency_cd=USGS&referred_module=sw , Date accessed: January 3, 2008.

USGS, 2008b. National Water Information System, Danville, PA, Website: http://waterdata.usgs.gov/nwis/nwisman/?site_no=01540500&agency_cd=USGS, Date accessed: January 3, 2008.

USGS, 2008c. 30-day Moving Average, Station 01536500 Susquehanna River at Wilkes-Barre, PA, Website: http://pa.water.usgs.gov/monitor/sw/images/f30_01536500.html, Date accessed: June 19, 2008.

USGS, 2008d. 30-day Moving Average, Station 01540500 Susquehanna River at Danville, PA, Website: http://pa.water.usgs.gov/monitor/sw/images/f30_01540500.html, Date accessed: June 19, 2008.

USGS, 2008e. USGS 01540500 Susquehanna River at Danville, PA, Surface Water Field Measurements, Website: http://waterdata.usgs.gov/nwis/measurements?site_no=01540500&agency_cd=USGS&format=html_table, Date accessed: June 24, 2008.

USGS, 2008f. USGS 01536500 Susquehanna River at Wilkes-Barre, PA, Surface Water Field Measurements, Website http://waterdata.usgs.gov/nwis/measurements?site_no=01536500&agency_cd=USGS&format=html_table, Date accessed: June 24, 2008.

USGS, 2008g. Computing Low-Flow Statistics for Ungaged Locations on Pennsylvania Streams By Use of Drainage-Area Ratios, http://pa.water.usgs.gov/pc38/flowstats/revised_deplowflow.pdf, Date accessed: March 27, 2008.

2.4.12 Groundwater

The U.S. EPR FSAR includes the following COL Item in Section 2.4.12:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information to identify local and regional groundwater reservoirs, subsurface pathways, onsite use, monitoring or safeguard measures, and to establish the effects of groundwater on plant structures.

This COL Item is addressed as follows:

{This section provides a description of the hydrogeologic conditions present at, and in the vicinity of the BBNPP site and describes regional and local groundwater resources that could be affected by construction and operations at the site. The regional and site-specific physical and hydrologic characteristics of these resources are summarized to provide the basic data required for an evaluation of potential impacts on the aquifers of the area.

Section 2.4.12.1 through Section 2.4.12.6 are added as a supplement to the U. S. EPR FSAR.

2.4.12.1 Description and Use

2.4.12.1.1 Physiographic and Geologic Setting

The BBNPP site area is encompassed by three of the Commonwealth of Pennsylvania's physiographic regions, namely the Appalachian Plateaus, Ridge and Valley, and Piedmont provinces. The geology, stratigraphy, and tectonic history of these areas are described in detail in Section 2.5. However, a very brief discussion of the geology and hydrogeology is provided here.

2.4.12.1.1.1 Appalachian Plateaus Physiographic Province

The Appalachian Plateaus Province extends over most of West Virginia, much of Pennsylvania, and small parts of westernmost Virginia and Maryland, and is bounded on the east and southeast by the Ridge and Valley Province. The Appalachian Plateaus region is underlain primarily by flat lying Cambrian- to Permian-age (i.e., Paleozoic) sedimentary rocks (Trapp, 1997).

Aquifers in the Appalachian Plateau consist mostly of Paleozoic shale, sandstone, conglomerate, limestone, and coal beds. The water-yielding characteristics of these aquifers differ significantly due to local variations in lithology and thickness of the geologic units. The most productive aquifers lie within sandstones or conglomerates, but many limestone formations also yield significant volumes of water (Trapp, 1997). Sand and gravel deposits derived from glacial outwash, kame terraces, and ground moraine also form secondary aquifers.

2.4.12.1.1.2 Ridge and Valley Physiographic Province

The northeast-southwest trending Ridge and Valley Physiographic Province extends from West Virginia and Maryland to northeastern Pennsylvania, and encompasses approximately 25 percent of Pennsylvania. This region is bounded to the north and west by the Appalachian Plateaus and to the southeast by the Piedmont Province. The Ridge and Valley Province is characterized by complexly faulted and folded Paleozoic sedimentary rocks. These rocks range in age from Cambrian to Pennsylvanian. Elongated mountain crests within the Ridge and Valley Province are formed by wellcemented sandstones and conglomerates that are resistant to weathering. These ridges typically are the remnant flanks of breached anticlines. Limestone, dolomite, and shale are more easily weathered and eroded and, as a result, form intervening valleys.

The principal aquifers in the Ridge and Valley Province are carbonate rocks (limestone and dolomite) and sandstones. Most of the more productive aquifers are composed of carbonate rocks, primarily limestone, and are typically found in valley bottoms. However, the water-yielding characteristics of the carbonate rocks largely depend upon the degree of fracturing and development of solution cavities in the rock. Sandstone formations also yield large volumes of water where these rocks are well fractured. Generally, the carbonate aquifer rocks are early Paleozoic in age, whereas the sandstone aquifers are typically found in late Paleozoic rocks (Trapp, 1997).

Similar to the Appalachian Plateaus Province, the Ridge and Valley Province contains secondary aquifers within glacial outwash, kame terrace, and ground moraine sands and gravels.

2.4.12.1.1.3 Piedmont Physiographic Province

The Piedmont Province lies southeast of the Great Valley Section of the Ridge and Valley Province (Figure 2.5-125). In southeastern Pennsylvania, the Piedmont Province ranges in elevation between 20 and 1,355 ft (6 to 413 m) NAVD 88 (DCNR, 2007c) (DCNR, 2007d) and is approximately 60 miles (97 km) wide.

The Piedmont Province is specifically divided into three sections, the Piedmont Lowland, the Gettysburg-Newark Lowland, and the Piedmont Upland (Figure 2.5-126). The Piedmont Lowland consists of wide, moderately dissected valleys separated by broad low hills and is developed primarily on limestone and dolomite rocks, which are highly susceptible to karstification (DCNR, 2007b). The Gettysburg-Newark Lowland, in turn, comprises rolling low hills and valleys developed on rocks of fluvial and lacustrine origin (Root, 1999). Sedimentary basins within the Gettysburg-Newark Lowland are typically formed in early Mesozoic crustal rift zones, and contain shale, sandstone, and conglomerate, interbedded locally with basaltic lava flows and coal beds. In some places, these rocks are intruded by diabase dikes and sills (Trapp, 1997).

The Piedmont Upland is underlain primarily by metamorphosed sedimentary, volcanic, and plutonic rocks (Crawford, 1999). Meta-carbonate rocks of Cambrian and Ordovician age overly these basement rocks in the western Piedmont Upland (Crawford, 1999). To the east, Mesozoic clastic sedimentary rocks overly the basement.

Aquifers in the Piedmont Province occur predominantly in shallow, fractured igneous and metamorphic rocks. In topographically low areas, aquifers also exist within the carbonate rocks and sandstones (Trapp, 1997).

2.4.12.1.2 Regional Hydrogeologic Description

The BBNPP site is located in the Ridge and Valley Province, on the north limb of the so-called Berwick Anticlinorium, a moderately complex, northeast-southwest trending first-order fold that plunges 2 to 4 degrees east-northeast (Inners, 1978). The total thickness of Paleozoic sedimentary rocks in the vicinity of the site is nearly 33,000 ft (10,058 m), and includes Paleozoic sandstone, siltstone, shale, and limestone units, with lesser amounts of coal and conglomerate (Inners, 1978). The middle Devonian Mahantango Formation directly underlies the BBNPP site, although younger rocks (e.g., the Harrell Shale and Trimmers Rock formations) crop-out north of the site. Older rocks, including Marcellus Formation shales, are buried well below the surface, but crop-out to the west-southwest of the site, along the centerline of the anticlinorium.

Groundwater in the bedrock formations surrounding the BBNPP site (including shales and clay shales) is present primarily in secondary openings, including fractures, joints, and bedding plane separations. Dissolution of calcareous material, especially along fractures and bedding planes, greatly increases the secondary porosity and permeability of local carbonate rock units. It should also be noted that extensive aquitards are not found in the BBNPP site region, largely as a result of the folded, faulted, and fractured condition of the bedrock.

Bedrock in the BBNPP site area is overlain by a variable thickness of glacial till, colluvium, outwash, kame, and kame terrace deposits of late Wisconsinan age (approximately 22,000 to 17,000 years ago) (Figure 2.4-37). The outwash and kame terrace deposits constitute some of the most permeable aquifer units in the region (Lohman, 1937) (Hollowell, 1971) (Taylor, 1984) (Williams, 1987).

The glacial deposits and underlying rock formations of the BBNPP site area are discussed in greater detail below, in order of increasing age.

2.4.12.1.2.1 Glacial Outwash Deposits

In upland and lowland areas at the BBNPP site, surface deposits consist largely of glacial outwash sands and gravels (Figure 2.4-47 and Figure 2.4-48). Within the lowland valleys (e.g., in the NBSR valley) surface deposits also include recent alluvium. In these deposits, porosity and permeability are primary. That is, upland lowland glacial outwash aquifers are largely inter-granular in nature.

2.4.12.1.2.2 Catskill Formation

The Catskill Formation is the youngest Paleozoic sedimentary sequence in eastern Pennsylvania. The Duncannon Member of the Catskill Formation consists of approximately 1,100 ft (335 m) of repetitive, fining upward cycles of greenish-gray and grayish-red sandstone, siltstone, and shale. Each cycle is generally 30 to 65 ft (9 to 20 m) thick (Williams, 1987). The Sherman Creek Member, in turn, is approximately 2,500 ft (762 ft) thick and consists of interbedded grayish-red shale, siltstone, and sandstone. The Irish Valley Member, the lowermost member of the Catskill Formation, is approximately 1,800 to 2,000 ft (549 to 610 m) thick and consists of greenish-gray to gray interbedded shale, siltstone, and sandstone.

Note that the Catskill Formation is not directly present at the BBNPP site, but crops-out within approximately 2.9 mi (4.7 km) of the site. Specifically, the more resistant Duncannon Member forms the steeper, southern flank of Lee Mountain (north of the site) and the northern flank of Nescopeck Mountain, located south of the NBSR (Figure 2.4-45 and Figure 2.4-46).

2.4.12.1.2.3 Trimmers Rock Formation

The Trimmers Rock Formation consists of medium dark gray, very fine to fine-grained sandstone, medium to dark gray siltstone and silty shale, and medium dark to dark gray silty clay shale that is moderately resistant to erosion (Inners, 1978). Sandstones occur primarily in the upper 2,300 to 2,500 ft (701 to 762 m) of the formation, in beds that range from 2 in to 5 ft (5 to 152 cm) in thickness. The Trimmers Rock Formation underlies upland terrain of moderate relief in central and eastern Pennsylvania, and forms the steep escarpments on the north and south sides of much of the Susquehanna River Valley. This formation is absent, however, at the BBNPP site.

2.4.12.1.2.4 Harrell and Mahantango Formations

The Harrell Formation is a dark gray to grayish black clay shale and silty clay shale. It is noncalcareous, locally carbonaceous, pyritic, and frequently jointed. The formation is approximately 120 ft (37 m) thick (Inners, 1978). At the BBNPP site, the Harrell Formation forms an east-west trending swale located immediately south of Beach Grove Road.

The Mahantango Formation directly underlies the BBNPP site. It is approximately 1,500 ft (457 m) thick and consists primarily of dark gray, silty to very silty claystone. The uppermost section of the Mahantango Formation, the so-called Tully Member, is approximately 50 to 75 ft (15 to 23 m) thick and consists of argillaceous, fine-grained limestone and calcareous clay shale (Inners, 1978). Frequent joints and extensive pencil cleavage development causes the claystone to become fragmented upon weathering. The Mahantango Formation has low to moderate resistance to weathering and forms lowland terraine, with knobs and ridges of moderate relief formed by more resistant silty and calcareous beds (Inners, 1978).

2.4.12.1.2.5 Marcellus Formation

The Marcellus Formation lies at a depth approximately 1,500 ft (457 m) below the ground surface at the BBNPP site. It is approximately 350 ft (107 m) thick and consists of dark gray to black clay shale (Inners, 1978). Upper sections of the Marcellus are moderately silty, whereas lower sections are typically, noncalcareous to slightly calcareous, pyritic, and carbonaceous. In outcrops, the formation generally has low resistance to weathering and forms lowlands.

2.4.12.1.2.6 Onondaga and Old Port Formations

The Onondaga Formation immediately underlies the Marcellus Formation, is approximately 175 ft (53 m) thick, and consists of medium dark gray, calcareous shale and gray argillaceous, fine-grained limestone (Inners, 1978).

The Onondaga, in turn, is underlain by the 100 to 150 ft (30 to 45 m) thick Old Port Formation. The Old Port consists of dark gray, argillaceous, fine-grained limestone; medium to dark gray, calcareous clay shale; and medium gray, silty, cherty, fine-grained limestone (in descending stratigraphic order).

2.4.12.1.2.7 Keyser and Tonoloway Formations

The Keyser and Tonoloway formations comprise the primary carbonate aquifers in the site area (Inners, 1978). The Keyser Formation is composed of gray to bluish gray, thin- to thick-bedded limestone. The limestone is, in part, argillaceous and dolomitic. The Tonoloway Formation consists of laminated, gray to dark gray limestone. Dolostone occurs in the lower sections of the Tonoloway.

2.4.12.1.2.8 Water Yielding Characteristics of the Geologic Materials

Table 2.4-41 and Table 2.4-42 present construction, water yield, and specific capacity data for domestic and non-domestic wells located within the NBSR basin area. These data (from Taylor, 1984) suggest that alluvium and glacial outwash deposits are generally characterized by high yield and specific capacity, with 50 percent of the non-domestic wells providing more than 164 gpm (approximately 620 lpm). Non-domestic well yields in rocks of the Onondaga, Old Port, Keyser, and Tonoloway formations are similarly high (Table 2.4-42). In these bedrock formations, dissolution along fractures, joints, and bedding planes has enlarged openings and created a greater number of water-producing zones in which to transmit groundwater more efficiently. Yield and specific capacity of wells screened in the claystone, shales, and silty shales of the Mahantango and Marcellus formations are, in contrast, somewhat lower, with only 50 percent of the measured non-domestic well yields exceeding 65 gpm (246 lpm) (Table 2.4-42). Wells in the Catskill and Trimmers Rock formations exhibit much lower yields (typically less than 35 gpm or 132 lpm) (Table 2.4-42).

In the area immediately surrounding the BBNPP site (i.e., in the Berwick-Bloomsburg-Danville area), Taylor (Taylor, 1984) noted that specific capacities were highest in wells screened in glacial outwash deposits, and significantly lower in the underlying Paleozoic rock formations (Table 2.4-43). When tabulated and/or viewed by lithology (Table 2.4-44 and Figure 2.4-49) these data indicate that sand and gravel deposits (glacial outwash, alluvium, etc.) and carbonate rocks generally yield the greatest quantities of water. Because valleys in the Berwick-Bloomsburg-Danville area are often covered by permeable sand and gravel deposits or are underlain by carbonate rocks, wells located in this area tend to be characterized by higher yields (Figure 2.4-50). In contrast, area ridges are often capped by more erosion resistant sandstones and siltstones and thus exhibit lower yields.

In the Berwick area, Williams (Williams, 1987) noted that the size and frequency of water-bearing zones generally decreases with depth (Figure 2.4-51). This is largely related to fracture closure with increasing confining pressure (i.e., with increasing rock weight with depth).

2.4.12.1.2.9 Precipitation, Water Budgets, and Groundwater Recharge

Mean annual precipitation in the Middle Susquehanna Sub-Basin (which includes the NBSR) generally decreases from southeast to northwest, from a high near 45 in (114.3 cm) per year in northwestern Schuylkill County, to less than 34 in per year (86.4 cm per year) in northwestern Bradford County (Figure 2.4-52). Drier conditions are observed within the Susquehanna and Lackawanna river valleys in central Columbia, central Luzerne, and south-central Lackawanna counties. At the BBNPP site, mean annual precipitation is between about 38 and 39 in (97 and 99 cm) per year. This rainfall total is, however, highly variable from year-to-year. Between 1931 and 1980, for example, mean annual rainfall fluctuated between 25 and 56 in (64 and 142 cm) per year (Figure 2.4-53).

Taylor (Taylor, 1984) evaluated the water budgets for three drainage basins in the NBSR region using rainfall, runoff, evaporation, and groundwater discharge data collected over a 20-year span, between 1961 and 1980. At Wapwallopen Creek, located approximately 2 miles (3.2 km) southeast of the BBNPP site (Figure 2.4-54), Taylor (Taylor, 1984) noted high rainfall totals (44 in per year, or 112 cm per year) (Table 2.4-45) and relatively high groundwater discharge rates (14.2 inches [36.1 cm] per year). This discharge rate was effectively equated with a basin-wide groundwater recharge of 469 gpm per square mile (685 lpm per square kilometer). Generally lower groundwater discharge rates were noted in areas north of the BBNPP site, in the Towanda and Tunkhannock creek basins (Table 2.4-45). It should be noted, however, that groundwater discharge (runoff) at Wapwallopen Creek is highly variable from year-to-year (Figure 2.4-55).

Williams and Eckhardt (Williams, 1987) similarly developed water budgets for two small stream basins west of the NBSR (Table 2.4-45). Notably, water budgets were determined for these basins under both dry and wet conditions. Although evapotranspiration rates were not significantly different in the basins during dry and wet periods (1963-1966 and 1972-1975, respectively) surface runoff and groundwater discharge were considerably reduced under dry conditions.

2.4.12.1.2.10 Fluctuations in Groundwater Elevations

Groundwater elevations in the glacial deposits and underlying rock formations of the BBNPP site area typically decline in summer and fall, when precipitation rates are low and evapotranspiration rates are high. For example, monitoring well data for Luzerne County (maintained by the USGS) indicate that groundwater levels in the near-surface glacial outwash deposits of the site area vary seasonally by as much as 14 ft (4.3 m) (Figure 2.4-56). Groundwater elevations in the underlying bedrock formations (e.g., the Catskill Formation) vary slightly less (6 to 8 ft; 1.8 to 2.4 m) between spring and winter high levels, and summer lows (Figure 2.4-57).

2.4.12.1.3 Site-Specific Hydrogeologic Investigations

Geotechnical and hydrogeological investigations at the BBNPP site have provided detailed information on the sub-surface characteristics of the site to a depth of 600 ft (183 m) bgs. An initial investigation was completed between 2007 and 2008, and included the installation of 41 groundwater observation monitoring wells. A second investigation was initiated in 2010 (and completed in 2011) following relocation of the Power Block to an area approximately 1,000 ft (305 m) to the north of the originally proposed location. This secondary investigation included the installation of 44 geotechnical borings and an additional ten groundwater observation wells. A detailed description of the geotechnical subsurface investigation, including the location of all borings installed at the site, is provided in Section 2.5.

Wells established during the 2007-2008 field investigation were constructed with 2 or 4-in (5 or 10-cm) diameter polyvinyl-chloride (PVC) screens and riser pipe. Fifteen geotechnical borings were also converted to groundwater monitoring wells using 1 to 1.5-in (2.5 to 3.8-cm) PVC screens and risers (Table 2.4-46). Fourteen (14) wells ("A" wells) were screened in glacial outwash deposits, identified hereafter as the Glacial Outwash aquifer. An additional 19 wells were screened within the fractured bedrock at the site, in the so-called Shallow Bedrock aquifer. The remaining 8 wells were installed at depths greater than 175 ft (53 m) bgs, in a zone identified as the Deep Bedrock aquifer. Note that Glacial Outwash aquifer wells at the site are identified as “A” wells. Shallow Bedrock aquifer wells, in turn, are generally identified as “B” wells, with the exception of MW302B and MW307B. At these two locations, the shallow bedrock provided few water-bearing zones, and deeper drilling was required. As a consequence, these wells instead have been grouped with the Deep Bedrock aquifer or “C” wells. The “C” wells, it should also be noted, exclude MW313C. The total depth of MW313C was originally designed to reach a depth 200 ft (61 m) bgs. However, drilling complications resulted in the grouting of the bottom portion of the well, and the actual screen depth (130 ft, or 40 m) is comparable to the “B” wells.

Monitoring wells installed during the second site investigation were designed to provide more detailed information on the sub-surface characteristics in the vicinity of the relocated Power Block. Of the ten additional wells installed, nine were constructed as 4-in (10-cm) diameter Shallow Bedrock aquifer “B” wells, and one as a 4-in (10-cm) diameter Glacial Outwash aquifer “A” well (Table 2.4-46).

The locations of groundwater observation and monitoring wells installed at the site are provided in Figure 2.4-58. Surface water monitoring locations are also provided in Figure 2.4-59. Note that the wells established during the 2007-2008 field investigation are designated by identification numbers in the 300s, whereas wells added during the 2010-2011 field study are denoted by identification numbers in the 400s. These wells were distributed to provide adequate characterization of groundwater levels, subsurface flow directions, hydraulic gradients, and flow velocities beneath the site. Well clusters (two or more wells placed in close lateral proximity, but monitoring different water-bearing intervals) were installed in 10 locations at the BBNPP site specifically to determine vertical hydraulic gradients. Vertical extent of a subset of these groundwater monitoring wells and inferred depths of water-bearing intervals at the BBNPP site are identified in the hydrogeologic cross-sections (see Figure 2.4-60) provided in Figure 2.4-61 and Figure 2.4-62.

During the initial investigation, groundwater levels were measured monthly in each of the 41 wells (existing at that time) at the BBNPP site. The monitoring was initiated in November 2007 and continued through October 2008 (Table 2.4-47). Note also that surface water levels were measured in four pond and seven stream locations at the BBNPP site over the same time period (Table 2.4-48). In the second investigation, from May 2010 to April 2011, groundwater levels were measured monthly in all wells, (Table 2.4-71). Surface water level measurements were also recommenced during this latter investigation in each of the stream locations, but only in two of the ponds (Table 2.4-72).

It should also be noted, here, that hydraulic testing (slug, pumping, and packer testing) was completed in multiple wells at the site during the 2007-2008 and 2010-2011 field investigations. Test methodologies and results are discussed below, in Section 2.4.12.3.2.

2.4.12.1.3.1 Site Hydrogeology

The elevations, thicknesses, and descriptions of the geological materials encountered at the BBNPP site to depths up to 600 ft (183 m) bgs were determined from geotechnical and hydrogeological borings. Geotechnical descriptions of these geologic materials are provided in Section 2.5. However, discussion of the hydrogeology is included here.

2.4.12.1.3.1.1 Glacial Outwash Aquifer

The glacial outwash aquifer at the BBNPP site consists primarily of sands and gravels deposited during the late Pleistocene. Specifically, these materials include kame, kame terrace, and outwash deposits, as well as unstratified ground moraine, end moraine, and alluvium. East of the BBNPP Power Block, near the SSES Spray Pond, glacial deposits reach thicknesses near 100 ft (approximately 30 m). In the immediate vicinity of the BBNPP Power Block area, the greatest saturated thickness of the glacial outwash deposits is approximately 40 ft (or 12 m). These thicknesses occur largely along Beach Grove Road, on the north side of the BBNPP property (Figure 2.4-63). This elongated 'trough' of glacial sediments (the so-called northern trough) likely represents an outwash channel that was eroded into bedrock by melt waters of the receding glaciers.

A second trough of thick glacial sands and gravels extends across the BBNPP property (i.e., south of the Power Block area) (Figure 2.4-63). This southern trough is physically separated from the northern trough by low bedrock hills comprised largely of the Mahantango Formation shales, and more specifically, the relatively erosion resistant Tully Member of the upper Mahantango Formation (see Section 2.4.12.1.3.1.2, below). It should be noted, however, that these hills are dissected by small creeks and drainages that generally run north to south across the BBNPP property. Walker Run, a small stream that flows southward along the western boundary of the BBNPP property, effectively delineates a 'notch' in the westernmost bedrock hills at the site (the western notch) (Figure 2.4-63). Another small unnamed tributary stream flows along the eastern and southern boundary of the BBNPP protected area boundary, through an eastern notch in the bedrock hills at the site, and into the southern trough, to Walker Run (Figure 2.4-63).

2.4.12.1.3.1.2 Shallow Bedrock and Deep Bedrock Aquifers

The shallow and deep bedrock aquifers at the BBNPP site are comprised of shale and claystone from the Harrell and Mahantango formations. The weaker, erosion prone Harrell Formation crops out in northern areas of the site, and forms an elongated trough (i.e., a topographic and bedrock low identified as the "Northern Trough") along Beach Grove Road, north of the BBNPP Power Block area (Figure 2.4-64). The Harrell is approximately 120 ft (37 m) thick at the site, and dips to the north. The Mahantango Formation, in contrast, is much thicker (approximately 1,500 ft, or 457 m). Bedrock (specifically, the Tully Member of the Mahantango Formation) is found near the current ground surface in the vicinity of the BBNPP Power Block area (Figure 2.4-65).

The Harrell and Mahantango shales are similar both lithologically and hydraulically, and cannot be treated as distinct aquifers. Instead, the 'shallow' and 'deep' designations simply provide a means by which to evaluate general groundwater flow characteristics in three dimensions (rather than two). Here, a depth of approximately 175 ft (53 m) bgs has been arbitrarily selected as the division between the shallow bedrock aquifer and deep bedrock aquifer. Note also that the Harrell and Mahantango formations are folded, jointed, and fractured, and that the degree of fracturing is one of the most important controls on the hydraulic conductivity of bedrock layers at the site.

The exact depth to older formations (e.g., the Marcellus Shale) at the BBNPP site is not known, but is thought to be at least 1,000 to 1,200 ft (300 to 365 m) bgs. As such, no consideration has been given here to groundwater flow within older (deeper) formations at the site.

2.4.12.2 Groundwater Resources and Groundwater Use

2.4.12.2.1 Groundwater Use

This section provides a discussion of the U.S. Environmental Protection Agency (EPA) Sole Source Aquifers Program and sole source aquifer designations for the BBNPP site region, as well as groundwater use at, and in the vicinity of the BBNPP. The latter includes a general discussion of groundwater use in northeastern Pennsylvania, and current groundwater users in Luzerne and Columbia counties. Groundwater use at SSES Units 1 and 2, anticipated demands for groundwater in Luzerne and Columbia counties, expected use at the BBNPP, and possible impacts on groundwater supplies associated with construction and operation of the BBNPP are also reviewed.

2.4.12.2.2 Sole Source Aquifers

The Sole Source Aquifer (SSA) Program, which is authorized by the Federal Safe Drinking Water Act, allows for protection of drinking water supplies in areas where there are few or no alternative sources to groundwater resources. The USEPA defines a sole or principal source aquifer as one which supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer (USEPA, 2008).

The BBNPP site is located in USEPA Region 3 (Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia). There are six sole source aquifers in this region (Figure 2.4-66). One of these aquifers, the Seven Valleys aquifer, is located in York County, Pennsylvania, approximately 90 mi (145 km) south of the BBNPP site. A second, the New Jersey Coastal Plain aquifer, is recharged by the Delaware River which lies approximately 55 miles (89 km) east of the BBNPP site. The other four sole-source aquifers are located in Maryland and Virginia and are more than 100 mile (161 km) from the BBNPP. As such, all six of these sole source aquifers are beyond the surface water and groundwater flow systems of the BBNPP, and will not be impacted by any activities at the site.

2.4.12.2.3 Northeastern Pennsylvania Groundwater Use

In northeastern Pennsylvania, groundwater extraction is concentrated in areas of high population density, and along major former glacial outwash valleys. In the NBSR basin, total water use in 1970 was estimated to be approximately 308 million gpd (1.16E+09 lpd) (Table 2.4-49). Roughly 14 percent of this total (44.2 million gpd, or 1.67E+08 lpd) was obtained from groundwater. More recently, in 1995, the USGS estimated groundwater use in the NBSR basin to be between 32 and 50 million gpd (1.2E+08 to 1.9E+08 lpd) (Figure 2.4-67). Within the NBSR sub-basin that includes the BBNPP site, groundwater use was estimated to be 21 to 30 million gpd (0.79E+08 to 1.14E+08 lpd) (Figure 2.4-67).

2.4.12.2.4 Luzerne and Columbia Counties Groundwater Use

The locations of groundwater wells within a 25 mi (40 km) and 5 mi (8 km) radius surrounding the BBNPP site are provided in Figure 2.4-68 and Figure 2.4-69, respectively. Note that the 25 mi (40 km) inventory covers all of Columbia County, most of Luzerne County, and portions of seven other Pennsylvania counties, but includes only those wells for which location coordinates are available. However, a full listing of wells in the 5 mi (8 km) radius is provided in Table 2.4-50. Information on these wells is provided by the Pennsylvania Ground Water Information System (PaGWIS) database, maintained by the Pennsylvania Department of Conservation and Natural Resources (DCNR). PaGWIS contains state-level information on 44,411 wells and 1,538 springs adapted from the USGS's Ground Water Site Inventory (GWSI) (DCNR, 2010). This database also contains information on more than 300,000 wells from the PGS Water Well Inventory (WWI), and data from 9,067 public water supply wells, as provided by the PADEP Bureau of Water Supply Management (DCNR, 2010). It should be noted, however, that the information contained in the PaGWIS database is of varying reliability. For example, much of the early WWI data was submitted in paper form by well drillers with location information provided only by hand-written directions and/or hand-drawn maps.

The PADEP also maintains a database of industrial, agricultural, commercial, and/or mineral use groundwater withdrawals associated with Water Use Planning Program primary facilities. Data entries from this inventory are also provided here, in Table 2.4-51 and Table 2.4-52 and Figure 2.4-70 and Figure 2.4-71, respectively, for the 25 mi (40 km) and 5 mi (8 km) radii.

A listing of public supply system wells within Columbia and Luzerne counties is included in Table 2.4-53. This listing, from the PADEP Drinking Water Reporting System (PADEP, 2010b), associates the largest public supply wells in the greater BBNPP site area with the Pennsylvania American Water Company (Berwick District). This public water supplier serves a population of approximately 16,000 through nearly 6,300 connections in five municipalities. Raw water is obtained from four wells located at the company's Canal Street pumping station in Berwick. These wells are screened in bedrock, approximately 87 to 180 ft (27 to 55 m) below ground surface on the north bank of the North Branch of the Susquehanna River. The combined potential yield of the four wells is approximately 4.60 million gpd (1.74E+07 lpd). The average production rate is 1.74 million gpd (6.58E+06 lpd) and the maximum daily production rate is 2.48 million gpd (9.39E+06 lpd)(PPL, 2006).

2.4.12.2.5 Susquehanna SES Units 1 and 2 Groundwater Use

The SSES maintains water supplies for drinking, pump seal cooling, sanitation, and fire protection through an on-site well system. This system consists of two groundwater wells (TW-1 and TW-2) which are located approximately 1,200 ft (366 m) northeast of the SSES reactor building (Figure 2.4-72). Both of these wells are screened in glacial outwash deposits (sand and gravel) at a depth of approximately 75 ft (23 m) bgs. The potential production capacities of TW-1 and TW-2 are approximately 50 and 150 gpm (189 and 568 lpm), respectively (PPL, 1989). Note that TW-2 is the primary well in the system for water supply, and TW-1 serves as a back-up well.

Additional wells provide water on an intermittent basis for drinking and/or sanitary use in SSES-owned buildings adjacent to the primary reactor site area. These wells are located at the West Building (formerly known as the Emergency Operations Facility), the Energy Information Center, and the Riverlands Recreation Area (Figure 2.4-72). These wells are likely screened in glacial outwash and/or NBSR alluvium.

2.4.12.2.6 Projected Northeastern Pennsylvania Groundwater Demands

Under the auspices of the Water Resources Planning Act, the Statewide Water Resources Committee, six regional water resources committees, and the PADEP cooperate and coordinate with appropriate basin commissions, federal, interstate, and state agencies, municipalities, and public water suppliers for efficient planning for the maintenance and enhancement of water resources in Pennsylvania. The State Water Plan, completed in 2008, included an inventory of water resources within Pennsylvania, assessment and projection of future water use, needs, and demands, and evaluation of water supply alternatives. In this assessment, the Statewide Water Resources Committee and the PADEP identified no sites in the NBSR basin as Critical Water Planning Areas (i.e., as sites where existing or future demands exceed or threaten to exceed the safe yield of available water resources).

Similar efforts by the SRBC (SRBC, 2005) identified several geographic areas in the greater Susquehanna River Basin wherein existing or projected groundwater withdrawals and uses were anticipated to exceed sustainable levels (so-called potentially stressed or water challenged areas) (Figure 2.4-73). None of these areas, however, are located in Columbia or Luzerne counties (i.e., near the BBNPP).

Note also that state projections indicate that the population of Luzerne County (for example) will likely decrease by 7 percent by 2030 (PADEP, 2008a). This suggests that the demand for groundwater in the BBNPP site area will likely decline over the next 10 to 20 years, and that groundwater supplies will not be over-drafted (i.e., demand is not likely to exceed available supplies in the future).

2.4.12.2.7 BBNPP Groundwater Use Projections

Presently, on-site groundwater use is not planned for operation of the BBNPP. Instead, all cooling make-up water will be extracted from the Susquehanna River. Water for drinking and other uses will be obtained from a public water supply.

2.4.12.3 Subsurface Pathways

2.4.12.3.1 Observation Well Data

As previously discussed, water levels were measured monthly in 41 wells and in several streams and ponds at the BBNPP site between November 2007 and October 2008 (Table 2.4-47 and Table 2.4-48). Well and surface water levels were also measured between May 2010 and April 2011, following the proposed relocation of the BBNPP Power Block area (Table 2.4-71 and Table 2.4-72). This latter measurement effort included water level determinations in 10 new wells, in addition to the existing 41 wells.

Monthly data from the monitoring wells were used to characterize long term (i.e., seasonal) trends in groundwater levels at the BBNPP site (Figure 2.4-74 to Figure 2.4-78 and Figure 2.4-108 to Figure 2.4-112). Pressure transducer data from the monitoring wells was also used to identify higher frequency (short term) changes in groundwater levels (Figure 2.4-79 and Figure 2.4-80). These data were then used to develop representative spring, summer, fall, and winter potentiometric surface maps for the site and thereby identify typical groundwater flow directions (Figure 2.4-81 to Figure 2.4-92 and Figure 2.4-113 to Figure 2.4-124).

2.4.12.3.1.1 Glacial Outwash Aquifer

Comparable patterns in groundwater levels were observed across the BBNPP site in wells screened within the glacial outwash aquifer (Figure 2.4-125). These data suggest that groundwater elevations in the glacial outwash deposits at the site are typically higher during winter and early spring months (December to April) and lower in summer and early fall months (July to October). The highest water levels in the glacial outwash aquifer were generally observed in well MW303A, located north of the BBNPP Power Block area. Groundwater levels in wells MW305A1 and MW305A2, located east-northeast of well MW303A, were also relatively high. In contrast, monitoring well MW309A exhibited the greatest range in elevations, nearly 10.2 ft (3.1 m) between September 2010 and April 2011 (Table 2.4-71). The lowest range in groundwater levels, 2.90 ft (0.88 m), was observed in monitoring well MW308A (located within the southern bedrock trough) between March 2008 and September 2008 (Table 2.4-47).

Generally, groundwater in the glacial outwash aquifer flows from north to south or northeast to southwest (Figure 2.4-81 to Figure 2.4-84 and Figure 2.4-113 to Figure 2.4-116). In the higher elevation areas at the BBNPP site surrounding monitoring well MW303A, for example, groundwater flow in the glacial outwash aquifer is generally toward the west-southwest, around the raised Mahantango Formation bedrock highs underlying the BBNPP Power Block area. In the western notch, this groundwater then flows toward the south and southwest, following Walker Run. In the area surrounding well cluster MW305, groundwater flow in the glacial outwash aquifer is similarly directed around the bedrock high underlying the BBNPP Power Block area, toward the southeast, and into the so-called eastern notch. In the eastern notch, groundwater flows toward the south, and enters the southern trough.

In the southern trough (south and southeast of the BBNPP Power Block area) groundwater in the glacial outwash deposits generally flows from the east toward the west, and, ultimately, to the southwest (Figure 2.4-81 to Figure 2.4-84 and Figure 2.4-113 and Figure 2.4-116). Immediately south of the Power Block, the southern trough narrows and the glacial outwash deposits thin considerably. As a consequence, the southwestward flowing groundwater is forced to the surface, and discharges effectively as springs and seeps into the wetland areas located south of the Power Block, and into an abandoned farm pond (identified by surface monitoring station G8) at the BBNPP site. Spring and seep discharge is also concentrated along Walker Run.

It should be mentioned here that anecdotal evidence supports the classification of the aforementioned areas as a discharge region for the glacial outwash aquifer. For example, in February 2008, several surface water bodies at the BBNPP site (identified by gauging stations G6, G7, and G9) were noted to have been covered with a thin layer of ice. However, no ice had developed on the surface of the abandoned farm pond, suggesting that relatively warm groundwater was discharging into the pond. Moreover, the farm pond appears to discharge water throughout the year, even in dry summer months.

2.4.12.3.1.2 Shallow Bedrock Aquifer

Shallow bedrock aquifer water level data collected during the 2007-2008 and 2010-2011 field investigations are provided in Table 2.4-47 and Table 2.4-71, respectively. These data are also presented in Figure 2.4-126.

Groundwater elevations in the shallow bedrock are typically higher during winter and lower in summer, as observed in the glacial outwash aquifer (Figure 2.4-126). The highest groundwater levels in the shallow bedrock zone were also generally observed to the north of the BBNPP Power Block area, within well cluster MW303 and well cluster MW305 (Table 2.4-47 and Table 2.4-71). The greatest range in shallow bedrock groundwater elevations (15.50 ft, or 4.72 m) was identified in well MW404, between September 2010 and April 2011. The lowest range in shallow bedrock aquifer elevation values was measured in well MW304B (3.24 ft, or 0.99 m) between March 2008 and October 2008. These two wells are located beneath the proposed location of the BBNPP nuclear island, and in the eastern bedrock notch at the site, respectively.

Throughout the year, at least in general, water in the shallow bedrock zone flows radially from a mound-like feature located north-northeast of the BBNPP Power Block, near monitoring well MW315B (Figure 2.4-85 to Figure 2.4-88 and Figure 2.4-117 to Figure 2.4-120).

2.4.12.3.1.3 Deep Bedrock Aquifer

Groundwater elevation data for the deep bedrock aquifer are provided in Table 2.4-47, Table 2.4-71, and Figure 2.4-127. As observed in the glacial outwash and shallow bedrock aquifers, groundwater elevations measured in the deep bedrock wells at the BBNPP site are typically higher during winter and early spring months and lower in the summer and early fall months. The highest groundwater levels were also observed in areas north of the BBNPP Power Block. However, the maximum range in measured groundwater elevations, 33.51 ft (10.21 m), is significantly higher than the range obtained in the glacial outwash and shallow bedrock aquifers. The lowest range in elevation values for the deep bedrock aquifer (2.12 ft, or 0.65 m) is comparable to values determined for the glacial outwash and shallow bedrock aquifers.

Potentiometric contours in the deep bedrock aquifer generally reflect surface topography, with high groundwater elevations in the northern areas of the site and a relatively uniform decrease southward across the site (Figure 2.4-89 to Figure 2.4-92 and Figure 2.4-121 to Figure 2.4-124.).

2.4.12.3.1.4 Vertical Hydraulic Gradients and Vertical Flow Directions

Vertical hydraulic gradients between the glacial outwash, shallow bedrock, and deep bedrock aquifers at the BBNPP site were determined in multiple well pairs using measured groundwater elevations (Table 2.4-47 and Table 2.4-71) and well screen elevation data (Table 2.4-46). Specifically, vertical gradients were calculated as the difference in the groundwater elevations measured in two wells in a cluster (but screened at different depths) divided by the vertical distance between the mid-points of the two well screens. Potential vertical flow (leakage) directions were then determined from the resulting gradient such that positive values indicated downward flow potential and negative values indicate upward flow potential. Note that differences in vertical head do not necessarily imply the existence of a continuous or discontinuous aquitard separating two aquifer units; it simply means that vertical flow has the potential to occur. Therefore, the vertical flow directions are considered potential flow directions.

Vertical hydraulic gradients between the glacial outwash and shallow bedrock aquifers were evaluated in seven well clusters (see Gradient 1, in Table 2.4-55 and Table 2.4-74). In both the 2007-2008 and 2010-2011 groundwater monitoring periods, estimated vertical flow directions were generally downward (i.e., positive vertical gradients were determined) between the glacial outwash and shallow bedrock aquifers in well clusters MW304, MW305, MW308, and MW309. In contrast, upward flow was indicated by negative vertical gradients in well clusters MW301, MW303, and MW310. A maximum positive vertical gradient of 1.4998 occurred between wells MW308A and MW308B on 24 March 2008 (Table 2.4-55). A maximum negative gradient of -0.1722 occurred between wells MW310A and MW310B on 20 April 2011 (Table 2.4-74).

Vertical hydraulic gradients between the glacial outwash and deep bedrock aquifers at the BBNPP site were also determined for the 2007-2008 and 2010-2011 monitoring periods, although in only three well clusters (MW302, MW306, and MW307) (see Gradient 2, in Table 2.4-55 and Table 2.4-74). In both instances, downward flow potentials (positive vertical gradients) were determined only in well cluster MW307. The maximum positive vertical gradient in the MW307 well cluster of 0.3113 occurred on 23 July 2008 (Table 2.4-55). A maximum negative gradient of -0.0499 occurred between wells MW302A1 and MW302B on 23 July 2008 (Table 2.4-55).

Data from the 2007-2008 field investigation indicate that two well clusters, namely MW303 and MW304, maintained downward flow potentials (positive vertical hydraulic gradients) between the shallow and deep bedrock aquifers at the BBNPP site and that one well cluster (MW310) was characterized by upward flow potentials (negative vertical hydraulic gradients) (see Gradient 3, in Table 2.4-55). The maximum positive gradient in the 2007-2008 (0.1145) occurred in well cluster MW303 on 23 July 2008, and the maximum negative gradient (-0.1491) occurred within well cluster MW310 on July 23 2008 (Table 2.4-55). For the 2010-2011 monitoring period, downward flow potentials (positive gradients) were identified only in well cluster MW303 (Table 2.4-74). The maximum positive gradient of 0.1243 occurred between wells MW303B and MW303C on 6 May 2010. The maximum negative vertical gradient of -0.1671 occurred between wells MW310B and MW310C on 14 September 2010.

In general, for the 2007-2008 and 2010-2011 investigations, the greatest potential for upward flow was identified in well clusters MW301, MW302, MW303, MW306, and MW310. Artesian pressures were also encountered in bedrock groundwater monitoring wells (MW301B4, MW302B, and MW310C) and a geotechnical boring (B302) in three of these locations, and in monitoring wells MW312B and MW313C, located in the wetlands south of the BBNPP Power Block area. From this, it was inferred that the greatest potential for upward groundwater flow from bedrock at the BBNPP site likely exists in areas south of the BBNPP Power Block, within the southern trough, and in areas along Beach Grove Road, north of the BBNPP Power Block (Figure 2.4-93).

Although vertical gradients suggest that upward groundwater flow is occurring, the exact areas where upward flow takes place, the overall rate of flow, and the temporal changes in flow rate, are not known with any degree of certainty.

2.4.12.3.2 Hydraulic Properties

The hydraulic properties of the geologic materials (i.e., the glacial outwash and shale bedrock) present at the BBNPP site were characterized by slug, constant-rate pumping, and packer tests. Results from these tests are discussed below, in Sections 2.4.12.3.2.1 and 2.4.12.3.2.2.

Falling head slug tests were conducted in 14 glacial outwash wells, 6 shallow bedrock wells, and 5 deep bedrock wells at the BBNPP site during the 2007-2008 field investigation. Falling and rising head slug tests were also completed in the new wells installed at the site between 2010 and 2011. Data collected from the slug tests were analyzed using AquiferTest Pro software, and the Butler High-K (Butler, 2003) and Hvorslev (Hvorslev, 1951) methods were used to estimate hydraulic conductivity (K_h) values for both the rising and falling head slug tests. Estimates of K_h from each slug test analysis are listed in Table 2.4-56.

During the 2007-2008 site investigation, constant-rate pumping tests were completed within the glacial outwash aquifer at well cluster MW302 and in the shallow bedrock at well cluster MW301. The pumping test in well cluster MW302 utilized wells MW302A2, 302A3, and 302A4 as observation wells and MW202A1 as a pumping well. The pumping test in well cluster MW301, in turn, implemented MW301B2, MW301B3, and MW301B4 as observation wells and MW301B1 as a pumping well. Prior to the pumping tests, pressure transducers were installed within the pumping wells and nearby observation wells to collect detailed water level readings, and a step-drawdown test was performed to establish an optimal pumping rate for each test (i.e., a pumping rate that would stress a monitored aquifer but not result in drawdown below the depth of a respective well screen). Target pumping rates of 60 gpm (227 lpm) and 6 gpm (23 lpm) were selected for wells MW302A1 and MW301B1, respectively.

Constant rate pumping tests in well cluster MW302 and MW301 were run continuously over a 24-hour period. Upon completion of each pumping test, the transducers continued to collect water level data (i.e., recovery data) for an additional 12 hours. Drawdown and recovery data from the pumping tests were similarly analyzed using the AquiferTest Pro software program in an effort to determine K_h, transmissivity, and storativity (storage coefficient) values for the glacial outwash deposits and shale bedrock at the site.

In the 2010-2011 field investigation period, three additional pumping tests were conducted in the shallow bedrock zone underlying the relocated BBNPP Power Block area, at well clusters MW404, MW405, and MW407. Observation wells for each of the pumping tests consisted of nearby shallow bedrock wells, including MW405 and MW407 for the pumping test at MW404, MW404 and MW406 for the pumping test at MW405, and MW404 and MW409 for the pumping test at MW407. Step-drawdown tests were also completed prior to each pumping test, and indicated optimum pumping rates of 11.3, 6.5, and 5.6 gpm (42.77, 24.60, and 21.20 lpm, respectively) at MW404, MW405, and MW407, respectively. The duration of pumping in these wells was 8, 9, and 10 hours, respectively. Following pumping, recovery data was collected for a minimum of 8 hours. Drawdown and recovery data from the 2010-2011 pumping tests were also analyzed using AquiferTest Pro. Hydraulic property estimates from these pumping test analyses, as well as the 2007-2008 analyses, are provided in Table 2.4-57. Again, test results are discussed below, in Sections 2.4.12.3.2.1 and 2.4.12.3.2.2.

Packer tests were also performed on 56 intervals within 5 open-hole bedrock borings at the BBNPP site during the 2007-2008 site investigation. These borings were later converted into monitoring wells MW301C, MW304C, MW306C, MW310C, and MW313C. In the 2010-2011 field study, additional packer tests were completed on 34 intervals within another four open-hole bedrock borings. These borings were also converted to monitoring wells (specifically, wells MW401, MW402, MW403, and MW408). Hydraulic conductivity estimates from the packer tests are provided in Table 2.4-58.

Note that a significant number of slug, pumping, packer, and other hydraulic property tests were previously completed at the SSES, adjacent to the BBNPP. For comparison, the results of these tests are summarized in Table 2.4-59.

Finally, it should also be noted that open-hole sections in 5 monitoring wells were surveyed using down-hole optical and acoustic televiewers. Data from this imaging was used to better characterize the vertical distribution and orientation of fractures located along the surfaces of the open boreholes. Results of the optical and acoustic surveys in wells MW301C and MW310C are provided in Figure 2.4-94, Figure 2.4-95, Figure 2.4-96, Figure 2.4-97, Figure 2.4-100, and Figure 2.4-101.

2.4.12.3.2.1 Glacial Outwash Aquifer

Slug tests were completed in all 15 monitoring wells screened in the glacial outwash aquifer at the BBNPP site. The horizontal hydraulic conductivity (K_h) values calculated from these tests ranged from a low value of 3.38E-02 ft/day (1.19E-05 cm/s) in MW307A to a high of 9.63E+01 ft/day (3.40E-02 cm/s) in MW306A (i.e., K_h values for the glacial outwash aquifer vary by nearly three orders of magnitude) (Table 2.4-56). More specifically, the lowest K_h values at the site were measured in three wells located north of the BBNPP Power Block area (namely MW303A, MW305A1, and MW305A2) and in three wells installed in areas south of the BBNPP Power Block (i.e., in wells MW307A, MW308A, and MW309A). Low K_h values were also identified in well MW410, adjacent to the proposed ESWEMS Pump House location. In these wells, K_h values ranged from 3.38E-02 to 1.51E+01 ft/day (1.19E-05 to 5.33E-03 cm/s). In the remaining 8 glacial outwash wells, all located within the so-called southern trough, K_h values ranged from 23.8 to 96.3 ft/day (8.40E-03 to 3.40E-02 cm/s). The geometric mean of the slug test K_h estimates for the glacial outwash aquifer (9.84 ft/day, or 3.47E-03 cm/s) compares reasonably well with previously determined K_h estimates from slug tests completed at the adjacent SSES. These tests at the SSES resulted in K_h values between 1.8 and 6.6 ft/day (6.35E-04 to 2.33E-03 cm/s) (Table 2.4-59).

The pumping test conducted in the glacial outwash aquifer at the MW302 well cluster at the BBNPP site provided a mean (geometric) K_h estimate of 186 ft/day (6.57E-02 cm/s) (Table 2.4-57). Pumping tests performed in the glacial outwash aquifer at the nearby SSES yielded an overlapping range of values (between 3.3 to 200 ft/day, or 1.16E-03 to 7.06E-02 cm/s) (Table 2.4-59). It should be noted, however, that the SSES pumping tests that yielded the highest K_h values were based on specific capacity data, and are only rough estimates of K_h.

Estimates of specific yield in the glacial outwash aquifer from well cluster MW302 pumping tests ranged from 2.53E-01 to 5.00E-01, with a median value equal to 0.322 (Table 2.4-57). Here, it is assumed that (for sand and gravel deposits) specific yield is equivalent to effective porosity. Consequently, the median specific yield value of 0.322 was used in all flow calculations for the site that required an estimate of effective porosity.

2.4.12.3.2.2 Shallow and Deep Bedrock Aquifers

Slug tests were also completed in 15 wells screened in the shallow bedrock aquifer at the BBNPP site. The K_h values estimated from these tests ranged from 1.39E-01 ft/day (4.89E-05 cm/s) in MW301B1 to 38.5 ft/day (1.36E-02 cm/s) in MW304B, with an overall geometric mean K_h estimate of 1.54 ft/day (5.43E-01 cm/s) (Table 2.4-56). This value is approximately 16 percent of the value determined for the glacial outwash aquifer using slug tests.

Horizontal hydraulic conductivity (K_h) values estimated from slug tests in 5 deep bedrock wells at the BBNPP site, in turn, ranged from 3.25E-02 ft/day (1.15E-05 cm/s) in well MW306C to 4.27E+00 ft/day (1.51E-03 cm/s) in well MW307B (Table 2.4-56). The overall geometric mean K_h estimate for the deep bedrock aquifer was 3.35E-01 ft/day (1.18E-04 cm/s), approximately one order of magnitude less than the value determined for the shallow bedrock aquifer using slug tests (Table 2.4-56).

Pumping tests completed in the shallow bedrock well at the MW301, MW404, MW405, and MW407 well clusters provided a geometric mean K_h estimate of 1.50 ft/day (5.30E-04 cm/s). This value is roughly two orders of magnitude lower than the value determined for glacial outwash deposits at the BBNPP. No pumping tests were completed in the deep bedrock aquifer.

A total of 90 packer tests (constant pressure, pump-in tests) were conducted in nine open bedrock borings at the BBNPP site. Each packer test was completed on 12.6 to 23 ft (3.8 to 7 m) rock intervals. Approximately half of these tests (51) were conducted in shallow bedrock wells. These wells yielded K_h estimates ranging from less than 1.13E-03 to 1.08 ft/day (4.00E-07 to 3.82E04 cm/s) (Table 2.4-58). The geometric mean estimate packer test derived K_h values in the shallow bedrock wells equaled 5.49E-03 ft/day (1.94E-06 cm/s) (Table 2.4-58). In the other 39 tests conducted in deep bedrock wells, K_h estimates ranged from less than 1.13E-03 ft/day to 3.34E-01 ft/day (4.00E-07 to 1.18E-04 cm/s) (Table 2.4-58). The geometric mean of these K_h estimates equaled 4.30E-03 ft/day (1.52E-06 cm/s), a value that is roughly comparable to that determined for the shallow bedrock (Table 2.4-58).

This comparison contradicts values based on slug test results, in which the shallow bedrock appears to have K_h values that are significantly higher (one order of magnitude) than the deep bedrock.

In both the shallow and deep bedrock wells, K_h estimates determined by packer tests were considerably lower than K_h values determined by slug tests and pumping tests. Hydraulic conductivity estimates from packer testing at the SSES were similarly higher than the values obtained by packer tests at the BBNPP site. These tests yielded K_h values that ranged from 0 to approximately 0.85 ft/day (0 to 3.00E-04 cm/s) (Table 2.4-59). Moreover, it should be recalled that slug test based K_h estimates for the shallow bedrock at the BBNPP site are higher (by an order of magnitude) than the estimated K_h for the deep bedrock. This difference contradicts the roughly comparable K_h values determined by packer testing (described above). Accordingly, it is assumed that the hydraulic conductivity of the shallow and deep bedrock zones at the BBNPP site is highly variable, as expected for a fractured rock mass.

Optical and acoustic televiewer data were consequently used to more effectively characterize the distribution and orientation of fractures in the shallow and deep bedrock zones, and thereby identify any possible fracture influence on hydraulic conductivity. Results of the televiewer surveys for two wells, MW301C and MW310C, are provided in Figure 2.4-94, Figure 2.4-95, Figure 2.4-96, Figure 2.4-97, Figure 2.4-100, and Figure 2.4-101.

In well MW301C, fractures were more frequently encountered at depth intervals between 47 and 58 ft (14.3 and 17.7 m) and 251 and 261 ft (76.5 and 79.6 m) bgs (Figure 2.4-94). These intervals coincide with well zones where packer tests identified measurable fracture permeabilities (Table 2.4-58). In well MW301C, the primary dip direction of these fractures was southward, and the primary dip angle was relatively steep (60 to 90°) (Figure 2.4-95 and Figure 2.4-96, respectively). In well MW310C, fracture density was generally higher, but greatest from approximately 24 to 80 ft (7.3 to 24.4 m), 141 to 145 ft (43.0 to 44.2 m), and 195 to 200 ft (59.4 to 61.0 m) bgs (Figure 2.4-97). Again, these three intervals generally coincide with depths where packer tests identified measureable fracture permeabilities. Fracture dip directions in well MW310C were predominantly northward (in contrast to MW301C) and the fracture dip angle was less steep (50 to 60°) (Figure 2.4-100 and Figure 2.4-101, respectively). These data therefore suggest that fracture density likely influences hydraulic conductivity in the shallow and deep bedrock zones at the site, but that fracture orientation is not necessarily important.

2.4.12.3.3 Horizontal Hydraulic Gradients and Groundwater Flow Velocities

Horizontal hydraulic gradients and groundwater flow velocities (Table 2.4-54 and Table 2.4-73) were calculated for generalized groundwater flow pathlines in the glacial outwash, shallow bedrock, and deep bedrock aquifers at the BBNPP site. These pathlines, identified in

Figure 2.4-81 to Figure 2.4-92 and Figure 2.4-113 to Figure 2.4-124 are considered representative of spring, summer, fall, and winter months in the 2007-2008 and 2010-2011 monitoring periods.

Specifically, horizontal hydraulic gradients were calculated along each of the pathlines by dividing the difference in hydraulic head at the beginning and ending point of each flow path by the total distance of the flow path. Groundwater flow velocities, in turn, were calculated as the product of the hydraulic conductivity (K_h) along the pathline and the horizontal hydraulic gradient, divided by the effective porosity for the transporting medium (glacial outwash or fractured shale). Here, K_h values were based on geometric mean values resulting from pumping tests for the glacial outwash and shallow bedrock aquifers and slug tests for the deep bedrock aquifer (Table 2.4-57 and Table 2.4-56, respectively).

2.4.12.3.3.1 Glacial Outwash Aquifer

The calculated horizontal hydraulic gradients in the glacial outwash range from 3.20E-03 to 2.68E-02 (Table 2.4-54 and Table 2.4-73). The largest (steepest) hydraulic gradients in the glacial outwash aquifer generally occurred in the spring, when groundwater elevations were highest. Relatively low gradients, in contrast, developed in the summer when groundwater elevations were typically lowest. Groundwater flow velocities (seepage velocities) resulting from these gradients ranged from 1.85E+00 to 1.55E+01 ft/day (6.53E-04 to 5.47E-03 cm/s) (Table 2.4-54 and Table 2.4-73).

2.4.12.3.3.2 Shallow and Deep Bedrock Aquifers

In the shallow bedrock aquifer at the BBNPP site, calculated horizontal hydraulic gradients range from 1.97E-02 to 6.75E-02 (Table 2.4-54 and Table 2.4-73). Based on these calculated gradients, a mean hydraulic conductivity value derived from pumping tests (1.50 ft/day, or 5.29E-04 cm/s) (Table 2.4-57) and an assumed minimum effective porosity value of 0.01, linear groundwater velocities for the shallow bedrock aquifer at the BBNPP site were estimated to range from 2.95E-01 to 1.01E+00 ft/day (1.04E-04 to 3.56E-04 cm/s) (Table 2.4-54 and Table 2.4-73). Using a maximum estimated effective porosity value of 0.10, groundwater velocities ranged from approximately 2.95E+00 to 1.01E+01 ft/day (1.04E-03 to 3.56E-03 cm/s) Table 2.4-54 and Table 2.4-73).

In the deep bedrock aquifer, horizontal hydraulic gradients ranged from 1.46E-02 to 3.17E-02 over the 2007-2008 and 2010-2011 monitoring periods (Table 2.4-54 and Table 2.4-73). Using a slug test derived K_h value equal to 3.35E-01 ft/day (1.18E-04 cm/s) (Table 2.4-56) and an assumed minimum effective porosity value of 0.01, the calculated horizontal hydraulic gradient in the deep bedrock aquifer yielded linear groundwater flow velocities from 4.90E-01 to 1.06E+00 ft/day (1.73E-04 to 3.74E-04 cm/s) (Table 2.4-54 and Table 2.4-73). Using an assumed maximum effective porosity value equal to 0.10, flow velocities in the deep bedrock aquifer at the BBNPP site varied between 4.90E-02 to 1.06E-01 ft/day (1.73E-05 to 3.74E-05 cm/s) (Table 2.4-54 and Table 2.4-73).

2.4.12.4 Monitoring or Safeguard Requirements

Some of the existing BBNPP monitoring wells will be taken out of service prior to construction activities at the site. Prior to construction, the observation well monitoring network will be evaluated to determine groundwater data gaps and needs created by the abandonment of any existing wells. These data needs will be met by the installation of new monitoring wells. Additionally, the hydrologic properties and groundwater flow regimes of the shallow water-bearing units will likely be impacted by the proposed earthmoving, regrading, and construction of infrastructure (buildings, parking lots, etc.). Revisions to the observation well network will be implemented to ensure that resulting changes in local groundwater regime will be identified.

Safeguards will be used to minimize the potential of adverse impacts to the groundwater by construction and operation of BBNPP. These safeguards could include the use of lined containment structures around storage tanks (where appropriate), hazardous materials storage areas, emergency cleanup procedures to capture and remove surface contaminants, and other measures deemed necessary to prevent or minimize adverse impacts to the groundwater beneath the BBNPP site. No groundwater wells are planned for safety-related purposes.

2.4.12.5 Site Characteristics for Subsurface Hydrostatic Loading and Dewatering

2.4.12.5.1 Dewatering During Construction

Prior to construction activities at the BBNPP, the Power Block, ESWEMS Pond, and Cooling Towers areas will be excavated down to competent bedrock, with placement of localized concrete fill as necessary. These excavations will then be partially backfilled with compacted engineering fill in preparation for construction (building foundations, etc.). During this excavation, groundwater will be encountered in varying amounts in each of these areas. Because the excavation, backfilling, and construction activities need to be performed in dry conditions, temporary groundwater controls will be required. Specifically, groundwater elevations will need to be drawn downward to a depth below the base level of each excavation unit, using dewatering wells and/or sumps. Once construction has been completed in each area, the pumps will be turned off, and groundwater elevations will be allowed to rebound to levels approximately equal to or slightly lower than the pre-construction elevations.

Construction areas in the BBNPP Power Block vicinity are underlain by roughly 10 to 35 feet (3 to 11 m) of silty and sandy glacial deposits and clayey weathered shale, and 75 to 90 feet (23 to 27 m) of fractured and/or weathered Mahantango Formation shale. Basal layers of the glacial deposits in the Power Block area are saturated, and will need to be dewatered and stripped from the rock surface prior to excavation into the weathered shale and competent bedrock. Dewatering of the existing hilltop in the Power Block area will commence prior to excavation, and will extend throughout excavation activities. Dewatering wells will be required around the perimeter of the excavation, and may be augmented (or replaced) by sumps and sump pumps. Groundwater elevations in the excavation area will likely be drawn down below 624 ft (190 m) NAVD 88.

In the area surrounding the ESWEMS Pond and Pump House at the BBNPP site, saturated glacial deposits (sand and gravel) are approximately 30 to 55 ft (9 to 17 m) thick. Groundwater within these deposits is generally flowing to the south and southwest toward Walker Run and an unnamed Walker Run tributary. This groundwater is likely to be a significant source of seepage into the excavation during the construction of the ESWEMS Pond.

A three-dimensional, seven-layer, finite-difference groundwater flow model was developed using Visual MODFLOW software in an effort to assess dewatering requirements. Based on the results of the modeling, the Power Block dewatering will require the extraction of approximately 50 gpm (189 lpm). The actual pumping rate will be partially dependent on how long in advance of excavation the dewatering system is implemented, and how fast the excavation proceeds downward.

The groundwater model also predicts that approximately 920 gpm (3,482 lpm) of groundwater will need to be pumped continuously from the area to keep the ESWEMS Pond excavation dry during construction. This dewatering effort will likely impact wetland areas immediately northwest of the ESWEMS Pond and wetlands adjacent to the unnamed tributary to Walker Run (south of the ESWEMS Pond area). The model predicts that groundwater elevations in the glacial deposits underlying the wetlands immediately northwest of the Pond area could be lowered approximately 15 to 25 ft (4.6 to 7.6 m), and that groundwater levels beneath the wetlands adjacent to the unnamed Walker Run tributary could be lowered by 20 to 35 ft (6 to 11 m).

In an effort to reduce the amount of groundwater extraction that will be required during construction of the ESWEMS Pond area (and thereby minimize impacts to the wetland areas), a groundwater flow barrier (e.g., soil-bentonite slurry wall) will be installed around the entire ESWEMS Pond area (including the Pump House). The flow barrier will greatly reduce the dewatering rate and the number of dewatering wells required to keep the excavation dry. With the use of a flow barrier, the pumping rate required to keep the excavation dry could be as low as 230 gpm (871 lpm). Results from the groundwater flow model also suggest that the drawdown in groundwater elevation beneath the wetlands will likely be only 5 to 10 ft (1.5 to 3.0 m) following the installation of the flow barrier. The slurry wall will be rendered non-functional after completion of construction.

Similar to the Power Block area, excavations in the vicinity of the proposed location of the BBNPP Cooling Towers will proceed down to competent bedrock. As a result, the excavation will likely intersect the glacial outwash aquifer, which would require dewatering. However, in this area, the thickness (and saturated thickness) of the glacial deposits (approximately 24 to 35 ft, or 7 to 11 m) is considerably less than in the vicinity of the ESWEMS Pond area, as is its saturated thickness. As a result, a groundwater flow barrier should not be necessary for dewatering in the Cooling Towers area. According to the groundwater modeling results, a continuous pumping rate of approximately 70 gpm (265 lpm) will be required to keep the Cooling Towers excavation dry.

A cumulative dewatering rate of approximately 350 gpm (1325 lpm) will be required to keep excavations dry. This cumulative dewatering rate includes the installation of a flow barrier around the entire ESWEMS Pond and Pump House area. In the vicinity of the ESWEMS Pond and Cooling Towers, dewatering of the glacial outwash aquifer is necessary, but should only require the use of shallow dewatering wells. In the Power Block area, the saturated thickness of the overburden is minimal, and much of the dewatering can likely be achieved with sump pumps in the floor of the excavation. The dewatering system design will be developed and finalized closer to the time of construction.

2.4.12.5.2 Maximum Groundwater Elevations During Operation

The U.S. EPR standard design has been selected for construction at the BBNPP. The safe operation of this design is based on a set of conservatively established site characteristics that are required to meet the design criteria. The U.S. EPR FSAR (AREVA, 2011) specifies that the maximum groundwater levels should be at least 3.3 ft (1.0 m) below grade in the vicinity of safety-related structures. At the BBNPP, these structures include not only the Power Block, but also the ESWEMS Pond and Pump House.

In the vicinity of the Power Block, excavation to competent bedrock will remove both glacial deposits and any weathered shale. Following completion of the building foundations, the remainder of the excavation will be backfilled with compacted granular materials, to an elevation of 719 ft (219 m) (i.e., finished plant grade). It should also be noted that a majority of the surface area in the vicinity of the Power Block area will be rendered relatively impermeable due to the presence of buildings, sidewalks, and parking areas. As a result, recharge to the groundwater system in this developed area will be reduced in comparison to currently existing conditions. In addition, swales, culverts, and storm sewers will be installed to rapidly convey surface water away from the Power Block area. Accordingly, it is assumed that post-construction groundwater elevations within the Power Block area will likely be equal to below current elevations. Existing maximum groundwater elevations in the Power Block area should therefore provide an estimate of the maximum groundwater elevation that is likely to occur after construction.

In the vicinity of the ESWEMS Pond and Pump House, the final plant grade (i.e., ground surface) is expected to range between 696 and 701 ft (212 and 214 m) NAVD 88. Similar to the Power Block area, recharge to the groundwater system in the vicinity of the ESWEMS Pond and Pump House will be greatly reduced by removal of surface soils during grading and paving, and by construction of buildings and other surface features. Furthermore, installation of surface drainage systems and storm drains will rapidly convey surface water away from the ESWEMS Pond area and up-gradient areas. It is thus assumed that post-construction groundwater elevations will be no higher than current elevations in the ESWEMS Pond area, and will likely be lower. Identification of the maximum groundwater elevation that currently exists in this area will therefore also conservatively estimate the maximum groundwater elevation that is likely to occur after construction.

Twelve (12) monitoring wells (MW310B, MW318B, MW319B, and wells MW401 through MW409) were installed in the shallow bedrock beneath the Power Block area during the 2007-2008 and 2010-2011 field investigations at the BBNPP site, in part to monitor existing groundwater elevations. A total of 5 groundwater monitoring wells (MW302A1, MW302A2, MW302A3, MW302A4, and MW410) were similarly installed in the vicinity of the ESWEMS Pond and Pump House. Construction details for these wells are provided in Table 2.4-46 and locations are shown on Figure 2.4-58.

It should be noted here that two monitoring wells located in the Power Block area at the BBNPP (MW318B and MW319B) were installed in geotechnical borings and thereby possess screen elevations that are higher than adjacent wells in the Power Block area (see Table 2.4-46). The screen intervals of these two monitoring wells intersect the top of fractured bedrock surface at the site, and consequently maintain hydraulic communication with overlying glacial deposits. The screen elevation of monitoring well MW318B is above the finished grade level designed for the Power Block (719 ft, or 219 m). As such, the geologic materials intersected by this well will be removed and not replaced during construction activities. The fractured rock that surrounds the well screen in MW319B is below the projected finished grade elevation of 719 ft (219 m), but will similarly be removed during excavation and replaced with engineered fill. Accordingly, the water levels measured in these two monitoring wells was not considered representative of projected post-construction groundwater elevations in the competent, unweathered bedrock and the data for these two wells was not used to assess groundwater elevations beneath the Power Block area. Monitoring well MW402 was also excluded from the groundwater elevation assessments for the Power Block. This well is located in the far northeast corner of the Power Block area (Figure 2.4-58) and is not close to any safety-related buildings.

Based on water level measurements made in the appropriate shallow bedrock wells located in the vicinity of the Power Block, the maximum groundwater elevation (712.03 ft, or 217.03 m, NAVD 88) and average groundwater elevation (689.82 ft, or 210.26 m, NAVD 88) are both below the U.S. EPR maximum allowable elevation of 715.7 ft (218.1 m) NAVD 88. Similarly, the maximum and average groundwater elevation in the ESWEMS Pond area, 665.07 and 659.69 ft (202.71 and 201.07 m) NAVD 88, are both below the U.S. EPR design criterion of 692.7 ft (211.1 m) NAVD 88. Thus, the U.S. EPR safety requirement regarding groundwater elevations in the vicinity of the Power Block and ESWEMS Pond and Pump House will be met during the operational phase of the NPP. There is no exception to the U.S. EPR requirement that post-construction groundwater levels must be at least 3.3 ft (1 m) below grade.

Groundwater elevations will continue to be monitored, and any observed deviations in groundwater elevations potentially impacting the current design bases will be addressed.

2.4.12.5.3 Hydrostatic Loading During Operation

Dewatering activities intended to keep the BBNPP Power Block area dry during construction will significantly lower groundwater elevations (see Section 2.4.12.5.2, above). Following construction, dewatering will be stopped, and groundwater elevations will be allowed to return to pre-construction levels. The maximum expected groundwater elevation beneath the Power Block area is expected to be less than 712.0 ft (217.0 m) NAVD 88. The base elevation (deepest safety-related foundation) for building structures in the Power Block will be at 677.5 ft (206.5 m) NAVD 88. Based on the expected maximum groundwater level, the post-construction hydrostatic loading on the base of building structures in the Power Block area will likely not exceed 34.5 ft (10.5 m) (i.e., 712.0 ft – 677.5 ft = 34.5 ft). Loading will be less in the shallower substructures in the Power Block area.

In the ESWEMS Pond area, the maximum expected post-construction groundwater elevation is expected to be less than 665.1 ft (202.7 m) NAVD 88. The base elevation for the ESWEMS Pump House will be at 695.0 ft (211.8 m) NAVD 88. The base elevation of the Pond will be 677.5 ft (206.5 m) NAVD 88. Based on this expected maximum groundwater level, there will be no post-construction hydrostatic loading on the base of the Pump House or the ESWEMS Pond, as the groundwater elevation will be below the base elevations of both structures.

2.4.12.5.4 Permanent Dewatering System during Operation

The maximum projected water-table surface is expected to be at least 7 ft (2.1 m) below plant grade in the BBNPP Power Block area, and at least 29.9 ft (9.1 m) below grade in the ESWEMS Pond area after construction. As a result, no permanent groundwater dewatering system should be required during operation of the BBNPP. Nonetheless, groundwater elevations will continue to be monitored during operation to ensure that U.S. EPR design bases are maintained.

2.4.12.6 References

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2.4.13 Pathways of Liquid Effluents in Ground and Surface Waters

The U.S. EPR FSAR includes the following COL Item in Section 2.4.13:

> A COL applicant that references the U.S. EPR design certification will provide site-specific information on the ability of the groundwater and surface water environment to delay, disperse, dilute or concentrate accidental radioactive liquid effluent releases, regarding the effects that such releases might have on existing and known future uses of groundwater and surface water resources.

This COL Item is addressed as follows:

{Sections 2.4.13.1 through 2.4.13.3 are added as a supplement to the U.S. EPR FSAR.

2.4.13.1 Groundwater

This section provides a conservative analysis of a hypothetical accidental release of radionuclide-containing liquid effluents to groundwater and surface waters at the BBNPP. The hypothetical release scenario is described, and the conceptual model used to evaluate radionuclide transport is presented. Site-specific calculations that detail the ability of the groundwater and surface water systems to delay, disperse, or dilute the liquid effluent prior to reaching a potential water receptor are also provided. Possible radiological consequences associated with the radionuclide release are then evaluated by comparison with established regulatory limits. This analysis applies conservative assumptions and transport parameters to obtain an evaluation with a large margin of safety.

2.4.13.1.1 Accident Release Scenario Outline

This analysis considers a hypothetical accidental release from a liquid waste storage tank located below grade in the power block area at the BBNPP site, and southwestward effluent migration in groundwater through engineered backfill materials, shallow bedrock, and glacial outwash deposits at the site, toward Walker Run (Figure 2.4-98). Mixing of the radionuclide-containing groundwater with surface waters of Walker Run then occurs, and is followed by discharge into the North Branch of the Susquehanna River (NBSR), with subsequent mixing and dilution (Figure 2.4-99).

Advection, decay, dispersion, retardation, and dilution of the radionuclide-containing groundwater plume were determined in four steps, described in detail within Section 2.4.13.1.9. For each step, the resulting radionuclide activities were compared against accepted NRC Effluent Concentration Limit (ECL) values, as compiled in Appendix B to Part 20, Chapter 1, Title 10 of the Code of Federal Regulations, hereafter denoted as 10 CFR 20 (CFR, 2010). Only the radionuclides that exceeded 1 percent of a respective ECL were evaluated in subsequent analyses. Note that all radionuclide activities are reported and discussed using units of microcuries per cubic centimeter ($\mu Ci/cm^3$) in an effort to facilitate direct comparison to the NRC's ECL values.

Step 1 involved the release of the source-term radionuclides and migration through the groundwater system, assuming only advection and radioactive decay. All parent radionuclides expected to be present in the liquid waste storage tank, along with daughter progeny in the decay chain sequences that are important for dosimetric purposes, were considered. International Commission on Radiological Protection (ICRP) Publication 107 (ICRP, 2008) was used to identify the progeny for which the decay chain sequences could be truncated. Consideration of up to three members of the decay chain was required for several of the radionuclides present in the liquid waste storage tank.

Step 2 evaluated the additional impact of retardation on radionuclide transport. Retardation, modeled here by a partition ratio, K_d, is the process whereby radionuclides are sorbed to and desorbed from aquifer matrices via cation/anion exchange, oxidation and reduction (redox) reactions, and mineral precipitation (among other reactions).

Step 3 considered discharge of the groundwater plume to Walker Run and dilution of the radionuclides within the stream. It was assumed that the entire volume of the radionuclide-containing groundwater plume would seep through the stream bank and fully mix with the creek water under typical low flow conditions.

Step 4 included the migration of the radionuclide-containing creek waters into the North Branch of the Susquehanna River (NBSR) and subsequent dilution. Specifically, the Step 4 calculations included mixing of Walker Run flow with 25 percent of the flow in the NBSR. This volume was selected to represent a low mixed volume and minimal dilution.

An important assumption in the hypothetical release scenario presented here is that the radionuclide-containing groundwater plume is transported within the NBSR and arrives at a potential user that consumes the water directly, or uses the water to produce crops or raise animals for later consumption, as outlined in the NRC's NUREG 0800 Standard Review Plan (SRP) Section 2.4.13 (NRC, 2007a) and Branch Technical Position (BTP) 11-6 (NRC, 2007b). For direct consumption, conditions are considered acceptable if a release does not result in radionuclide concentrations in excess of the ECLs included in 10 CFR 20 (CFR, 2010) in the nearest source of potable water, located in an unrestricted area. Here, it is assumed that any radionuclides in the NBSR continue downstream and flow toward public water supply wells associated with the Berwick District of the Pennsylvania American Water Company. This public water supplier serves a population of approximately 16,000 through nearly 6,300 connections in five municipalities.

2.4.13.1.2 Accident Scenario and Assumptions

In this analysis, a liquid waste (reactor coolant) storage tank in the Nuclear Auxiliary Building at the BBNPP is postulated to be the source of an accidental radionuclide release. This tank, with an estimated capacity of 4,061 cubic feet (ft^3) or 115 cubic meters (m^3) (AREVA, 2011a) is assumed to rupture completely and release 80 percent of the contained liquid volume (3,249 ft^3; 92 m^3) in accordance with NUREG 0800 SRP Section 2.4.13 (NRC, 2007a) and BTP 11-6 (NRC, 2007b). At the BBNPP site, these tanks would likely contain the largest volume of reactor coolant water. Moreover, an instantaneous release from a ruptured tank would discharge a larger quantity of water more rapidly than a pipe rupture.

Liquid from the tank rupture is assumed to flood the building and migrate beyond secondary containment structures and sump collection systems within the building. This effluent then exits the building via cracks in the foundation floor, and enters the subsurface at a depth of 41.5 feet (ft; 12.7 meters [m]) below the proposed finished plant grade, 719 ft (219.2 m) North American Vertical Datum of 1988 (NAVD 88). The actual elevation of this release point is therefore assumed to equal 677.5 ft (206.5 m) NAVD 88.

Existing hydrogeologic data indicate that groundwater flow is consistently to the southwest and/or south at the BBNPP site. It is therefore assumed that subsurface migration of the radionuclide-containing effluent plume would be generally southwestward or southward, toward Walker Run and an unnamed tributary to Walker Run, identified hereafter as Unnamed Tributary (UT) 1. Flow is also assumed to be lateral, through post-construction backfill materials (compacted sand and gravel), shallow bedrock (fractured shale), and glacial outwash deposits. It is also assumed that the plume does not change shape, become diluted, or disperse during migration in the groundwater system. These mechanisms would only act to reduce the concentrations of the radionuclides. Dilution is assumed to occur only when the plume seeps into Walker Run and the NBSR (in Steps 3 and 4, respectively).

It should be noted (from field observations) that Walker Run is a gaining stream, and receives groundwater discharge from the shallow bedrock and glacial outwash deposits at the site. Groundwater similarly discharges to UT 1 and the wetland areas located south of the BBNPP. This suggests that very little (if any) shallow groundwater flows beneath Walker Run or UT 1. That is, groundwater flow does not likely continue in the subsurface to locations south of the site. Nonetheless, it is assumed here that at least some radionuclide-containing groundwater could migrate beneath UT 1 to a possible receptor (a domestic well user) located approximately 5,315 ft (approximately 1,620 m) south-southeast of the BBNPP.

2.4.13.1.3 Liquid Release Source Terms

An inventory of radionuclides in the release source (a reactor coolant storage tank) is provided in Table 2.4-60. This list includes parent radionuclides and daughter progeny with the greatest potential for exposure consequences. Half-life and branching fraction values listed in Table 2.4-60 are consistent with values provided by the ICRP (ICRP, 2008). The initial radionuclide concentrations used in this evaluation correspond to a 0.25 percent defective fuel rod rate (AREVA, 2011a). This rate is nearly two times the failure rate established by BTP 11-6 (0.12 percent) (USNRC, 2007b). Accordingly, the analysis provides a conservative bounding estimate of the radionuclide inventory and associated activity levels in the postulated release.

2.4.13.1.4 Possible Groundwater Flowpaths

Four possible groundwater flowpaths were identified at the BBNPP site (Figure 2.4-98). Flowpath A assumes that a subsurface effluent plume will migrate toward the southwest (Figure 2.4-98) through post-construction backfill materials (compacted sand and gravel) and into the shale bedrock surrounding the BBNPP power block excavation area. This plume then enters the glacial outwash deposits covering the bedrock at the site, and ultimately discharges into Walker Run (and therein mixes with surface waters in the stream).

Groundwater flow along pathway B assumes that the plume will initially migrate directly to the south (also through backfill materials) but is followed by southwestward flow within the shallow bedrock zone, along the dominant groundwater flow directions at the site (Figure 2.4-98). Flow continues through glacial outwash deposits, with discharge into Walker Run occurring approximately 440 ft (134.11 m) downstream of the groundwater discharge point for flowpath A.

For paths C-1 and C-2, initial plume migration is assumed to be toward the south-southeast, through excavation backfill. The radionuclide-containing groundwater then enters the shallow bedrock zone, and migrates along a more southerly route, again following the dominant flow directions at the site. Flow is then assumed, most plausibly, to continue through the glacial outwash deposits at the site, with discharge into UT 1 and subsequent transport to Walker Run (pathway C-1, Figure 2.4-98). Alternatively, plume migration could be retained within the shallow bedrock zone, with continued flow southward, beneath UT 1 and adjacent wetlands. Subsurface flow would then continue to the south, toward a cluster of several homes located outside of the BBNPP Owner-Controlled Area (pathway C-2). Here, it is postulated that the plume enters a private well (positioned roughly at the end of an unnamed road west of Confers Lane) at a depth 41.5 ft (12.65 m) below the ground surface (i.e., at a depth comparable to the initial effluent release point).

2.4.13.1.5 Groundwater Velocities and Travel Times

Hydraulic properties (hydraulic conductivity, porosity, and dry density) of the transporting media (geologic materials and engineering backfill planned for the excavation) are provided in Table 2.4-61. Hydraulic gradients, Darcy velocities, seepage velocities, and groundwater travel times (Table 2.4-61) were calculated for each postulated effluent pathway at the BBNPP site using the Darcy equation for flow (Freeze and Cherry, 1979) and the input data provided in Table 2.4-61. Along flow pathway A, for example, with a total length of 710 ft (216.41 m), a horizontal hydraulic gradient ($i_{horizontal}$) equaling 0.072 was calculated by assuming that the maximum post-construction groundwater elevation in the release area will be equal to 712.03 ft (217.03 m) NAVD 88 and that the surface water elevation in Walker Run at the discharge point is approximately 661 ft (201.47 m) NAVD 88:

$$i_{horizontal} = \frac{h_{difference}}{x_{total}} = \frac{(712.03 \text{ ft NAVD 88} - 661 \text{ ft NAVD 88})}{710 \text{ ft}} = 0.072 \quad \text{(Eq. 2.4.13-1)}$$

From this, a Darcy velocity (q) was calculated using a harmonic mean of the hydraulic conductivities provided in Table 2.4-61:

$$q = i_{horizontal} \times K_{harmonic} = 0.072 \times 9.383 \text{ ft/day} = 0.674 \text{ ft/day} \quad \text{(Eq. 2.4.13-2)}$$

A linear groundwater flow velocity (or seepage velocity, v_s) was also calculated for pathway A, using a porosity value (n) equal to the average of values determined for backfill, bedrock, and glacial outwash deposits at the BBNPP site:

$$v_s = \frac{q}{n_{average}} = \frac{0.674 \text{ ft/day}}{0.206} = 3.27 \text{ ft/day} \quad \text{(Eq. 2.4.13-3)}$$

A conservative estimate of total travel time (t_{total}) for the groundwater plume (along path A) was then determined using the seepage velocity value calculated above:

(Eq. 2.4.13-4)

$$t_{total} = \frac{x_{total}}{v_s} = \frac{710 \text{ ft}}{3.27 \text{ ft/day}} = 217 \text{ days}$$

It should be noted that the seepage velocity and total travel time values calculated here (Table 2.4-62) are directly applicable only to groundwater flow and not necessarily radionuclide migration. Nonetheless, these results indicate that flowpath A is the fastest (and thereby most direct) migration pathway for radioactive effluent at the BBNPP site. Although plausible, flow along pathways B and C-1 is considerably slower than flow along pathway A (by 50 and 697 days, respectively) and therefore is considered less conservative. Pathway C-2, in turn, is considered extremely unlikely, and also results in a significantly longer travel time relative to flowpaths A, B, and C-1. Accordingly, only pathway A is considered (here) as an effluent migration pathway at the site.

2.4.13.1.6 Groundwater Plume Dimensions and Volumetric Flow Rate

A volume for the radionuclide-containing groundwater plume (????) was determined from the initial spill volume (3,249 ft^3, or 92 m^3) and the average porosity of the transporting media at the BBNPP site (0.206) (Table 2.4-63):

$$V_{\text{plume}} = \frac{V_{\text{spill}}}{n_{\text{average}}} = \frac{3249\ \text{ft}^3}{0.206} = 15{,}771\ \text{ft}^3 \qquad \text{(Eq. 2.4.13-5)}$$

The groundwater plume is assumed to maintain a height equal to 12 ft (3.66 m), a value that is 50 percent of the average thickness of the glacial outwash deposits at the site. Assuming a length to width to height ratio that is roughly 10:1:1, the plume cross-sectional area (*A*) was determined to equal 144 square feet (ft^2) (13.38 square meters [m^2]):

$$A = H \times W = 12\ \text{ft} \times 12\ \text{ft} = 144\ \text{ft}^2 \qquad \text{(Eq. 2.4.13-6)}$$

This cross-sectional area is considered normal to the direction of groundwater flow. In turn, a volumetric groundwater flow rate (*Q*) of 97 cubic feet per day (ft^3/day) or approximately 2.75 cubic meters per day (m^3/day) was estimated from this cross-sectional area and the calculated Darcy velocity (*q*; see Eq. 2.4.13-2, above) for the radioactive effluent plume:

$$Q = A \times q = 144\ \text{ft}^2 \times 0.674\ \text{ft/day} = 97\ \text{ft}^3\text{/day} \qquad \text{(Eq. 2.4.13-7)}$$

Note that the Darcy velocity (*q*) is an apparent velocity that characterizes the rate at which water would move through the subsurface if the groundwater system were an open conduit.

2.4.13.1.7 Radionuclide Transport Equations

In this analysis, radionuclide transport along groundwater flowpath A was evaluated using the one-dimensional advection-dispersion-reaction equation of Javandel (Javandel, 1984):

$$R\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} - v_s\frac{\partial C}{\partial x} - \lambda R C \qquad \text{(Eq. 2.4.13-8)}$$

where *C* is the radionuclide activity, *R* is a retardation factor, *D* is a coefficient of longitudinal hydrodynamic dispersion, v_s is the previously defined (Eq. 2.4.13-3, above) linear groundwater flow (or seepage) velocity, λ is the radioactive decay constant, *t* is the groundwater travel time from source to receptor, and *x* is the total horizontal distance along the flowpath.

The retardation factor, *R*, in Eq. 2.4.13-8 is defined by the relationship:

$$R = \left(1 + \frac{\rho K_d}{n}\right) \qquad \text{(Eq. 2.4.13-9)}$$

where ρ (rho) is the dry (or bulk) density of the transporting medium, K_d is a partition ratio, and *n* is the porosity. The radioactive decay constant in Eq. 2.4.13-8, in turn, can be written as:

$$\lambda = \frac{\ln 2}{t_{1/2}} \qquad \text{(Eq. 2.4.13-10)}$$

where $t_{½}$ denotes the half-life a specified radionuclide.

As described by Konikow and Bredehoeft (Konikow and Bredehoeft, 1978), the method of characteristics approach can be applied to Eq. 2.4.13-8 to determine the rate of change in the activity of the radionuclide:

$$\frac{dC}{dt} = \frac{\partial C}{\partial t} + \frac{dx}{dt}\frac{\partial C}{\partial x} \qquad \text{(Eq. 2.4.13-11)}$$

Conservatively neglecting the coefficient of longitudinal hydrodynamic dispersion, *D*, the advection-dispersion-reaction equation can then be integrated to yield:

$$\frac{dC}{dt} = -\lambda C \qquad \text{(Eq. 2.4.13-12)}$$

and

$$\frac{dx}{dt} = \frac{v_s}{R} \qquad \text{(Eq. 2.4.13-13)}$$

Note that Eq. 2.4.13-12 represents the decay reaction for a radionuclide of interest, and that Eq. 2.4.13-13, in turn, describes transport of the radionuclide within the groundwater system. Solutions for Eq. 2.4.13-12 and Eq. 2.4.13-13 can be obtained by integration to yield the characteristic curves (integral curves) of Eq. 2.4.13-8. For transport of a parent radionuclide, expressed in units of activity, these characteristic curve equations are:

$$C_1(t) = C_1^0 \exp(-\lambda_1 t) \qquad \text{(Eq. 2.4.13-14)}$$

and

$$t = R_1 \frac{x}{v_s} \qquad \text{(Eq. 2.4.13-15)}$$

where C_1 (*t*) denotes the parent radionuclide concentration (activity) at time *t*, C^0_1 is the initial parent activity (i.e., the activity at time zero), λ_1 is the radioactive decay constant for the parent radionuclide (from Eq. 2.4.13-10), and R_1 is the retardation factor for the parent radionuclide.

Similar relationships exist for progeny radionuclides. For the first progeny in a decay chain, the advection-dispersion-reaction equation is:

(Eq. 2.4.13-16)

$$R_2 \frac{\partial C_2}{\partial t} = D \frac{\partial^2 C_2}{\partial x^2} - v_s \frac{\partial C_2}{\partial x} + d_{12} \lambda_1 R_1 C_1 - \lambda_2 R_2 C_2$$

where the subscript 2 identifies the activities and/or properties (half-life, retardation, etc.) of first progeny radionuclides, and d_{12} is the fraction of parent radionuclide transitions that result in the production of first progeny radionuclides.

The characteristic (integral) curves for Eq. 2.4.13-16, conservatively neglecting (again) the coefficient of longitudinal hydrodynamic dispersion, can be reduced to:

(Eq. 2.4.13-17)

$$\frac{dC_2}{dt} = d_{12} \lambda_1^{'} C_1 - \lambda_2 C_2$$

and

(Eq. 2.4.13-18)

$$\frac{dx}{dt} = \frac{v_s}{R_2}$$

where λ'_1 is defined as the product of the radioactive decay constant for the parent radionuclide (again, λ_1) and the quotient of the retardation factors for the parent radionuclide and the first progeny in the decay chain (i.e., R_1 divided by R_2):

(Eq. 2.4.13-19)

$$\lambda_1^{'} = \lambda_1 \frac{R_1}{R_2}$$

Recognizing that Eq. 2.4.13-17 is formally similar to Equation B.30 in NUREG/CR-5512 (NRC, 1992), these equations can be integrated to yield:

(Eq. 2.4.13-20)

$$C_2 = K_1 \exp(-\lambda_1^{'} t) + K_2 \exp(-\lambda_2 t)$$

and

(Eq. 2.4.13-21)

$$t = R_2 \frac{x}{v_s}$$

where R_2 is the retardation factor for the first progeny radionuclide, and x and v_s are, again, the total horizontal distance along the groundwater flowpath and the groundwater seepage velocity, respectively. The decay chain coefficients for the parent (K_1) and first progeny (K_2) radionuclides in Eq. 2.4.13-19 are defined by the following:

(Eq. 2.4.13-22)

$$K_1 = \frac{d_{12}\lambda_2 C_1^0}{\lambda_2 - \lambda_1'}$$

and

(Eq. 2.4.13-23)

$$K_2 = C_2^0 - \frac{d_{12}\lambda_2 C_1^0}{\lambda_2 - \lambda_1'}$$

It should be noted, here, that Eq. 2.4.13-20 and supporting Eqs. 2.4.13-21 through 2.4.13-23 are formally similar to equation B.43 in NUREG/CR-5512 (NRC, 1992).

The advection-dispersion-reaction equation for second progeny radionuclides in a decay chain follows an expanded form of Eq. 2.4.13-16:

(Eq. 2.4.13-24)

$$R_3 \frac{\partial C_3}{\partial t} = D\frac{\partial^2 C_3}{\partial x^2} - v_s \frac{\partial C_3}{\partial x} + d_{13}\lambda_1 R_1 C_1 + d_{23}\lambda_2 R_2 C_2 - \lambda_3 R_3 C_3$$

where subscript 3 identifies the activities or properties (again, half-life, retardation, etc.) of second progeny radionuclides, and d_{13} and d_{23} denote the fraction of parent radionuclide transitions and first progeny transitions, respectively, that result in the production of second progeny radionuclides.

By ignoring the coefficient of longitudinal hydrodynamic dispersion, *D*, Eq. 2.4.13-24 can be reduced to:

(Eq. 2.4.13-25)

$$\frac{dC_3}{dt} = d_{13}\lambda_1' C_1 + d_{23}\lambda_2' C_2 - \lambda_3 C_3$$

and

(Eq. 2.4.13-26)

$$\frac{dx}{dt} = \frac{v_s}{R_3}$$

where λ'_1 in this case, is defined as the product of the radioactive decay constant for the parent radionuclide (again, λ_1) and the quotient of the retardation factors for the parent radionuclide and the second progeny in the decay chain (i.e., R_1 divided by R_3):

(Eq. 2.4.13-27)

$$\lambda_1' = \lambda_1 \frac{R_1}{R_3}$$

where λ'_2 is defined as the product of the radioactive decay constant for the first progeny radionuclide (λ_2) and the quotient of the retardation factors for the first and second progeny radionuclides in the decay chain (i.e., R_2 divided by R_3):

(Eq. 2.4.13-28)

$$\lambda_2' = \lambda_2 \frac{R_2}{R_3}$$

Equations 25 and 26, above, can also be integrated to yield the following:

(Eq. 2.4.13-29)

$$C_3 = K_1 \exp(-\lambda_1' t) + K_2 \exp(-\lambda_2' t) + K_3 \exp(-\lambda_3 t)$$

and

(Eq. 2.4.13-30)

$$t = R_3 \frac{x}{v_s}$$

where R_3 is the retardation factor for the second progeny radionuclide, and x and v_s are, again, the total horizontal distance along the groundwater flowpath and the groundwater seepage velocity, respectively. The decay chain coefficients for the parent (K_1) and first and second progeny (K_2 and K_3, respectively) radionuclides in Eq. 2.4.13-28 are defined by the following:

(Eq. 2.4.13-31)

$$K_1 = \frac{d_{13}\lambda_3 C_1^0}{\lambda_3 - \lambda_1'} + \frac{d_{23}\lambda_2' d_{12}\lambda_3 C_1^0}{(\lambda_3 - \lambda_1')(\lambda_2' - \lambda_1')}$$

(Eq. 2.4.13-32)

$$K_2 = \frac{d_{23}\lambda_3 C_2^0}{\lambda_3 - \lambda_2'} - \frac{d_{23}\lambda_2' d_{12}\lambda_3 C_1^0}{(\lambda_3 - \lambda_2')(\lambda_2' - \lambda_1')}$$

(Eq. 2.4.13-33)

$$K_3 = C_3^0 - \frac{d_{13}\lambda_3 C_1^0}{\lambda_3 - \lambda_1'} - \frac{d_{23}\lambda_3 C_2^0}{\lambda_3 - \lambda_2'} + \frac{d_{23}\lambda_2' d_{12}\lambda_3 C_1^0}{(\lambda_3 - \lambda_1')(\lambda_3 - \lambda_2')}$$

Eqs. 2.4.13-29 through 2.4.13-33 are collectively similar to Equation B.54 in NUREG/CR-5512 (NRC, 1992). To estimate the radionuclide concentrations in groundwater, Eq. 2.4.13-14, 2.4.13-20, and 2.4.13-29 were applied as appropriate along the groundwater transport pathway.

2.4.13.1.8 Partition Ratios (K_d Values)

As described previously, retardation incorporates the geochemical processes which slow the movement of radionuclides (relative to groundwater) during groundwater transport. These processes include adsorption and desorption, redox reactions, chemical precipitation, and cation/anion exchange, and can be represented mathematically as a partition ratio, or K_d

value. Because the volume of the effluent plume (here) is small relative to the volume of water encountered during migration through the groundwater system at the Site, radionuclide mobility is assumed to be controlled by the chemistry of the groundwater and transporting media (backfill, outwash deposits, etc.). That is, the overall chemical characteristics of the plume are assumed to reflect local groundwater and geologic conditions during migration, rather than the initial chemistry of the liquid effluent. It should also be noted that no chelating agents such as ethylenediaminetetraacetate (EDTA) will be used to clean pumps, pipes, tanks, or other components related to cooling water circulation systems at the BBNPP. Accordingly, no other complexing compounds are expected to influence the chemistry of the liquid release source.

Table 2.4-64 compiles site-specific K_d values determined by laboratory testing of possible fill materials and glacial outwash deposits (ANL, 2010 and BNL, 2010, respectively) and partition ratios that have been reported and evaluated in scientific literature. The most conservative (i.e., lowest) K_d value reported for each element is identified in Table 2.4-64, and has been used in the calculations for the Step 2 transport analysis.

2.4.13.1.9 Transport Analyses

The radionuclide transport analyses presented here included four steps, as outlined in Section 2.4.13.1.1. Step 1 provided calculations of radionuclide activities at the point of groundwater discharge, with consideration of only advection and radioactive decay. Step 2 calculations, in turn, incorporated the effects of retardation. Step 3 utilized the calculated radionuclide concentrations from Step 2 to determine activities in Walker Run (under low flow conditions) following mixing with the discharged plume. Step 4 calculations modeled the dilution of radionuclides in the NBSR. In Steps 3 and 4, it was assumed that no other surface water inputs enter Walker Run or the NBSR (e.g., tributary inflows). Moreover, adsorption of radionuclides to bottom or suspended sediments is assumed not to occur, and uptake by biota (e.g., algae) was not considered. Accordingly, the calculations are considered conservative, as the attenuation of radionuclides during surface water transport is minimal.

2.4.13.1.9.1 Transport Analyses Considering Advection and Radioactive Decay (Step 1)

An inventory of equation inputs for the Step 1 transport calculations are provided in Table 2.4-65. The calculated radionuclide activities at the point of groundwater discharge into Walker Run are also presented in Table 2.4-65 and compared with the ECLs established by NRC requirements (CFR, 2010). Results indicate that 29 of the 76 radionuclides exhibited activities that exceeded 1 percent of a defined ECL (Table 2.4-60). ECLs were not available for an additional 12 radionuclides. However, these 12 radionuclides had low (or zero) activities at the point of discharge, with the exception of barium-137m (Ba-137m). Tritium (H-3) had the highest activity at the point of groundwater discharge (9.67E-01 $\mu Ci/cm^3$), although cesium-134 (Cs-134) had the highest activity to ECL ratio (1.55E+05).

The radionuclide activities presented in Table 2.4-65 that were less than 1 percent of a respective ECL were eliminated from further consideration in the Step 2 analysis.

2.4.13.1.9.2 Transport Considering Advection, Decay, and Retardation (Step 2)

The 29 radionuclides identified in Step 1 with activity to ECL ratios greater than 1.0E-02 were retained for further evaluations in Step 2 that considered partition ratio (K_d) derived retardation factors (R values; see also Section 2.4.13.1.8 and Table 2.4-66). Daughter progeny associated with the 29 radionuclides identified in Step 1 were also considered in Step 2.

Calculated radionuclide activities within the discharged groundwater that consider the combined effects of advection, decay, and retardation are presented in Table 2.4-66. These values establish that only 5 of the radionuclides considered here, namely H-3, strontium-90 (Sr-90), yttrium-90 (Y-90), iodine-129 (I-129), and plutonium-239 (Pu-239) exceeded 1 percent of the respective ECLs. Tritium had the highest calculated activity and highest activity to ECL ratio (9.67E-01 µCi/cm^3 and 9.67E+02, respectively). It should be noted that the H-3 concentration at the groundwater discharge point calculated in Step 2 is identical to the value determined in Step 1 because the K_d of H-3 is zero (i.e., tritiated water moves through the groundwater system with no retardation).

2.4.13.1.9.3 Transport Considering Dilution in Walker Run (Step 3)

Only the radionuclides with calculated activities in excess of 1 percent of a respective ECL value (H-3, Sr-90, Y-90, I-129, and Pu-239) were evaluated in Step 3. In this analysis, it was assumed that the entire radionuclide-containing groundwater plume (15,771 ft^3; 447 m^3) (Table 2.4-63) was instantaneously discharged into, and mixed with, surface waters in Walker Run. Radioactive decay, additional dilution, dispersion, and adsorption to bottom sediments during mixing were not considered in Step 3 in an effort to simplify the analysis and ensure a conservative estimate of radionuclide activities that would occur in the stream water.

A flow rate of 1.12E-03 ft^3 per second (ft^3/s; 3.18E-05 m^3 per second [m^3/s]) was calculated for the water discharged into Walker Run along path A (Table 2.4-63 and Table 2.4-67). Mixing of the discharged groundwater with surface waters in Walker Run is therefore approximated by a dilution ratio equal to 1.32E-03 (Table 2.4-67), assuming low flow conditions in the stream (equivalent to 8.48E-01 ft^3/s, or 2.40E-02 m^3/s).

Radionuclide activities following application of the dilution ratio are presented in Table 2.4-67. With mixing in Walker Run, the activities of H-3, Sr-90, Y-90, I-129, and Pu-239 were significantly reduced. Only H-3 and Sr-90 maintained activity to ECL ratios greater than 0.01 (1.28E+00 and 1.03E-02, respectively).

2.4.13.1.9.4 Dilution in the NBSR (Step 4)

In Step 4, it was assumed that the radionuclide-containing water within Walker Run flows into, and mixes with, 25 percent of the water within the NBSR. For this dilution, an assumed 7-day, 10-year stream low-flow value ($Q_{7,\,10}$) in the NBSR equal to 8.70E+02 ft^3/s (2.46E+01 m^3/s) resulted in a reduction of H-3 and Sr-90 activities to 4.97E-06 and 1.99E-11 µCi/cm^3, respectively (Table 2.4-68). These calculated values are well below 1 percent of the defined ECLs.

2.4.13.1.10 Compliance with 10 CFR Part 20

It should be noted that 10 CFR 20 (CFR, 2010) requires the summation of all radionuclide activity to ECL ratios, and specifies that the sum of these ratios should be less than or equal to 1 (i.e., unity). Summation of the conservatively estimated radionuclide activity to ECL ratios resulted in an overall total equaling only 1.38E-02, less than 2 percent of the established limit (Table 2.4-69). Accordingly, no direct or indirect impacts related to the release scenario presented here (contamination of public supply wells, etc.) are identified.

2.4.13.2 Direct Releases to Surface Waters

U.S. EPR secondary containment design features include shielding of storage tanks with roughly 2.5-feet thick concrete walls, and labyrinth shielding for piping compartments.

Moreover, the concrete compartments housing the reactor coolant storage tanks identified in the accidental release scenario contain elevated access doors, sealed floor penetrations, and floor drains that are normally closed so that each compartment has the capability of retaining the complete drainage of a tank. The liquid from potential tank leaks is also contained by berms and collected by drain systems used for processing in the liquid waste management system. Floor drains, sumps and piping that transfer potentially radioactive liquids to the liquid waste management system are designed with barriers and leakage detection instrumentation. These barriers and detection instrumentation minimize the introduction of uncontrolled radioactive effluent into the environment. Consequently, it is highly unlikely that a release from a liquid waste storage tank would reach an open ground surface and thereby directly impact surface waters.

2.4.13.3 References

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2.4.14 Technical Specification and Emergency Operation Requirements

The U.S. EPR FSAR includes the following COL Item in Section 2.4.14:

> A COL applicant that references the U.S. EPR design certification will describe any emergency measures required to implement flood protection in safety-related facilities and to verify that there is an adequate water supply for shutdown purposes.

This COL Item is addressed as follows:

{References to elevation values in this section are based on the North American Vertical Datum of 1988 (NAVD 88), unless stated otherwise.

Sections 2.4.14.1 and 2.4.14.2 are added as a supplement to the U.S. EPR FSAR.

2.4.14.1 Need for Technical Specifications and Emergency Operations Requirements

The preceding subsections of Section 2.4 provide an in-depth evaluation of the site's hydrologic acceptability for locating BBNPP. The information provided below concludes that there is no need for emergency protective measures designed to minimize the impact of hydrology-related events on safety-related facilities. Therefore, the requirements of 10 CFR 50.36 (CFR, 2007a), 10 CFR Part 50, Appendix A, General Design Criteria 2 (CFR, 2007b), 10 CFR Part 100 (CFR, 2007c), and 10 CFR 52.79 (CFR, 2008) are met with respect to determining the acceptability of the site.

Sections 2.4.1 through 2.4.11 present a comprehensive discussion of the potential for flooding and low water at the site, including details of each potential cause and the resulting effects. These evaluations conclude that flooding in the Powerblock area of safety-related structures, systems, and components due to local intense precipitation, or local Probable Maximum Precipitation (PMP), will be prevented by the site drainage features engineered and constructed for that purpose. The BBNPP design finished plant grade elevation is located above the design basis flood level and the Probable Maximum Flood (PMF) elevation from local streams. The finished plant grade elevation will be at 719 ft (219.2 m) NAVD 88, which is approximately 206.7 ft (63.0 m) above the Susquehanna River 100-yr floodplain of approximately 513 ft (156 m) National Geodetic Vertical Datum of 1929 (NGVD 29) (Federal Emergency Management Agency (FEMA), 2008) or 512.3 ft (156.1 m) NAVD 88. Additionally, there are no major water bodies (e.g., area greater than 10 acres (4.05 hectares)) directly adjacent to or within the BBNPP Property Boundary (except for the Susquehanna River south of US RT 11) . The PMF on local streams (i.e., Walker Run, Unnamed Tributary-1, and Unnamed Tributary-2) was analyzed and discussed in Section 2.4.3, and maximum PMF water surface elevations in the vicinity of safety-related facilities (i.e., the various safety-related structures located within the Powerblock, and the safety-related ESWEMS Retention Pond) can be summarized as follows: 675.69 ft (205.95 m) NAVD 88 along Walker Run, 672.34 ft (204.93 m) NAVD 88 along Unnamed Tributary-1, and 715.03 ft (217.94 m) NAVD 88 along Unnamed Tributary-2 at River Station 1645.505 as shown on Figure 2.4-33. The wave runup within the ESWEMS Retention Pond during a localized PMP event was analyzed and discussed in Section 2.4.8. Under the 1,000 year wind event, the PMF evaluation of the ESWEMS Retention Pond results in a freeboard of 0.17 ft (0.05 m) to the top of the dike embankment at 700 ft (213.4 m) NAVD 88 and 0.67 ft (0.20 m) of freeboard to the grade level of the ESWEMS Pump House at 700.5 ft (213.5 m) NAVD 88. Therefore, the plant is dry with respect to major flooding of local streams and localized PMP events. Because the BBNPP site is not located near a coastal region and due to the higher elevation of the plant relative to the Susquehanna River 100-yr floodplain, tsunami and storm surge and seiche flooding considerations are not applicable for this site.

The U.S.EPR FSAR requires that the maximum post-construction groundwater elevation be at least 3.3 ft (1 m) below grade for any safety-related structure. Since the finished plant grade elevation is 719 ft (219.2 m) NAVD 88 at the Powerblock and the maximum expected groundwater level for the existing conditions is elevation 712.03 ft (217.03 m) NAVD 88 for the Shallow Bedrock, a permanent dewatering system is not needed during operation of BBNPP at the Powerblock. Additionally, the finished site grade elevation is 700.5 ft (213.5 m) NAVD 88 at the ESWEMS Pump House and the maximum expected groundwater level for the existing conditions is elevation 665.07 ft (202.71 m) NAVD 88 for the Glacial Outwash Aquifer, a permanent dewatering system is not needed during operation of BBNPP at the ESWEMS Pumphouse.

BBNPP is designed such that no actions need be captured in Technical Specifications or Emergency Operating Procedures to protect the facility from flooding or interruption of water supply for shutdown and cooldown purposes.

Additionally, as described in U.S. EPR FSAR Section 9.2.5, the Essential Service Water System (ESWS) cooling tower basins are designed for operation without makeup for 3 days following a design basis accident (DBA), and the ESWEMS makeup pumps are only required for ESWS makeup following those 72 hours post-DBA. Three days of cooling water inventory in the ESWS cooling tower basin is sufficient for shutdown and cooldown, should a potential flooding event require plant shutdown. Operation of the ESWEMS pumps is therefore not required for achieving cold shutdown. The minimum 3 day water inventory in the ESWS cooling tower basin, along with additional details of ESWEMS/ESWS operation, are discussed in U.S. EPR FSAR Section 9.2.1 and Section 9.2.5.

The worst case low water event does not pose a potential of interrupting the supply of cooling water, as discussed in Section 2.4.11. There are no other uses of water drawn from the BBNPP ESWEMS Retention Pond, such as fire water or system charging requirements. There are no other interdependent safety-related water supply systems to the ESWS, such as reservoirs or cooling lakes. There is no potential of blockage to the safety-related ESWS intake due to ice or channel diversions as discussed in Sections 2.4.7 and 2.4.8. Other potential low water conditions are also evaluated and accounted for in the establishment of the design low water level, as discussed Section 2.4.11.

Accordingly, no emergency protective measures are required to minimize the effect of hydrology-related events on safety-related facilities.

2.4.14.2 References

CFR, 2007a. Technical Specifications, Title 10, Code of Federal Regulations, Part 50.36, 2007.

CFR, 2007b. General Design Criteria for Nuclear Power Plants, Criteria 2, Design Bases for Protection Against Natural Phenomena, Title 10, Code of Federal Regulations, Part 50, Appendix A, 2007.

CFR, 2007c. Reactor Site Criteria, Title 10, Code of Federal Regulations, Part 100, 2007.

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Table 2.4-1— {Sub-basin Flow Path Length and Slope}

Sub-basin	Length of longest flow path (ft)	Length of longest flow path (m)	Slope (ft/mi)	Average Slope (m/km)
SB1-1	2791.16	850.75	189.71	35.93
SB1-2	8365.51	2549.81	206.19	39.05
SB1-3	8691.82	2649.27	138.80	26.29
SB2-1	8949.22	2727.72	107.26	20.32
SB2-2	6626.43	2019.74	330.33	62.56
SB2-3	5689.13	1734.05	429.71	81.38
SB2-4	4744.73	1446.19	98.13	18.59
SB3-1	6685.73	2037.81	326.30	61.80
SB3-2	4170.91	1271.29	33.19	6.29
SB3-3	2862.04	872.35	58.10	11.00
SB3-4	2779.25	847.12	112.14	21.24

Table 2.4-2— {Annual Peak Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1787 through 2006)}
(Page 1 of 3)

Water Year	Date	Gage Height (ft)	Streamflow (cfs)
1787	Oct. 05, 1786	N.A.	189,000
1807	Apr. 1807	N.A.	202,000
1809	Jul. 1809	N.A.	95,200
1833	May 14, 1833	N.A.	176,000
1865	Mar. 18, 1865	33.10	232,000
1891	Jan. 24, 1891	26.80	164,000
1892	Apr. 04, 1892	21.60	112,000
1893	May 05, 1893	22.02	115,000
1894	May 21, 1894	20.00	97,100
1895	Apr. 10, 1895	21.82	113,000
1896	Apr. 01, 1896	24.00	135,000
1897	Oct. 15, 1896	19.00	88,600
1898	Apr. 26, 1898	17.82	78,900
1899	Mar. 06, 1899	18.22	82,100
1900	Mar. 02, 1900	19.70	94,500
1901	Nov. 28, 1900	22.00	115,000
1902	Mar. 02, 1902	31.40	213,000
1903	Mar. 25, 1903	22.40	119,000
1904	Mar. 09, 1904	30.60	204,000
1905	Mar. 26, 1905	23.40	129,000
1906	Apr. 01, 1906	18.10	81,300
1907	Mar. 16, 1907	16.00	65,500
1908	Feb. 17, 1908	23.50	130,000
1909	May 02, 1909	23.00	125,000
1910	Mar. 03, 1910	26.10	157,000
1911	Mar. 29, 1911	19.70	94,500
1912	Apr. 03, 1912	23.20	127,000
1913	Mar. 28, 1913	28.50	184,000
1914	Mar. 29, 1914	28.30	182,000
1915	Feb. 26, 1915	23.30	127,000
1916	Apr. 02, 1916	26.50	160,000
1917	Mar. 28, 1917	17.70	75,700
1918	Mar. 15, 1918	23.00	124,000
1919	May 24, 1919	16.60	66,900
1920	Mar. 13, 1920	26.00	155,000
1921	Mar. 10, 1921	19.00	86,600
1922	Nov. 29, 1921	22.30	117,000
1923	Mar. 05, 1923	19.60	91,800
1924	Apr. 08, 1924	23.50	129,000
1925	Feb. 13, 1925	25.10	145,000
1926	Mar. 26, 1926	19.40	90,100
1927	Nov. 17, 1926	22.70	121,000
1928	Oct. 20, 1927	24.70	141,000
1929	Apr. 22, 1929	26.40	159,000
1930	Mar. 09, 1930	16.70	67,600
1931	Mar. 30, 1931	17.60	74,700

Table 2.4-2— {Annual Peak Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1787 through 2006)}
(Page 2 of 3)

Water Year	Date	Gage Height (ft)	Streamflow (cfs)
1932	Apr. 02, 1932	20.50	107,000
1933	Aug. 25, 1933	19.72	99,800
1934	Mar. 06, 1934	18.00	85,500
1935	Jul. 10, 1935	25.39	151,000
1936	Mar. 20, 1936	33.07	232,000
1937	Jan. 23, 1937	17.15	77,300
1938	Sep. 24, 1938	14.70	64,900
1939	Feb. 22, 1939	23.80	137,000
1940	Apr. 01, 1940	31.53	212,000
1941	Apr. 07, 1941	23.50	138,000
1942	Mar. 11, 1942	20.62	111,000
1943	Jan. 01, 1943	29.37	191,000
1944	May 09, 1944	18.50	90,000
1945	Mar. 05, 1945	21.80	119,000
1946	May 29, 1946	32.01	210,000
1947	Apr. 07, 1947	24.88	151,000
1948	Mar. 23, 1948	28.76	193,000
1949	Dec. 31, 1948	17.39	82,700
1950	Mar. 30, 1950	27.04	172,000
1951	Apr. 01, 1951	22.72	128,000
1952	Mar. 13, 1952	22.39	124,000
1953	Dec. 12, 1952	19.43	98,000
1954	May 5, 1954	16.85	78,900
1955	Mar. 03, 1955	17.80	85,900
1956	Mar. 09, 1956	28.17	186,000
1957	Apr. 07, 1957	20.48	107,000
1958	Apr. 08, 1958	26.80	170,000
1959	Jan. 23, 1959	21.14	113,000
1960	Apr. 02, 1960	29.60	184,000
1961	Feb. 27, 1961	26.20	163,000
1962	Apr. 02, 1962	22.84	128,000
1963	Mar. 28, 1963	22.26	131,000
1964	Mar. 10, 1964	N.A.	188,000
1965	Feb. 14, 1965	11.10	44,600
1966	Feb. 15, 1966	18.25	93,500
1967	Mar. 29, 1967	17.16	84,800
1968	Mar. 24, 1968	19.19	101,000
1969	Apr. 07, 1969	16.57	80,500
1970	Apr. 04, 1970	20.92	115,000
1971	Mar. 17, 1971	20.28	110,000
1972	Jun. 24, 1972	40.91	345,000
1973	Apr. 06, 1973	18.04	91,800
1974	Dec. 28, 1973	18.24	93,400
1975	Sep. 27, 1975	35.06	228,000
1976	Feb. 19, 1976	21.34	118,000
1977	Sep. 26, 1977	21.62	121,000

Table 2.4-2— {Annual Peak Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1787 through 2006)}
(Page 3 of 3)

Water Year	Date	Gage Height (ft)	Streamflow (cfs)
1978	Jan. 27, 1978	21.08	116,000
1979	Mar. 07, 1979	31.02	192,000
1980	Mar. 23, 1980	19.50	104,000
1981	Feb. 22, 1981	19.57	104,000
1982	Oct. 29, 1981	17.24	86,400
1983	Apr. 16, 1983	23.86	138,000
1984	Dec. 14, 1983	29.76	192,000
1985	Mar. 14, 1985	13.04	55,800
1986	Mar. 16, 1986	27.36	172,000
1987	Apr. 05, 1987	19.22	98,500
1988	May 21, 1988	16.88	82,200
1989	May 12, 1989	21.12	117,000
1990	Feb. 18, 1990	15.75	74,900
1991	Oct. 25, 1990	22.69	134,000
1992	Mar. 28, 1992	18.46	92,000
1993	Apr. 02, 1993	29.87	185,000
1994	Mar. 26, 1994	24.16	148,000
1995	Jan. 22, 1995	15.76	72,100
1996	Jan. 20, 1996	34.45	221,000
1997	Nov. 10, 1996	23.57	128,000
1998	Jan. 09, 1998	24.79	138,000
1999	Jan. 25, 1999	21.59	112,000
2000	Feb. 29, 2000	23.66	129,000
2001	Apr. 11, 2001	19.49	96,800
2002	Mar. 28, 2002	17.02	78,900
2003	Mar. 22, 2003	22.84	122,000
2004	Sep. 19, 2004	34.96	227,000
2005	Apr. 04, 2005	30.88	189,000
2006	Jun. 28, 2006	34.14	218,000
Note: N.A. = Not Available			

Table 2.4-3— {Monthly Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1899 through 2006)}

(Page 1 of 4)

Year	Discharge, cubic feet per second												
	Monthly Mean in cfs (Calculation Period: 1/ 04/1899 to 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1899				28,770	8,567	3,378	1,965	1,653	1,140	1,072	7,045	12,680	
1900	18,270	28,220	23,770	26,340	6,583	3,506	2,320	1,635	1,239	1,120	10,850	14,070	11,494
1901	5,532	3,893	32,830	39,250	21,450	15,670	3,065	7,403	4,257	3,570	5,288	25,910	14,010
1902	11,530	7,264	65,710	21,860	4,847	4,968	29,010	10,070	4,917	14,970	8,394	22,930	17,206
1903	13,320	34,970	53,490	23,650	3,388	10,260	7,877	13,070	10,930	27,370	12,570	7,036	18,161
1904	14,090	15,720	52,520	31,290	15,750	11,170	3,636	5,192	4,119	11,250	5,972	7,658	14,864
1905	19,680	5,289	41,070	24,550	5,873	10,750	5,488	5,466	12,650	8,081	5,527	20,020	13,704
1906	15,400	10,690	18,650	37,390	12,100	13,920	6,493	3,662	1,869	5,128	10,070	11,070	12,204
1907	29,450	5,347	24,070	17,920	13,720	4,808	4,367	1,485	5,139	11,100	18,550	30,440	13,866
1908	14,070	21,570	45,190	25,010	25,840	4,471	2,718	1,480	869.3	1,059	1,476	1,357	12,093
1909	14,490	33,760	21,360	27,200	28,210	10,610	2,076	1,451	1,124	1,188	1,206	2,143	12,068
1910	12,730	6,407	51,580	17,050	15,620	10,970	1,946	996.1	1,030	1,117	3,074	2,611	10,428
1911	20,760	7,584	21,620	30,540	5,980	7,086	1,764	1,278	3,637	9,217	8,976	14,310	11,063
1912	6,796	8,097	32,870	46,810	16,450	3,641	1,249	1,817	12,860	9,300	13,080	15,590	14,047
1913	36,070	7,294	40,100	19,960	9,271	4,425	1,359	920.6	1,008	2,992	10,670	5,988	11,671
1914	7,662	14,860	29,750	53,770	26,430	4,183	4,774	5,100	3,800	1,448	1,689	2,130	12,966
1915	25,850	35,260	12,120	13,440	8,379	2,479	26,580	18,630	6,652	10,290	6,982	11,990	14,888
1916	25,390	11,490	18,370	59,300	16,650	22,970	5,886	1,758	2,360	4,871	5,166	6,873	15,090
1917	8,178	4,319	26,620	19,990	13,000	27,230	16,900	14,020	5,403	15,240	13,850	2,499	13,937
1918	1,450	18,650	41,430	27,980	16,850	9,701	3,672	1,480	5,144	9,190	14,180	11,490	13,435
1919	12,130	6,480	20,760	20,690	26,190	4,701	4,576	3,694	1,980	2,577	15,160	9,185	10,677
1920	2,839	2,710	48,990	23,090	9,845	3,896	7,191	7,686	7,497	10,080	13,200	24,170	13,433
1921	8,949	9,669	35,460	16,860	10,450	2,428	3,142	2,557	1,848	2,879	19,960	17,860	11,005
1922	6,303	15,530	32,910	32,310	9,612	24,760	11,890	5,544	4,555	2,056	2,069	2,458	12,500
1923	9,361	6,578	35,250	19,070	15,250	4,580	1,612	1,440	1,887	3,361	4,175	15,860	9,869
1924	19,480	5,369	14,990	40,400	23,830	6,096	3,983	2,554	3,865	16,760	3,658	5,501	12,207
1925	2,912	34,590	22,310	16,390	11,350	3,668	6,191	4,574	5,241	6,519	19,490	16,100	12,445
1926	10,370	14,760	28,820	35,280	8,108	4,088	2,052	5,947	5,990	14,490	30,970	9,160	14,170
1927	11,480	20,860	44,130	16,630	26,190	7,843	2,845	3,210	4,003	24,560	32,130	35,260	19,095
1928	15,090	17,640	21,790	32,330	23,720	23,050	17,160	7,714	2,520	2,090	3,554	7,607	14,522

Table 2.4-3— {Monthly Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1899 through 2006)}
(Page 2 of 4)

Discharge, cubic feet per second													
Year	Monthly Mean in cfs (Calculation Period: 1/ 04/1899 to 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1929	5,094	5,985	39,710	52,190	29,710	5,257	2,737	1,527	1,284	6,861	9,856	13,970	14,515
1930	21,510	12,780	29,640	18,360	9,824	9,205	3,542	1,105	1,968	1,105	1,089	1,933	9,338
1931	1,386	3,516	20,320	30,170	22,500	7,557	7,231	2,679	1,838	1,248	2,454	10,080	9,248
1932	21,670	20,910	13,790	41,680	16,620	3,803	4,292	2,240	1,116	11,290	23,390	6,096	13,908
1933	8,742	6,148	25,060	33,520	11,260	4,794	2,536	12,160	14,390	6,120	8,315	11,810	12,071
1934	17,540	3,882	20,790	32,410	6,496	4,413	2,050	1,657	7,036	4,734	9,027	13,840	10,323
1935	20,740	7,950	30,980	28,470	17,920	4,142	20,330	4,837	2,348	2,193	22,530	13,280	14,643
1936	8,910	5,233	80,560	26,230	8,509	3,261	1,479	2,132	1,602	3,417	12,630	11,800	13,814
1937	29,760	13,690	12,980	35,000	15,600	8,682	4,684	6,650	5,355	11,910	14,750	13,580	14,387
1938	11,100	21,240	23,240	17,790	7,799	4,326	3,667	4,648	12,470	4,771	7,107	23,010	11,764
1939	8,180	31,060	32,500	27,160	6,113	2,453	1,284	1,225	769.9	1,930	4,473	6,160	10,276
1940	3,523	3,800	16,890	85,900	15,430	8,798	5,736	2,103	4,709	3,159	9,089	15,950	14,591
1941	12,400	6,389	14,030	39,500	5,216	3,904	2,046	2,545	1,059	904.9	2,405	6,802	8,100
1942	6,200	6,554	36,930	20,310	15,050	9,016	4,167	5,583	5,040	12,310	18,120	21,510	13,399
1943	28,000	20,890	36,320	27,250	39,590	12,190	2,910	2,737	1,737	6,640	18,140	5,562	16,831
1944	3,124	6,258	26,340	28,050	20,310	9,326	3,343	1,544	1,882	3,481	5,022	10,100	9,898
1945	10,600	14,070	58,930	17,050	28,990	14,220	8,212	5,731	10,010	17,940	25,280	16,360	18,949
1946	17,750	6,591	33,520	6,918	31,800	21,870	7,571	6,876	3,019	8,004	5,342	4,075	12,778
1947	17,480	11,910	22,990	41,480	36,940	18,130	14,020	7,032	4,295	1,775	6,875	5,935	15,739
1948	3,503	13,100	50,290	32,680	22,200	9,963	5,886	4,287	1,514	1,605	7,474	10,340	13,570
1949	29,220	18,450	15,920	18,500	12,650	3,814	1,671	1,917	3,279	3,651	6,137	13,910	10,760
1950	20,880	11,830	33,230	41,180	14,060	10,620	4,331	4,639	11,120	6,144	18,670	29,980	17,224
1951	22,970	29,250	27,810	32,020	7,077	5,389	7,967	3,039	1,959	1,806	9,802	16,750	13,820
1952	29,560	16,460	32,470	30,100	19,900	6,702	5,783	2,753	2,868	1,681	5,252	20,200	14,477
1953	20,620	18,820	26,870	23,900	21,570	6,924	2,239	1,348	1,143	1,218	3,272	10,020	11,495
1954	7,011	22,010	20,700	23,300	22,120	8,750	2,105	1,133	2,173	1,408	10,730	17,090	11,544
1955	14,140	12,090	42,870	16,500	6,530	3,773	1,409	6,229	2,270	27,750	25,580	9,335	14,040
1956	7,138	14,700	44,380	55,210	17,570	7,812	5,722	2,580	6,346	5,035	7,171	21,930	16,300
1957	13,970	10,900	21,490	36,210	14,820	4,756	3,196	2,186	1,642	1,933	3,910	16,130	10,929
1958	10,880	6,400	27,030	72,870	25,600	11,420	6,419	3,028	4,221	6,490	12,520	8,166	16,254

Table 2.4-3— {Monthly Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1899 through 2006)}
(Page 3 of 4)

Discharge, cubic feet per second													
Year	Monthly Mean in cfs (Calculation Period: 1/ 04/1899 to 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1959	16,900	14,240	23,870	33,830	9,965	3,041	1,663	1,330	1,735	8,333	24,820	32,810	14,378
1960	18,110	22,090	13,210	57,530	22,600	22,280	5,162	3,425	9,404	3,774	4,878	2,862	15,444
1961	2,044	24,330	32,710	45,110	21,320	11,850	4,647	4,654	2,593	1,449	3,120	5,132	13,247
1962	12,800	5,855	26,660	42,730	9,660	2,519	1,086	1,118	861.7	7,335	11,230	7,981	10,820
1963	6,415	4,752	36,900	24,560	13,120	5,776	2,493	1,674	1,054	816.5	2,444	8,188	9,016
1964	16,260	8,928	55,860	24,200	13,350	2,784	1,452	853.2	636.7	704.7	723.6	2,451	10,684
1965	4,704	15,470	10,250	23,010	10,170	3,688	1,187	1,282	1,634	3,753	6,439	8,566	7,513
1966	7,521	18,240	36,870	16,560	19,580	7,569	1,862	1,260	1,346	1,656	3,552	10,110	10,511
1967	9,553	11,000	24,860	27,530	22,980	6,503	5,145	7,098	3,912	8,988	22,100	18,660	14,027
1968	6,505	13,740	27,100	13,710	18,800	20,470	7,344	2,190	5,413	2,884	22,460	16,070	13,057
1969	10,250	11,090	13,810	29,700	12,250	9,353	4,792	4,988	1,625	1,347	13,830	14,380	10,618
1970	5,874	22,800	17,510	51,580	13,790	4,132	4,021	1,994	2,241	5,925	14,730	11,060	12,971
1971	7,767	19,740	38,400	34,460	18,690	3,699	1,879	3,253	2,307	2,040	3,005	20,400	12,970
1972	16,220	6,116	43,240	38,690	29,620	54,330	14,570	3,648	1,849	2,357	29,280	36,630	23,046
1973	19,470	17,140	26,240	30,490	20,920	10,810	7,681	3,399	3,314	2,356	4,818	32,540	14,932
1974	22,850	18,390	23,190	36,500	14,200	5,423	6,097	2,467	5,865	4,053	11,950	20,440	14,285
1975	20,840	29,320	25,430	18,730	19,580	11,460	3,920	2,762	28,680	25,020	14,030	15,520	17,941
1976	16,160	43,030	30,810	18,630	17,690	12,950	9,978	9,028	4,863	29,510	13,020	9,375	17,920
1977	4,565	9,047	50,960	30,020	13,040	3,763	3,330	3,991	24,940	39,860	27,930	33,670	20,426
1978	33,900	12,740	39,440	39,740	17,690	7,113	2,779	5,043	2,789	4,496	4,799	9,565	15,008
1979	34,360	12,090	53,400	24,870	14,660	6,938	2,444	1,979	3,667	8,481	15,970	14,510	16,114
1980	7,779	3,326	31,090	37,530	11,500	3,701	4,497	1,975	1,152	1,762	4,645	7,363	9,693
1981	2,290	40,790	12,550	11,970	15,020	8,667	3,694	2,535	3,769	14,000	16,970	11,510	11,980
1982	10,240	16,870	32,180	30,600	7,935	20,780	7,588	2,458	1,339	1,267	3,487	8,053	11,900
1983	6,995	18,160	19,070	51,430	31,020	8,614	3,637	1,877	1,171	1,338	5,446	34,770	15,294
1984	5,548	36,800	15,660	50,110	31,200	14,800	10,800	7,481	3,254	1,995	4,493	19,310	16,788
1985	9,432	8,889	21,270	14,260	5,520	3,692	2,828	1,806	4,752	6,413	17,260	17,210	9,444
1986	12,160	18,620	42,820	21,230	10,770	11,930	6,083	8,627	2,581	6,454	21,960	20,430	15,305
1987	8,313	4,682	24,780	35,420	6,451	4,690	5,725	2,001	8,459	5,971	8,365	14,200	10,755
1988	6,334	16,060	19,730	13,220	19,150	4,155	2,357	1,985	3,293	2,888	12,090	5,955	8,935

Table 2.4-3— {Monthly Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1899 through 2006)}
(Page 4 of 4)

Discharge, cubic feet per second													
Year	Monthly Mean in cfs (Calculation Period: 1/ 04/1899 to 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1989	5,107	7,206	13,360	25,890	38,140	24,420	6,988	2,695	3,167	8,989	14,190	5,239	12,949
1990	14,550	37,320	17,650	22,600	21,320	6,815	5,823	3,874	2,957	24,180	22,160	28,540	17,316
1991	20,800	19,540	27,590	21,420	10,990	2,712	1,311	1,346	1,209	1,919	5,246	11,190	10,439
1992	12,460	8,367	24,330	26,780	14,270	10,660	6,203	10,040	7,683	9,541	22,580	15,820	14,061
1993	23,150	5,857	22,170	100,000	12,800	4,445	2,039	1,589	2,166	3,162	16,940	19,600	17,827
1994	6,917	17,430	43,670	61,030	11,450	11,680	9,344	19,560	7,105	5,358	10,760	18,080	18,532
1995	19,380	8,199	20,670	14,180	6,508	4,091	1,841	1,352	1,079	9,809	15,750	10,600	9,455
1996	40,740	19,470	21,020	32,350	36,730	8,321	8,785	4,846	4,778	13,040	29,540	44,610	22,019
1997	12,780	14,640	28,580	20,490	14,800	7,063	2,680	1,809	1,813	1,912	7,600	10,970	10,428
1998	36,890	21,510	41,770	32,420	20,380	13,140	13,990	2,388	1,781	2,354	2,078	2,997	15,975
1999	19,670	18,000	23,070	22,980	6,720	2,137	1,850	977.2	5,629	5,660	6,522	12,500	10,476
2000	14,040	21,930	35,820	42,570	32,330	18,920	6,466	5,308	3,217	5,470	5,309	14,310	17,141
2001	6,057	14,130	20,660	42,310	5,076	9,479	3,451	1,497	3,100	2,123	2,043	9,778	9,975
2002	5,599	20,470	18,500	20,520	31,090	23,330	4,078	1,387	2,146	10,330	15,860	17,870	14,265
2003	16,060	9,674	43,550	31,090	13,520	28,280	10,210	11,860	15,980	17,550	26,180	34,030	21,499
2004	16,350	6,844	33,800	26,890	22,110	9,290	13,870	18,180	37,600	10,400	13,250	30,870	19,955
2005	30,770	18,550	24,500	47,890	7,532	4,134	3,076	1,317	2,284	17,970	20,430	22,730	16,765
2006	35,210	21,190	13,930	13,280	9,054	31,720	23,620	8,361	12,880				
Mean of Monthly Discharge	14,300	14,900	30,100	31,200	16,400	9,490	5,640	4,150	4,700	7,110	11,300	14,400	**13,641**

Table 2.4-4— {Mean Daily Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1899 through 2006)}

	Discharge, cubic feet per second											
Day	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	15,700	13,300	23,200	40,600	20,400	11,500	8,600	4,510	4,240	6,340	8,680	15,000
2	15,200	12,800	23,600	40,300	19,900	11,300	8,440	4,540	4,330	6,170	8,270	15,300
3	15,200	13,300	22,900	40,800	18,800	11,200	7,740	4,500	4,680	5,780	8,730	15,200
4	15,000	14,000	22,600	40,100	18,100	11,300	7,130	4,360	4,840	5,430	8,910	14,900
5	14,800	13,200	23,700	39,800	17,600	10,700	6,460	4,470	4,430	5,040	8,850	15,000
6	14,700	12,100	24,700	41,200	17,100	10,300	6,080	4,260	4,070	4,900	9,000	14,800
7	15,000	11,300	26,300	41,500	16,900	10,900	6,100	4,360	3,770	5,450	8,720	14,600
8	15,400	10,900	25,700	39,600	17,400	10,400	5,910	4,080	3,390	5,250	8,970	14,700
9	15,500	10,800	26,000	37,700	17,300	9,740	6,970	4,000	3,190	5,480	10,900	14,800
10	15,000	10,300	25,800	35,700	17,200	9,150	7,850	4,210	3,440	6,590	11,700	14,300
11	13,600	11,700	24,600	35,100	18,000	8,590	6,740	4,100	3,390	6,690	11,500	15,100
12	12,800	13,300	26,100	33,000	18,600	8,370	5,690	3,960	3,480	6,180	11,000	15,700
13	12,500	12,900	27,400	31,800	19,300	8,380	5,310	3,970	3,830	5,860	10,300	15,200
14	12,400	12,900	27,800	31,200	19,200	8,480	5,260	3,850	3,880	5,620	10,700	15,800
15	12,500	13,800	29,300	31,200	17,900	9,040	5,000	4,050	3,710	5,820	11,100	17,100
16	12,100	15,500	30,800	31,400	16,500	9,220	4,780	4,080	3,890	6,390	10,700	16,900
17	11,800	15,400	31,500	31,100	15,600	9,140	4,530	3,740	4,120	6,720	12,000	15,400
18	11,200	15,100	32,300	29,300	15,100	9,340	4,290	3,930	5,230	7,030	12,600	14,100
19	11,900	14,700	32,000	27,000	14,700	8,910	4,240	4,810	5,900	7,460	12,800	13,700
20	13,400	14,700	30,300	25,300	14,800	8,120	4,180	4,040	5,310	8,660	12,800	13,000
21	13,800	16,700	30,200	25,200	15,400	8,160	4,330	3,730	4,830	9,230	12,700	12,800
22	14,900	17,500	31,400	25,700	15,800	8,910	4,740	3,890	4,770	8,890	12,200	12,900
23	15,800	18,000	33,100	25,300	15,600	10,700	5,080	4,080	4,830	8,380	12,000	12,700
24	15,900	18,800	33,100	24,000	14,800	11,000	5,270	4,270	4,780	8,490	11,600	12,800
25	16,300	20,300	33,500	24,000	14,800	10,100	5,420	4,630	5,310	8,750	11,600	13,600
26	17,100	21,500	34,300	24,200	14,600	8,310	5,140	4,230	6,550	8,740	12,300	13,400
27	16,800	20,700	36,900	22,500	13,900	7,510	4,610	3,680	7,710	8,770	13,600	13,100
28	15,900	20,400	40,300	21,000	13,600	8,490	4,790	3,900	7,180	8,640	14,600	12,600
29	14,700	17,500	42,400	20,400	14,300	8,730	4,880	3,770	5,910	9,240	15,500	12,500
30	13,700		41,300	20,000	14,100	8,550	4,620	4,330	5,870	9,390	15,400	13,300
31	13,600		40,500		12,400		4,540	4,330		8,910		15,000

Table 2.4-5— {Maximum Daily Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1899 through 2006)}

	Discharge, cubic feet per second											
Day	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	180,000	68,900	193,000	206,000	97,200	64,100	120,000	47,100	47,600	111,000	66,900	99,100
2	111,000	59,500	206,000	199,000	118,000	76,800	94,000	36,500	38,400	107,000	50,900	70,700
3	103,000	50,500	198,000	181,000	103,000	72,600	59,100	34,500	39,700	70,000	39,000	124,000
4	90,900	77,900	149,000	187,000	77,800	64,200	39,500	27,200	50,200	41,500	60,300	99,000
5	61,900	84,500	112,000	157,000	74,700	54,600	34,500	49,200	44,900	35,100	47,900	113,000
6	54,800	66,100	166,000	170,000	54,700	38,400	28,300	46,300	33,300	29,400	52,500	95,000
7	77,300	48,100	202,000	178,000	59,600	67,400	42,300	55,300	35,000	45,800	42,500	63,600
8	73,600	36,600	150,000	167,000	78,100	65,900	49,900	36,000	27,700	50,300	53,800	83,900
9	123,000	51,600	179,000	141,000	81,200	50,000	99,700	28,600	17,600	40,300	68,400	78,100
10	126,000	38,800	139,000	137,000	66,300	39,000	142,000	51,500	51,600	89,400	123,000	65,200
11	103,000	62,400	187,000	167,000	84,200	35,900	115,000	32,300	56,500	107,000	92,600	71,100
12	85,700	130,000	129,000	174,000	111,000	38,400	56,200	32,800	36,400	106,000	80,500	89,600
13	70,300	138,000	182,000	132,000	120,000	36,900	37,400	25,900	28,700	79,200	61,200	81,100
14	93,200	95,400	150,000	97,500	101,000	36,400	35,300	27,200	33,600	47,100	58,600	157,000
15	132,000	108,000	131,000	89,900	76,300	44,600	35,500	27,400	26,500	44,500	68,700	184,000
16	92,500	179,000	169,000	115,000	64,000	61,600	26,900	31,000	26,600	151,000	61,900	166,000
17	66,900	133,000	136,000	125,000	67,800	55,900	21,400	22,500	43,300	144,000	95,400	122,000
18	48,500	102,000	192,000	123,000	56,200	59,600	22,200	32,700	122,000	109,000	112,000	59,500
19	97,300	115,000	229,000	93,000	57,500	52,000	23,400	95,300	204,000	99,800	84,900	58,300
20	210,000	110,000	221,000	69,600	56,400	35,300	16,500	64,600	125,000	130,000	70,800	50,400
21	193,000	113,000	184,000	98,100	77,200	41,700	39,400	46,800	67,000	120,000	70,500	45,000
22	128,000	129,000	144,000	148,000	68,500	81,200	57,800	38,900	57,900	70,700	61,400	73,700
23	99,400	84,700	180,000	141,000	68,500	272,000	48,100	38,200	57,000	63,500	47,100	75,100
24	82,300	88,400	162,000	94,500	77,800	329,000	45,900	59,500	64,100	69,900	39,900	65,000
25	110,000	144,000	134,000	100,000	70,000	275,000	48,300	90,400	58,200	126,000	42,000	86,100
26	92,300	154,000	139,000	136,000	100,000	128,000	54,700	65,800	126,000	80,400	81,700	69,300
27	101,000	158,000	155,000	115,000	80,000	73,500	37,400	38,000	244,000	79,700	110,000	54,900
28	103,000	123,000	178,000	91,800	149,000	184,000	63,500	37,600	201,000	58,600	102,000	88,300
29	73,100	127,000	179,000	66,100	206,000	179,000	72,100	30,600	80,300	73,700	107,000	79,200
30	54,500		168,000	64,600	138,000	151,000	60,500	90,000	50,000	69,600	96,300	75,200
31	66,100		173,000		87,900		42,300	68,700		78,200		176,000

Table 2.4-6— {Minimum Daily Streamflow for Wilkes-Barre, PA USGS Station No. 01536500, (1899 through 2006)}

	Discharge, cubic feet per second											
Day	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	1,090	1,300	2,100	8,050	6,230	2,000	1,330	787	725	681	699	992
2	1,090	1,300	2,200	8,390	5,910	2,000	1,320	836	746	674	664	984
3	1,160	1,280	2,300	7,590	5,340	2,000	1,280	808	706	658	642	992
4	1,110	1,280	2,200	7,140	5,070	1,810	1,280	774	708	729	632	1,140
5	1,060	1,220	2,200	6,750	4,800	1,810	1,280	780	712	722	627	1,190
6	1,060	1,160	2,100	6,470	4,540	1,810	1,210	768	704	722	642	1,220
7	1,160	1,160	2,100	6,780	4,280	1,810	1,150	732	675	720	637	1,240
8	1,160	1,160	2,600	7,660	4,280	1,810	1,110	808	670	720	627	1,230
9	1,060	1,110	2,820	7,600	4,280	2,000	1,090	720	675	699	637	1,090
10	1,060	1,060	2,820	7,380	3,780	2,000	1,070	722	670	693	653	860
11	1,010	1,060	2,600	7,100	3,540	1,810	995	716	637	687	653	1,090
12	1,160	1,110	2,390	6,930	3,540	1,970	983	799	627	675	653	1,060
13	1,390	1,340	2,390	6,280	3,300	1,840	990	842	597	675	653	1,060
14	1,340	1,800	3,270	6,280	3,070	1,840	969	822	588	670	637	1,060
15	1,300	1,530	3,400	6,540	3,070	1,840	924	815	588	664	627	1,060
16	1,290	1,530	3,300	6,540	3,070	1,720	909	801	583	670	632	1,060
17	1,300	1,950	3,300	5,660	2,840	1,790	872	780	578	681	653	1,060
18	1,320	2,100	3,600	5,660	2,840	1,960	1,040	774	569	681	653	1,060
19	1,410	2,200	4,200	7,100	2,620	1,880	1,020	810	552	693	653	1,090
20	1,660	2,100	5,340	6,540	2,620	1,810	986	787	548	716	710	1,220
21	1,530	2,470	4,800	6,000	2,620	1,700	920	794	544	722	681	1,340
22	1,300	2,290	4,800	5,730	2,660	1,670	920	822	544	700	681	1,400
23	1,210	2,200	4,280	5,690	2,620	1,570	928	836	552	700	681	1,090
24	1,220	2,000	4,280	5,470	2,620	1,480	986	836	569	720	704	970
25	1,230	2,000	4,540	5,210	2,200	1,440	942	818	548	722	761	1,490
26	1,310	2,000	4,800	5,210	2,200	1,400	920	785	536	722	913	1,490
27	1,410	2,000	5,070	5,210	2,200	1,350	944	795	532	710	992	1,490
28	1,530	2,000	6,440	5,470	2,200	1,350	878	805	578	704	1,100	1,220
29	1,470	2,200	7,070	5,470	2,000	1,470	843	785	699	704	1,080	1,360
30	1,400		7,450	6,000	2,000	1,400	815	735	684	710	1,040	1,090
31	1,360		7,660		2,000		787	725		710		1,090

Table 2.4-7— {Annual Peak Streamflow for Danville, PA USGS Station No. 01540500, (1865 through 2006)}
(Page 1 of 3)

Water Year	Date	Gage Height (ft)	Streamflow (cfs)
1865	Mar. 18, 1865	28.00	N.A.
1900	Mar. 02, 1900	15.90	105,000
1901	Nov. 28, 1900	18.50	135,000
1902	Mar. 03, 1902	26.90	243,000
1903	Mar. 25, 1903	18.20	132,000
1904	Mar. 27, 1904	19.62	148,000
1905	Mar. 26, 1905	18.62	136,000
1906	Apr. 01, 1906	15.40	99,500
1907	Mar. 17, 1907	13.00	73,400
1908	Feb. 17, 1908	17.40	122,000
1909	May 2, 1909	18.40	134,000
1910	Mar. 03, 1910	21.00	165,000
1911	Mar. 29, 1911	15.20	97,300
1912	Apr. 03, 1912	17.91	129,000
1913	Mar. 28, 1913	23.11	192,000
1914	Mar. 29, 1914	22.60	186,000
1915	Feb. 26, 1915	19.00	141,000
1916	Apr. 02, 1916	21.80	175,000
1917	Mar. 29, 1917	14.80	92,900
1918	Mar. 16, 1918	18.60	139,000
1919	May 24, 1919	13.70	80,800
1920	Mar. 14, 1920	20.90	170,000
1921	Mar. 10, 1921	15.50	101,000
1922	Nov. 30, 1921	18.10	133,000
1923	Mar. 05, 1923	15.80	105,000
1924	Apr. 08, 1924	18.80	142,000
1925	Feb. 13, 1925	20.30	162,000
1926	Mar. 27, 1926	15.50	101,000
1927	Nov. 17, 1926	18.80	142,000
1928	Oct. 21, 1927	19.90	156,000
1929	Apr. 23, 1929	20.35	163,000
1930	Mar. 09, 1930	13.50	78,700
1931	Mar. 30, 1931	14.35	88,500
1932	Apr. 02, 1932	17.05	119,000
1933	Aug. 25, 1933	17.04	119,000
1934	Mar. 06, 1934	14.50	98,600
1935	Jul. 11, 1935	20.00	153,000
1936	Mar. 20, 1936	27.42	250,000
1937	Jan. 23, 1937	15.20	93,400
1938	Oct. 24, 1937	13.80	79,400
1939	Feb. 22, 1939	19.20	139,000
1940	Apr. 02, 1940	25.25	222,000
1941	Apr. 07, 1941	19.45	142,000
1942	Mar. 11, 1942	17.08	116,000
1943	Jan. 01, 1943	24.00	204,000
1944	May 9, 1944	15.48	97,600

Table 2.4-7— {Annual Peak Streamflow for Danville, PA USGS Station No. 01540500, (1865 through 2006)}
(Page 2 of 3)

Water Year	Date	Gage Height (ft)	Streamflow (cfs)
1945	Mar. 05, 1945	17.55	121,000
1946	May 26, 1946	25.98	234,000
1947	Apr. 07, 1947	19.95	150,000
1948	Mar. 24, 1948	22.63	184,000
1949	Jan. 01, 1949	15.16	89,600
1950	Mar. 30, 1950	21.81	168,000
1951	Dec. 05, 1950	19.02	131,000
1952	Mar. 13, 1952	18.84	127,000
1953	Dec. 13, 1952	16.80	103,000
1954	May 5, 1954	14.71	82,100
1955	Mar. 03, 1955	15.09	85,900
1956	Mar. 09, 1956	22.47	175,000
1957	Apr. 08, 1957	17.78	114,000
1958	Apr. 08, 1958	21.87	169,000
1959	Jan. 24, 1959	17.45	112,000
1960	Apr. 02, 1960	23.92	198,000
1961	Feb. 28, 1961	21.72	167,000
1962	Apr. 02, 1962	19.38	136,000
1963	Mar. 29, 1963	18.89	130,000
1964	Mar. 11, 1964	25.13	261,000
1965	Feb. 14, 1965	N.A	44,900
1966	Feb. 15, 1966	16.26	98,900
1967	Mar. 30, 1967	15.23	87,500
1968	Mar. 24, 1968	16.75	104,000
1969	Apr. 07, 1969	14.67	81,700
1970	Apr. 04, 1970	18.24	122,000
1971	Mar. 17, 1971	17.34	111,000
1972	Jun. 25, 1972	32.16	363,000
1973	Dec. 08, 1972	15.96	99,600
1974	Dec. 29, 1973	16.39	103,000
1975	Sep. 28, 1975	27.52	257,000
1976	Feb. 19, 1976	18.13	120,000
1977	Sep. 27, 1977	18.04	122,000
1978	Mar. 23, 1978	17.98	116,000
1979	Mar. 07, 1979	23.93	188,000
1980	Mar. 23, 1980	16.65	104,000
1981	Feb. 22, 1981	16.95	105,000
1982	Oct. 30, 1981	14.61	83,300
1983	Apr. 17, 1983	20.53	149,000
1984	Apr. 07, 1984	24.14	194,000
1985	Mar. 14, 1985	11.77	55,300
1986	Mar. 16, 1986	22.68	173,000
1987	Apr. 06, 1987	16.74	104,000
1988	May 21, 1988	14.81	83,500
1989	May 15, 1989	17.70	116,000
1990	Feb. 18, 1990	13.51	70,900

Table 2.4-7— {Annual Peak Streamflow for Danville, PA USGS Station No. 01540500, (1865 through 2006)}
(Page 3 of 3)

Water Year	Date	Gage Height (ft)	Streamflow (cfs)
1991	Oct. 25, 1990	18.51	124,000
1992	Mar. 29, 1992	15.37	89,200
1993	Apr. 03, 1993	23.97	187,000
1994	Mar. 26, 1994	20.15	139,000
1995	Jan. 22, 1995	13.81	73,700
1996	Jan. 21, 1996	25.96	209,000
1997	Dec. 03, 1996	19.06	130,000
1998	Jan. 10, 1998	20.43	143,000
1999	Jan. 25, 1999	17.81	116,000
2000	Feb. 29, 2000	19.24	132,000
2001	Apr. 11, 2001	15.95	97,800
2002	May 15, 2002	14.84	84,700
2003	Mar. 22, 2003	18.81	130,000
2004	Sep. 19, 2004	26.22	220,000
2005	Apr. 04, 2005	24.28	202,000
2006	Jun. 28, 2006	28.19	260,000
Note: N.A. = Not Available			

Table 2.4-8— {Monthly Streamflow for the Danville, PA USGS Station No. 01540500, (1905 through 2006)}

(Page 1 of 4)

Year	Discharge, cubic feet per second												
	Monthly mean in cfs (Calculation Period: 4/01/1905 - 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1905				26,690	6,975	11,620	6,260	6,885	15,520	10,060	6,878	22,370	
1906	18,760	13,000	22,820	44,750	14,010	18,240	8,100	5,331	3,203	7,000	12,300	13,950	15,122
1907	32,910	5,861	26,290	20,100	15,810	6,923	6,359	2,296	6,974	12,670	22,020	35,290	16,125
1908	16,680	25,740	51,260	27,780	31,220	5,752	3,637	1,960	1,016	1,346	1,935	1,602	14,161
1909	16,220	38,830	23,740	31,820	32,710	11,850	2,798	1,852	1,437	1,545	1,593	2,584	13,915
1910	12,070	7,473	55,380	20,850	17,720	14,050	2,864	1,486	1,566	1,636	4,058	3,169	11,860
1911	23,580	9,125	23,720	34,140	7,699	8,713	2,594	2,343	5,892	12,700	11,550	16,960	13,251
1912	7,800	10,780	38,270	53,280	21,170	5,148	2,088	3,116	15,420	11,570	16,190	19,600	17,036
1913	43,230	9,358	45,020	24,970	12,600	6,498	2,440	1,318	1,540	4,069	11,870	8,030	14,245
1914	8,545	18,160	34,920	64,170	31,080	5,310	6,131	6,258	4,822	2,159	2,400	2,742	15,558
1915	33,090	42,620	14,230	14,970	10,860	4,194	28,490	23,110	8,444	10,920	7,879	13,260	17,672
1916	28,700	13,950	22,340	71,860	18,850	27,360	10,610	3,262	3,701	6,272	6,212	9,144	18,522
1917	16,300	6,172	31,350	23,400	14,130	31,190	19,040	17,000	7,562	17,750	18,310	3,981	17,182
1918	2,347	25,200	49,110	34,650	18,290	12,060	5,111	2,849	6,956	11,030	16,260	12,810	16,389
1919	14,250	7,635	23,630	24,330	31,250	6,039	5,546	4,664	2,473	3,100	17,670	13,300	12,824
1920	4,013	2,841	60,370	26,320	11,050	5,347	8,229	8,514	7,688	11,500	14,870	29,340	15,840
1921	9,878	11,120	42,470	19,140	12,590	3,280	3,948	3,594	2,664	3,542	20,660	22,200	12,924
1922	7,430	18,650	37,800	38,940	11,050	28,690	14,460	5,834	4,916	2,402	2,329	2,821	14,610
1923	10,690	7,754	41,870	21,040	17,200	5,029	2,908	2,134	2,489	4,246	4,884	18,240	11,540
1924	23,650	6,335	16,110	46,590	27,550	7,487	6,139	3,030	4,367	21,010	4,001	6,196	14,372
1925	3,600	42,760	23,410	17,220	13,090	4,436	6,850	5,852	5,555	7,076	21,570	18,530	14,162
1926	11,030	17,380	32,950	37,850	8,879	4,755	2,623	6,863	7,270	16,560	38,540	9,884	16,215
1927	13,620	24,310	49,610	17,990	28,470	9,109	3,675	3,729	4,692	27,320	34,140	41,170	21,486
1928	15,980	19,430	23,570	35,390	26,120	25,300	22,670	8,542	3,481	2,541	3,878	7,904	16,234
1929	5,729	6,196	43,640	57,570	34,080	6,229	3,345	2,015	1,802	7,475	11,290	15,510	16,240
1930	23,530	14,160	32,470	21,570	10,890	10,450	4,406	1,318	2,093	1,186	1,169	2,215	10,455
1931	1,853	4,309	22,200	34,740	25,440	8,604	7,905	3,169	2,181	1,501	2,730	10,830	10,455
1932	23,410	22,480	14,430	45,700	19,010	4,794	4,662	2,627	1,279	12,850	26,930	7,636	15,484
1933	10,230	7,600	29,370	38,910	13,080	5,651	3,423	14,990	18,410	6,982	8,904	12,650	14,183
1934	19,520	4,192	21,120	37,360	7,989	5,057	2,447	1,979	8,769	6,301	11,070	18,820	12,052

Table 2.4-8— {Monthly Streamflow for the Danville, PA USGS Station No. 01540500, (1905 through 2006)}

(Page 2 of 4)

Discharge, cubic feet per second													
Year	Monthly mean in cfs (Calculation Period: 4/01/1905 - 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1935	22,380	9,110	35,520	33,970	21,640	5,199	22,850	5,455	2,698	2,206	25,460	17,460	16,996
1936	11,610	6,014	91,900	30,280	9,428	4,058	1,738	2,352	1,768	3,523	14,260	14,800	15,978
1937	36,760	17,490	16,090	41,430	19,630	9,863	5,218	7,180	5,984	14,650	17,010	15,760	17,255
1938	13,430	25,760	26,470	20,810	9,120	5,055	5,117	5,448	13,280	5,505	8,292	27,460	13,812
1939	9,322	34,870	36,540	32,930	7,258	2,803	1,605	1,662	911.5	2,139	5,257	7,104	11,867
1940	3,911	4,176	20,620	97,110	18,020	10,990	6,578	2,343	6,115	3,741	10,950	18,200	16,896
1941	14,990	7,337	16,390	43,570	5,643	4,415	2,465	3,132	1,457	1,127	2,712	8,076	9,276
1942	7,613	8,429	41,600	24,080	20,540	10,580	4,605	6,132	4,972	13,660	20,190	23,630	15,503
1943	33,560	22,900	40,340	29,810	44,980	14,600	3,654	2,941	2,011	8,207	23,310	6,597	19,409
1944	3,754	7,272	30,950	32,900	24,280	11,170	4,149	1,845	2,161	3,931	5,461	11,790	11,639
1945	11,520	14,770	66,550	19,050	32,990	15,570	10,140	7,149	12,030	19,910	27,540	18,900	21,343
1946	20,490	7,163	38,140	7,664	37,300	25,600	7,933	7,651	3,090	8,306	5,702	4,394	14,453
1947	18,590	13,560	24,790	43,390	41,620	20,500	18,230	8,488	4,690	1,941	8,676	6,634	17,592
1948	4,121	14,370	54,340	37,420	24,970	10,650	6,838	4,418	1,623	1,734	8,543	11,810	15,070
1949	35,400	21,690	18,290	22,480	15,480	4,502	1,971	2,173	3,479	3,987	6,451	16,140	12,670
1950	24,950	15,360	36,690	45,660	16,260	13,770	4,992	4,979	11,580	6,291	21,130	35,330	19,749
1951	27,270	35,210	31,730	36,270	7,972	6,465	8,685	3,544	2,209	2,206	12,090	19,780	16,119
1952	34,060	19,190	35,650	34,000	23,940	7,858	7,143	3,423	4,159	1,829	7,034	23,580	16,822
1953	23,490	21,100	29,130	26,670	24,500	8,629	2,608	1,589	1,653	1,477	3,817	12,460	13,094
1954	7,151	23,560	24,230	25,310	25,180	9,309	2,410	1,380	2,335	1,642	11,060	17,820	12,616
1955	15,950	13,270	44,810	17,850	7,356	4,393	1,708	8,922	3,071	30,330	29,280	9,984	15,577
1956	7,694	16,860	45,600	56,540	20,630	9,339	7,264	3,276	7,350	6,066	8,861	24,810	17,858
1957	15,940	12,210	23,660	41,090	15,530	5,294	3,321	2,268	1,836	2,209	4,507	18,600	12,205
1958	13,370	7,872	29,950	75,350	28,060	12,570	7,421	3,451	4,858	7,035	13,690	8,810	17,703
1959	18,280	16,340	25,170	36,320	11,630	3,675	2,289	1,514	2,188	9,127	25,600	35,820	15,663
1960	20,550	23,580	12,950	61,820	24,610	23,230	5,934	4,531	12,430	4,796	5,715	3,983	17,011
1961	3,274	25,900	37,090	47,330	23,860	12,710	5,200	5,043	3,096	1,546	3,461	5,740	14,521
1962	13,180	6,175	28,160	46,910	10,470	2,923	1,359	1,675	1,339	8,947	14,020	9,736	12,075
1963	8,029	6,514	43,000	26,730	14,650	6,684	2,889	1,934	1,241	984.3	2,717	9,145	10,376
1964	20,300	10,970	61,210	29,170	14,840	3,420	1,745	1,091	740.3	867.7	852.4	2,786	12,333

Table 2.4-8— {Monthly Streamflow for the Danville, PA USGS Station No. 01540500, (1905 through 2006)}
(Page 3 of 4)

Discharge, cubic feet per second													
Year	Monthly mean in cfs (Calculation Period: 4/01/1905 - 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1965	5,624	17,150	11,740	24,410	11,850	4,189	1,308	1,625	2,080	4,580	6,735	9,639	8,411
1966	8,595	20,440	39,060	17,930	22,370	8,552	2,165	1,613	1,574	2,083	3,854	11,340	11,631
1967	10,160	12,080	27,270	29,710	25,990	7,602	5,666	8,076	4,438	9,505	23,460	20,470	15,369
1968	7,423	15,990	28,220	15,440	20,160	23,070	8,742	2,452	6,052	3,334	23,610	16,750	14,270
1969	10,890	11,890	14,670	31,140	14,180	10,920	5,906	6,460	1,892	1,787	14,840	15,540	11,676
1970	7,226	26,450	19,530	55,460	15,920	5,449	4,482	2,666	2,633	6,641	16,550	12,700	14,642
1971	9,125	23,530	42,660	35,140	20,990	4,894	2,298	4,425	2,944	2,684	4,070	23,410	14,681
1972	18,110	7,645	46,580	41,550	33,120	62,370	17,240	4,701	2,416	2,947	31,840	42,700	25,935
1973	22,360	20,490	28,310	34,380	23,570	12,670	9,428	4,203	4,500	3,078	5,471	37,380	17,153
1974	26,780	20,990	26,140	40,960	16,070	6,803	7,448	3,229	8,007	4,983	12,400	23,030	16,403
1975	23,040	31,680	28,960	20,670	22,150	13,790	5,816	3,435	30,900	29,060	16,280	15,570	20,113
1976	18,760	46,420	32,500	20,480	19,450	14,540	11,430	10,040	5,698	35,080	15,240	11,090	20,061
1977	5,187	11,250	57,620	34,250	14,000	4,443	4,050	4,237	25,450	43,890	30,970	37,730	22,756
1978	37,030	13,910	44,050	43,570	21,820	8,738	3,502	5,632	3,754	5,335	5,659	11,440	17,037
1979	40,070	15,070	55,340	27,040	17,820	8,873	3,034	2,615	5,315	10,040	17,240	15,760	18,185
1980	8,755	4,010	32,190	40,040	13,140	3,984	4,474	2,226	1,417	1,796	4,388	7,380	10,317
1981	2,729	43,290	13,240	12,120	16,410	9,403	4,523	2,874	3,893	13,080	17,500	12,120	12,599
1982	11,490	18,030	33,400	33,170	8,892	23,790	8,542	3,128	1,816	1,783	4,192	8,903	13,095
1983	8,560	19,620	20,320	56,670	34,060	10,080	4,799	2,358	1,588	1,799	6,226	39,040	17,093
1984	6,461	38,810	18,270	55,060	34,360	18,060	12,910	8,550	3,356	2,417	5,029	22,070	18,779
1985	11,380	10,600	23,500	16,570	7,275	5,319	3,657	2,811	5,619	7,923	19,850	20,260	11,230
1986	12,640	21,340	46,380	24,880	12,940	14,110	6,766	10,080	3,082	7,225	24,780	24,530	17,396
1987	10,160	5,771	28,000	40,150	7,786	5,250	7,155	2,550	13,140	7,070	10,590	16,850	12,873
1988	8,529	18,380	21,940	15,350	23,100	5,380	3,434	2,732	4,601	3,266	14,130	6,839	10,640
1989	6,531	8,508	14,050	28,440	44,090	27,710	8,753	3,365	3,641	11,060	16,660	6,548	14,946
1990	16,500	40,980	20,070	25,260	25,800	8,817	7,579	5,668	4,079	26,710	25,310	32,050	19,902
1991	24,930	22,320	30,730	24,190	13,420	3,435	1,729	1,715	1,480	2,220	6,080	13,280	12,127
1992	13,760	9,441	27,960	30,280	16,710	12,410	7,591	10,980	8,582	10,860	25,470	18,250	16,025
1993	26,550	6,229	21,870	106,900	16,290	4,904	2,365	2,081	2,733	3,898	18,800	24,950	19,798
1994	8,276	20,330	48,400	68,430	14,580	12,630	11,290	21,810	8,567	6,622	12,100	21,680	21,226

Table 2.4-8— {Monthly Streamflow for the Danville, PA USGS Station No. 01540500, (1905 through 2006)}

(Page 4 of 4)

Discharge, cubic feet per second													
Year	Monthly mean in cfs (Calculation Period: 4/01/1905 - 9/30/2006)												Average Yearly Discharge
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1995	22,830	9,418	23,150	16,080	7,515	4,984	2,527	1,937	1,605	10,850	18,460	12,560	10,993
1996	44,410	21,470	25,310	36,640	40,940	9,710	10,710	5,867	5,504	14,980	31,230	49,410	24,682
1997	14,240	15,160	29,850	21,720	16,010	7,591	2,972	2,166	2,306	2,072	7,568	11,440	11,091
1998	39,690	24,400	44,160	36,060	22,520	13,560	14,090	2,745	2,003	2,797	2,327	3,303	17,305
1999	21,190	19,580	24,940	26,100	7,587	2,427	1,961	1,087	6,046	6,697	6,917	14,520	11,588
2000	14,310	21,490	40,550	45,100	32,860	21,720	7,803	7,372	4,247	7,028	5,771	15,200	18,621
2001	6,745	15,660	22,020	46,520	6,408	10,530	4,397	2,154	3,849	2,856	2,552	10,170	11,155
2002	6,552	23,180	20,410	20,610	34,040	23,660	4,578	1,795	2,543	13,030	17,810	20,840	15,754
2003	18,500	12,350	48,140	33,290	14,250	32,960	11,420	13,990	17,460	18,550	28,830	37,990	23,978
2004	19,150	7,373	34,870	27,970	23,720	10,630	13,780	19,720	40,630	12,380	14,500	35,800	21,710
2005	36,310	21,020	26,950	54,720	8,578	4,813	3,675	1,591	2,374	18,200	21,280	25,800	18,776
2006	40,330	24,280	14,620	15,360	10,930	36,060	28,330	8,739	14,520				
Mean of Monthly Discharge	16,500	16,900	32,500	35,000	19,300	11,100	6,590	4,830	5,580	8,000	13,000	16,500	**15,483**

Table 2.4-9— {Mean Daily Streamflow for Danville, PA USGS Station No. 01540500, (1905 through 2006)}

	Discharge, cubic feet per second											
Day	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	17,600	14,900	24,000	44,800	23,200	13,400	9,900	5,270	4,540	7,300	10,100	17,700
2	17,900	14,500	23,900	44,700	22,600	13,100	9,740	5,300	4,610	7,320	9,860	17,700
3	18,100	14,600	23,800	44,800	21,700	12,800	9,220	5,180	5,070	6,860	9,800	18,200
4	17,800	15,700	24,100	44,600	20,900	12,900	8,560	5,100	5,580	6,400	10,300	17,900
5	17,000	15,000	25,000	44,100	20,500	13,100	7,830	5,240	5,570	6,140	10,100	17,900
6	16,900	13,800	26,700	45,300	19,700	12,200	7,380	5,120	4,910	5,800	10,200	17,400
7	17,100	12,900	28,300	46,200	19,800	12,600	6,910	4,990	4,790	6,040	10,400	17,300
8	17,800	12,400	28,800	44,500	20,300	12,300	6,670	4,810	4,310	6,370	10,200	17,100
9	18,400	12,000	28,100	41,700	20,300	11,500	6,910	4,580	3,990	6,260	11,800	17,100
10	17,800	11,700	28,300	39,400	20,100	10,700	8,840	4,850	3,950	6,800	13,400	17,100
11	16,400	12,900	27,800	38,100	20,600	9,860	8,400	4,870	4,230	6,840	13,500	17,700
12	15,200	14,800	27,900	36,600	21,700	9,620	7,060	4,800	4,100	6,420	13,000	18,200
13	15,000	14,800	29,100	35,200	22,300	9,710	6,270	4,610	4,590	6,060	12,200	18,000
14	14,700	14,300	30,000	34,600	22,800	9,890	6,270	4,680	4,780	6,190	12,200	18,200
15	14,600	15,400	32,000	35,100	21,600	10,000	6,180	4,530	4,650	6,210	12,900	18,800
16	14,400	17,500	34,000	35,600	20,200	10,700	5,860	4,950	4,540	6,990	13,000	18,100
17	14,000	17,600	34,700	35,400	19,000	10,600	5,600	4,770	5,090	7,590	13,900	17,000
18	13,500	17,500	36,300	33,900	17,900	10,800	5,290	4,550	5,700	7,760	14,400	15,900
19	13,900	17,200	36,100	31,100	17,600	11,100	5,180	5,470	7,020	8,350	14,400	15,500
20	15,100	17,000	34,000	29,100	17,100	9,990	5,090	5,200	6,600	9,450	14,900	15,100
21	15,700	18,500	33,000	28,300	17,300	9,620	4,990	4,610	6,080	10,300	14,800	14,700
22	16,700	19,900	33,700	28,400	18,200	10,700	5,100	4,430	5,810	10,200	14,500	14,800
23	17,400	20,400	35,600	28,300	18,800	12,200	5,540	4,700	5,970	9,660	14,100	14,600
24	17,200	21,000	35,600	27,300	17,800	12,500	5,810	5,020	5,880	9,490	13,600	14,500
25	18,000	22,700	34,900	26,800	17,500	12,100	6,070	5,300	6,160	9,730	13,500	15,200
26	19,000	24,800	35,900	27,400	17,400	10,200	6,060	4,940	7,440	9,820	14,000	15,300
27	19,400	25,200	37,400	26,100	16,700	8,980	5,540	4,400	8,430	10,200	14,400	15,100
28	18,600	24,200	41,300	24,700	16,200	10,100	5,410	4,240	8,710	10,000	15,600	14,600
29	17,100	19,900	45,200	23,700	16,500	10,500	5,840	4,560	7,280	10,100	17,500	14,000
30	15,900		45,700	23,200	16,500	10,300	5,520	4,260	6,930	10,700	17,800	14,700
31	14,900		44,900		14,700		5,230	4,360		10,700		16,200

Table 2.4-10— {Maximum Daily Streamflow for Danville, PA USGS Station No. 01540500, (1905 through 2006)}

	Discharge, cubic feet per second											
Day	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	201,000	82,200	124,000	205,000	91,900	76,600	147,000	44,400	40,000	129,000	94,200	93,600
2	161,000	77,600	144,000	219,000	126,000	75,500	117,000	44,800	27,800	126,000	72,500	92,400
3	102,000	54,300	160,000	187,000	116,000	75,800	82,200	31,400	38,400	96,500	52,700	116,000
4	106,000	83,000	154,000	199,000	86,300	84,400	50,600	24,400	47,300	60,800	59,200	120,000
5	74,300	70,600	127,000	188,000	76,900	66,100	44,100	55,000	50,200	41,100	56,000	125,000
6	61,600	59,000	128,000	168,000	64,500	49,200	45,800	58,500	42,200	33,100	50,800	115,000
7	85,000	54,400	182,000	191,000	68,100	72,500	36,900	66,500	39,700	41,200	52,800	82,500
8	81,300	43,900	166,000	160,000	82,800	69,000	35,000	49,900	37,400	57,200	52,900	91,100
9	115,000	43,800	163,000	161,000	95,400	57,700	51,300	35,100	24,400	48,400	62,500	85,400
10	138,000	40,600	158,000	146,000	73,400	46,800	138,000	39,100	26,200	93,600	113,000	77,900
11	117,000	78,700	203,000	140,000	90,900	40,800	134,000	47,600	63,300	106,000	113,000	94,100
12	98,400	147,000	185,000	177,000	98,000	40,800	80,600	43,500	43,200	76,200	85,400	99,900
13	80,300	159,000	186,000	154,000	114,000	45,000	45,800	31,100	35,400	50,900	72,500	98,100
14	73,400	131,000	179,000	110,000	112,000	49,200	41,300	27,800	38,400	37,500	55,400	131,000
15	142,000	93,900	125,000	106,000	99,000	42,500	39,600	30,300	33,800	43,600	73,400	189,000
16	126,000	159,000	170,000	112,000	75,500	54,500	33,000	40,800	31,800	123,000	77,400	154,000
17	85,600	149,000	148,000	144,000	76,700	60,200	25,200	30,800	69,400	164,000	128,000	102,000
18	63,500	114,000	190,000	119,000	76,300	69,300	21,800	27,500	74,600	117,000	134,000	68,600
19	98,000	117,000	241,000	113,000	56,800	82,900	25,300	78,500	205,000	106,000	112,000	57,600
20	155,000	116,000	245,000	85,200	63,700	47,600	25,700	82,100	179,000	131,000	93,000	64,600
21	205,000	107,000	210,000	84,100	73,200	40,800	19,100	56,900	93,500	152,000	73,500	51,000
22	155,000	133,000	157,000	131,000	72,400	91,200	21,800	47,900	61,000	110,000	69,600	84,400
23	103,000	101,000	160,000	158,000	87,900	262,000	24,100	45,800	54,200	72,100	55,800	78,700
24	101,000	89,400	181,000	121,000	98,000	328,000	38,800	53,000	67,800	69,500	51,000	69,600
25	100,000	112,000	135,000	92,300	82,800	335,000	39,200	114,000	62,400	116,000	46,100	88,400
26	110,000	154,000	138,000	119,000	105,000	188,000	50,100	88,500	112,000	99,300	80,700	85,100
27	91,600	166,000	118,000	135,000	90,800	96,300	26,600	53,600	217,000	82,500	114,000	64,200
28	112,000	152,000	187,000	109,000	131,000	206,000	30,900	34,600	236,000	70,400	94,800	90,200
29	90,900	127,000	216,000	82,600	226,000	234,000	76,500	47,200	124,000	59,000	105,000	97,400
30	67,300		212,000	75,600	200,000	180,000	66,500	26,000	65,300	76,800	124,000	78,800
31	61,400		162,000		105,000		50,500	40,000		109,000		175,000

Table 2.4-11— {Minimum Daily Streamflow for Danville, PA USGS Station No. 01540500, (1905 through 2006)}

	Discharge, cubic feet per second											
Day	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	1,300	1,850	2,400	7,730	6,370	3,250	1,760	974	880	980	842	1,310
2	1,300	1,800	2,600	8,630	6,940	3,420	1,720	924	860	916	842	1,220
3	1,500	1,800	3,000	8,810	6,750	3,170	1,660	940	860	931	813	1,240
4	1,500	1,800	3,400	8,460	6,180	3,000	1,600	920	840	978	784	1,400
5	1,280	1,750	4,000	8,010	5,800	2,920	1,560	894	840	978	755	1,450
6	1,430	1,700	3,600	7,660	5,250	3,000	1,480	888	857	886	755	1,420
7	1,700	1,700	3,440	7,570	5,250	2,900	1,420	921	857	857	742	1,500
8	1,920	1,700	3,530	8,100	5,440	2,790	1,380	974	813	842	742	1,420
9	1,850	1,750	3,600	8,540	6,030	2,720	1,280	940	770	857	755	1,250
10	1,800	1,700	3,600	8,440	5,920	2,600	1,230	876	755	842	742	1,100
11	1,810	1,600	4,360	8,130	6,110	2,500	1,270	880	770	799	742	1,350
12	1,850	1,550	4,260	7,730	5,760	2,400	1,210	860	755	813	755	1,300
13	1,550	1,650	4,050	7,530	5,540	2,300	1,250	860	715	813	742	1,300
14	1,600	1,800	3,800	6,970	5,260	2,200	1,190	1,140	674	799	742	1,650
15	1,700	1,900	3,680	6,930	4,820	2,200	1,270	1,090	661	799	742	1,700
16	1,700	2,100	3,680	7,140	4,700	2,100	1,100	1,020	647	799	742	1,600
17	1,750	2,700	3,710	6,750	4,540	2,100	1,040	1,020	634	828	728	1,530
18	1,800	3,200	3,770	6,560	4,470	2,300	1,180	1,000	634	857	728	1,700
19	1,900	3,000	4,190	7,140	4,380	2,400	1,150	1,000	647	891	755	1,500
20	2,100	3,000	5,480	7,340	4,200	2,300	1,170	1,020	634	889	799	1,400
21	1,900	2,900	7,220	6,750	4,000	2,000	1,150	1,020	595	871	813	1,600
22	1,800	2,800	7,350	6,180	3,980	1,900	1,130	993	595	871	828	1,600
23	1,750	2,600	7,150	5,990	3,820	1,800	1,090	1,010	595	871	784	1,430
24	1,700	2,600	6,800	5,990	3,940	1,800	1,090	1,020	558	869	799	1,250
25	1,700	2,600	6,960	5,800	3,790	1,700	1,140	1,040	558	842	842	1,700
26	1,800	2,400	6,720	5,620	3,640	1,700	1,120	993	595	850	1,100	1,700
27	1,950	2,300	6,530	5,620	3,700	1,600	1,060	993	558	839	1,200	1,700
28	2,100	2,300	6,940	5,620	3,610	1,500	1,010	978	595	857	1,180	1,500
29	2,100	2,600	6,790	5,620	3,610	1,600	978	947	770	842	1,150	1,700
30	2,050		6,980	5,800	3,390	1,760	947	947	952	871	1,290	1,500
31	1,900		7,610		3,170		900	900		846		1,300

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}
(Page 1 of 2)

NAME	TIOGA[1,2] (PA)	HAMMOND[1,2](PA)	STILLWATER[1,2] (PA)	AYLESWORTH CREEK[4] (PA)	COWANESQUE[1, 2] (PA)	EAST SIDNEY[1,3] (NY)	WHITNEY POINT[1,3] (NY)	ALMOND[1,3] (NY)
OWNER	**CENAB**	**CENAB**	**CENAB**	**CENAB**	**CENAB**	**CORPS OF ENGINEERS - BALTIMORE DISTRICT**	**CENAB**	**CORPS OF ENGINEERS - BALTIMORE DISTRICT**
PURPOSE	**FLOOD CONTROL / RECREATION**	**FLOOD CONTROL / RECREATION**	**FLOOD CONTROL / WATER SUPPLY**	**FLOOD CONTROL / RECREATION**	**FLOOD CONTROL / RECREATION / WATER SUPPLY**	**FLOOD CONTROL / RECREATION**	**FLOOD CONTROL / RECREATION**	**FLOOD CONTROL / RECREATION**
STATUS (DATE)	**COMPLETE (1980)**	**COMPLETE (1980)**	**COMPLETE (1960)**	**COMPLETE (1970)**	**COMPLETE (1980)**	**COMPLETE (1950)**	**COMPLETE (1942)**	**COMPLETE (1949)**
Stream	Tioga River	Crooked Creek	Lackawanna River	Aylesworth Creek	Cowanesque River	Ouleout Creek	Otselic River	Canacadea Creek
River Mile	350	350	234	-	341	405	331	373
Drainage Area (sq. mi.)	280	122	37.1	6	298	103	257	55.8
Structure Type	Earth Fill	Earth Fill	Earth Fill	Earth Fill	Rolled Earth / Rock Fill	Concrete Dam / Rock Fill Dike	Earth Fill	Earth Fill
Dam Crest Length (ft)	2,710	6, 450	1,700	1,270	3,100	750 (concrete) 2,010(earth)	4,900	1,260
Height of Dam (ft)	140	122	77	90	151	130	95	90
Design Freeboard (ft)	5.2	5.3	4.9	-	5.7	6	8.7	5.5
Spillway Crest Length (ft)	312	312	264	80	400	240	220	285
Design Discharge (cfs)	-	215,500	37,780	10, 000	224,000	81,000	75,000	54,000
Elevations (ft msl)								
Gate Sill	-	-	-	-	-	1,115.0	950.0	1,229.0
Conservation Pool	-	-	-	-	-	-	-	-
Recreation Pool	1,081.0	1,086.0	-	-	1,080.0	-	-	-
Flood Control Pool	1,131.0	1,131.0	1,621.0	-	1,117.0	1,203.0	1,010.0	1,300.0
Maximum Pool	-	-	-	-	-	-	-	-
Top of Dam	1,171.0	1,168.5	-	-	1,154.0	1,228.5	1,039.5	1,320.0
Storage Volumes (Acre-ft)								
Conservation Pool	-	-	-	-	-	-	-	-
Recreation Pool	9,500	8,850	-	-	32,600	-	-	-
Flood Control Pool	62,000	63,000	12,000	-	89,110	33,606	86,468	14,800

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}
(Page 2 of 2)

NAME	TIOGA[1,2] (PA)	HAMMOND[1,2](PA)	STILLWATER[1,2] (PA)	AYLESWORTH CREEK[4] (PA)	COWANESQUE[1, 2] (PA)	EAST SIDNEY[1,3] (NY)	WHITNEY POINT[1,3] (NY)	ALMOND[1,3] (NY)
Maximum Pool	143, 200	136, 000	17, 000	3, 040	171,000	58,350	176,000	22,600
Reservoir Areas (Acres)								
Recreation Pool	-	-	-	-	-	-	-	-
Flood Control Pool	-	-	-	-	-	-	-	-

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}

(Page 1 of 2)

NAME	MILL BROOK SITE 2 DAM [4] (NY)	PATTERSON BRIXIUS GREY WATERSHED[4] (NY)	FINCH HOLLOW SITE 2 [4] (NY)	NANTICOKE CREEK SITE 13 [4] (NY)	NANTICOKE CREEK SITE 7A [4] (NY)	ARKPORT [4] (NY)	NEWTOWN HOFFMAN SITE 3A [4] (NY)	NEWTOWN HOFFMAN SITE 12E [4] (NY)
OWNER	TOWN OF NEW BERLIN	BROOME COUNTY	BROOME COUNTY	BROOME COUNTY	BROOME COUNTY	CENAB	CHEMUNG COUNTY	CHEMUNG COUNTY
PURPOSE	FLOOD CONTROL	FLOOD CONTROL	FLOOD CONTROL	FLOOD CONTROL	FLOOD CONTROL	FLOOD CONTROL	FLOOD CONTROL / RECREATION	FLOOD CONTROL
STATUS (DATE)	COMPLETE (1986)	COMPLETE (1966)	COMPLETE (1973)	COMPLETE (1967)	COMPLETE (1981)	COMPLETE (1940)	COMPLETE (1976)	COMPLETE (1989)
Stream	Tr-Unadilla River	Patterson Creek	Little Choconut Creek	Bradley Creek	Tr-Nanticoke Creek	Canisteo River	Newton Creek	N Branch Newtown Crk.
River Mile	-	-	-	-	-	-	-	-
Drainage Area (sq. mi.)	1.35	4.4199	11.72	6.09999	5	30	2.6699	18.09
Structure Type	Earth Fill	Earth Fill	Earth Fill	Earth Fill	Earth Fill	Earth Fill	Earth Fill	Earth Fill
Dam Crest Length (ft)	730	1,300	1,050	700	1,300	1,200	800	2,250
Height of Dam (ft)	87	65	57	57	67	113	53	71
Design Freeboard (ft)	-	-	-	-	-	-	-	-
Spillway Crest Length (ft)	190	355	107	331	500	160	200	166
Design Discharge (cfs)	5,617	17,500	31,403	12,600	19,084	29,100	7,155	47,919
Elevations (ft msl)								
Gate Sill	-	-	-	-	-	-	-	-
Conservation Pool	-	-	-	-	-	-	-	-
Recreation Pool	-	-	-	-	-	-	-	-
Flood Control Pool	-	-	-	-	-	-	-	-
Maximum Pool	-	-	-	-	-	-	-	-
Top of Dam	-	-	-	-	-	-	-	-
Storage Volumes (Acre-ft)								
Conservation Pool	-	-	-	-	-	-	-	-
Recreation Pool	-	-	-	-	-	-	-	-
Flood Control Pool	-	-	-	-	-	-	-	-
Maximum Pool	1,065	1,280	1,480	1,395	1,475	10,800	1,191	8,081
Reservoir Areas (Acres)								

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}
(Page 2 of 2)

Recreation Pool	-	-	-	-	-	-	-	-
Flood Control Pool	-	-	-	-	-	-	-	-

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}

(Page 1 of 2)

NAME	NEWTOWN HOFFMAN SITE 5A[4] (NY)	EATON BROOK RESERVOIR[4] (NY)	KINGSEY BROOK RESERVOIR [4](NY)	LAKE MORAIN[4](NY)	BROWNEL RESERVOIR[4] (PA)	ELMHURST[4](PA)	WILLIAMS BRIDGE RESERVOIR[4] (PA)	LAKE SCRANTON [4] (PA))
OWNER	CHEMUNG COUNTY	NYS CANAL CORP	NYS CANAL CORP	NYS CANAL CORP	PENNSYLVANIA - AMERICAN WATER COMPANY	PENNSYLVANIA - AMERICAN WATER COMPANY	PENNSYLVANIA - AMERICAN WATER COMPANY	PENNSYLVANIA - AMERICAN WATER COMPANY
PURPOSE	FLOOD CONTROL	NAVIGATION / RECREATION	RECREATION	NAVIGATION / RECREATION/ OTHER	WATER SUPPLY	WATER SUPPLY	WATER SUPLY	WATER SUPPLY
STATUS (DATE)	COMPLETE (1999)	COMPLETE (1893)	COMPLETE (1867)	COMPLETE (1836)	COMPLETE (1908)	COMPLETE (1889)	COMPLETE (1893)	COMPLETE (1898)
Stream	Jackson Creek	Eaton Brook	Kingsley Brook	Payne Brook	Racket Brook	Roaring Brook	Stafford Meadow Brook	Stafford Meadow Brook
River Mile	-	-	-	-	-	-	-	-
Drainage Area (sq. mi.)	1977	7.96	5.21	8.21	4	37.2999	5.4	7.0499
Structure Type	Earth Fill	Earth Fill	Earth Fill	Earth Fill	Concrete	Earth Fill	Earth Fill	Earth Fill
Dam Crest Length (ft)	315	820	900	1,400	613	380	810	460
Height of Dam (ft)	58	58	63	57	64	64	54	60
Design Freeboard (ft)	-	-	-	-	-	-	-	-
Spillway Crest Length (ft)	0	41	16	35	0	0	0	0
Design Discharge (cfs)	21,243	3,060	671	1,070	0	0	0	0
Elevations (ft msl)								
Gate Sill	-	-	-	-	-	-	-	-
Conservation Pool	-	-	-	-	-	-	-	-
Recreation Pool	-	-	-	-	-	-	-	-
Flood Control Pool	-	-	-	-	-	-	-	-
Maximum Pool	-	-	-	-	-	-	-	-
Top of Dam	-	-	-	-	-	-	-	-
Storage Volumes (Acre-ft)								
Conservation Pool	-	-	-	-	-	-	-	-
Recreation Pool	-	-	-	-	-	-	-	-
Flood Control Pool	-	-	-	-	-	-	-	-
Maximum Pool	1,469	7,886	2,260	2,850	2,995	3,744	1,276	8,397

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}
(Page 2 of 2)

Reservoir Areas (Acres)								
Recreation Pool	-	-	-	-	-	-	-	-
Flood Control Pool	-	-	-	-	-	-	-	-

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}
(Page 1 of 2)

NAME	NESBITT[4] (PA)	WATRES[4] (PA)	LACKAWANNA[4](PA)	BEECHWOOD LAKE[4](PA)	MILL CREEK[4] (PA)	FRANCES SLOCUM[4](PA)	PIKES CREEK[4] (PA)	COLUMN NOT USED
OWNER	PENNSYLVANIA - AMERICAN WATER COMPANY	PENNSYLVANIA - AMERICAN WATER COMPANY	DCNR	PA FISH AND BOAT COMMISION	PENNSYLVANIA - AMERICAN WATER COMPANY	DCNR	PENNSYLVANIA - AMERICAN WATER COMPANY	
PURPOSE	HYDROELECTRIC WATER SUPPLY	WATER SUPPLY	RECREATION	FLOOD CONTROL / RECREATION	WATER SUPPLY	FLOOD CONTROL / RECREATION	WATER SUPPLY	
STATUS (DATE)	COMPLETE (1903)	COMPLETE (1925)	COMPLETE (1971)	COMPLETE (1963)	COMPLETE (1898)	COMPLETE (1965)	COMPLETE (1911)	
Stream	Spring Brook	Spring Brook	S Branch Tunchannock Ck.	E Beech Woods Creek	Mill Creek	Abrahams Creek	Pikes Creek	
River Mile	-	-	-	-	-	-	-	
Drainage Area (sq. mi.)	37.1	15.4	44.8999	3.2999	3	6.0999	10.5	
Structure Type	Earth Fill	Earth Fill	Rock Fill	Earth Fill	Earth Fill	Earth Fill	Earth Fill	
Dam Crest Length (ft)	267	1,406	350	1,030	1,345	935	2,360	
Height of Dam (ft)	101	135	69	63	74	51	65	
Design Freeboard (ft)	-	-	-	-	-	-	-	
Spillway Crest Length (ft)	0	0	0	0	0	0	0	
Design Discharge (cfs)	0	0	0	0	0	0	0	
Elevations (ft msl)								
Gate Sill	-	-	-	-	-	-	-	
Conservation Pool	-	-	-	-	-	-	-	
Recreation Pool	-	-	-	-	-	-	-	
Flood Control Pool	-	-	-	-	-	-	-	
Maximum Pool	-	-	-	-	-	-	-	
Top of Dam	-	-	-	-	-	-	-	
Storage Volumes (Acre-ft)								
Conservation Pool	-	-	-	-	-	-	-	
Recreation Pool	-	-	-	-	-	-	-	
Flood Control Pool	-	-	-	-	-	-	-	
Maximum Pool	5,034	8,241	14,200	2,400	2,350	5,340	10,556	
Reservoir Areas (Acres)								

Table 2.4-12— {Susquehanna River Basin Upstream Dam Information}
(Page 2 of 2)

Recreation Pool	-	-	-	-	-	-	-	
Flood Control Pool	-	-	-	-	-	-	-	

Sources: USGS, 2002; USGS, 2008c through g; PPL, 1999a; USACE, 2007

[1]Dam information obtained from **PPL, 1999a**

[2]Dam information obtained from **USGS, 2008c through g**

[3]Dam information obtained from **USGS, 2002**

[4]Dam information obtained from **USACE, 2007**

Table 2.4-13— {Surface Water Users in Luzerne County}
(Page 1 of 2)

ORGANIZATION	SITE_ID	WATER BODY	PRIMARY USE	SITE STATUS
AIRPORT SAND & GRAVEL CO INC	256331	ABRAHAM CREEK DIV	MINERAL USE	ACTIVE
AMER ASPHALT PAVING CO	448323	BROWNS CREEK DIV	MINERAL USE	ACTIVE
APPLEWOOD GC	625899	LEWIS CREEK	COMMERCIAL USE	ACTIVE
BARLETTA BROS	245902	NESCOPECK CREEK	COMMERCIAL USE	ACTIVE
BARLETTA MATERIALS & CONST INC	271224	SUSQUEHANNA RIVER	INDUSTRIAL USE	ACTIVE
BURTAM CORP	491078	POND HOLE 18	COMMERCIAL USE	ACTIVE
CARBON SALES INC	259022	MILL CREEK WITH	MINERAL USE	ACTIVE
CHRISTINE & WILLIAM MISSON	245088	POND A	COMMERCIAL USE	ACTIVE
CHRISTINE & WILLIAM MISSON	245088	POND B	COMMERCIAL USE	ACTIVE
CHRISTINE & WILLIAM MISSON	245088	POND C	COMMERCIAL USE	ACTIVE
CONTINENTIAL ENERGY ASSOC	492489	POND DIV	MINERAL USE	ACTIVE
DIAMOND COAL CO INC	250506	RESERVOIR DIV	MINERAL USE	ACTIVE
DRUE CHAPIN & SONS	662342	INTAKE 1	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662342	INTAKE 2	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662342	INTAKE 3	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	672354	INTAKE 1	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662343	RIVER INTAKE 1	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662343	RIVER INTAKE 2	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662343	RIVER INTAKE 3	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662343	RIVER INTAKE 4	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662343	RIVER INTAKE 5	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662343	RIVER INTAKE 6	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	662343	RIVER INTAKE 7	AGRICULTURAL USE	ACTIVE
DRUE CHAPIN & SONS	672341	INTAKE 1	AGRICULTURAL USE	ACTIVE
FRED W ECKEL SONS	677216	SUSQUEHANNA RIVER INTAKE	AGRICULTURAL USE	ACTIVE
GEN CRUSHED STONE CO	258181	POND WITHDRAWAL	MINERAL USE	ACTIVE
GERALD & LEWIS NAUGLE	261815	PIKES CRK DIV	MINERAL USE	ACTIVE
HUNLOCK SAND & GRAVEL CO	450734	ROARING BROOK	MINERAL USE	ACTIVE
HUNLOCK SAND & GRAVEL CO	450734	POND	MINERAL USE	ACTIVE
HUNTSVILLE GC	446924	MARKET STREET IRRIGATION POND	COMMERCIAL USE	ACTIVE
INDIAN SPRINGS SAWMILL	549919	YEAGER RUN	INDUSTRIAL USE	ACTIVE
JA & WA HESS INC	452784	SUSQUEHANNA RVR	MINERAL USE	ACTIVE

Table 2.4-13— {Surface Water Users in Luzerne County}
(Page 2 of 2)

ORGANIZATION	SITE_ID	WATER BODY	PRIMARY USE	SITE STATUS
JA & WA HESS INC	452784	SUSQUEHANNA WITHDRAWAL	MINERAL USE	ACTIVE
JEAN RUN INC	449143	FARM POND	COMMERCIAL USE	ACTIVE
KAMINSKI BROS INC	442707	POND WITHDRAWAL	MINERAL USE	ACTIVE
KAMINSKI BROS INC	449046	SILT POND	INDUSTRIAL USE	ACTIVE
KELLY INVESTORS INC	445826	RESERVOIR DIV	MINERAL USE	INACTIVE
KEYSTONE COCA COLA BOTTLING CORP	258071	SURFACE WITHDRAW	INDUSTRIAL USE	ACTIVE
NEWBERRY GOLF ESTATE CC	269371	POND	COMMERCIAL USE	ACTIVE
PG ENERGY INC	494082	COAL CREEK	COMMERCIAL USE	ACTIVE
PG ENERGY INC	494082	HARVEYS CREEK	COMMERCIAL USE	ACTIVE
PG ENERGY INC	494082	CAMPBELLS LEDGE	COMMERCIAL USE	ACTIVE
PG ENERGY INC	494082	LAUREL RUN	COMMERCIAL USE	ACTIVE
PG ENERGY INC	494082	PINE RUN INTAKE	COMMERCIAL USE	ACTIVE
PG ENERGY INC	494082	WANAMIE	COMMERCIAL USE	ACTIVE
SHIRLEY M RINEHIMER	254432	POND WITHDRAWAL	MINERAL USE	INACTIVE
SUGARLOAF GC INC	243760	POND	COMMERCIAL USE	ACTIVE
SUGARLOAF GC INC	243760	BUCK MOUNTAIN STREAM	COMMERCIAL USE	ACTIVE
Unavailable	259075	SURFACE WITHDRAWAL	AGRICULTURAL USE	ACTIVE
VALLEY CC	243972	POND 3	COMMERCIAL USE	ACTIVE
WILKES BARRE CITY GEN MUNI AUTH LUZERNE CNTY	243780	FIVE MILE RUN	COMMERCIAL USE	ACTIVE
WYOMING VALLEY CC	260442	POND	COMMERCIAL USE	ACTIVE

Table 2.4-14— {SSES Units 1 and 2 Monthly Consumptive Water Use (Million Gallons per Month)}

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001	824	785	569	554	1,011	1,089	1,131	1,157	1,046	1,028	950	894
2002	868	748	436	592	1,030	1,103	1,175	1,173	1,079	770	894	851
2003	986	927	865	625	1,042	1,051	1,145	1,139	931	986	927	865
2004	740	702	503	581	1,081	1,060	1,112	1,129	1,045	985	833	850
2005	791	682	531	870	1,024	1,032	1,145	1,153	1,078	985	757	827
2006	884	744	525	739	974	1,054	1,149	1,138	1,008	685	930	911

Table 2.4-15— {Major Public Water Suppliers within Luzerne and Columbia Counties}

PWSIS	System Name	County	Source Waterbody Name	Source Pumping Capacity (GPD)	Source Safe Yield (GPD)
4190008	United Water PA Bloomsburg	Columbia	Fishing Creek	5,760,000	5,000,000
2409002	PA American Water Company- Ceasetown	Luzerne	Ceasetown Reservoir	8,300,000	13,200,000
2409002	PA American Water Company- Ceasetown	Luzerne	Harveys Creek	1,300,000	1,300,000
2409003	PA American Water Company- Crystal Lake	Luzerne	Crystal Lake	0	5,000,000
2409003	PA American Water Company- Crystal Lake	Luzerne	Crystal Lake	-	-
2409013	PA American Water Company- Huntsville	Luzerne	Huntsville Reservoir	4,500,000	6,000,000
2409010	PA American Water Company- Nesbitt	Luzerne	Maple Lake	0	0
2409010	PA American Water Company- Nesbitt	Luzerne	Watres Reservoir	-	2,600,000
2409010	PA American Water Company- Nesbitt	Luzerne	Nesbitt	0	0
2409011	PA American Water Company- Watres	Luzerne	Mill Creek Reservoir	-	-
2409011	PA American Water Company- Watres	Luzerne	Gardner Cr. Reservoir	-	-
2409011	PA American Water Company- Watres	Luzerne	Watres Reservoir	0	0
2400148	Stockton Water System	Luzerne	Ponds	-	-
2408001	HCA Roan Filter Plant ID-006	Luzerne	Stony Cabin Creek	0	0
2408001	HCA Roan Filter Plant ID-005	Luzerne	Wolfe's Run	0	0
2408001	HCA Roan Filter PlantID-004	Luzerne	Dreck Creek	0	0
2408001	HCA Roan Filter Plant ID-003	Luzerne	Biesel's Run	0	0
2408001	HCA Roan Filter Plant ID-002	Luzerne	Oberson's Run	0	0
2408001	HCA Roan Filter Plant ID-018	Luzerne	Shaffers Run	0	0
2408001	HCA Roan Filter Plant ID-012	Luzerne	Mt. Pleasant Spring	0	0
2408001	HCA Roan Filter Plant ID-021	Luzerne	Lehigh River	0	0

Note: GPD = Gallons per day

Table 2.4-16— {SSES Units 1 and 2 Cooling Tower Blowdown Discharge Rate Permit No PA0047325}

MONTH	2000		2001		2002		2003		2004		2005		2006		2007	
	Mean	**Max**	**Mean**	**Max**	**Mean**	**Max**	**Mean**	**Max**	**Mean**	**Max**	**Mean**	**Max**	**Mean**	**Max**	**Mean**	**Max**
January	6.86	11.81	11.17	15.55	8.91	10.42	6.58	10.42	11.08	17.72	12.09	17.29	9.41	15.08	10.63	16.92
February	9.68	17.28	10.24	11.88	7.52	10.08	9.22	10.30	12.36	14.36	11.15	17.28	9.72	12.10	11.47	14.69
March	8.26	17.28	6.45	10.94	5.67	9.07	6.70	8.64	8.84	14.44	8.76	17.28	8.16	11.48	9.49	16.48
April	7.80	11.28	6.96	11.52	8.46	10.85	7.28	10.37	11.94	17.28	14.54	17.28	10.93	12.94	13.04	17.28
May	14.37	17.28	15.86	17.28	12.80	17.06	12.84	16.85	11.30	15.88	12.89	14.28	12.01	15.56	14.36	17.22
June	15.19	17.28	17.08	17.28	16.68	17.28	13.64	17.28	14.53	16.98	13.15	17.28	14.33	17.28	17.17	17.28
July	15.66	17.28	15.40	17.28	17.13	17.28	16.79	17.28	16.35	17.28	12.27	16.05	16.15	17.28	17.20	17.28
August	13.51	17.28	16.33	16.70	17.05	17.28	17.13	17.28	15.61	17.28	12.63	17.28	17.01	17.28	17.28	17.28
September	14.40	17.28	16.72	17.28	16.16	17.28	13.26	17.28	16.54	17.28	13.28	17.28	16.35	17.28	15.24	17.28
October	11.12	13.39	13.18	15.26	10.60	15.12	9.56	15.26	11.62	16.72	13.71	17.28	12.83	17.10	13.51	17.28
November	9.36	16.92	13.71	16.18	9.19	12.24	11.57	17.28	9.84	13.61	8.59	13.21	12.74	17.16	10.73	17.28
December	11.46	17.28	11.17	15.55	6.49	11.52	9.73	17.78	13.42	17.28	9.91	16.71	11.75	16.36	9.23	14.33

Table 2.4-17— {Water Pollution Control Facilities in Luzerne County}

(Page 1 of 2)

ORGANIZATION	SITE_ID	SUB_FACI_2	SITE_STATUS
ABF FREIGHT SYS INC	535140	DISCHARGE POINT	ACTIVE
AGWAY PETRO CORP	245439	DISCHARGE POINT	ACTIVE
ALLIANCE LDFL	452024	DISCHARGE POINT	ACTIVE
AMER ROCK SALT CO LLC	534131	DISCHARGE POINT	ACTIVE
AQUA PA INC	257459	CONVEYANCE SYSTEM	ACTIVE
BEMIS CO INC	238511	DISCHARGE POINT	ACTIVE
BP PROD NORTH AMER INC	245780	DISCHARGE POINT	ACTIVE
BRIDON AMER CORP	465509	DISCHARGE POINT	ACTIVE
BRUSH WELLMAN CORP	450819	DISCHARGE POINT	ACTIVE
BUTLER PROD	540068	DISCHARGE POINT	ACTIVE
CABOT CORP	241624	PRODUCTION SERVICE UNIT	ACTIVE
CASTEK INC	515571	DISCHARGE POINT	ACTIVE
CBD ENTERPRISES INC	250561	DISCHARGE POINT	ACTIVE
CELOTEX CORP	513776	DISCHARGE POINT	ACTIVE
CERTAINTEED CORP	242936	DISCHARGE POINT	ACTIVE
CON WAY FREIGHT INC	534973	DISCHARGE POINT	ACTIVE
DALLAS AREA MUNI AUTH	681690	PUMP STATION	ACTIVE
DIAL CORP	262476	DISCHARGE POINT	ACTIVE
EDWARD LUKASHEWSKI	532225	DISCHARGE POINT	ACTIVE
ELDORADO PROP CORP	236472	DISCHARGE POINT	ACTIVE
ENTENMANNS	534395	DISCHARGE POINT	INACTIVE
EXXON 739 CORP	260255	TREATMENT PLANT	ACTIVE
FABRAL INC	607189	DISCHARGE POINT	ACTIVE
FEDEX CORP	533615	PRODUCTION SERVICE UNIT	ACTIVE
FEDEX NATL LTL INC	662274	DISCHARGE POINT	ACTIVE
FLEXTRONICS	547487	DISCHARGE POINT	ACTIVE
GEN MILLS INC	536701	DISCHARGE POINT	ACTIVE
GRAHAM PKG CO LP	635944	DISCHARGE POINT	ACTIVE
GRAHAM PKG CO LP	637387	DISCHARGE POINT	ACTIVE
GREIF BROS CORP	534867	DISCHARGE POINT	ACTIVE
GRUMA CORP	655837	DISCHARGE POINT	ACTIVE
GSD PKG LLC	670073	PRODUCTION SERVICE UNIT	ACTIVE
GULF OIL LTD PARTNERSHIP	465179	DISCHARGE POINT	ACTIVE
HAZLETON CASTING CO	647590	DISCHARGE POINT	ACTIVE
HAZLETON CITY WATER AUTH LUZERNE CNTY	447541	DISCHARGE POINT	ACTIVE
HERSHEY FOODS CORP	481099	DISCHARGE POINT	ACTIVE
HPG INTL INC	248877	TREATMENT PLANT	ACTIVE
INDALEX INC - MOUNTAINTOP DIV	525674	DISCHARGE POINT	ACTIVE
INTERMETRO IND CORP	248955	DISCHARGE POINT	ACTIVE
INTERMETRO IND CORP	527804	DISCHARGE POINT	ACTIVE
INTERSIL CORP	471870	DISCHARGE POINT	ACTIVE
IRECO INC	241565	DISCHARGE POINT	ACTIVE
JACOBSON CO INC	699736	PRODUCTION SERVICE UNIT	ACTIVE
LOUIS COHEN & SON INC	534190	DISCHARGE POINT	ACTIVE
OFFSET PAPERBACK MANUFACTURERS INC	243274	PRODUCTION SERVICE UNIT	ACTIVE
PA AMER WATER CO	243286	TREATMENT PLANT	ACTIVE
PA AMER WATER CO	446349	DISCHARGE POINT	ACTIVE

Table 2.4-17— {Water Pollution Control Facilities in Luzerne County}

(Page 2 of 2)

ORGANIZATION	SITE_ID	SUB_FACI_2	SITE_STATUS
PA AMER WATER CO	449229	DISCHARGE POINT	ACTIVE
PA AMER WATER CO	449233	DISCHARGE POINT	ACTIVE
PA AMER WATER CO	452022	DISCHARGE POINT	ACTIVE
PA AMER WATER CO	480951	DISCHARGE POINT	ACTIVE
PA DEP NERO	544343	DISCHARGE POINT	ACTIVE
PA DEPT OF CORR	516545	DISCHARGE POINT	ACTIVE
PETRO SVC CORP	547319	DISCHARGE POINT	ACTIVE
PILOT CORP	250389	DISCHARGE POINT	ACTIVE
POLYGLASS USA INC	525105	DISCHARGE POINT	ACTIVE
PPL ELEC UTILITIES CORP	250359	DISCHARGE POINT	ACTIVE
SANDUSKY LEWIS METAL PROD INC	236732	DISCHARGE POINT	ACTIVE
SCHOTT GLASS TECH INC	256591	DISCHARGE POINT	ACTIVE
SLUSSER BROS TRUCKING & EXCAV CO INC	513213	DISCHARGE POINT	ACTIVE
SLUSSER BROS TRUCKING & EXCAV CO INC	534045	DISCHARGE POINT	ACTIVE
SMITHS AEROSPACE COMPONENTS	665612	DISCHARGE POINT	ACTIVE
SOUTHERN ALLEGHENIES LDFL INC	803	TREATMENT PLANT	ACTIVE
STAR ENTERPRISE	248793	DISCHARGE POINT	ACTIVE
STERICYCLE INC	535121	DISCHARGE POINT	ACTIVE
SUNOCO INC	465963	DISCHARGE POINT	ACTIVE
SVC MFG INC	481491	DISCHARGE POINT	ACTIVE
TECHNEGLAS INC	244619	DISCHARGE POINT	ACTIVE
THREE SPRINGS WATER CO	261223	DISCHARGE POINT	ACTIVE
UGI DEVELOPMENT COMPANY	264295	DISCHARGE POINT	ACTIVE
UNISON ENGINE COMPONENTS INC	511980	DISCHARGE POINT	ACTIVE
UPS INC	534803	DISCHARGE POINT	ACTIVE
WEIR HAZLETON INC	511126	DISCHARGE POINT	ACTIVE
WILKES BARRE SCRANTON INTL AIRPORT	489635	DISCHARGE POINT	ACTIVE
WILLIAMS GAS PIPELINE TRANSCO	689478	DISCHARGE POINT	ACTIVE

Table 2.4-18— {1-Hour 1 mi^2 Probable Maximum Precipitation (PMP) Depths}

Duration (min)	All Season PMP (in)	All Season PMP (cm)
5	5.9	15.0
15	9.3	23.6
30	13.3	33.8
60	17.5	44.5

Table 2.4-19— {72-Hour 10 mi^2 Probable Maximum Precipitation (PMP) Depths}

Duration (hrs)	All Season PMP (in)	All Season PMP (cm)
6	26.3	66.8
12	30.0	76.2
24	32.6	82.8
48	36.4	92.5
72	37.6	95.5

Table 2.4-20— {Sub-Basin Drainage Areas for BBNPP (Site Drainage)}

Hydrologic Element/ Sub-Basin	Drainage Area (ft^2) (m^2)	Drainage Area (acre) (ha)
Basin 10.1	1,467,115.4 (136,299.5)	33.678 (13.629)
Basin 10.4A	588,560.4 (54,679.1)	13.511 (5.468)
Basin 10.4B	1,462,812.7 (135,899.7)	33.579 (13.589)
Basin 10.4C	61,006.0 (5,667.6)	1.400 (0.567)
Basin 12	1,910,550.5 (177,495.9)	43.857 (17.748)
Basin 13.1	277,125.2 (25,745.8)	6.361 (2.574)
Basin 13.2	194,929.3 (18,109.5)	4.475 (1.811)
Wetland Area	710,604.1 (66,017.3)	16.312 (6.601)
ESWEMS Pond	312,271.3 (29,011.0)	7.168 (2.901)

Table 2.4-21— {Safety-Related Facility Entrance Elevation Summary}

Safety-Related Facility	**Entrance Elevation ft (m)**	**PMP Peak Water Elevation ft (m)**	**Freeboard ft (m)**
Nuclear Island[*,1]	720.00 (219.46)	718.36 (218.96)	1.64 (0.50)
ESWS Cooling Tower Structures[1]	720.00 (219.46)	718.36 (218.96)	1.64 (0.50)
Emergency Power Generator Building[1]	720.00 (219.46)	718.36 (218.96)	1.64 (0.50)
ESWEMS Building[2]	700.50 (213.51)	698.36 (212.86)	2.14 (0.65)

[*] Includes Reactor, Fuel and Safeguards Buildings.
[1]Evaluated using 1-hour PMP data (see Table 2.4-18).
[2]Evaluated using 72-hour PMP data (see Table 2.4-19).

Table 2.4-22— {Walker Run Sub-basin Areas}

Sub-basin	Area (sq mi)
SB1-1	0.15
SB1-2	0.44
SB1-3	0.59
SB2-1	1.15
SB2-2	0.88
SB2-3	0.38
SB2-4	0.10
SB3-1	0.25
SB3-2	0.11
SB3-3	0.12
SB3-4	0.15
Total Area	4.32

Table 2.4-23— {SCS Loss Method Parameters for Walker Run Sub-basins}

Sub-basin	Curve Number	Initial Abstraction (I_a) (in)	Impervious %
SB1-1	66	1.04	3
SB1-2	71	0.81	3
SB1-3	58	1.43	3
SB2-1	73	0.74	3
SB2-2	74	0.71	3
SB2-3	67	0.96	3
SB2-4	56	1.60	12.67
SB3-1	68	0.95	3
SB3-2	67	0.99	3
SB3-3	66	1.01	91.67
SB3-4	68	0.94	42.56

Table 2.4-24— {Clark Unit Hydrograph Parameters for Walker Run Sub-basins}

Sub-basin	Time of Concentration (Tc) (hr)	Storage Coefficient (R) (hr)
SB1-1	0.34	0.21
SB1-2	0.88	0.28
SB1-3	0.97	0.39
SB2-1	1.05	0.49
SB2-2	0.66	0.18
SB2-3	0.55	0.14
SB2-4	0.61	0.42
SB3-1	0.66	0.18
SB3-2	0.66	0.95
SB3-3	0.43	0.54
SB3-4	0.37	0.32

Table 2.4-25— {PMF Flow and Flow Change Locations}

River Name	River Station (ft)	HEC-HMS Junctions/Outlets	PMF (cfs)
Walker Run	19611.64	Junction B-2	16396.0
Walker Run	15788.7	Junction B-3	19663.3
Walker Run	13352.65	Junction B-4	19492.3
Walker Run	10497.04	Junction A-1	24963.5
Walker Run	8567.727	Junction A-2	27835.4
Walker Run	6600.763	Junction A-3	31569.0
Walkerrun TR#1_1	1614.092	Junction C-3	4940.9
Walkerrun TR#1_2	2594.424	Outlet of Reach SB3-2 and Outlet of SB3-2	3218.10
Walker TR#2	1645.505	Outlet of SB3-3	1025.5
Note: TR = Tributary, SB = Sub-basin			

Table 2.4-26— {Walker Run PMF Water Surface Elevations near the Proposed Site}

Reach	River Station	Q Total (cfs)	Water Surface El. (ft) (NAVD88)
Walker Run Upstream	12790.74	Bridge	Bridge
Walker Run Upstream	12764.15	19492.30	675.69
Walker Run Upstream	12621.46	19492.30	672.10
Walker Run Upstream	12484.2	19492.30	671.28
Walker Run Upstream	12378.4	19492.30	671.04
Walker Run Upstream	12288.75	19492.30	670.92
Walker Run Upstream	12223.66	19492.30	670.57
Walker Run Upstream	12125.81	19492.30	669.86
Walker Run Upstream	12005.02	19492.30	669.40
Walker Run Upstream	11827.5	19492.30	669.02
Walker Run Upstream	11691.35	19492.30	668.56
Walker Run Upstream	11607.94	19492.30	668.31
Walker Run Upstream	11513.03	19492.30	668.15
Walker Run Upstream	11424.58	19492.30	667.98
Walker Run Upstream	11363.19	19492.30	667.99
Walker Run Upstream	11351.37	Bridge	Bridge
Walker Run Upstream	11331.06	19492.30	667.84
Walker Run Upstream	11257.47	19492.30	667.79
Walker Run Upstream	11070.75	19492.30	667.80
Walker Run Upstream	10926.4	19492.30	667.78
Walker Run Upstream	10829.1	19492.30	667.77

Table 2.4-27— {Tributary #1 and Tributary #2 PMF Water Surface Elevations near the Proposed Site}

Reach	River Station	Q Total (cfs)	Water Surface El. (ft) (NAVD88)
WalkerrunTR#1_1	624.6631	4940.90	672.30
WalkerrunTR#1_1	741.0195	4940.90	672.30
WalkerrunTR#1_1	995.4287	4940.90	672.31
WalkerrunTR#1_1	1129.112	4940.90	672.30
WalkerrunTR#1_1	1225.459	4940.90	672.30
WalkerrunTR#1_1	1299.731	4940.90	672.31
WalkerrunTR#1_1	1447.257	4940.90	672.32
WalkerrunTR#1_1	1614.092	4940.90	672.34
WalkerrunTR#1_2	351.9543	3218.10	672.40
WalkerrunTR#1_2	462.8771	3218.10	672.42
WalkerrunTR#1_2	688.9208	3218.10	672.47
WalkerrunTR#1_2	805.65	3218.10	672.50
WalkerrunTR#1_2	1098.944	3218.10	672.59
WalkerrunTR#1_2	1269.473	3218.10	672.75
WalkerrunTR#1_2	1471.046	3218.10	673.26
WalkerrunTR#1_2	1687.279	3218.10	674.13
WalkerrunTR#1_2	1939.839	3218.10	674.37
WalkerrunTR#1_2	2285.067	3218.10	676.28
WalkerrunTR#1_2	2594.424	3218.10	683.58
WalkerTR#2	53.11654	925.50	672.40
WalkerTR#2	149.6818	925.50	672.40
WalkerTR#2	722	Culvert	Culvert
WalkerTR#2	742.3789	925.50	696.38
WalkerTR#2	843.369*	925.50	696.38
WalkerTR#2	944.3609	925.50	696.39
WalkerTR#2	1056.754	925.50	696.36
WalkerTR#2	1213.469	925.50	699.89
WalkerTR#2	1336.411	925.50	704.78
WalkerTR#2	1645.505	925.50	715.03
* Note: Denotes Interpolated Cross-section			

Table 2.4-28— {Walker Run Probable Maximum Precipitation Depths}

Area (mi^2)	6-hr	12-hr	24-hr	48-hr	72-hr
10	26.3 (in)	30.0 (in)	32.6 (in)	36.4 (in)	37.6 (in)
Source: NOAA, 1978.					

Table 2.4-29— {Historical Tsunamis and Maximum Generated Wave Heights}

Date	Country	City	Latitude	Longitude	Earthquake[1] Magnitude	Tsunami Cause	Maximum Tsunami Water Height (meter) above sea level
11/01/1755	Portugal	Lisbon	36.000	-11.000	8.5	Earthquake	30.00
06/27/1864	Canada	SW Avalon Peninsula, Newfoundland	46.500	-53.700	N.A.	Earthquake	N.A.
12/16/1811	USA	New Madrid Earthquakes, MO	35.600	-90.400	8.5	Earthquake	N.A.
12/16/1811	USA	New Madrid Earthquakes, MO	35.600	-90.400	8.0	Earthquake	N.A.
01/23/1812	USA	New Madrid, MO	36.300	-89.600	8.4	Earthquake	N.A.
02/07/1812	USA	New Madrid, MO	36.500	-89.600	8.8	Earthquake	N.A.
09/01/1886	USA	Charleston, SC	32.900	-80.000	7.7	Earthquake	N.A.
09/01/1895	USA	High Bridge, NJ	40.667	-74.883	4.3	Earthquake	N.A.
10/11/1918	USA Territory	Mona Passage, Puerto Rico	18.500	-67.500	7.3	Earthquake	6.10
11/18/1929	Canada	Grand Banks, Newfoundland	44.690	-56.000	7.2	Earthquake and Landslide	7.00
08/04/1946	Dominican Republic	Northeastern Coast	19.300	-68.900	8.1	Earthquake	5.00
08/08/1946	Dominican Republic	Northeastern Coast	19.710	-69.510	7.9	Earthquake	0.60
05/19/1964	USA	Long Island, NY	40.800	-73.100	N.A.	Landslide	0.28

[1] The value in this column contains the primary earthquake magnitude: 0.0 to 9.9

N.A. = Not Available

Source: NOAA, 2010

Table 2.4-30— {Estimated Average Monthly Ice Thickness, Susquehanna River 2001-2007}

Month	AFDD (°F)	Ice Thickness (in)	Ice Thickness (cm)
January	190.4	2.07	5.26
February	125.1	1.68	4.27
December	88.1	1.41	3.58
Average	134.5	1.72	4.37
Note: Estimated values based on SSES Unit 1 & 2 Meteorological Tower data (PPL, 2008).			

Table 2.4-31— {Estimated Average Monthly Ice Thickness, ESW Emergency Makeup Retention Pond 2001-2007}

Month	AFDD (°F)	Ice Thickness (in)	Ice Thickness (cm)
January	190.4	9.66	24.54
February	125.1	7.83	19.89
December	88.1	6.57	16.69
Average	134.5	8.02	20.37
Note: Estimated values based on SSES Unit 1 & 2 Meteorological Tower data (PPL, 2008).			

Table 2.4-32— {10 mi^2 (25.9 km^2)Probable Maximum Precipitation Depths at the ESWEMS}

Duration (hrs)	All Season PMP (in)	All Season PMP (cm)
6	26.3	66.8
12	30.0	76.2
24	32.6	82.8
48	36.4	92.5
72	37.6	95.5

Table 2.4-33— Data Input and Results for Wind Setup Calculations

Case	Wind Velocity U (mph)	Effective Fetch Fe (mi)	Wind Tide Fetch F (mi)	Average Depth D (ft)	Wind Setup S (ft)
Fastest Annual Recorded Wind	57	0.1307	0.2614	20.86	0.03
2 Year Frequency Wind Event	50	0.1307	0.2614	20.86	0.02
10 Year Frequency Wind Event	60	0.1307	0.2614	20.86	0.03
25 Year Frequency Wind Event	70	0.1307	0.2614	20.86	0.04
50 Year Frequency Wind Event	71	0.1307	0.2614	20.86	0.05
100 Year Frequency Wind Event	83	0.1307	0.2614	20.86	0.06
1,000 Year Frequency Wind Event	118	0.1307	0.2614	20.86	0.12
Case	**Wind Velocity U (km/hr)**	**Effective Fetch Fe (km)**	**Wind Tide Fetch F (km)**	**Average Depth D (m)**	**Wind Setup S (m)**
Fastest Annual Recorded Wind	92	0.2103	0.4207	6.36	0.01
2 Year Frequency Wind Event	80	0.2103	0.4207	6.36	0.01
10 Year Frequency Wind Event	97	0.2103	0.4207	6.36	0.01
25 Year Frequency Wind Event	113	0.2103	0.4207	6.36	0.01
50 Year Frequency Wind Event	114	0.2103	0.4207	6.36	0.02
100 Year Frequency Wind Event	134	0.2103	0.4207	6.36	0.02
1,000 Year Frequency Wind Event	190	0.2103	0.4207	6.36	0.04

Table 2.4-34— Wave Runup Results

Case	Wind Setup S (ft)	Wave Runup $R_{u2\%}$ (mi)	Freeboard Requirement $S + R_{u2\%}$ (ft)
Fastest Annual Recorded Wind	0.03	0.65	0.68
2 Year Frequency Wind Event	0.02	0.57	0.59
10 Year Frequency Wind Event	0.03	0.68	0.71
25 Year Frequency Wind Event	0.04	0.79	0.83
50 Year Frequency Wind Event	0.05	0.80	0.85
100 Year Frequency Wind Event	0.06	0.94	1.00
1,000 Year Frequency Wind Event	0.12	1.35	1.47
Case	**Wind Setup S (m)**	**Wave Runup $R_{u2\%}$ (m)**	**Freeboard Requirement $S + R_{u2\%}$ (m)**
Fastest Annual Recorded Wind	0.01	0.20	0.21
2 Year Frequency Wind Event	0.01	0.17	0.18
10 Year Frequency Wind Event	0.01	0.21	0.22
25 Year Frequency Wind Event	0.0	0.24	0.25
50 Year Frequency Wind Event	0.02	0.24	0.26
100 Year Frequency Wind Event	0.02	0.29	0.30
1,000 Year Frequency Wind Event	0.04	0.41	0.45

Table 2.4-35— {Highest Wind Speeds Using Fisher-Tippet Type I (Frechet) Distribution}

Scenario	[1]Highest Wind Speed(mph)	Highest WindSpeed (km/h)
[2]Highest Annual Wind	57	92
2-year Wind Event	50	80
10-year Wind Event	60	97
25-year Wind Event	70	113
50-year Wind Event	71	114
100-year Wind Event	83	134
1,000-year Wind Event	118	190

[1] Highest Wind Speed Interpolated for BBNPP site.
[2] Highest Annual wind was obtained from the SSES Unit 1 & 2 meteorological tower, based on available data from 2001 to 2007.

Table 2.4-36— {Summary of Information of the Stations and Range of Data Used}

Station Name	USGS Station ID	Location		Station Datum ft (m) NAVD 88	Period of Record
		Latitude	Longitude		
Danville, PA	01540500	40°57′9″	76°37′10″	430.52 (131.23)	1900-2006
Wilkes-Barre, PA	01536500	41°15′03″	75°52′52″	510.86 (155.71)	1899-2006
Sources: USGA, 2008a; USGS, 2008b					

Table 2.4-37— {Annual Minimum Water Levels and Streamflow Measurements at Danville, PA Station}

(Page 1 of 5)

Date	[(1)]Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
25-Sep-1900	432.12	1.60	822
27-Oct-1901	433.62	3.10	4,510
19-Sep-1902	433.27	2.75	3,115
8-Oct-1903	433.98	3.46	5,728
8-Jul-1905	434.42	3.90	7,720
30-Jun-1906	434.75	4.23	9,360
15-Oct-1907	436.19	5.67	14,700
15-Sep-1908	432.26	1.74	981
25-Jun-1909	434.50	3.98	8,426
20-May-1912	438.07	7.55	25,612
4-Aug-1913	432.62	2.10	1,593
3-May-1915	435.58	5.06	14,022
4-Oct-1915	434.32	3.80	7,655
25-Sep-1917	433.52	3.00	3,767
5-Oct-1917	433.22	2.70	2,766
5-Oct-1918	435.75	5.23	12,900
29-Aug-1919	433.28	2.76	3,240
23-Jun-1920	434.70	4.18	9,290
21-Jun-1921	432.99	2.47	2,360
27-Aug-1922	436.89	6.37	20,400
18-Jul-1923	432.61	2.09	1,540
11-Aug-1924	433.00	2.48	2,360
22-Jul-1925	434.08	3.56	5,990
15-Aug-1929	433.06	2.54	2,550
16-Nov-1929	433.22	2.70	3,110

Table 2.4-37— {Annual Minimum Water Levels and Streamflow Measurements at Danville, PA Station}
(Page 2 of 5)

Date	[1]Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
17-Sep-1930	432.79	2.27	1,680
13-Nov-1931	432.78	2.26	1,730
25-May-1933	434.98	4.46	9,790
17-Oct-1933	433.43	2.91	3,750
12-Jun-1935	433.98	3.46	5,780
14-Oct-1936	432.68	2.16	1,640
24-Aug-1937	433.84	3.32	4,840
13-Jun-1938	433.60	3.08	4,140
31-Aug-1939	432.31	1.79	980
13-Aug-1940	433.05	2.53	2,450
2-Oct-1941	432.32	1.80	962
1-Dec-1941	433.04	2.52	2,450
4-Oct-1943	432.61	2.09	1,440
1-Sep-1944	432.72	2.20	1,510
17-Aug-1945	433.80	3.28	4,580
14-Sep-1946	433.06	2.54	2,000
6-Oct-1947	432.98	2.46	2,010
27-Sep-1948	432.70	2.18	1,370
1-Aug-1949	433.03	2.51	2,300
29-Sep-1950	433.69	3.17	4,140
29-Aug-1951	433.09	2.57	2,370
21-Oct-1952	432.78	2.26	1,700
2-Sep-1953	432.35	1.83	1,040
17-Aug-1954	432.55	2.03	1,400
2-Aug-1955	432.31	1.79	978

Table 2.4-37— {Annual Minimum Water Levels and Streamflow Measurements at Danville, PA Station}
(Page 3 of 5)

Date	[1]Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
8-Aug-1956	433.58	3.06	3,960
27-Aug-1957	432.79	2.27	1,750
15-Oct-1958	433.42	2.90	3,440
29-Jul-1959	432.69	2.17	1,540
3-Aug-1960	433.35	2.83	2,990
30-Oct-1961	432.58	2.06	1,310
20-Jul-1962	432.73	2.21	1,640
16-Oct-1963	432.33	1.81	936
9-Sep-1964	432.25	1.73	823
30-Nov-1964	432.56	2.04	1,280
16-Aug-1966	432.69	2.17	1,430
5-Oct-1967	433.66	3.14	3,980
10-Sep-1968	433.24	2.72	2,840
30-Sep-1969	432.69	2.17	1,550
25-Aug-1970	433.05	2.53	2,330
8-Sep-1971	433.12	2.60	2,520
21-Sep-1972	433.24	2.72	2,860
2-Oct-1973	433.60	3.08	4,020
22-Jul-1974	433.51	2.99	3,610
6-Aug-1975	433.44	2.92	3,360
9-Dec-1975	436.33	5.81	7,060
8-Jun-1977	433.70	3.18	4,290
2-Oct-1978	433.32	2.80	2,940
19-Jul-1979	432.21	2.69	2,560
9-Sep-1980	432.72	2.20	1,500

Table 2.4-37— {Annual Minimum Water Levels and Streamflow Measurements at Danville, PA Station}
(Page 4 of 5)

Date	[1]Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
28-Aug-1981	432.84	2.32	1,850
17-Aug-1982	433.20	2.68	2,700
3-Oct-1983	432.73	2.21	1,660
10-Nov-1983	432.78	2.26	1,610
31-Oct-1984	433.29	2.77	2,930
11-Mar-1986	436.53	6.01	16,400
6-Aug-1986	436.54	6.02	15,800
12-Jul-1988	432.75	2.23	1,650
12-Oct-1988	432.87	2.35	1,970
16-Aug-1989	433.39	2.87	3,110
8-Aug-1991	432.56	2.04	1,380
30-Oct-1991	433.08	2.56	2,160
21-Jul-1993	432.83	2.31	1,840
17-Oct-1994	433.84	3.32	4,560
27-Sep-1995	432.75	2.23	1,830
2-Jul-1996	434.82	4.30	8,510
20-Oct-1997	432.71	2.19	1,640
29-Jun-1998	436.34	5.82	14,700
24-Jun-1999	432.90	2.38	1,820
24-Nov-1999	435.19	4.67	4,080
23-May-2001	433.77	3.25	4,330
24-Sep-2001	432.70	2.18	1,670
15-Jul-2003	434.43	3.91	7,080
27-Aug-2004	436.47	5.95	16,600
10-Aug-2005	432.80	2.28	1,600

Table 2.4-37— {Annual Minimum Water Levels and Streamflow Measurements at Danville, PA Station}

(Page 5 of 5)

Date	[1]Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
16-Sep-2005	432.79	2.27	1,720
10-Aug-2007	433.34	2.82	3,130
5-Nov-2007	434.64	4.12	8,340

[1] Stage elevation determined based on gage datum of 430.52 ft NAVD 88

Source: USGS, 2008e

Table 2.4-38— {Annual Minimum Water Levels and Streamflow Measurements at Wilkes-Barre PA Station}

(Page 1 of 3)

Date	[1]Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
26-Sep-1900	513.06	2.20	961
20-Aug-1901	513.96	3.10	2,170
20-Sep-1902	513.96	3.10	2,170
15-Sep-1904	514.56	3.70	3,540
7-Nov-1904	515.35	4.49	5,660
29-Mar-1905	530.83	19.97	97,680
2-Jul-1906	516.37	5.51	9,400
16-Oct-1907	516.35	5.49	11,200
29-Oct-1908	513.52	2.66	1,657
4-May-1909	526.44	15.58	59,171
5-Aug-1913	512.99	2.13	1,017
2-Jun-1914	515.21	4.35	5,581
25-Aug-1914	516.82	5.96	10,492
8-Oct-1915	517.87	7.01	15,146
11-Jul-1916	515.15	4.29	5,859
1-Oct-1919	513.26	2.40	1,810
12-Feb-1920	513.81	2.95	2,620
11-Jun-1920	513.94	3.08	3,200
14-Sep-1921	512.99	2.13	1,490
21-Aug-1922	513.82	2.96	2,930
14-Aug-1923	512.88	2.02	1,360
13-Aug-1924	513.64	2.78	2,410
18-May-1925	516.34	5.48	9,670
19-Jul-1926	513.42	2.56	1,950
13-Aug-1929	512.4	1.54	1,270
19-Aug-1930	511.93	1.07	1,010
11-Sep-1930	512.27	1.41	1,210
5-Oct-1932	512.34	1.48	1,240
5-Aug-1933	512.54	1.68	1,660
12-Jul-1934	512.64	1.78	1,870
22-Oct-1935	512.41	1.55	1,720
16-Jul-1936	512.38	1.52	1,350
31-Jul-1937	513.02	2.16	2,160
14-Sep-1938	512.55	1.69	1,710
18-Sep-1939	511.55	0.69	609
8-Aug-1940	512.71	1.85	1,960
3-Oct-1941	511.75	0.89	715
4-Dec-1941	512.84	1.98	1,920
29-Sep-1943	511.95	1.09	1,110
7-Sep-1944	511.9	1.04	1,200
29-Aug-1945	513.23	2.37	3,210
12-Sep-1946	512.57	1.71	2,210
8-Oct-1947	512.33	1.47	1,980
28-Sep-1948	511.92	1.06	1,280
8-Sep-1949	512.62	1.76	2,230

Table 2.4-38— {Annual Minimum Water Levels and Streamflow Measurements at Wilkes-Barre PA Station}
(Page 2 of 3)

Date	(1)Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
31-Oct-1950	513.3	2.44	3,570
16-Oct-1951	512.5	1.64	1,960
12-Nov-1952	511.76	0.90	1,530
2-Oct-1953	511.24	0.38	839
2-Nov-1954	511.78	0.92	1,340
12-Jul-1955	512.2	1.34	1,840
22-Aug-1956	512.26	1.40	2,090
4-Sep-1957	511.64	0.78	1,410
16-Aug-1958	512.95	2.09	3,220
22-Sep-1959	510.82	-0.04	833
23-Aug-1960	512.4	1.54	2,470
31-Oct-1961	511.05	0.19	1,370
7-Sep-1962	510.01	-0.85	671
21-Oct-1963	509.45	-1.41	736
22-Sep-1964	509.13	-1.73	545
13-Aug-1965	509.57	-1.29	788
7-Sep-1966	509.89	-0.97	985
19-Sep-1967	511.43	0.57	2,980
30-Sep-1968	509.8	-1.06	2,000
24-Sep-1969	510.67	-0.19	1,320
14-Sep-1970	510.77	-0.09	1,480
22-Jul-1971	510.76	-0.10	1,430
17-Oct-1972	511.39	0.53	2,200
25-Oct-1973	511.05	0.19	1,590
2-Aug-1974	511.99	1.13	3,720
28-Aug-1975	511.85	0.99	3,200
22-Jul-1976	513.35	2.49	6,820
13-Jul-1977	512.24	1.38	3,800
14-Sep-1978	511.06	0.20	1,500
24-Jul-1979	511.47	0.61	2,780
17-Sep-1980	510.19	-0.67	1,010
6-Aug-1981	511.3	0.44	2,220
6-Oct-1982	510.48	-0.38	1,270
13-Sep-1983	510.23	-0.63	994
31-Oct-1984	511.6	0.74	2,710
22-Aug-1985	510.54	-0.32	1,080
29-Aug-1986	512.23	1.37	3,990
2-Jun-1987	512.37	1.51	4,660
28-Oct-1987	513.03	2.17	5,790
23-Aug-1989	511.1	0.24	2,070
5-Oct-1989	511.57	0.71	2,780
8-Aug-1991	510.37	-0.49	905
9-Oct-1992	512.25	1.39	3,960
5-Aug-1993	510.69	-0.17	1,380
25-Aug-1994	518.06	7.20	21,900

Table 2.4-38— {Annual Minimum Water Levels and Streamflow Measurements at Wilkes-Barre PA Station}
(Page 3 of 3)

Date	[1]Stage Elevation (ft) NAVD 88	Gauge Height (ft)	Streamflow (cfs)
19-Jul-1995	510.78	-0.08	789
10-Jun-1996	514.03	3.17	9,230
18-Jul-1997	511.19	0.33	2,370
17-Oct-1997	510.64	-0.22	1,590
12-Aug-1999	510.28	-0.58	757
7-Oct-1999	513.05	2.19	6,530
9-Aug-2001	510.99	0.13	1,740
11-Sep-2001	510.59	-0.27	1,110
20-Nov-2003	510.86	9.91	4,470
31-Mar-2005	510.86	20.05	1,050
20-Jul-2006	514.09	3.23	9,270
5-Sep-2007	510.65	-0.21	1,380
4-Oct-2007	511.09	0.23	2,120

[1] Stage elevation determined based on gage datum of 510.86 ft NAVD 88
Source: USGS, 2008f

Table 2.4-39— {Annual Low Flow Statistics for Danville and Wilkes-Barre Stations}

Gauge Station	Drainage Area (mi^2)	Period of Record	$Q_{1,10}$ (cfs)	$Q_{7,10}$ (cfs)	$Q_{30,10}$ (cfs)	Mean (cfs)	Median (cfs)	Harmonic Mean (cfs)
USGS Wilkes-Barre (upstream)	9,960	1899 - 2006	799	850	1,032	13,606	7,390	4,283
USGS Danville (downstream)	11,220	1900 - 2006	945	1,017	1,284	15,501	8,770	5,262
BBNPP Site (using upstream gage)	10,200	-	818	870	1,056	-	-	-
BBNPP Site (using downstream gage)	10,200	-	859	924	1,167	-	-	-

Notes:

- BBNPP Site statistics were interpolated based on USGS gauging stations near SSES intake structure.
- Q1,10 flow is the mean stream flow over 1 day which, on a statistical basis, can be expected to occur once every 10 years.
- Q7,10 flow is the mean stream flow over 7 consecutive days which, on a statistical basis, can be expected to occur once every 10 years.
- Q30,10 flow is the mean stream flow over 30 consecutive days which, on a statistical basis, can be expected to occur once every 10 years.

Table 2.4-40— {Estimated Recurrence Interval for the Lowest Recorded Flow, Wilkes-Barre and Danville Stations}

Gage Station	Water Year of Low Flow Event	Flow(cfs)	Estimated Recurrence Interval		
			Weilbull T_r (yr)	Gumbel T_r (yr)	Log Pearson Type III *T_r (yr)
Wilkes-Barre	1964	532	109	33	4
Danville	1964	558	102	87	4
* T_r estimated using power trendline with R2 < 0.90 at each gauging station.					

Table 2.4-41— {Physical Characteristics of Groundwater Wells in the NBSR, Pennsylvania}

Geologic Unit	Well Type [1]	Well Depth (ft)				Casing Length (ft)				Depth to Water (ft)			
		No. of Wells	Percentile [2]			No. of Wells	Percentile [2]			No. of Wells	Percentile [2]		
			25th	50th	75th		25th	50th	75th		25th	50th	75th
Alluvium,Glacial Overburden	D	56	42	56	88	54	44	57	90	45	10	18	24
	N	71	35	68	97	43	28	51	83	37	8	17	30
Catskill Formation	D	950	145	198	275	918	30	42	80	737	7	55	101
	N	247	194	293	438	182	37	62	100	155	25	60	120
Trimmers Rock Formation	D	84	117	199	255	78	20	22	40	58	20	31	58
	N	11	197	300	395	8	-	60	-	7	-	35	-
Mahantango and Marcellus Formations	D	124	75	120	155	106	21	30	45	95	15	23	36
	N	29	150	300	500	24	25	39	46	20	7	16	30
Onondaga and Old Port Formations	D	6	-	147	-	5	-	22	-	5	-	30	-
	N	11	90	218	420	11	35	47	77	11	15	25	34
Keyser and Tonoloway Formations	D	17	75	150	185	17	35	45	95	13	10	35	71
	N	9	-	205	-	8	-	55	-	9	-	19	-

Notes:
(1) D = Domestic, N = Nondomestic
(2) Percent of wells that have values less than or equal to the value shown

Table 2.4-42— {Yields and Specific Capacities of Groundwater Wells in the NBSR, Pennsylvania}

Geologic Unit	Well Type(1)	Reported Well Yield (gpm)				Specific Capacity (gpm/ft)			
		No. of Wells	Percentile (2)			No. of Wells	Percentile (2)		
			25th	50th	75th		25th	50th	75th
Alluvium, Glacial Outwash	D	56	12	18	22	10	0.34	0.8	2
	N	60	50	164	500	20	7	20	43
Catskill Formation	D	931	7	12	20	352	0.16	0.5	1.0
	N	215	17	35	85	82	0.3	0.7	1.9
Trimmers Rock Formation	D	79	3	6	10	18	0.03	0.06	0.17
	N	11	10	15	30	5	-	0.10	-
Mahantango and Marcellus Formations	D	103	6	10	17	53	0.06	0.18	0.69
	N	29	20	65	175	15	0.23	1.1	2.5
Onondaga and Old Port Formations	D	6	-	10	-	4	-	0.16	-
	N	9	-	122	-	6	-	3.5	-
Keyser and Tonoloway Formations	D	16	10	14	28	7	-	0.53	-
	N	7	-	80	-	6	-	2.1	-

Notes:
(1) D = Domestic, N = Nondomestic
(2) Percent of wells that have values less than or equal to the value show

Table 2.4-43— {Specific Capacities of Groundwater Wells in the Berwick-Bloomsburg-Danville Area}

Geologic unit	No. of Wells	Median Well Depth (ft) (1)	Specific Capacity (gpm/ft)			
			Percentile (2)			Range
			25th	50th	75th	
Glacial outwash	10	66	3.7	11	19	1.4-84
Catskill Formation	15	165	0.16	0.39	1.2	0.08-3.8
Trimmers Rock Formation	8	200	0.06	0.13	0.37	0.03-0.55
Harrell and Mahantango Formations	16	263	0.06	0.27	0.79	0.03-2.5
Marcellus Formation	15	255	0.07	0.19	0.5	0.03-18
Onondaga and Old Port Formations	13	259	1.2	3.2	9.3	0.47-350
Keyser and Tonoloway Formations	18	205	1.6	4.6	20	0.35-280
Shale	35	268	0.07	0.23	0.5	0.03-18
Sandstone and shale	23	200	0.12	0.22	0.55	0.03-3.8
Sandstone, limestone, and shale	11	250	0.07	0.13	0.8	0.03-1.4
Carbonate rock and shale	28	202	1.5	3.1	5.5	0.23-250
Carbonate rock	18	205	1.6	4.6	20	0.35-280

Notes:
(1) Feet below ground surface
(2) Percent of wells that have values less than or equal to the value shown

Table 2.4-44— {Groundwater Well Yields in the Berwick-Bloomsburg - Danville Area as a Function of Lithology}

Aquifer	Well Type (1)	No. of Wells	Median Well Depth (ft)(2)	Reported Well Yield (gpm)			
				Percentile (3)			Range
				25th	50th	75th	
Sand and gravel	D	4	44	-	20	-	15-50
	N	8	58	-	40	-	18-100
Shale	D	168	122	5	10	15	0.5-50
	N	31	300	8	15	50	1-225
Sandstone and shale	D	163	150	6	8	10	0.5-60
	N	19	300	20	32	64	3-100
Sandstone, limestone and shale	D	31	191	5	10	20	2-50
	N	7	305	-	93	-	10-300
Carbonate rock and shale	D	63	110	6	12	20	2-100
	N	22	224	23	38	49	20-184
Carbonate rock	D	28	165	10	20	30	3-150
	N	14	280	65	160	383	24-900

Notes:
(1) D = Domestic, N = Nondomestic
(2) Feet below ground surface
(3) Percent of wells that have values less than or equal to the value shown

Table 2.4-45— {Computed Water Budget Components for Selected Drainage Basins in the NBSR Basin}

Watershed	Period of Data	Water Budget Components (in/yr)				Source
		Precipitation	Surface Runoff	Groundwater Discharge	Evapotranspiration	
Towanda Creek Basin	1961-1980	35.10(26.21-44.47)	7.82(1.98-16.44)	10.34(5.05-16.26)	16.94(10.71-24.28)	Taylor, 1984
Wapwallopen Creek Basin	1961-1980	43.87(32.04-64.48)	5.94(3.69-11.77)	14.20 (6.60-21.81)	23.73(16.57-41.85)	Taylor, 1984
Tunkhannock Creek Basin	1961-1980	42.69(34.41-52.74)	7.35(2.14-11.28)	11.98(5.65-18.43)	23.36(16.68-28.03)	Taylor, 1984
East Branch Chillisquaque Creek	1963-1966	33.3	11.4(1)		21.9	Williams, 1987
East Branch Chillisquaque Creek	1972-1975	50.3	27.1(1)		22.8	Williams, 1987
Fishing Creek	1963-1966	33.3	17.4(2)		15.9	Williams, 1987
Fishing Creek	1972-1975	50.3	31.9(2)		18.4	Williams, 1987

Notes:

(1) Number represents total runoff (surface water and groundwater combined). Groundwater is approximately 44% of the total runoff.

(2) Number represents total runoff (surface water and groundwater combined). Groundwater is approximately 63% of the total runoff

Table 2.4-46— {BBNPP Monitoring Wells and Construction Details}
(Page 1 of 2)

Well ID	Northing [(1)] (ft)	Easting [(1)] (ft)	Ground Elevation [(2)] (ft)	Top of Casing Elevation [(2)] (ft)	Well Depth (ft bgs)	Screen Diameter, Slot Size (in)	Screen Interval Depth		Screen Interval Elevation [(2)]		Filterpack Interval Depth	
							Top (ft bgs)	Bottom (ft bgs)	Top (ft)	Bottom (ft)	Top (ft bgs)	Bottom (ft bgs)
Glacial Overburden Wells												
MW301A	339097.64	2405396.73	662.48	664.54	36.50	4.0 / 0.01	21.50	36.50	640.98	625.98	13.00	21.50
MW302A1	339410.17	2406939.74	665.18	667.41	35.15	4.0 / 0.01	20.00	35.00	645.18	630.18	17.00	35.15
MW302A2	339410.07	2406925.67	665.25	667.42	35.34	4.0 / 0.01	20.00	35.00	645.25	630.25	11.00	35.34
MW302A3	339410.16	2406899.92	665.34	667.70	35.71	4.0 / 0.01	20.70	35.70	644.64	629.64	11.00	35.71
MW302A4	339495.31	2406939.42	665.56	667.70	37.60	4.0 / 0.01	22.50	37.50	643.06	628.06	12.00	39.00
MW303A	341504.72	2405505.31	734.13	736.18	28.00	4.0 / 0.01	18.00	28.00	716.13	706.13	12.00	28.00
MW304A	340228.16	2408455.38	680.61	682.65	37.00	4.0 / 0.01	17.00	37.00	663.61	643.61	17.00	37.00
MW305A1	341896.43	2407090.85	715.30	717.35	43.00	4.0 / 0.01	23.00	43.00	692.30	672.30	18.00	43.00
MW305A2	341888.61	2407096.81	714.64	717.01	76.00	4.0 / 0.01	56.00	76.00	658.64	638.64	51.00	76.00
MW306A	338899.63	2404351.67	662.46	664.67	38.00	4.0 / 0.01	23.00	38.00	639.46	624.46	11.00	38.00
MW307A	337632.51	2407085.99	688.60	690.96	37.00	4.0 / 0.01	22.00	37.00	666.60	651.60	12.00	37.00
MW308A	338355.50	2405979.80	661.38	663.42	33.50	4.0 / 0.01	13.50	33.50	647.88	627.88	12.00	33.50
MW309A	338707.94	2408989.20	673.33	675.62	20.90	4.0 / 0.01	10.80	20.80	662.53	652.53	6.00	29.90
MW310A	339453.78	2405156.30	674.48	676.73	19.20	4.0 / 0.01	9.20	19.20	665.28	655.28	8.00	19.20
MW410	339662.11	2406412.50	679.04	680.04	36.00	4.0/ 0.02	21.00	36.00	658.04	643.04	19.00	39.00
Shallow Bedrock Wells												
MW301B1	339098.94	2405384.28	662.40	664.39	160.00	4.0 / 0.01	130.00	160.00	532.40	502.40	105.00	162.00
MW301B2	339142.99	2405338.53	664.18	666.48	150.00	1.5 / 0.01	130.00	150.00	534.18	514.18	126.00	151.00
MW301B3	339069.30	2405288.63	662.41	664.61	100.00	1.5 / 0.01	80.00	100.00	582.41	562.41	75.00	100.00
MW301B4	338987.79	2405444.97	658.46	660.51	100.00	1.5 / 0.01	80.00	100.00	578.46	558.46	74.00	100.00
MW303B	341504.61	2405493.42	733.53	735.65	97.00	2.0 / 0.01	77.00	97.00	656.53	636.53	65.00	97.00
MW304B	340245.01	2408443.45	681.27	683.09	181.00	2.0 / 0.01	161.00	181.00	520.27	500.27	151.00	181.00
MW305B	341880.51	2407108.09	714.10	716.19	140.00	2.0 / 0.01	120.00	140.00	594.10	574.10	110.00	140.00
MW308B	338356.71	2405969.62	661.00	663.36	79.40	2.0 / 0.01	59.00	79.00	602.00	582.00	54.40	79.40
MW309B	338708.71	2408999.09	673.16	675.31	160.00	2.0 / 0.01	140.00	160.00	533.16	513.16	129.00	160.00
MW310B	339454.71	2405176.41	675.31	678.04	90.00	2.0 / 0.01	70.00	90.00	605.31	585.31	55.00	90.40
MW311B	339328.29	2405252.94	668.90	671.29	100.00	1.5 / 0.01	80.00	100.00	588.90	568.90	75.00	100.00
MW312B	338820.62	2405297.70	656.90	659.00	100.00	1.5 / 0.01	85.00	100.00	571.90	556.90	75.00	100.00
MW313B	338927.92	2405815.58	657.68	659.97	100.00	1.5 / 0.01	80.00	100.00	577.68	557.68	70.00	100.00

Table 2.4-46— {BBNPP Monitoring Wells and Construction Details}
(Page 2 of 2)

Well ID	Northing [1] (ft)	Easting [1] (ft)	Ground Elevation [2] (ft)	Top of Casing Elevation [2] (ft)	Well Depth (ft bgs)	Screen Diameter, Slot Size (in)	Screen Interval Depth		Screen Interval Elevation [2]		Filterpack Interval Depth	
							Top (ft bgs)	Bottom (ft bgs)	Top (ft)	Bottom (ft)	Top (ft bgs)	Bottom (ft bgs)
MW313C[3]	338922.54	2405754.79	657.24	659.42	130.00	1.0 / 0.01	110.00	130.00	547.24	527.24	100.00	130.00
MW315B	340738.30	2406234.46	720.08	719.82	70.00	1.5 / 0.01	50.00	70.00	670.08	650.08	45.00	70.00
MW316B	340298.18	2406433.93	702.37	702.08	80.00	1.0 / 0.01	60.00	80.00	642.37	622.37	55.00	80.00
MW317B	339772.49	2406401.48	681.17	683.30	70.00	1.0 / 0.01	50.00	70.00	631.17	611.17	45.00	70.00
MW318B	340439.18	2405516.32	801.32	803.79	70.00	1.0 / 0.01	50.00	70.00	751.32	731.32	40.00	70.00
MW319B	340239.46	2405518.14	790.57	793.04	100.00	1.0 / 0.01	80.00	100.00	710.57	690.57	60.00	100.00
MW401	340753.25	2405097.68	780.44	782.20	150.20	4.0/ 0.04	120.00	150.00	660.44	630.44	116.00	153.90
MW402	340870.66	2405855.94	785.24	787.51	117.20	4.0/ 0.04	87.00	117.00	698.24	668.24	82.00	122.00
MW403	340579.28	2405542.37	801.97	804.23	167.00	4.0/ 0.04	137.00	167.00	664.97	634.97	132.00	167.00
MW404	340170.50	2404985.30	735.42	738.02	95.00	4.0/ 0.04	65.00	95.00	670.42	640.42	60.50	95.00
MW405	339970.47	2404646.35	693.84	696.52	75.85	4.0/ 0.04	45.45	75.45	648.39	618.39	40.00	76.00
MW406	339710.35	2404789.81	712.51	715.04	90.00	4.0/ 0.04	60.00	90.00	652.51	622.51	55.00	90.00
MW407	339784.93	2405144.25	734.76	737.49	115.00	4.0/ 0.04	85.00	115.00	649.76	619.76	83.00	115.00
MW408	340342.30	2405819.88	767.00	768.96	130.20	4.0/ 0.04	100.00	130.00	667.00	637.00	96.10	134.30
MW409	339760.65	2405905.35	720.79	723.57	100.00	4.0/ 0.04	70.00	100.00	650.79	620.79	65.00	100.00
Deep Bedrock Wells												
MW301C	339151.79	2405430.68	666.38	668.79	400.00	1.0 / 0.01	370.00	400.00	296.38	266.38	375.00	400.00
MW302B[4]	339409.88	2406954.17	665.29	667.42	215.00	2.0 / 0.01	195.00	215.00	470.29	450.29	165.00	215.00
MW303C	341503.54	2405483.36	732.94	734.98	250.00	2.0 / 0.01	230.00	250.00	502.94	482.94	181.00	250.00
MW304C	340236.49	2408449.59	680.57	682.44	400.00	2.0 / 0.01	360.00	400.00	320.57	280.57	340.00	400.00
MW306C	338889.03	2404353.48	662.47	664.70	330.00	2.0 / 0.01	280.00	330.00	382.47	332.47	270.00	330.00
MW307B[4]	337632.75	2407096.69	688.33	690.85	270.00	2.0 / 0.01	250.00	270.00	438.33	418.33	200.00	270.00
MW310C	339452.09	2405233.06	675.38	678.35	119.50	2.0 / 0.01	169.50	199.50	505.88	475.88	159.50	199.50
MW311C	339313.21	240.00	669.07	671.18	203.00	1.5 / 0.01	183.00	203.00	486.07	466.07	178.00	203.00

Notes:

(1) Horizontal Datum NAD83 State Plane feet

(2) Vertical Datum NAVD88 feet

(3) Well MW313C grouped with Shallow Bedrock Wells because well screen is only 130 ft bgs.

(4) Wells MW302B and MW307B were grouped with Deep Bedrock Wells because water-producing zones were not detected in shallow bedrock and, as a result, the wells were installed deeper than originally planned.

Table 2.4-47— {Monthly Groundwater Elevation Measurements, BBNPP Site, 2007-2008}

(Page 1 of 2)

Monitoring Well ID	Elevation (ft) (1)		Groundwater Elevation (ft) (1)												
	Ground Surface	Top of Riser Pipe Reference Point	November 1, 2007	November 29, 2007	December 13, 2007	January 26, 2008	February 25, 2008	March 24, 2008	April 14, 2008	May 20, 2008	June 9, 2008	July 23, 2008	August 12, 2008	September 4, 2008	October 1-2, 2008
Glacial Outwash Wells															
MW301A	662.48	664.54	655.71	657.66	657.53	657.68	658.76	659.33	658.08	657.38	656.86	655.79	655.67	655.03	654.58
MW302A1	665.18	667.41	658.38	660.74	660.81	661.57	662.95	663.85	662.09	660.87	660.12	658.56	658.36	657.86	657.65
MW302A2	665.25	667.42	658.38	660.75	660.82	661.58	662.95	663.84	662.10	660.85	660.12	658.56	658.36	657.86	657.66
MW302A3	665.34	667.70	658.37	660.73	660.80	661.53	662.91	663.79	662.03	660.80	660.07	661.51	658.31	657.81	657.59
MW302A4	665.56	667.70	658.37	660.75	660.80	661.57	662.97	663.86	661.71	660.86	660.13	658.57	658.37	657.87	657.67
MW303A	734.13	736.18	713.33	714.62	714.18	714.32	715.96	717.11	714.82	714.93	714.41	713.54	713.79	713.13	712.64
MW304A	680.61	682.65	668.74	670.32	670.59	671.05	671.73	672.16	671.41	670.92	670.08	669.07	669.00	668.27	668.53
MW305A1	715.30	717.35	704.70	705.94	706.11	706.86	708.43	708.01	706.96	706.75	705.96	704.86	704.81	704.30	704.60
MW305A2	714.64	717.01	704.63	705.76	705.90	706.44	707.65	707.23	706.41	706.20	705.48	704.58	704.58	704.05	704.39
MW306A	662.46	664.67	655.09	656.66	656.22	655.93	656.85	657.07	655.92	655.67	655.10	654.41	654.45	653.83	654.29
MW307A	688.60	690.96	684.75	686.10	686.01	684.65	685.55	685.82	685.83	686.50	684.22	684.04	683.34	681.80	683.23
MW308A	661.38	663.42	655.35	656.79	656.52	656.21	656.93	657.02	656.40	656.31	655.63	655.03	654.96	654.12	654.70
MW309A	673.33	675.62	667.23	669.84	669.62	669.25	670.57	670.57	669.25	669.01	667.19	664.26	665.08	664.64	664.89
MW310A	674.48	676.73	657.40	659.51	659.18	659.25	660.64	661.09	659.37	658.37	657.90	656.89	656.76	656.40	657.40
Shallow Bedrock Wells															
MW301B1	662.40	664.39	657.47	659.77	659.44	659.37	660.43	660.62	659.29	658.93	658.36	657.50	657.46	656.93	657.38
MW301B2	664.18	666.48	656.13	657.71	657.58	660.69	658.76	659.28	657.92	657.38	656.86	655.83	655.70	655.05	655.29
MW301B3	662.41	664.61	654.20	657.40	657.23	657.22	658.22	658.64	657.45	657.04	656.52	658.63	655.51	654.86	655.18
MW301B4	658.46	660.51	649.70	657.84	657.59	657.80	659.16	658.98	657.82	657.37	656.76	655.85	655.78	655.10	655.46
MW303B	733.53	735.65	717.15	720.17	718.55	717.64	720.11	720.27	717.89	718.67	716.81	715.68	716.09	715.16	714.76
MW304B	681.27	683.09	668.61	670.07	670.24	670.60	670.95	671.56	670.93	670.49	669.66	668.49	669.27	668.75	668.32
MW305B	714.10	716.19	704.62	705.68	705.82	706.35	707.54	707.09	706.30	706.12	705.40	704.55	704.52	704.00	704.36
MW308B*	661.00	663.36	594.86	596.91	597.79	600.48	594.13	588.69	589.96	587.38	588.51	590.84	587.64	588.78	590.03
MW309B	673.16	675.31	665.56	667.47	667.16	666.61	667.15	667.33	666.57	666.10	664.98	663.87	664.52	663.17	663.61
MW310B	675.31	678.04	661.69	664.23	664.03	664.81	666.33	666.24	664.71	664.36	663.75	662.82	662.89	662.57	662.85

Table 2.4-47— {Monthly Groundwater Elevation Measurements, BBNPP Site, 2007-2008}

(Page 2 of 2)

Monitoring Well ID	Elevation (ft) (1)		Groundwater Elevation (ft) (1)												
	Ground Surface	Top of Riser Pipe Reference Point	November 1, 2007	November 29, 2007	December 13, 2007	January 26, 2008	February 25, 2008	March 24, 2008	April 14, 2008	May 20, 2008	June 9, 2008	July 23, 2008	August 12, 2008	September 4, 2008	October 1-2, 2008
MW311B	668.90	671.29	656.95	659.58	659.31	659.47	660.75	661.17	659.56	658.68	658.16	656.89	656.71	656.10	656.08
MW312B	656.90	659.00	650.12	656.60	656.47	656.99	657.70	658.20	656.70	656.39	655.83	655.00	654.98	654.34	654.80
MW313B	657.68	659.97	655.82	657.77	657.63	658.24	659.32	659.97	657.99	657.61	656.87	655.93	655.81	655.07	655.37
MW313C	657.24	659.42	NA	657.87	658.77	658.24	657.76	658.01	657.84	657.44	656.76	655.91	655.80	655.12	655.48
MW315B	720.08	719.82	NA	717.67	717.65	718.67	719.27	719.79	718.05	717.75	717.09	716.06	715.98	715.65	715.22
MW316B	702.37	702.08	NA	692.24	692.10	693.54	694.72	693.78	693.12	694.27	693.21	691.36	691.31	690.65	690.58
MW317B	681.17	683.30	NA	660.06	660.10	660.78	662.07	662.91	661.20	659.97	659.40	657.88	657.70	657.15	656.94
MW318B*	801.32	803.79	NA	750.22	750.28	759.15	761.39	761.04	758.43	758.61	757.18	754.29	755.57	751.19	750.91
MW319B*	790.57	793.04	NA	705.90	709.38	719.19	722.66	721.71	718.85	718.27	716.62	713.52	713.19	712.02	710.71
Deep Bedrock Wells															
MW301C	668.38	668.79	(2)	(2)	(2)	(2)	(2)	(2)	(2)	662.01	664.76	663.97	663.75	663.38	663.49
MW302B(3)	665.29	667.42	666.68	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
MW303C	732.94	734.98	703.90	706.34	705.08	704.18	705.71	704.70	702.00	701.34	699.76	698.08	699.12	698.72	698.22
MW304C	680.57	682.44	NA	666.97	668.69	670.43	670.72	671.14	670.59	670.43	669.87	668.63	667.93	667.25	668.46
MW306C	662.47	664.70	655.70	657.30	656.90	656.79	657.72	657.82	656.69	657.15	657.23	656.48	656.48	656.06	656.34
MW307B(3)	688.33	690.85	611.55	618.73	621.15	626.86	635.13	637.52	626.94	622.27	620.23	612.25	612.33	610.95	611.32
MW310C	675.38	678.35	NA	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
MW311C*	669.07	671.18	NR	523.54	524.84	528.81	531.51	534.15	535.98	539.27	541.08	545.07	NR	549.10	551.58

Notes:

(1) Vertical datum NAVD88 feet

(2) Monitoring well MW301C was installed on May 20, 2008; water level monitoring was not performed prior to this date.

(3) Monitoring wells MW302B and MW307B were drilled deeper than originally planned in order to intersect a water-bearing zone. These wells are therefore classified as Deep Bedrock wells because their screens are deeper than 175 ft bgs.

(4) Flowing groundwater conditions encountered. Groundwater elevation was set equal to the top of the PVC riser pipe (reference point).

NA = Not Applicable

NR = Not Recorded

* = Groundwater elevations are considered anomalous. Data are not used to construct potentiometric contours (when applicable).

Table 2.4-48— {Monthly Surface Water Elevation Measurements, BBNPP}

Gauging Station ID	Elevation (ft)													
	Reference Point	November 1, 2007	November 29, 2007	December 13, 2007	January 28, 2008	February 29, 2008	March 25, 2008	April 15, 2008	April 30, 2008	May 21, 2008	June 10, 2008	July 23, 2008	August 12, 2008	September 4, 2008	October 2, 2008
Stream Gauging Stations															
G1	670.97	(1)	662.20	659.39	662.09	662.30	662.28	662.21	(1)	662.24	661.97	661.98	662.04	661.85	662.07
G2	656.81	(1)	647.25	647.21	646.57	646.98	647.00	646.18	(1)	646.89	646.24	646.53	646.38	646.04	646.45
G3	729.20	(1)	722.50	722.45	722.47	722.49	719.54	722.45	(1)	722.60	722.45	722.45	722.42	(2)	722.50
G5	608.10	(1)	(1)	601.70	601.77	601.95	601.90	601.85	(1)	601.77	601.66	604.75	601.80	(2)	601.70
G10	529.77	(1)	(1)	518.39	520.77	521.02	(1)	518.20	(1)	518.35	518.27	518.28	518.25	518.16	518.15
G12	661.25	(1)	(1)	(1)	(1)	(1)	(1)	658.46	658.44	658.53	658.31	659.29	658.39	658.29	658.43
G13	649.12	(1)	(1)	(1)	(1)	(1)	638.82	638.62	(1)	638.71	638.23	638.88	638.36	638.08	638.44
Pond Gauging Stations															
G6	714.27	711.97	711.77	713.07	713.29	713.47	713.79	713.41	(1)	713.03	712.71	712.14	712.05	711.65	711.66
G7	687.52	685.04	685.00	684.93	684.58	684.52	684.66	685.12	(1)	685.36	685.30	685.17	685.48	684.62	685.21
G8	656.62	653.86	654.16	654.31	654.04	654.22	654.30	654.54	654.53	654.72	654.72	653.41	654.12	653.90	654.49
G9	667.75	665.48	666.03	666.04	666.02	666.55	666.63	665.45	(1)	666.47	666.19	665.85	665.87	665.56	665.69

Notes:
Vertical datum NAVD88
(1) No measurement taken
(2) No measurement; wet conditions, but no flow

Table 2.4-49— {Water Use in the Upper Susquehanna River Basin 1970}

Type of Use	Withdrawals					
	Groundwater		Surface Water		Total	
	million gpd	lpd	million gpd	lpd	million gpd	lpd
Public Supply	13.1	4.95E+07	99.5	3.76E+08	112.6	4.26E+08
Domestic Supply	8.3	3.14E+07	0.0	0.00E+00	8.3	3.14E+07
Industrial	8.1	3.06E+07	34.0	1.29E+08	42.1	1.59E+08
Mineral	10.3	3.89E+07	5.5	2.08E+07	15.8	5.97E+07
Agricultural	3.6	1.36E+07	2.0	7.56E+06	5.6	2.12E+07
Golf Course	0.2	7.56E+05	1.0	3.78E+06	1.2	4.54E+06
Institutional	0.6	2.27E+06	0.4	1.51E+06	1.0	3.78E+06
Power	0.0	0.00E+00	120.9	4.57E+08	120.9	4.57E+08
Totals	44.2	1.67E+08	263.3	9.95E+08	307.5	1.16E+09

Notes:
gpd = gallons per day
lpd = liters per day
Reference: Taylor, 1984

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 1 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
92309	BERWICK WATER C	NA	Columbia	41.05444	-76.23167	160	500	NK	NA	PS
92310	BERWICK WATER C	NA	Columbia	41.05417	-76.23222	90	500	NK	NA	PS
92311	BERWICK WATER C	NA	Columbia	41.05389	-76.23278	87	500	NK	NA	PS
92306	CONSOL CIGAR CO	NA	Columbia	41.07833	-76.24111	284	NA	NA	NA	I
92307	CONSOL CIGAR CO	NA	Columbia	41.06139	-76.24222	151	NA	NA	NA	I
14175	CONSOLIDATED CIGAR CORP	3/12/1957	Columbia	41.06139	-76.24083	284	200	NK	NA	AC
14176	CONSOLIDATED CIGAR CORP	4/11/1957	Columbia	41.06139	-76.24194	151	NA	NA	NA	U
260836	DANA	11/18/1998	Columbia	41.05583	-76.2075	54	NA	NA	NA	O
260837	DANA	11/18/1998	Columbia	41.05583	-76.2075	48	NA	NA	NA	O
260838	DANA	11/18/1998	Columbia	41.05583	-76.2075	54	NA	NA	NA	O
260839	DANA	11/18/1998	Columbia	41.05583	-76.2075	42	NA	NA	NA	O
261342	DANA	11/18/1998	Columbia	41.05583	-76.2075	42	NA	NA	NA	O
14000	DIBATTISTA JOHN	4/28/1975	Columbia	41.06028	-76.2500	100	10	TM	36	D
14165	KEYSTONE WATER CO.	1/1/1957	Columbia	41.05444	-76.2325	87	1300	NK	32	PS
14166	KEYSTONE WATER CO.	6/24/1957	Columbia	41.05444	-76.23278	90	1200	NK	31	PS
14167	KEYSTONE WATER CO.	3/29/1957	Columbia	41.05500	-76.23278	160	1300	NK	32	PS
13991	PENNDOT	1/1/1977	Columbia	41.05361	-76.23278	NA	NA	NA	NA	U
13992	PENNDOT	1/1/1977	Columbia	41.05389	-76.23306	NA	NA	NA	NA	U
13993	PENNDOT	1/1/1977	Columbia	41.05417	-76.23333	NA	NA	NA	NA	U
13994	PENNDOT	1/1/1977	Columbia	41.05417	-76.23333	NA	NA	NA	NA	U
92426	NA	1/1/1969	Columbia	41.09250	-76.25500	150	8	NK	NA	D
92407	ALBERTSON R	1/1/1966	Columbia	41.09083	-76.25778	115	15	NK	30	D
92367	ALBERTSON T	11/17/1982	Columbia	41.08556	-76.25139	122	5	V	NA	D
424584	ALLEY-O'REILLY	6/17/2008	Columbia	41.07347	-76.25232	400	3	V	NA	D
14283	BECK, JACK	8/3/1973	Columbia	41.10222	-76.23611	175	10	V	NA	D
14287	CARRATHERS MARTIN	9/21/1972	Columbia	41.10306	-76.23000	100	8	V	NA	D
14288	CARRATHERS WILLIAM	9/18/1972	Columbia	41.10389	-76.23056	105	8	V	65	D
92422	COLLINS E	1/1/1970	Columbia	41.09250	-76.25500	185	10	NK	NA	D
14272	COLLINS, EUGENE A	2/19/1970	Columbia	41.09722	-76.25333	185	NA	NA	114	D
417939	DICKDELAVENTIST	9/15/2006	Columbia	41.13162	-76.24232	200	10	V	NA	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}
(Page 2 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
92423	DENT JACK	1/1/1973	Columbia	41.09250	-76.25500	150	12	NK	NA	D
14281	DENT, JACK W	8/2/1973	Columbia	41.10056	-76.24111	150	12	NK	NA	D
14265	DENT, RICHARD	3/26/1974	Columbia	41.09583	-76.25917	150	6	NK	NA	D
14280	FULTZ, CURTIS	7/18/1972	Columbia	41.10000	-76.23917	175	16	V	80	D
92425	GRASLEY HAROLD	1/1/1972	Columbia	41.09250	-76.25500	150	8	NK	NA	D
14017	HECKMAN, DREW	8/16/1968	Columbia	41.07667	-76.24333	75	12	NK	NA	D
14292	HESS, KENNETH L	9/12/1973	Columbia	41.10639	-76.25556	100	8	NK	NA	D
14254	HOFFMAN, DRUE C	10/9/1966	Columbia	41.09250	-76.25500	130	7	B	65	D
92366	HOLLINGAER H	10/14/1982	Columbia	41.09167	-76.25500	160	30	V	NA	D
92451	HUNSINGER DON	NA	Columbia	41.07889	-76.23667	100	15	NK	NA	D
92360	KARC M	5/12/1983	Columbia	41.10972	-76.22972	200	6	V	NA	D
92389	KEPNER F	6/8/1981	Columbia	41.07167	-76.24500	185	40	EST	NA	D
14267	KERIS, ALEX	7/24/1975	Columbia	41.09611	-76.25833	150	7	NK	NA	D
14019	KISHBAUGH	10/14/1975	Columbia	41.07750	-76.24750	100	NA	NA	44	D
14018	KISHBAUGH, RANDALL C	11/1/1978	Columbia	41.07694	-76.24722	150	NA	NA	31	D
92444	KISLY WALTER	1/1/1974	Columbia	41.08833	-76.25694	175	10	NK	NA	D
92427	KISLY WALTER	1/1/1974	Columbia	41.09250	-76.25500	150	6	NK	NA	D
92359	KLINESMITH D	11/23/1983	Columbia	41.09583	-76.25750	177	8	V	NA	D
92385	KLINGER L	8/19/1983	Columbia	41.06250	-76.25389	160	9	V	NA	D
92379	KOWALCHICK S	9/25/1980	Columbia	41.07000	-76.25472	150	NA	NA	NA	D
14261	KREISCHER, GARY	2/12/1977	Columbia	41.09389	-76.25056	100	8	NK	NA	D
14258	KREISCHER, WILLIAM	2/12/1977	Columbia	41.09361	-76.25139	100	6	NK	NA	D
14011	MAGRONE, JOHN	1/1/1981	Columbia	41.06806	-76.25667	30	NA	NA	23	U
14012	MAGRONE, JOHN	9/25/1979	Columbia	41.06806	-76.25667	67	NA	NA	28	D
92353	MILLER P	11/6/1984	Columbia	41.10250	-76.22972	275	6	B	NA	D
14264	PERSANS, EDMUND C	7/19/1974	Columbia	41.09583	-76.25833	175	10	NK	NA	D
92355	RABER T	6/28/1985	Columbia	41.10083	-76.23111	225	6	EST	NA	D
14235	RICHARDS, REBA	NA	Columbia	41.08667	-76.22889	NA	NA	NA	NA	D
92365	ROBBINS W	9/29/1982	Columbia	41.09194	-76.25944	200	6	V	NA	D
14248	ROTHERY	5/29/1974	Columbia	41.09111	-76.25806	100	8	NK	NA	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 3 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
14270	SHULTZ, EDWARD A	5/6/1976	Columbia	41.09639	-76.25722	175	6	NK	NA	D
92424	SITLER ALLEN	1/1/1974	Columbia	41.09250	-76.25500	175	12	NK	NA	D
92421	SMITH JACK	1/1/1969	Columbia	41.09250	-76.25500	135	8	NK	NA	D
423164	GLENN STRAUSSER	10/22/2007	Columbia	41.07277	-76.24680	150	30	V	NA	D
420681	KEVINTANRIBILIR	6/12/2007	Columbia	41.06910	-76.25692	300	15	V	NA	D
92361	VANDERMARK R	5/12/1983	Columbia	41.08111	-76.23722	175	6	V	NA	D
92453	VENCLOSKI DAVID	NA	Columbia	41.11806	-76.23694	200	9	NK	NA	D
92452	VENCLOSKI JOSPH	NA	Columbia	41.11944	-76.23750	100	10	NK	NA	D
92409	WALTMAN H J	1/1/1966	Columbia	41.08528	-76.25750	130	7	NK	65	D
92380	WHITMIRE C	11/1/1980	Columbia	41.09778	-76.26056	150	10	EST	NA	D
92406	WHITMYER VERNON	1/1/1967	Columbia	41.09444	-76.25500	150	6	NK	NA	D
92398	WOLFINGER	1/1/1967	Columbia	41.09972	-76.24444	120	6	NK	30	D
92382	YALCH A	7/25/1980	Columbia	41.10111	-76.25417	150	7	EST	NA	D
14148	ANDREZZI, LEW	3/17/1969	Columbia	41.04472	-76.23139	125	10	NK	NA	D
13982	PENNDOT	1/1/1977	Columbia	41.05167	-76.23111	NA	NA	NA	NA	U
13983	PENNDOT	1/1/1977	Columbia	41.05167	-76.23111	NA	NA	NA	NA	U
13984	PENNDOT	1/1/1977	Columbia	41.05194	-76.23139	NA	NA	NA	NA	U
13985	PENNDOT	1/1/1977	Columbia	41.05222	-76.23167	NA	NA	NA	NA	U
13986	PENNDOT	1/1/1977	Columbia	41.05222	-76.23167	NA	NA	NA	NA	U
13988	PENNDOT	1/1/1977	Columbia	41.05250	-76.23194	NA	NA	NA	NA	U
13989	PENNDOT	1/1/1977	Columbia	41.05278	-76.23222	NA	NA	NA	NA	U
13990	PENNDOT	1/1/1977	Columbia	41.05333	-76.23278	NA	NA	NA	NA	U
182729	BEACH HAVEN FIR	1/1/1973	Lancaster	41.06806	-76.16167	100	12	NK	40	U
182732	BRADER HERB	1/1/1972	Lancaster	41.08944	-76.18056	100	12	NK	NA	D
182730	MOLYNEAUX SHLDN	1/1/1974	Lancaster	41.06917	-76.16639	50	15	NK	NA	D
182731	VARNER ARTHUR	1/1/1974	Lancaster	41.08583	-76.19250	125	7	NK	NA	D
128352	BECK P	9/1/1983	Luzerne	41.12833	-76.12639	175	15	V	20	D
25778	BLUE COAL CO	1/1/1966	Luzerne	41.14500	-76.14083	170	10	V	57	U
25779	BLUE COAL CO	1/1/1967	Luzerne	41.14639	-76.12611	305	10	V	155	U
25780	BLUE COAL CO	1/1/1967	Luzerne	41.14639	-76.12611	315	10	V	152	U

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}
(Page 4 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method [(1)]	Static Water Level (ft bgs)	Water Use [(2)]
25781	BLUE COAL CO	1/1/1966	Luzerne	41.14778	-76.11472	80	10	NK	1	U
25782	BLUE COAL CO	1/1/1967	Luzerne	41.14944	-76.11750	115	12	PT	60	U
25783	BLUE COAL CO	1/1/1967	Luzerne	41.15028	-76.14444	55	10	V	22	U
25786	BLUE COAL CO	1/1/1967	Luzerne	41.15194	-76.13278	485	10	V	185	U
250942	COUNCIL CUP CAMPGROUND	NA	Luzerne	41.09970	-76.10500	480	10	NK	NA	PS
128349	DUSKOSKY	12/1/1987	Luzerne	41.11750	-76.11194	250	6	EST	NA	D
250959	ENERGY INFORMATION CENTER	NA	Luzerne	41.10190	-76.12080	100	15	NK	NA	C
25480	FRANK BUTZ	3/30/1979	Luzerne	41.12250	-76.12000	200	30	NK	30	D
128345	HERRING DOROTHY	7/24/1978	Luzerne	41.13083	-76.10417	250	NA	NA	20	D
250921	HESS'S COUNTRY CONE	NA	Luzerne	41.09500	-76.11440	100	NA	NA	NA	C
25453	HESS,RALPH	1/1/1950	Luzerne	41.10083	-76.09806	397	NA	NA	NA	U
128344	LEWIS R	8/1/1977	Luzerne	41.12889	-76.09083	345	3	V	50	D
128357	MACANAQUA WATER	1/1/1967	Luzerne	41.14194	-76.13167	307	75	NK	15	PS
128347	PIZIA	4/1/1989	Luzerne	41.10889	-76.07444	250	10	EST	25	D
128348	PIZIA	3/1/1989	Luzerne	41.11000	-76.07444	240	35	EST	20	D
128358	READLER HOYT	1/1/1966	Luzerne	41.14111	-76.13833	217	3	NK	24	D
128346	SPAIDE H	10/1/1982	Luzerne	41.09333	-76.10389	160	25	V	10	D
128350	UTILITY ENGINEERS	11/1/1985	Luzerne	41.14222	-76.13111	603	25	V	27	PS
128823	ARNER GENNY	9/1/1987	Luzerne	41.07361	-76.10111	300	4	EST	NA	D
128820	BADMAN RON	7/17/1974	Luzerne	41.06611	-76.10222	510	2	EST	NA	D
128838	BECK	7/1/1984	Luzerne	41.08944	-76.09250	345	3	V	30	D
25378	BREISCH CONKLIN	11/22/1976	Luzerne	41.06750	-76.10361	150	10	NK	NA	D
128827	BUCK	12/1/1987	Luzerne	41.08111	-76.08167	375	2	EST	NA	D
128833	CHAPIN C	11/1/1985	Luzerne	41.05139	-76.10639	248	30	EST	NA	D
250854	CITIZENS WATER CO.	NA	Luzerne	41.07970	-76.11860	375	50	NK	40	PS
25407	D. SULT	8/1/1980	Luzerne	41.08278	-76.10889	200	NA	NA	150	D
128831	DAILEY K	7/1/1986	Luzerne	41.04722	-76.09639	320	15	EST	NA	D
128839	DENNIS R	NA	Luzerne	41.08083	-76.10528	300	3	V	30	D
128830	FRASSO J	7/1/1986	Luzerne	41.09972	-76.08306	180	20	EST	25	D
25410	GROBER,A.	NA	Luzerne	41.08389	-76.10944	142	7	NK	65	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 5 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
128821	LASKOSKY FRANCIS	2/16/1976	Luzerne	41.05083	-76.08778	140	20	EST	30	D
128834	LEWIS I	11/1/1984	Luzerne	41.08556	-76.08833	225	20	NK	20	D
25401	M. PETERS	1/1/1981	Luzerne	41.07889	-76.09111	250	10	NK	NA	D
128817	READLER C	3/5/1974	Luzerne	41.04722	-76.11389	200	20	EST	18	D
25368	READLER,CALVIN P.	NA	Luzerne	41.05778	-76.09639	30	NA	NA	27	D
128815	RINEHIMER R	12/1/1981	Luzerne	41.08167	-76.09167	250	5	V	60	D
128840	ROBBINS	3/1/1989	Luzerne	41.04639	-76.09500	500	20	EST	40	D
128837	SENSON R	9/1/1983	Luzerne	41.04722	-76.09333	225	10	V	30	D
128819	SHOBERT RALPH	3/10/1974	Luzerne	41.06556	-76.10222	480	4	EST	NA	D
128836	SIEGAL R	8/1/1983	Luzerne	41.07444	-76.07611	200	8	V	25	D
128832	STEINBRENNER	2/1/1986	Luzerne	41.08250	-76.08444	240	15	EST	60	D
25376	W. ZIMSKI	9/1/1979	Luzerne	41.06694	-76.11444	245	15	NK	45	D
25399	WEISS,MR.	NA	Luzerne	41.07722	-76.07944	75	12	NK	25	D
128816	WHITEBREAD D	11/1/1983	Luzerne	41.07861	-76.08944	200	10	V	20	D
128818	WYDA BOB	1/10/1976	Luzerne	41.06583	-76.08667	170	20	EST	40	D
128835	WYDA L	4/1/1985	Luzerne	41.08750	-76.09694	225	8	V	30	D
25511	D BARRETTS	12/11/1980	Luzerne	41.15639	-76.19694	235	8	NK	62	D
128864	FEATHERMAN E	6/1/1985	Luzerne	41.15222	-76.21139	150	4	EST	NA	D
128969	DOUTHAT J	3/2/1983	Luzerne	41.05194	-76.20500	200	NA	NA	NA	D
25366	RYMAN, WALTER	1/1/1980	Luzerne	41.05611	-76.21056	340	35	NK	82	S
25732	SELIC, ROBERT	8/21/1975	Luzerne	41.05000	-76.20750	150	10	NK	NA	D
25328	NA	7/18/1974	Luzerne	41.03389	-76.17222	140	15	NK	NA	D
128988	ADAMS A	5/1/1988	Luzerne	41.04417	-76.18389	360	15	B	85	D
25327	ADAMS, MARK	3/27/1974	Luzerne	41.03361	-76.18028	230	18	V	30	D
25333	ATEN, TOM	7/17/1974	Luzerne	41.03611	-76.17472	125	8	V	NA	D
128995	AUDIMATION	4/1/1988	Luzerne	41.05278	-76.16556	240	20	NK	60	I
129027	BENJAMIN ORVILL	NA	Luzerne	41.04278	-76.19833	125	NA	NA	NA	D
25344	BENJAMIN, ORVILLE	7/2/1974	Luzerne	41.04361	-76.19861	125	NA	NA	20	D
128975	BLACKBURN ED	8/1/1978	Luzerne	41.03667	-76.17611	300	20	V	40	D
128987	BOENICH J	5/1/1988	Luzerne	41.04306	-76.14028	200	15	EST	40	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 6 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
128996	BOWER K	11/7/1986	Luzerne	41.05361	-76.17056	420	1	EST	NA	D
128993	BREMMER M	6/1/1987	Luzerne	41.04167	-76.13333	398	1	EST	NA	D
25314	CALLAHAN	4/9/1974	Luzerne	41.02611	-76.18361	300	NA	NA	160	D
129028	CHAPIN CURTIS	NA	Luzerne	41.04583	-76.12056	140	30	NK	NA	D
129018	DEISCHAINE RLND	NA	Luzerne	41.03944	-76.13778	275	20	NK	NA	D
25339	DEISCHAINE ROLAND	5/1/1974	Luzerne	41.03917	-76.13750	275	20	V	NA	D
128978	DEISEHAINE B	4/1/1978	Luzerne	41.03917	-76.13722	100	8	V	NA	D
128979	DEISEHAINE B	4/1/1978	Luzerne	41.03778	-76.13750	150	6	EST	NA	D
128972	DRIBELLIS W	5/3/1982	Luzerne	41.04167	-76.19889	225	6	V	NA	D
128970	EROH G	11/1/1982	Luzerne	41.05278	-76.16389	300	5	V	NA	D
25758	FELIX, RUDY	NA	Luzerne	41.06222	-76.15639	471	NA	NA	23	D
129020	FILMORE MARTIN	NA	Luzerne	41.03361	-76.17306	175	6	NK	NA	D
250952	GOOD TIME GOLF	NA	Luzerne	41.04780	-76.15030	340	8	NK	220	C
251149	H&W OIL CO DBA MOTOR-VU DRIVE	NA	Luzerne	41.04417	-76.13944	NA	NA	NA	NA	C
129024	HAWK GEORGE	NA	Luzerne	41.03333	-76.18000	230	18	NK	30	D
128973	HOPPY B	7/2/1981	Luzerne	41.03417	-76.16722	225	8	EST	NA	D
129022	HOUCH HAROLD	NA	Luzerne	41.03333	-76.17222	140	15	NK	NA	D
129005	HOUGH H	8/30/1984	Luzerne	41.02472	-76.20667	150	15	EST	NA	D
129019	JUMPER HARRY	NA	Luzerne	41.03472	-76.17444	125	8	NK	NA	D
129007	KESSLER J	7/1/1983	Luzerne	41.04333	-76.20528	225	9	NK	NA	
129017	KLINE LARRY	NA	Luzerne	41.04944	-76.16528	140	NA	NA	NA	D
25354	KLINE, LARRY	2/19/1974	Luzerne	41.04944	-76.16556	140	NA	NA	NA	D
128982	LLOYD BILL	4/1/1989	Luzerne	41.04444	-76.14639	275	7	EST	35	D
128985	LUNDY CONSTRUCTION	11/23/1988	Luzerne	41.04944	-76.15778	200	20	EST	NA	D
128983	LYNN J	4/1/1989	Luzerne	41.04444	-76.18667	200	25	EST	30	D
128990	MADISH M	9/25/1987	Luzerne	41.03250	-76.21861	340	3	EST	NA	D
128981	MARGARM HOWARD	4/1/1989	Luzerne	41.04333	-76.18389	360	15	EST	70	D
128971	MATASH A	7/28/1982	Luzerne	41.04333	-76.20306	450	4	V	NA	D
128998	MCCREARY J	6/1/1985	Luzerne	41.04111	-76.14889	275	5	EST	NA	D
128991	MILLER G	8/13/1987	Luzerne	41.04083	-76.19028	300	1	EST	NA	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 7 of 15)

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129008	PADEN J	9/15/1983	Luzerne	41.04472	-76.20611	400	2	V	NA	D
129003	PADEN J	7/5/1984	Luzerne	41.04389	-76.20444	300	5	B	NA	D
128984	PALERY D	4/1/1989	Luzerne	41.04417	-76.18667	220	12	EST	50	D
129004	READLER K	2/1/1986	Luzerne	41.03917	-76.18917	223	12	EST	NA	D
25731	READLER, HOYT	1/24/1967	Luzerne	41.04778	-76.15056	NA	15	NK	NA	D
128999	REIMARD E	10/1/1986	Luzerne	41.04361	-76.18278	380	20	EST	70	D
418813	MICHAELROINICK	11/13/2006	Luzerne	41.03265	-76.1477	300	5	V	NA	D
128994	RYMAN FARM	4/1/1988	Luzerne	41.05417	-76.17472	200	20	NK	60	D
128992	RYMAN H	9/1/1987	Luzerne	41.05500	-76.18833	280	8	EST	NA	D
128997	RYMAN V	10/15/1986	Luzerne	41.03694	-76.21250	360	3	EST	NA	D
128974	RYMAN W	8/1/1980	Luzerne	41.05278	-76.16389	360	35	V	NA	D
129015	RYMAN WARREN	1/1/1966	Luzerne	41.04083	-76.14306	235	10	NK	91	D
129023	SEWARD HAROLD	NA	Luzerne	41.03194	-76.17194	245	22	NK	50	D
25320	SEWARO, HAROLD	2/17/1976	Luzerne	41.03139	-76.17167	245	22	V	50	D
25348	SLOSSER,MR.	NA	Luzerne	41.04639	-76.15056	138	NA	NA	NA	D
129000	SMITH	8/1/1986	Luzerne	41.04278	-76.14361	180	12	EST	40	D
128989	SMITH R	5/1/1988	Luzerne	41.03500	-76.14028	180	25	EST	40	D
129021	STEINHAUER REV	NA	Luzerne	41.03306	-76.17389	170	25	NK	35	D
25326	STEINHAVER DONALD L	4/2/1974	Luzerne	41.03361	-76.17333	170	25	V	35	D
129006	SUPERKO D	7/1/1983	Luzerne	41.03889	-76.15194	330	15	NK	40	D
128986	TYRRELL C	3/11/1988	Luzerne	41.04444	-76.18806	275	40	EST	NA	D
128976	U S GEOL SURVEY	10/20/1980	Luzerne	41.05889	-76.19806	200	6	V	23	
128977	U S GEOL SURVEY	10/20/1980	Luzerne	41.05889	-76.19778	55	36	TM	23	
25756	U.S. GEOL. SURVEY	10/20/1980	Luzerne	41.05889	-76.19806	200	NA	NA	23	U
25757	U.S. GEOL. SURVEY	10/21/1980	Luzerne	41.05889	-76.19806	55	NA	NA	20	U
129025	VALENTINO DAN	NA	Luzerne	41.02861	-76.18278	300	2	NK	160	D
129001	WENNER R	7/1/1986	Luzerne	41.04333	-76.17889	280	60	EST	70	D
25330	WHITMIRE	10/11/1974	Luzerne	41.03444	-76.17389	175	6	V	NA	D
25386	WOLFE, MALVERN	4/15/1970	Luzerne	41.07000	-76.13611	175	5	NK	NA	D
129002	WOOD LAND PRODUCT	1/14/1985	Luzerne	41.05528	-76.12861	508	2	EST	NA	S

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(Page 8 of 15)

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25306	YODER,G.	NA	Luzerne	41.02306	-76.19833	96	6	NK	55	D
129098	BULFORD	12/1/1988	Luzerne	41.14444	-76.19694	330	4	EST	25	D
25486	B. GENSEL	6/1/1977	Luzerne	41.13083	-76.22778	175	6	NK	NA	D
129225	BAER RUSSEL	NA	Luzerne	41.10472	-76.15611	125	10	NK	NA	D
25474	BAER, RUSSEL	7/8/1975	Luzerne	41.11306	-76.16361	125	10	V	NA	D
129140	BAKER W	11/25/1981	Luzerne	41.08056	-76.18861	325	5	EST	NA	D
129149	BANKES R	1/5/1984	Luzerne	41.15000	-76.16278	150	10	V	NA	D
129190	BCH HVN FIRE CO	NA	Luzerne	41.06806	-76.16167	100	12	NK	40	D
129187	BEACH HAV COM	1/1/1968	Luzerne	41.06722	-76.16972	51	40	NK	12	D
25377	BEACH HAVEN COMMTY. BD	10/21/1968	Luzerne	41.06722	-76.17167	51	40	NK	12	D
25380	BEACH HAVEN FIRE	4/13/1973	Luzerne	41.06806	-76.16167	100	12	NK	40	C
129152	BECHTOLD S	6/22/1987	Luzerne	41.08000	-76.15861	150	40	EST	NA	D
129141	BENSCOTER L	5/18/1982	Luzerne	41.07444	-76.15167	128	12	V	NA	D
250899	BIG B DRIVE IN	NA	Luzerne	41.06560	-76.19720	100	NA	NA	NA	C
129223	BLOOM FRANK	NA	Luzerne	41.11250	-76.19056	150	8	NK	NA	D
25475	BLOOM, FRANK	10/19/1976	Luzerne	41.11306	-76.18889	150	8	V	NA	D
129209	BOGART LARUE	NA	Luzerne	41.09083	-76.20333	125	7	NK	NA	D
25428	BOGART, LARUE	10/25/1976	Luzerne	41.09250	-76.20667	125	7	NK	NA	D
25424	BOGNAR, RICHARD	6/1/1976	Luzerne	41.09056	-76.20222	200	25	NK	60	D
25413	BOMBUSHIME HARRY	6/22/1973	Luzerne	41.08583	-76.22333	300	6	V	NA	D
129210	BOONER RICHARD	NA	Luzerne	41.09056	-76.20222	200	25	NK	60	D
25774	BOSTON, ROBERT	9/20/1973	Luzerne	41.11861	-76.16611	175	6	V	NA	D
129196	BRADER HERB	NA	Luzerne	41.08944	-76.18056	100	12	NK	NA	D
25768	BRADER, HERB	7/5/1972	Luzerne	41.08944	-76.18056	100	NA	NA	35	D
129157	BUCK J	8/15/1986	Luzerne	41.07722	-76.20694	125	15	NK	NA	D
129189	BURKE RUSSEL	NA	Luzerne	41.06972	-76.16417	100	8	NK	NA	D
25384	BURKE, RUSSEL	8/8/1973	Luzerne	41.06972	-76.16361	100	8	NK	NA	D
250937	BUTCH'S ONE STOP	NA	Luzerne	41.06810	-76.16220	140	NA	NA	NA	C
421702	SIDBUTLER	9/24/2007	Luzerne	41.12045	-76.17738	250	15	V	NA	D
25484	CISCO,MR.	NA	Luzerne	41.12639	-76.14417	145	25	NK	25	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}
(Page 9 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
250847	COUNTRY ESTATES M H COURT	NA	Luzerne	41.11110	-76.15420	235	20	NK	54	PS
129211	COWIE ROBERT	NA	Luzerne	41.09556	-76.19139	615	2	NK	375	D
129148	CRANE L	10/25/1984	Luzerne	41.14000	-76.20333	200	4	B	NA	D
129155	CRANE N	9/26/1986	Luzerne	41.08556	-76.15306	400	2	EST	NA	D
25481	CRISBELL, WILLIAM	11/22/1972	Luzerne	41.12278	-76.16778	110	NA	NA	35	U
129144	DAGOSTINE W	8/10/1982	Luzerne	41.08000	-76.19667	350	3	V	NA	D
129136	DAGOSTINE W	10/11/1982	Luzerne	41.07278	-76.21194	550	12	V	NA	D
129220	DALBERTO NICK	NA	Luzerne	41.10694	-76.17444	150	6	NK	NA	D
25466	DALBERTO, NICK	8/12/1976	Luzerne	41.10694	-76.18278	150	6	V	NA	U
129185	DAVENPORT WM	1/1/1968	Luzerne	41.06722	-76.17639	66	4	NK	14	D
25379	DAVENPORT, WELLINGTON	NA	Luzerne	41.06750	-76.17778	NA	NA	NA	12	D
129166	DAVIS J	4/28/1983	Luzerne	41.09083	-76.22333	275	7	V	NA	D
129191	DAVIS WILLIAM	NA	Luzerne	41.06750	-76.16389	100	6	NK	NA	D
25759	DAVIS, WILLIAM	7/9/1973	Luzerne	41.06694	-76.16556	100	NA	NA	7	D
25381	DAVIS,B.S.	1/1/1930	Luzerne	41.06889	-76.17500	102	9	NK	14	D
129151	DELLEGROTTI P	4/13/1987	Luzerne	41.07056	-76.22778	150	15	EST	NA	D
129213	DENN THOMAS	NA	Luzerne	41.08333	-76.18556	125	10	NK	NA	D
129153	DESCHAINE B	9/16/1987	Luzerne	41.09139	-76.21528	450	4	EST	NA	D
129154	DESCHAINE B	9/15/1987	Luzerne	41.09083	-76.21472	450	3	EST	NA	D
25390	DIAUGSTINE NEBBIE	10/14/1974	Luzerne	41.07167	-76.19667	275	4	NK	NA	D
129198	DIAUGSTINE V	NA	Luzerne	41.07167	-76.19667	275	4	NK	NA	D
129192	DOLLMAIV WM	NA	Luzerne	41.06583	-76.16000	150	6	NK	NA	D
129156	EDWARDS B	7/18/1984	Luzerne	41.07722	-76.22389	175	6	EST	NA	D
129221	FATUMA ROMAN	NA	Luzerne	41.10778	-76.17417	125	8	NK	45	D
129147	FEDORCO M	8/31/1983	Luzerne	41.08278	-76.18611	340	1	V	NA	D
129206	FEISSNOR LARRY	NA	Luzerne	41.08028	-76.22639	175	10	NK	100	D
25402	FEISSNOR, LARRY	3/9/1973	Luzerne	41.07972	-76.22611	175	10	NK	100	D
25398	FOX, CLARENCE	NA	Luzerne	41.07611	-76.13500	55	NA	NA	NA	D
129184	FULLER MAURICE	1/1/1968	Luzerne	41.06944	-76.16750	80	32	NK	12	D
129178	GARRISON IRVIN	1/1/1966	Luzerne	41.13917	-76.20528	135	30	NK	50	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 10 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
25409	GOLOMB, DEBRA	4/25/1970	Luzerne	41.08333	-76.18556	125	NA	NA	9	D
25393	GRIFFIN, GEORGE	1/1/1957	Luzerne	41.07278	-76.15167	98	NA	NA	63	D
129227	GRISBELL WM	NA	Luzerne	41.12278	-76.16778	110	10	NK	NA	D
129182	GUNTHER BART	1/1/1967	Luzerne	41.10694	-76.21556	215	4	NK	80	D
25465	GUNTHER, BART	9/9/1967	Luzerne	41.10667	-76.21556	215	4	V	80	D
129197	GUYER ANTHONY	NA	Luzerne	41.08500	-76.17333	125	6	NK	NA	D
129164	HART K	10/3/1983	Luzerne	41.06861	-76.19611	200	5	NK	NA	D
129181	HAUGH HAROLD W	1/1/1967	Luzerne	41.07250	-76.19583	193	2	NK	75	D
129208	HILLS COMPANY	NA	Luzerne	41.08694	-76.22056	250	6	NK	NA	D
129226	HIXON WILLIAM	NA	Luzerne	41.11778	-76.16611	175	6	NK	NA	D
129224	HOLLOWAY THOMAS	NA	Luzerne	41.11306	-76.18361	125	6	NK	NA	D
25473	HOLLOWAY, THOMAS	10/3/1974	Luzerne	41.11278	-76.18250	125	6	V	NA	D
129216	HONSE GEORGE	NA	Luzerne	41.10444	-76.17750	150	5	NK	NA	D
129137	HONSE JOE	8/9/1978	Luzerne	41.10111	-76.17056	100	8	EST	NA	D
25461	HONSE, GEORGE	12/26/1975	Luzerne	41.10500	-76.17639	150	5	V	NA	D
25463	HUMMEL, FRED	5/7/1976	Luzerne	41.10667	-76.13806	90	10	NK	NA	PS
25493	J. ROBINSON	4/1/1979	Luzerne	41.14000	-76.21500	200	8	NK	NA	D
129146	JOHNSON B	1/28/1988	Luzerne	41.10111	-76.22833	150	10	EST	NA	D
129138	JOHNSON R	5/14/1982	Luzerne	41.11222	-76.16417	200	5	EST	NA	D
129212	KARCHNER GERALD	NA	Luzerne	41.08639	-76.19083	130	10	NK	25	D
25416	KARCHNER, GERALD	11/9/1967	Luzerne	41.08639	-76.19139	130	10	EST	25	D
129162	KECK R	10/21/1985	Luzerne	41.09389	-76.21694	500	3	EST	NA	D
129202	KELLER EARL	NA	Luzerne	41.10444	-76.21167	125	8	NK	NA	D
25470	KELLER, EARL	6/26/1973	Luzerne	41.10361	-76.21167	125	8	NK	NA	D
129167	KEMMER C	8/23/1983	Luzerne	41.07111	-76.19806	350	4	V	NA	D
25418	KENNEDY, MICHAEL	7/5/1974	Luzerne	41.08694	-76.22278	250	7	V	NA	D
129200	KESSLER HAROLD	NA	Luzerne	41.08972	-76.22361	300	5	NK	NA	D
25423	KESSLER, HAROLD	9/14/1973	Luzerne	41.09028	-76.22333	300	5	V	NA	D
25385	KILLIAN, GENE	3/30/1967	Luzerne	41.06972	-76.16750	100	20	B	8	D
418914	HAROLDKLEINSMITH	10/25/2006	Luzerne	41.14197	-76.21738	450	12	V	NA	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}
(Page 11 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
25388	KMETOVICZ, GENE	12/9/1967	Luzerne	41.07056	-76.17611	85	NA	NA	22	D
129180	KNORR SAMUEL	1/1/1967	Luzerne	41.08667	-76.19278	117	8	NK	20	D
25420	KNORR, SAMUEL	6/18/1967	Luzerne	41.08861	-76.18750	117	NA	NA	33	D
129214	KOONS ROBERT	NA	Luzerne	41.07778	-76.18667	125	6	NK	NA	D
129215	KOONS ROBERT	NA	Luzerne	41.0775	-76.18556	125	6	NK	NA	D
129158	KRAMER B	5/29/1986	Luzerne	41.07361	-76.17889	300	2	EST	NA	D
129217	KRISANDA JOHN	NA	Luzerne	41.10139	-76.17139	100	6	NK	NA	D
25455	KRISANDA, JOHN	7/8/1975	Luzerne	41.10111	-76.17167	100	6	V	NA	D
129159	KYTTLE O	5/1/1985	Luzerne	41.11111	-76.19306	200	4	EST	NA	D
129161	LAUBACH B	7/16/1985	Luzerne	41.10889	-76.21167	225	5	EST	NA	D
129165	LUCIW T	10/10/1984	Luzerne	41.10694	-76.18611	150	7	V	NA	D
129150	LUNDY CONSTRUCTION	3/10/1987	Luzerne	41.06806	-76.16417	325	110	EST	NA	D
25397	MARKOVICH,M.J.	9/3/1930	Luzerne	41.07444	-76.14861	100	NA	NA	30	D
129160	MASON JR. R	8/23/1985	Luzerne	41.07778	-76.22361	250	5	EST	NA	D
25417	MCCOY, DONALD	7/4/1974	Luzerne	41.08667	-76.22444	250	6	V	NA	D
25411	MINGLE INN	NA	Luzerne	41.08417	-76.13972	150	NA	NA	NA	C
25389	MOLNOR, STEVE	9/24/1976	Luzerne	41.07139	-76.16778	150	6	NK	NA	D
129194	MOLYNEAUX SHLDN	NA	Luzerne	41.06917	-76.16639	50	15	NK	NA	D
25383	MOLYNEAUX, SHELDON	10/4/1974	Luzerne	41.06917	-76.16694	50	NA	NA	2	D
25419	MONT, MICHAIL	10/23/1972	Luzerne	41.08722	-76.13917	100	NA	NA	5	D
129199	MORGAN PIERCE	NA	Luzerne	41.06722	-76.21750	125	8	NK	65	D
129203	NAUNCZEK BENNIE	NA	Luzerne	41.07972	-76.22528	100	12	NK	30	D
129204	NAUNCZEK BENNIE	NA	Luzerne	41.07417	-76.22750	100	10	NK	NA	D
129205	NAUNCZEK BENNIE	NA	Luzerne	41.07417	-76.22611	125	15	NK	NA	D
25403	NAUNCZEK, BENNIE	8/19/1971	Luzerne	41.08000	-76.22472	100	12	NK	30	D
25395	NAUNCZEK, BENNIE	5/2/1977	Luzerne	41.07389	-76.22611	125	NA	NA	26	D
25396	NAUNCZEK, BENNIE	3/16/1976	Luzerne	41.07389	-76.22750	100	NA	NA	15	C
129174	PA POWER &LIGHT	1/1/1973	Luzerne	41.09250	-76.13167	81	500	NK	8	I
129175	PA POWER &LIGHT	1/1/1973	Luzerne	41.09250	-76.13167	96	NA	NA	NA	
129176	PA POWER &LIGHT	1/1/1973	Luzerne	41.09806	-76.13167	54	NA	NA	NA	

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 12 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
25425	PA. POWER AND LIGHT	12/14/1970	Luzerne	41.09083	-76.14472	NA	NA	NA	21	U
25426	PA. POWER AND LIGHT	9/29/1970	Luzerne	41.09194	-76.14417	NA	NA	NA	17	U
25427	PA. POWER AND LIGHT	11/18/1970	Luzerne	41.09194	-76.14778	NA	NA	NA	7	U
25429	PA. POWER AND LIGHT	8/1/1972	Luzerne	41.09278	-76.13306	55	NA	NA	NA	U
25430	PA. POWER AND LIGHT	10/20/1970	Luzerne	41.09278	-76.14361	NA	NA	NA	27	U
25431	PA. POWER AND LIGHT	11/16/1970	Luzerne	41.09278	-76.14472	NA	NA	NA	26	U
25432	PA. POWER AND LIGHT	11/20/1970	Luzerne	41.09278	-76.14778	NA	NA	NA	34	U
25433	PA. POWER AND LIGHT	8/1/1972	Luzerne	41.09361	-76.13444	23	NA	NA	NA	U
25434	PA. POWER AND LIGHT	11/18/1970	Luzerne	41.09389	-76.14417	NA	NA	NA	28	U
25456	PA. POWER AND LIGHT	10/12/1977	Luzerne	41.10250	-76.13722	100	NA	NA	25	D
25422	PA. POWER AND LIGHT	10/16/1970	Luzerne	41.09028	-76.14444	NA	NA	NA	5	U
25450	PA. POWER AND LIGHT	11/10/1970	Luzerne	41.09778	-76.14500	NA	NA	NA	NA	U
25451	PA. POWER AND LIGHT	1/16/1973	Luzerne	41.09833	-76.13028	91	NA	NA	NA	U
25436	PA. POWER AND LIGHT	8/1/1972	Luzerne	41.09417	-76.1325	75	9	NK	25	I
25437	PA. POWER AND LIGHT	10/6/1970	Luzerne	41.09417	-76.14333	NA	NA	NA	32	U
25438	PA. POWER AND LIGHT	10/8/1970	Luzerne	41.09417	-76.14778	NA	NA	NA	18	U
25439	PA. POWER AND LIGHT	10/6/1970	Luzerne	41.09500	-76.14500	NA	NA	NA	30	U
25440	PA. POWER AND LIGHT	10/14/1970	Luzerne	41.09528	-76.14361	NA	NA	NA	15	O
25441	PA. POWER AND LIGHT	10/9/1970	Luzerne	41.09528	-76.14472	NA	NA	NA	62	U
25442	PA. POWER AND LIGHT	11/9/1970	Luzerne	41.09556	-76.14472	NA	NA	NA	36	U
25443	PA. POWER AND LIGHT	10/29/1970	Luzerne	41.09556	-76.14667	NA	NA	NA	65	U
25444	PA. POWER AND LIGHT	NA	Luzerne	41.09583	-76.13028	44	NA	NA	13	U
25445	PA. POWER AND LIGHT	10/23/1970	Luzerne	41.09583	-76.14556	NA	NA	NA	55	U
25446	PA. POWER AND LIGHT	11/12/1970	Luzerne	41.09611	-76.14417	NA	NA	NA	29	U
25447	PA. POWER AND LIGHT	10/29/1970	Luzerne	41.09611	-76.14472	NA	NA	NA	32	U
25448	PA. POWER AND LIGHT	10/21/1970	Luzerne	41.09694	-76.14500	NA	NA	NA	NA	U
25458	PA. POWER AND LIGHT	1/11/1973	Luzerne	41.10361	-76.13194	54	NA	NA	16	U
25769	PA. POWER AND LIGHT	1/22/1973	Luzerne	41.09528	-76.13028	58	NA	NA	8	I
25770	PA. POWER AND LIGHT	10/1/1973	Luzerne	41.09528	-76.13528	NA	65	NK	9	I
25771	PA. POWER AND LIGHT	10/1/1973	Luzerne	41.09556	-76.13528	NA	150	NK	17	I

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}
(Page 13 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
129218	PETERS FRANK	NA	Luzerne	41.10556	-76.18056	150	6	NK	NA	D
129219	PETERS FRANK	NA	Luzerne	41.10556	-76.18056	130	8	NK	10	D
25462	PETERS, FRANK	1/27/1972	Luzerne	41.10639	-76.18167	130	NA	NA	10	D
25464	PETERS, FRANK	8/13/1976	Luzerne	41.10667	-76.18083	150	6	V	NA	D
129207	PINTERICH ROBT	NA	Luzerne	41.07306	-76.22556	175	5	NK	NA	D
25394	PINTERICH, ROBERT	3/12/1976	Luzerne	41.07389	-76.22528	175	NA	NA	36	D
250843	PLEASANT VIEW M H P	NA	Luzerne	41.08670	-76.18810	300	13	NK	NA	PS
250844	PLEASANT VIEW M H P	NA	Luzerne	41.08670	-76.18810	300	60	NK	NA	PS
250845	PLEASANT VIEW M H P	NA	Luzerne	41.08670	-76.18500	380	19	NK	300	PS
250926	PMC LIFESTYLE	NA	Luzerne	41.07170	-76.15670	325	50	NK	NA	C
250956	PP&L SUSQUEHANNA S&A WELLS	NA	Luzerne	41.09170	-76.14860	75	50	NK	NA	C
250957	PP&L SUSQUEHANNA S&A WELLS	NA	Luzerne	41.09170	-76.14860	75	50	NK	NA	C
129135	PPL COMPANY	8/26/1981	Luzerne	41.09389	-76.14611	225	35	NK	7	PS
25382	PRICE, ROBERT B	8/25/1973	Luzerne	41.06917	-76.15194	125	9	NK	48	D
25391	PRICE, ROBERT P	10/11/1967	Luzerne	41.07250	-76.15194	160	NA	NA	63	D
250898	PRIME TIME RESTAURANT	NA	Luzerne	41.10670	-76.13670	98	NA	NA	98	C
250897	RED BARN CAFE	NA	Luzerne	41.10830	-76.13890	265	NA	NA	20	C
25468	REICHARD, PAUL	1/7/1973	Luzerne	41.10778	-76.18250	125	NA	NA	45	D
129177	RHINARD VIRGIL	1/1/1966	Luzerne	41.09778	-76.21417	95	9	NK	25	D
25449	RHINARD, VIRGIL	10/27/1966	Luzerne	41.09750	-76.21556	95	9	V	25	D
250958	RIVERLANDS RECREATION CENTER	NA	Luzerne	41.09940	-76.13580	105	30	NK	NA	C
129188	ROMAN HOMES	NA	Luzerne	41.06944	-76.16500	125	7	NK	NA	PS
129186	SALEM TWP	1/1/1970	Luzerne	41.08333	-76.14056	175	12	NK	NA	D
25406	SALEM TWP.	1/4/1970	Luzerne	41.08222	-76.14056	175	12	NK	NA	D
129139	SEELLY E	9/8/1980	Luzerne	41.09333	-76.16944	100	NA	NA	NA	D
129142	SEELY E	9/9/1980	Luzerne	41.09167	-76.16917	55	NA	NA	NA	D
25374	SEIGFRED WILLIAM	6/15/1976	Luzerne	41.06556	-76.21056	85	25	NK	5	D
129143	SHUMAN S	3/12/1982	Luzerne	41.06778	-76.17472	410	40	EST	NA	D
25469	SIESKO,EMIL	9/3/1930	Luzerne	41.10806	-76.13833	148	NA	NA	48	D
25412	SINK, WILLIAM H	NA	Luzerne	41.08472	-76.15694	50	NA	NA	5	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}
(Page 14 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)
129222	SITLER LEMUEL	NA	Luzerne	41.10917	-76.17778	100	12	NK	NA	D
25471	SITLER, LEMUEL	9/24/1973	Luzerne	41.10944	-76.17778	100	12	V	NA	D
250853	SLEEPY HOLLOW MOBILE HOME PARK	NA	Luzerne	41.13060	-76.22640	125	25	NK	NA	PS
25761	SMITH, BRAD	2/1/1980	Luzerne	41.07056	-76.16083	130	NA	NA	37	D
250940	SUSQ STEAM ELECTRIC STAT EOF	NA	Luzerne	41.08720	-76.15440	55	30	NK	NA	C
129201	SWITZER JIM	NA	Luzerne	41.10361	-76.21167	75	6	NK	35	D
25459	SWITZER, JIM	11/9/1972	Luzerne	41.10472	-76.21194	75	NA	NA	35	D
25762	U.S. GEOL. SURVEY	10/14/1980	Luzerne	41.07222	-76.15194	102	NA	NA	62	U
25760	U.S. GEOL. SURVEY	10/16/1980	Luzerne	41.06861	-76.15139	300	NA	NA	51	U
25421	VANDERMARK WILSON	1/1/1959	Luzerne	41.08889	-76.19250	90	NA	NA	65	D
129195	VARNER ARTHUR	NA	Luzerne	41.08583	-76.19250	125	7	NK	NA	D
25414	VARNER, ARTHUR	7/16/1974	Luzerne	41.08611	-76.19194	125	7	EST	NA	D
25496	W. KISHBAUGH	5/1/1979	Luzerne	41.14222	-76.19667	150	12	NK	NA	D
25764	WATTS	8/1/1980	Luzerne	41.07278	-76.18889	230	NA	NA	72	D
25767	WEADON BILL	7/3/1974	Luzerne	41.08472	-76.19167	125	NA	NA	38	D
250852	WHIPPORWILL MOBILE HOME PARK	NA	Luzerne	41.12970	-76.22750	100	15	NK	90	PS
129145	YARON D	10/13/1988	Luzerne	41.07222	-76.14000	450	10	EST	NA	D
25375	ZETTLE, WILLIAM	1/1/1958	Luzerne	41.06639	-76.19694	196	NA	NA	94	D
129193	ZIETTS ANDY	NA	Luzerne	41.06611	-76.15778	225	3	NK	NA	D
129163	ZWALHUSKI A	4/13/1984	Luzerne	41.08944	-76.20083	100	1	V	NA	D
129183	ZWOLINSKI S	1/1/1967	Luzerne	41.07194	-76.17556	85	14	NK	22	D
129179	ZWOLINSKI STEVE	1/1/1967	Luzerne	41.06944	-76.16750	100	20	NK	15	D
25387	ZWOLINSKI, STEVEN	8/9/1968	Luzerne	41.07000	-76.16694	145	20	B	36	D
129228	GROOVER	6/1/1988	Luzerne	41.15361	-76.15500	100	40	EST	20	D
129229	WOOD V	12/5/1988	Luzerne	41.15167	-76.15750	225	7	EST	NA	D
129365	FOAMANOWSKI S	3/1/1988	Luzerne	41.10917	-76.13194	300	15	EST	45	D
25516	BALSHAMER,JAKE	10/7/1930	Luzerne	41.15889	-76.15611	47	NA	NA	7	D
25514	SELECKY, FRANK	1/1/1955	Luzerne	41.15722	-76.15583	62	40	NK	NA	D
28736	BRYFOGLE, KENNETH	7/1/1980	Montour	41.07583	-76.07639	250	25	NK	18	C
190082	SALVATERRA N	NA	Snyder	41.02278	-76.17556	275	18	NK	60	D

Table 2.4-50— {PaGWIS Documented Groundwater Wells Located Within a 5-Mile (8 km) Radius of the BBNPP Site}

(Page 15 of 15)

PA Well ID	Owner	Date Drilled	County	Latitude	Longitude	Well Depth (ft bgs)	Well Yield (gpm)	Yield Measure Method (1)	Static Water Level (ft bgs)	Water Use (2)

Notes:

Source: DCNR, 2010

NA = not available

(1) NK = Not Known, V = Volumetric (Watch and Bucket), TM = Totaling Meter, PT = Pitot-Tube Meter, EST = Estimated, B = Bailer

(2) PS = Public Supply, I = Industrial, AC = Air Conditioning, D = Domestic, U = Unused, O = Other, C = Commercial, S = Stock

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 1 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
39	COLUMBIA ASPHALT CORP	HANSON AGGREGATES PA BLOOMSBURG QUARRY	WELL 1	INDUSTRIAL	ACTIVE
189	DILLON FLORAL CORP	DILLON FLORAL	WELL 1	AGRICULTURAL	ACTIVE
352	BURTAM CORP	BLUE RIDGE TRAIL GC	WELL 2	COMMERCIAL	ACTIVE
354	BURTAM CORP	BLUE RIDGE TRAIL GC	WELL 1	COMMERCIAL	ACTIVE
1113	WEATHERLY CASTING & MACH CO	WEATHERLY CASTING & MACH MFG	WELL	INDUSTRIAL	ACTIVE
1125	KLEERDEX CO	KLEERDEX	WITHDRAW WELL	INDUSTRIAL	ACTIVE
1249	WISE FOODS INC	WISE FOODS BERWICK SNACK FOOD PLT	WELL	INDUSTRIAL	ACTIVE
1621	FED MOGUL CORP	WAGNER MFG	WELL 1A	COMMERCIAL	ACTIVE
1622	FED MOGUL CORP	WAGNER MFG	WELL 1B	COMMERCIAL	ACTIVE
1623	FED MOGUL CORP	WAGNER MFG	WELL 2A	COMMERCIAL	ACTIVE
1624	FED MOGUL CORP	WAGNER MFG	WELL 2B	COMMERCIAL	ACTIVE
1625	FED MOGUL CORP	WAGNER MFG	WELL 2C	COMMERCIAL	ACTIVE
1626	FED MOGUL CORP	WAGNER MFG	WELL 3A	COMMERCIAL	ACTIVE
1627	FED MOGUL CORP	WAGNER MFG	WELL 3B	COMMERCIAL	ACTIVE
1628	FED MOGUL CORP	WAGNER MFG	WELL 3C	COMMERCIAL	ACTIVE
1629	FED MOGUL CORP	WAGNER MFG	WELL 4A	COMMERCIAL	ACTIVE
1630	FED MOGUL CORP	WAGNER MFG	WELL 4B	COMMERCIAL	ACTIVE
1631	FED MOGUL CORP	WAGNER MFG	WELL 4C	COMMERCIAL	ACTIVE
1632	FED MOGUL CORP	WAGNER MFG	WELL 5A	COMMERCIAL	ACTIVE
1633	FED MOGUL CORP	WAGNER MFG	WELL 5B	COMMERCIAL	ACTIVE
1634	FED MOGUL CORP	WAGNER MFG	WELL 6A	COMMERCIAL	ACTIVE
1635	FED MOGUL CORP	WAGNER MFG	WELL 6B	COMMERCIAL	ACTIVE
1636	FED MOGUL CORP	WAGNER MFG	WELL 7B	COMMERCIAL	ACTIVE
1701	INTERSIL CORP	FAIRCHILD SEMICONDUCTOR MOUNTAINTOP PLT	RCA WELL	INDUSTRIAL	ACTIVE
1758	OI NEG TV PROD INC	OI NEG TV PROD	WELL 1	INDUSTRIAL	ACTIVE
1817	NORTHAMPTON FUEL SUPPLY CO INC	JEDDO HIGHLAND PROSPECT MINE	LOCAL MINE POOL	MINERAL	ACTIVE
1818	NORTHAMPTON FUEL SUPPLY CO INC	NORTHAMPTON FUEL SUPPLY LOOMIS MINE	UNDERGROUND WELL	MINERAL	ACTIVE
1850	FIMBEL DOOR CORP	FIMBEL DOOR	WELL	INDUSTRIAL	ACTIVE
1853	GROUSE HUNT FARMS INC	GROUSE HUNT FARMS	WELL	INDUSTRIAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 2 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
1953	HARRELL AUTOMATIC SPRINKLER CO	HARRELL AUTOMATIC SPRINKLER	WELL	INDUSTRIAL	ACTIVE
1955	CALIFORNIA EAST	CA EAST	WITHDRAW WELL	INDUSTRIAL	ACTIVE
2016	GENECO SVC INC	GENECO SVC	WITHDRAW WELL	INDUSTRIAL	ACTIVE
2019	VALLEY ORDNANCE	VALLEY ORDNANCE	WITHDRAW WELL	INDUSTRIAL	ACTIVE
2021	BARTSEN MEDIA INC	BARTSEN MEDIA	WITHDRAW WELL	INDUSTRIAL	ACTIVE
2040	Unavailable	FETTERMAN EUGENE	SPRING WITHDRAWAL	AGRICULTURAL	ACTIVE
2097	METCALF STEEL SVC	METCALF STEEL SVC	WITH WELL	INDUSTRIAL	ACTIVE
2099	R MARTIN PLASTIC SPECIALTIES	R MARTIN PLASTIC SPECIALTIES	WELL	INDUSTRIAL	ACTIVE
2188	LITTLE LUMBER CO INC	LITTLE LUMBER	WELL	INDUSTRIAL	ACTIVE
2294	SETON MANOR INC	SETON MANOR RUSH TWP SCHYLKILL CNTY	BOOSTER PARK 1 NORTH (WELL)	COMMERCIAL	ACTIVE
2295	SETON MANOR INC	SETON MANOR RUSH TWP SCHYLKILL CNTY	BOOSTER PARK 2 SOUTH (WELL)	COMMERCIAL	ACTIVE
2423	ROBERT W HART & SON INC	ROBERT W HART & SON MFG	WITH WELL	INDUSTRIAL	ACTIVE
2541	NATIVE TEXTILES	NATIVE TEXTILE	WITHDRAW WELL	INDUSTRIAL	INACTIVE
2609	HUNLOCK SAND & GRAVEL CO	HUNLOCK QUARRY	WELL 1	MINERAL	ACTIVE
2729	BARLETTA MATERIALS & CONST INC	BARLETTA HONEY HOLE QUARRY	LAB WELL 2	INDUSTRIAL	ACTIVE
2809	BISON MEADOWS LLC	BISON MEADOWS FARM BLYTHE TWP SCHUYLKILL CNTY	SPRING 1	AGRICULTURAL	ACTIVE
2814	DEL MONTE CORP	DEL MONTE BLOOMSBURG PLT	WELL 2	INDUSTRIAL	ACTIVE
2818	DEL MONTE CORP	DEL MONTE BLOOMSBURG PLT	WELL 3	INDUSTRIAL	ACTIVE
2819	DEL MONTE CORP	DEL MONTE BLOOMSBURG PLT	WELL 5	INDUSTRIAL	ACTIVE
2820	DEL MONTE CORP	DEL MONTE BLOOMSBURG PLT	WELL 6	INDUSTRIAL	ACTIVE
2821	DEL MONTE CORP	DEL MONTE BLOOMSBURG PLT	WELL 4	INDUSTRIAL	ACTIVE
2823	DEL MONTE CORP	DEL MONTE BLOOMSBURG PLT	WELL 7	INDUSTRIAL	ACTIVE
2824	DEL MONTE CORP	DEL MONTE BLOOMSBURG PLT	WELL 1	INDUSTRIAL	ACTIVE
3024	HAZEL PARK PACKING CO	HAZEL PARK PACKING	WELL	INDUSTRIAL	ACTIVE
3165	ROB BAR INC	BEAR CREEK LINE	WELL 1	COMMERCIAL	ACTIVE
3198	THREE SPRINGS WATER CO	THREE SPRINGS BOTTLED WATER PLT	SPRING 1	INDUSTRIAL	ACTIVE
3412	MILL RACE GOLF & CAMP RESORT INC	MILL RACE GC	MAINTENANCE BUILDING WELL	COMMERCIAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 3 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
3600	JEDDO HIGHLAND COAL CO	ROSA BREAKER COAL PREP PLT	RAW MINE WATERING	MINERAL	INACTIVE
3680	GROUP MTN SPRINGS	TULPEHOCKEN SPRINGS	BH-1	INDUSTRIAL	ACTIVE
3785	EMERALD ANTHRACITE II	HUD TA EMERALD ANTHRACITE	WITHDRAWAL WELLS	MINERAL	ACTIVE
3786	EMERALD ANTHRACITE II	HUD TA EMERALD ANTHRACITE	MINE WITHDRAWAL	MINERAL	ACTIVE
3825	BRUCH EYE CARE ASSOCS	BRUCH EYE CARE ASSOCS	WITH WELL	INDUSTRIAL	ACTIVE
4059	LEHIGH COAL & NAVIGATION CO	LEHIGH COAL & NAVIGATION LCN MINE	MINE 10 DIV	MINERAL	ACTIVE
4060	LEHIGH COAL & NAVIGATION CO	LEHIGH COAL & NAVIGATION LCN MINE	MINE 14	MINERAL	ACTIVE
4063	LEHIGH COAL & NAVIGATION CO	LEHIGH COAL & NAVIGATION LCN MINE	MINE SPRINGDALE WELL	MINERAL	ACTIVE
4064	LEHIGH COAL & NAVIGATION CO	LEHIGH COAL & NAVIGATION LCN MINE	RT 309 DISCHARGE	MINERAL	ACTIVE
4178	GEN CRUSHED STONE CO	GEN CRUSHED STONE WHITE HAVEN	WITHDRAWAL WELL	MINERAL	ACTIVE
4663	OFFSET PAPERBACK MANUFACTURERS INC	OFFSET PAPERBACK MFG	WELL 1	INDUSTRIAL	ACTIVE
4665	OFFSET PAPERBACK MANUFACTURERS INC	OFFSET PAPERBACK MFG	WELL 2	INDUSTRIAL	ACTIVE
4666	OFFSET PAPERBACK MANUFACTURERS INC	OFFSET PAPERBACK MFG	WELL 3	INDUSTRIAL	ACTIVE
4671	DIAMOND COAL CO INC	MAMMOTH ANTHRACITE LATTIMER BASIN MINE	MINE WITHDRAWAL	MINERAL	ACTIVE
4854	CHEROKEE GC	CHEROKEE GC	CLUBHOUSE WELL	COMMERCIAL	ACTIVE
4855	CHEROKEE GC	CHEROKEE GC	MAINTENANCE BUILDING WELL	COMMERCIAL	ACTIVE
4856	CHEROKEE GC	CHEROKEE GC	RESTROOMS WELL	COMMERCIAL	ACTIVE
4857	CHEROKEE GC	CHEROKEE GC	APARTMENT SOURCE WELL	COMMERCIAL	ACTIVE
4904	DRUMS SASH & DOOR CO INC	DRUMS SASH & DOOR MFG	WELL	INDUSTRIAL	ACTIVE
4908	GRANT CONCRETE PROD	GRANT CONCRETE PROD	WITH WELL	INDUSTRIAL	ACTIVE
4920	QUALITY METAL PROD INC	QUALITY METAL PROD MFG	WELL	INDUSTRIAL	ACTIVE
4928	WILLIAM WENTZ INC	WILLIAM WENTZ	WELL	INDUSTRIAL	ACTIVE
4977	BEMIS CO INC	BEMIS	WELL	INDUSTRIAL	ACTIVE
5146	JAC MAR COAL CO TA L & E COAL	L & E COAL JAC MAR MINE	WITHDRAWAL SURFACE MINE	MINERAL	ACTIVE
5155	SILVERBROOK ANTHRACITE INC	SILVERBROOK ANTHRACITE ALDEN BANK 1 MINE	A- SUR MINE WITHDRAWAL	MINERAL	ACTIVE
5159	SILVERBROOK ANTHRACITE INC	SILVERBROOK ANTHRACITE LAFLIN BANK	MINE	MINERAL	ACTIVE
5538	GERALD & LEWIS NAUGLE	READING MAT PIT 1 QUARRY	WITHDRAWAL WELL	MINERAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 4 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
5548	CATAWISSA LUMBER & SPECIALITY CO	CATAWISSA LUMBER MILL	WELL	INDUSTRIAL	ACTIVE
5570	RANGER IND	RANGER IND	WITHDRAW WELL	INDUSTRIAL	ACTIVE
5586	HARMONY ASSOC INC	HARMONY ASSOC	WELL	INDUSTRIAL	ACTIVE
5683	LEIBYS DAIRY INC	LEIBYS DAIRY	WITHDRAW WELL	INDUSTRIAL	ACTIVE
5684	LEIBYS DAIRY INC	LEIBYS DAIRY	SPRING	INDUSTRIAL	ACTIVE
5790	FRONT STREET FASHIONS	FRONT STREET FASHIONS	WITHDRAW WELL	INDUSTRIAL	ACTIVE
5794	FARR LUMBER	FARR LUMBER	WELL	INDUSTRIAL	ACTIVE
6056	PA COMBINING CORP	PA COMBINING	WITH WELL	INDUSTRIAL	ACTIVE
6068	CUSTOM FABRICATION CO	CUSTOM FABRICATION	WITH WELL	INDUSTRIAL	ACTIVE
6072	KLINGERMAN GALLICK AG SVC INC	MAINVILLE AG SVC	WITH WELL	INDUSTRIAL	ACTIVE
6074	GENSEMERS CUSTOM PROC	GENSEMERS CUSTOM PROC	WELL	INDUSTRIAL	ACTIVE
6370	THREE PONDS GC	THREE PONDS GOLF SHOP	CLUB HOUSE WELL	COMMERCIAL	ACTIVE
6391	MILL RACE GOLF & CAMP RESORT INC	MILL RACE GC	CLUBHOUSE WELL	COMMERCIAL	ACTIVE
6392	MILL RACE GOLF & CAMP RESORT INC	MILL RACE GC	UPPER CAMPGROUND WELL	COMMERCIAL	ACTIVE
6393	MILL RACE GOLF & CAMP RESORT INC	MILL RACE GC	LOWER CAMPGROUND WELL	COMMERCIAL	ACTIVE
6431	FOUNTAIN SPRINGS CC	FOUNTAIN SPRINGS WELL	WELL	COMMERCIAL	ACTIVE
6434	FOX HILL CC	FOX HILL CC FILW	HALF WAY WELL	COMMERCIAL	ACTIVE
6667	CROP PROD SVC INC	CROP PROD SVC	WITH WELL	INDUSTRIAL	ACTIVE
6811	MTN VALLEY GC	MT VALLEY GC	WELL 9	COMMERCIAL	ACTIVE
6812	MTN VALLEY GC	MT VALLEY GC	WELL 7	COMMERCIAL	ACTIVE
6813	MTN VALLEY GC	MT VALLEY GC	WELL 15	COMMERCIAL	ACTIVE
6817	ST JUDE POLYMER CORP	ST JUDE POLYMER FILW & CW	WELL	INDUSTRIAL	ACTIVE
7262	GALE COAL CO INC	GALE COAL E KASKA MINE	DEWATERING	MINERAL	INACTIVE
7425	BOSTON FARM PROD	BOSTON FARM PROD	WITHDRAW WELL	INDUSTRIAL	ACTIVE
7427	DEIHL VAULT & PRECAST	DEIL VAULT & PRECAST	WITHDRAW WELL	INDUSTRIAL	ACTIVE
7430	HESS READY MIX INC	HESS READY MIX	WELL	INDUSTRIAL	ACTIVE
7913	DEL BAR SHEET METAL CO	DEL BAR SHEET METAL	WITHDRAW WELL	INDUSTRIAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 5 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
7921	CUSTOM METAL PROD INC	CUSTOM METAL PROD	WITH WELL	INDUSTRIAL	ACTIVE
7923	COLUMBIA PORCH SHADE CO INC	COLUMBIA PORCH SHADE MFG	WITHDRAW WELL	INDUSTRIAL	ACTIVE
7925	AUDIMATION CORP	AUDIMATION	WITHDRAW WELL	INDUSTRIAL	ACTIVE
7937	BRUCE CHARLES SAWMILL	BRUCE CHARLES SAWMILL	WITHDR WELL	INDUSTRIAL	ACTIVE
8031	GREENLEAF CROP PROD SVC	GREENLEAF CROP PROD SVC	WITHDRAW WELL	INDUSTRIAL	ACTIVE
8089	BEAR RIDGE SHOPS INC	BEAR RIDGE SHOPS	WITHDR WELL	INDUSTRIAL	ACTIVE
8094	BRIEL TOOL & MACH WORKS	BRIEL TOOL & MACH WORKS PLT	WITHDRAW WELL	INDUSTRIAL	ACTIVE
8099	BIROS IRON WORKS	BIROS IRON WORKS	WITHDRAW WELL	INDUSTRIAL	ACTIVE
8805	A & E RINGTOWN INC	A & E RINGTOWN	WELL	INDUSTRIAL	ACTIVE
8807	HILLAS FASHIONS	HILLAS FASHIONS	WITHDRAW WELL	INDUSTRIAL	ACTIVE
8841	PRECISION TOOL & MACH CO	PRECISION TOOL & MACH	WITH WELL	INDUSTRIAL	ACTIVE
8904	SEESHOLTZ BROS INC	SEESHOLTZ BROS	SPRING WITHDRAWAL	AGRICULTURAL	ACTIVE
8905	SEESHOLTZ BROS INC	SEESHOLTZ BROS	QUARRY WITHDRAWAL	AGRICULTURAL	ACTIVE
8906	STREATER & SON INC	STREATER & SON	GROUND WITHDRAWA	AGRICULTURAL	ACTIVE
8943	DRESHER FARMS	DRESHER FARMS	SPRING	AGRICULTURAL	ACTIVE
9114	READING ANTHRACITE CO	OLD ST NICHOLAS 4 & 5 READING ANTH	MINE WITHDRAWAL	MINERAL	ACTIVE
9197	WILKES POOL CORP	WILKES POOL	WITHDRAW WELL	INDUSTRIAL	ACTIVE
9250	ANDREAS LUMBER INC	ANDREAS LUMBER	SPRING	INDUSTRIAL	ACTIVE
9256	BOLYS IRON WORKS	BOLYS IRON WORKS	WITHDR SPRING	INDUSTRIAL	ACTIVE
9258	PA ALUM	PA ALUM	WITHDR WELL	INDUSTRIAL	ACTIVE
9262	NATL SELECT FABRICS CORP	NATL SELECT FABRICS	WELL 1	INDUSTRIAL	ACTIVE
9263	NATL SELECT FABRICS CORP	NATL SELECT FABRICS	WELL 2	INDUSTRIAL	ACTIVE
9348	LIFESTYLE HOMES INC	LIFESTYLE HOMES	WITHDRAW WELL	INDUSTRIAL	ACTIVE
9354	BLASCHAK COAL CORP	BLASCHAK COAL ST NICHOLAS MINE	MINE POOL	MINERAL	ACTIVE
9434	BRIAR KNITTING MILLS	BRIAR KNITTING MILLS	WELL	INDUSTRIAL	ACTIVE
9554	EXPLO TECH	EXPLO TECH	WITHDRAW WELL	INDUSTRIAL	ACTIVE
9574	Unavailable	BODMAN GERALD J	SPRING WITHDRAWAL	AGRICULTURAL	ACTIVE
9575	Unavailable	BODMAN GERALD J	SPRING WITHDRAWAL	AGRICULTURAL	ACTIVE
9674	Unavailable	LEIBY ROBERT C	SPRING	AGRICULTURAL	ACTIVE
9720	IREM TEMPLE AAONMS	IREM CC	WELL 1	COMMERCIAL	ACTIVE
9774	HOCK TRANSIT MIX CONCRETE INC	HOCK TRANSIT MIX CONCRETE	WELL	INDUSTRIAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 6 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
9804	AMER ASPHALT PAVING CO	AMER ASPHALT CHASE QUARRY	MINE WITHDRAWAL	MINERAL	ACTIVE
9900	BLOOMSBURG CARPET IND INC	BLOOMSBURG CARPET IND	TWO WITHDR WELLS	INDUSTRIAL	ACTIVE
10201	FROSTY VALLEY CC	FROSTY VALLEY CC WELL 1	WELL 1	COMMERCIAL	ACTIVE
10202	FROSTY VALLEY CC	FROSTY VALLEY CC WELL 1	WELL 2	COMMERCIAL	ACTIVE
10245	GEN TANK INC	GEN TANK	WITHDRAW WELL	INDUSTRIAL	ACTIVE
10257	COUNTRY COUSINS SHOES INC	COUNTRY COUSINS SHOES	WELL	INDUSTRIAL	ACTIVE
10362	WYOMING VALLEY CC	WYOMING VALLEY CC POND	WELL 1	COMMERCIAL	ACTIVE
10379	CARBONITE FILTER CORP	CARBONITE FILTER	WELL 1	MINERAL	ACTIVE
10383	CARBONITE FILTER CORP	CARBONITE FILTER	WELL	INDUSTRIAL	ACTIVE
10396	BARRETT HAENTJENS & CO	BARRETT HAENTJENS	WELL	INDUSTRIAL	ACTIVE
10460	WAGNERS FRUIT FARM	WAGNERS FRUIT FARM	WELL WITHDRAWAL	AGRICULTURAL	ACTIVE
10461	WAGNERS FRUIT FARM	WAGNERS FRUIT FARM	SPRING WITHDRAWAL	AGRICULTURAL	ACTIVE
10552	BENTON FOUNDRY INC	BENTON FOUNDRY	WELL 1	INDUSTRIAL	ACTIVE
10648	SPRING HILL FARM INC	SPRINGHILL FARMS	WITH WELL	AGRICULTURAL	ACTIVE
10735	Unavailable	HETHERINGTON RAYMOND	SPRING	AGRICULTURAL	ACTIVE
11002	BERWICK WEAVING INC	BERWICK WEAVING	WELL 1	INDUSTRIAL	ACTIVE
11166	VALLEY CC	VALLEY CC	PARKING LOT WELL	COMMERCIAL	ACTIVE
11169	VALLEY CC	VALLEY CC	DRINKING WATER WELL	COMMERCIAL	ACTIVE
11170	VALLEY CC	VALLEY CC	SHOP WELL	COMMERCIAL	ACTIVE
11171	LEHMAN GC	LEHMAN GC	WELL	COMMERCIAL	ACTIVE
11173	FARMERS COOP DAIRY INC	FARMERS COOP DAIRY	WITHDRAW WELLS	INDUSTRIAL	ACTIVE
11251	IA CONST CORP	GROVANIA ASPHALT PLT	WELL	INDUSTRIAL	INACTIVE
11313	BRIARY HEIGHTS INC	ROLLING PINES GC WATER SYS	WELL 1	COMMERCIAL	ACTIVE
11314	BRIARY HEIGHTS INC	ROLLING PINES GC WATER SYS	WELL 2	COMMERCIAL	ACTIVE
11338	WHITE BIRCH GC INC	WHITE BIRCH GC	SPRG 1	COMMERCIAL	ACTIVE
11472	RIVERVIEW VIBRATED BLOCK CO	RIVERVIEW BLOCK MFG	WITH WELL	INDUSTRIAL	ACTIVE
12006	SCHULTZ ELECTROPLATING INC	SCHULTZ ELECTROPLATING	WITHD WELL	INDUSTRIAL	ACTIVE
12353	UAE COALCORP ASSOC	UAE COALCORP HARMONY MINE	WITHDRAWAL WELL	MINERAL	ACTIVE
12399	BALD EAGLE COAL CO INC	BALD EAGLE COAL WHITE PINE MINE	DEWATERING	MINERAL	INACTIVE
12475	KELLY INVESTORS INC	KELLY INVESTORS KELLY 1 MINE	WELL WITHDRAWAL	MINERAL	INACTIVE
12502	INTERCOAL INC	INTERCOAL COAL PREP PLT	WELL	MINERAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 7 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
12504	SMALL MTN QUARRY INC	PENNSY SUPPLY SMALL MTN III QUARRY & SLUSSER BROS PLT	WELL 1	MINERAL	ACTIVE
12508	SMALL MTN QUARRY INC	PENNSY SUPPLY SMALL MTN III QUARRY & SLUSSER BROS PLT	MINE DIV	MINERAL	ACTIVE
12648	HANSON AGGREGATES PENNSYLVANIA INC	HANSON AGGREGATES PA BLOOMSBURG QUARRY	SANITARY WELL	MINERAL	ACTIVE
12651	HANSON AGGREGATES PENNSYLVANIA INC	HANSON AGGREGATES PA BLOOMSBURG QUARRY	S & G PIT WATER	MINERAL	ACTIVE
12653	HANSON AGGREGATES PENNSYLVANIA INC	HANSON AGGREGATES PA BLOOMSBURG QUARRY	WELLS	MINERAL	ACTIVE
12754	Unavailable	SWEET VALLEY GC	WITHDRAW WELL	COMMERCIAL	ACTIVE
12758	JEBBON MFG CORP	JEBBON MFG	WITHDRAW WELL	INDUSTRIAL	INACTIVE
12776	HEMLOCK VALLEY CAMPGROUND	HEMLOCK VALLEY CAMPGROUND	WELL 1	COMMERCIAL	ACTIVE
13009	BEAVER BROOK COAL CO	BEAVER BROOK COAL MINE	QUARRY WITHDRAWAL	MINERAL	ACTIVE
13112	FEIBERITE INC	FIBERITE	WELL	INDUSTRIAL	ACTIVE
13133	CTL ASPHALT MATERIALS INC	CTL ASPHALT MATERIALS	TWO WITHDRAW WELLS	INDUSTRIAL	ACTIVE
13165	S & B FOUNDRY CO	BLOOMSBURG FOUNDRY	WELL	INDUSTRIAL	ACTIVE
13203	AIR PROD & CHEM INC	AIR PROD & CHEM TAMAQUA PLT	BOOSTER PARK 1 NORTH	INDUSTRIAL	ACTIVE
13606	BEAR GAP STONE INC	BEAR GAP QUARRY	FRESH WATER	MINERAL	ACTIVE
13894	MILLVILLE PROD	MILLVILLE PROD	WITHDRAW WELL	INDUSTRIAL	ACTIVE
13904	COLUMBIA GRAPHICS INC	COLUMBIA GRAPHICS	WITHDRAW WELL	INDUSTRIAL	ACTIVE
13929	AMETEK CORPORATE OFC	AMETEK WESTCHESTER PLASTICS DIV	WELL 1	INDUSTRIAL	ACTIVE
13931	AMETEK CORPORATE OFC	AMETEK WESTCHESTER PLASTICS DIV	WELL 2	INDUSTRIAL	ACTIVE
13932	AMETEK CORPORATE OFC	AMETEK WESTCHESTER PLASTICS DIV	WELL 3	INDUSTRIAL	ACTIVE
13933	AMETEK CORPORATE OFC	AMETEK WESTCHESTER PLASTICS DIV	WELL 4	INDUSTRIAL	ACTIVE
14495	BROCKMAN SHEET METAL	BROCKMAN SHEET METAL	WITHD SPRING	INDUSTRIAL	ACTIVE
15567	SILBERLINE MFG CO INC	SILBERLINE MFG LANSFORD PLT	WELL 1	INDUSTRIAL	ACTIVE
15568	SILBERLINE MFG CO INC	SILBERLINE MFG LANSFORD PLT	WELL 2	INDUSTRIAL	ACTIVE
15569	SILBERLINE MFG CO INC	SILBERLINE MFG LANSFORD PLT	WELL 3	INDUSTRIAL	ACTIVE
16007	BRADFORD CLOCKS LTD	BRADFORD CLOCKS	WITHD WELL	INDUSTRIAL	ACTIVE
16107	STONE CONTAINER CORP	BEMIS	WELL	INDUSTRIAL	ACTIVE
16169	UNIVERSAL FOREST PROD INC	UNIVERSAL FOREST PROD EASTERN DIV	PLANT WELL	INDUSTRIAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 8 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
16171	UNIVERSAL FOREST PRO INC	UNIVERSAL FOREST PROD EASTERN DIV	OFFICE WELL	INDUSTRIAL	ACTIVE
16362	CHROMATEX INC	CHROMATEX	WELL 1	INDUSTRIAL	ACTIVE
16364	CHROMATEX INC	CHROMATEX	WELL	INDUSTRIAL	ACTIVE
16385	BLOOMSBURG MILLS INC	BLOOMSBURG MILLS	THREE WITHDR WELLS	INDUSTRIAL	ACTIVE
16424	ALTADIS USA INC	ALTADIS USA MCADOO PLT	WELL 6	INDUSTRIAL	ACTIVE
16496	R VALLEY FARMS	R VALLEY FARMS BEAVER TWP COLUMBIA CNTY	WELL 1	AGRICULTURAL	ACTIVE
16515	WEIR HAZLETON INC	HAZLETON CASTING	WELL	INDUSTRIAL	ACTIVE
16796	Unavailable	COLLINS TOOL CORP	WELL	INDUSTRIAL	ACTIVE
16850	ALTADIS USA INC	ALTADIS USA MCADOO PLT	WELL 5	INDUSTRIAL	ACTIVE
16865	CASTEK INC	CASTEK	WELL 1	INDUSTRIAL	ACTIVE
17594	TEE TO GREEN GOLF CTR	TEE TO GREEN GC MFG	WELL	INDUSTRIAL	ACTIVE
17604	HOLOVIAKS CH SUPPLY INC	HOLOVIAKS CH SUPPLY MFG	WELL	INDUSTRIAL	ACTIVE
17616	DAVIS TROPHIES	DAVIS TROPHIES MFG	WELL	INDUSTRIAL	ACTIVE
17622	HIGHWAY EQUP & SUPPLY CO	HWY EQUIP & SUPPLY MFG	WELL	INDUSTRIAL	ACTIVE
17627	DURABOND CORP	DURABOND CARPET UNDERLAY MFG	WELL	INDUSTRIAL	ACTIVE
18143	FABCON EAST LLC	FABCON E	WELL 2	INDUSTRIAL	ACTIVE
18218	HOLLYWOOD MILLWORK	HOLLYWOOD MILLWORK	WELL	INDUSTRIAL	ACTIVE
18219	PRECISION LITHO GRAPHICS	PRECISION LITHO GRAPHICS	WELL	INDUSTRIAL	ACTIVE
18225	MC BON CORP	MC BON	WELL	INDUSTRIAL	ACTIVE
18227	SUGARLOAF PRINT SHOP	SUGARLOAF PRINT SHOP	WELL	INDUSTRIAL	ACTIVE
18229	BEACH MACH & GEAR	BEACH MACH & GEAR	WELL	INDUSTRIAL	ACTIVE
18715	KOCHS TURKEY FARM	KOCHS TURKEY FARM WALKER TWP SCHUYLKILL CNTY	GROUND WATER HATCHERY	AGRICULTURAL	ACTIVE
18716	KOCHS TURKEY FARM	KOCHS TURKEY FARM WALKER TWP SCHUYLKILL CNTY	GROUND WATER WELL 4	AGRICULTURAL	ACTIVE
18747	ALCOA KAMA INC	MULTI-PLASTICS EXTRUSIONS INC	WELL	INDUSTRIAL	ACTIVE
18824	FROSTY VALLEY CC	FROSTY VALLEY CC WELL 1	CLUB HOUSE WELL	COMMERCIAL	ACTIVE
18825	FROSTY VALLEY CC	FROSTY VALLEY CC WELL 1	BARN WELL	COMMERCIAL	ACTIVE
18973	Unavailable	PAUL R LEVAN & SONS FARM LOCUST TWP COLUMBIA CNTY	WELL 1	AGRICULTURAL	ACTIVE
18989	Unavailable	RAY LEVAN FARM LOCUST TWP COLUMBIA CNTY	SPRING 1	AGRICULTURAL	ACTIVE
18990	Unavailable	RAY LEVAN FARM LOCUST TWP COLUMBIA CNTY	WELL 1	AGRICULTURAL	ACTIVE

Table 2.4-51— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 25 Mile (40 km) Radius of the BBNPP Site}
(Page 9 of 9)

Site ID	Organization	Site Name	Facility	Use Type	Status
18996	Unavailable	ROBERT E KARNES FARM LOCUST TWP COLUMBIA CNTY	WELL AT HOUSE	AGRICULTURAL	ACTIVE
18997	Unavailable	ROBERT E KARNES FARM LOCUST TWP COLUMBIA CNTY	WELL AT BARN	AGRICULTURAL	ACTIVE
19172	HAZLETON MATERIALS LLC	HAZLETON MATERIALS FOSTER TWP LUZERNE CNTY	PRODUCTION WELL	MINERAL	ACTIVE
19173	HAZLETON MATERIALS LLC	HAZLETON MATERIALS FOSTER TWP LUZERNE CNTY	SCALEHOUSE WELL	MINERAL	ACTIVE
19174	HAZLETON MATERIALS LLC	HAZLETON MATERIALS FOSTER TWP LUZERNE CNTY	WASH PLANT WELL	MINERAL	ACTIVE
19243	Unavailable	WINSTON A JARRARD FARM ROARING CREEK TWP COLUMBIA CNTY	WELL 1	AGRICULTURAL	ACTIVE
19409	READING MATERIALS INC	HAINES & KIBBLEHOUSE PIKES CREEK ASPHALT	POND MAKEUP WELL	MINERAL	ACTIVE
19410	READING MATERIALS INC	HAINES & KIBBLEHOUSE PIKES CREEK ASPHALT	PRIMARY PLANT WELL	MINERAL	ACTIVE
19411	READING MATERIALS	HAINES & KIBBLEHOUSE PIKES CREEK ASPHALT	SCALEHOUSE WELL	MINERAL	ACTIVE
19412	READING MATERIALS INC	HAINES & KIBBLEHOUSE PIKES CREEK ASPHALT	GARAGE WELL	MINERAL	ACTIVE
19413	READING MATERIALS INC	HAINES & KIBBLEHOUSE PIKES CREEK ASPHALT	PORTABLE PLANT WELL	MINERAL	ACTIVE
19467	PHILA CITY TRUSTEE GIRARD ESTATE	PHILA CONTINENTAL MINE	MINE DEWATERING PUMP 1	MINERAL	ACTIVE
19468	PHILA CITY TRUSTEE GIRARD ESTATE	PHILA CONTINENTAL MINE	MINE DEWATERING PUMP 2	MINERAL	ACTIVE
19526	KAREN MFG CO INC	KAREN MFG	WITHDRAW WELL	INDUSTRIAL	ACTIVE
19676	GROUP MTN SPRINGS	SUGARLOAD MTN SPRINGS BENTON TWP COLUMBIA CNTY	SUGARLOAF MOUNTAIN SPRING	INDUSTRIAL	ACTIVE
19890	PA FISH & BOAT COMM FISHERIES BUR	BEAVER TWP ROD & GUN CLUB COLUMBIA CNTY	UNNAMED SPRING TRIBUTARY TO SCOTCH RUN	AGRICULTURAL	ACTIVE
20160	EAGLE ROCK COMM ASSOC INC	EAGLE ROCK RESORT	WELL C	COMMERCIAL	ACTIVE
20161	EAGLE ROCK COMM ASSOC INC	EAGLE ROCK RESORT	WELL A	COMMERCIAL	ACTIVE
20253	VALLEY CC	VALLEY CC	PUMPHOUSE WELL	COMMERCIAL	ACTIVE
20439	COATES TONERS	COATES TONERS	WITHDRAW WELL	INDUSTRIAL	ACTIVE
Source: PADEP, 2010b					

Table 2.4-52— {Agricultural, Commercial, Industrial, and Mineral Use Groundwater Withdrawals Within a 5-Mile (8-km) Radius of the BBNPP Site}

ORGANIZATION	SITE NAME	SUB FACILITY	USE TYPE	SITE STATUS
ROBERT W HART & SON INC	ROBERT W HART & SON MFG	WITH WELL	INDUSTRIAL USE	ACTIVE
LIFESTYLE HOMES INC	LIFESTYE HOMES	WITHDRAW WELL	INDUSTRIAL USE	ACTIVE
GEN TANK INC	GEN TANK	WITHDRAW WELL	INDUSTRIAL USE	ACTIVE
BERWICK WEAVING INC	BERWICK WEAVING	WELL 1	INDUSTRIAL USE	ACTIVE
RIVERVIEW VIBRATED BLOCK CO	RIVERVIEW BLOCK MFG	WITH WELL	INDUSTRIAL USE	ACTIVE
BROCKMAN SHEET METAL	BROCKMAN SHEET METAL	WITHD SPRING	INDUSTRIAL USE	ACTIVE
BEACH MACH & GEAR	BEACH MACH & GEAR	WELL	INDUSTRIAL USE	ACTIVE
BARLETTA MATERIALS & CONST INC	BARLETTA HONEY HOLE QUARRY	LAB WELL 2	INDUSTRIAL USE	ACTIVE
AUDIMATION CORP	AUDIMATION	WITHDRAW WELL	INDUSTRIAL USE	ACTIVE
ANDREAS LUMBER INC	ANDREAS LUMBER	SPRING	INDUSTRIAL USE	ACTIVE
COUNTRY COUSINS SHOES INC	COUNTRY COUSINS SHOES	WELL	INDUSTRIAL USE	ACTIVE
DURABOND CORP	DURABOND CARPET UNDERLAY MFG	WELL	INDUSTRIAL USE	ACTIVE
CASTEK INC	CASTEK	WELL 1	INDUSTRIAL USE	ACTIVE

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 1 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400001	RIVERVIEW VILLAGE MHP	C	100	Luzerne	WELL #1	Permanent	14,000
2400003	ECHO VALLEY MHP	C	490	Luzerne	WELL #1	Permanent	66,000
2400007	LEHMAN HOME PARK	C	98	Luzerne	WELL	Permanent	37,000
2400008	TOWER 80 81 LLC	C	55	Luzerne	WELL 1	Abandoned	43,200
2400008	TOWER 80 81 LLC	C	55	Luzerne	WELL 2	Permanent	43,200
2400012	AQUA PA FIELDCREST	C	110	Luzerne	WELL 1	Permanent	63,000
2400017	CHASE MANOR WATER ASSOC	C	145	Luzerne	WELL #1	Permanent	18,720
2400017	CHASE MANOR WATER ASSOC	C	145	Luzerne	WELL #2	Permanent	6,840
2400023	KEYSTONE JOB CORPS CENTER	C	950	Luzerne	WELL #1	Permanent	100,800
2400023	KEYSTONE JOB CORPS CENTER	C	950	Luzerne	WELL #2	Permanent	223,200
2400023	KEYSTONE JOB CORPS CENTER	C	950	Luzerne	WELL #3	Permanent	216,000
2400024	BONHAM NURSING CENTER	C	90	Luzerne	WELL 1	Emergency	10,000
2400024	BONHAM NURSING CENTER	C	90	Luzerne	WELL 2	Permanent	15,000
2400026	PENN ST WILKES BARRE CAMPUS	NN	891	Luzerne	WELL 1	Permanent	50,000
2400026	PENN ST WILKES BARRE CAMPUS	NN	891	Luzerne	WELL 2	Permanent	54,000
2400027	LAKESIDE NURSING HOME	C	91	Luzerne	WELL #1	Permanent	14,000
2400029	AQUA PA SHICKSHINNY LAKE	C	250	Luzerne	CHEROKEE WELL	Abandoned	14,000
2400029	AQUA PA SHICKSHINNY LAKE	C	250	Luzerne	SENECA WELL	Abandoned	7,000
2400029	AQUA PA SHICKSHINNY LAKE	C	250	Luzerne	CHEROKEE NEW WELL	Permanent	
2400029	AQUA PA SHICKSHINNY LAKE	C	250	Luzerne	APACHE NEW WELL	Permanent	
2400031	4 SEASONS ESTATES	C	98	Luzerne	WELL 1	Permanent	37,440
2400031	4 SEASONS ESTATES	C	98	Luzerne	WELL 2	Permanent	31,680
2400034	LAUREL RUN ESTATES	C	340	Luzerne	WELL #2	Permanent	21,000
2400034	LAUREL RUN ESTATES	C	340	Luzerne	WELL #3	Reserve	72,000
2400034	LAUREL RUN ESTATES	C	340	Luzerne	WELL #4	Permanent	31,000
2400036	COUNTRY CREST MHP	C	150	Luzerne	LOWER WELL #1	Permanent	17,000
2400036	COUNTRY CREST MHP	C	150	Luzerne	WELL #2 BEHIND BLDG	Reserve	11,000
2400038	VALLEY STREAM MHP	C	384	Luzerne	WELL 1	Permanent	
2400038	VALLEY STREAM MHP	C	384	Luzerne	WELL 3	Permanent	
2400038	VALLEY STREAM MHP	C	384	Luzerne	WELL #4	Emergency	
2400039	HANSON PARK MHP	C	126	Luzerne	WELL 1	Permanent	18,720
2400041	COUNTRY VILLAGE MHP	C	175	Luzerne	WELL #1	Permanent	43,200
2400042	BEECHCREST MHP	C	40	Luzerne	WELL #1	Permanent	
2400043	PLEASANT VIEW MHP	C	95	Luzerne	WELL 1	Abandoned	14,000
2400043	PLEASANT VIEW MHP	C	95	Luzerne	WELL 3	Reserve	18,000
2400043	PLEASANT VIEW MHP	C	95	Luzerne	WELL 4 GOLOMB HOUSE	Permanent	86,000
2400043	PLEASANT VIEW MHP	C	95	Luzerne	WELL 5 TRMT BLDG	Permanent	28,000
2400046	COUNTRY ESTATES MHP	C	25	Luzerne	WELL	Permanent	28,800

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}

(Page 2 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400048	CONYNGHAM WATER CO	C	2,400	Luzerne	WELL #1	Permanent	36,000
2400048	CONYNGHAM WATER CO	C	2,400	Luzerne	WELL #2	Abandoned	28,800
2400048	CONYNGHAM WATER CO	C	2,400	Luzerne	WELL #3	Permanent	72,000
2400048	CONYNGHAM WATER CO	C	2,400	Luzerne	WELL 5	Permanent	80,000
2400048	CONYNGHAM WATER CO	C	2,400	Luzerne	WELL 6	Permanent	252,000
2400048	CONYNGHAM WATER CO	C	2,400	Luzerne	BOREHOLE	Abandoned	
2400048	CONYNGHAM WATER CO	C	2,400	Luzerne	WELL 7	Permanent	216,000
2400049	EVERGREEN MHP	C	140	Luzerne	WELL #1	Permanent	5,000
2400049	EVERGREEN MHP	C	140	Luzerne	WELL #2	Permanent	22,000
2400050	COUNTRY PINE ESTATES	C	280	Luzerne	WELL #1	Permanent	18,000
2400050	COUNTRY PINE ESTATES	C	280	Luzerne	WELL #2	Permanent	16,000
2400051	VALLEY VIEW MHP	C	480	Luzerne	WELL #1	Permanent	109,000
2400052	DALLAS MHP	C	65	Luzerne	WELL #1	Permanent	28,000
2400052	DALLAS MHP	C	65	Luzerne	WELL #2	Permanent	44,000
2400053	AQUA PA HEX ACRES	C	255	Luzerne	WELL #1 INSIDE WELL	Permanent	84,000
2400053	AQUA PA HEX ACRES	C	255	Luzerne	WELL #2 HILLSIDE WEL	Permanent	43,000
2400053	AQUA PA HEX ACRES	C	255	Luzerne	WELL #3 OUTSIDE WELL	Permanent	
2400054	FREELAND BORO MUNI WATER AUTH	C	4,610	Luzerne	WELL 4	Permanent	252,000
2400054	FREELAND BORO MUNI WATER AUTH	C	4,610	Luzerne	WELL 6	Permanent	252,000
2400054	FREELAND BORO MUNI WATER AUTH	C	4,610	Luzerne	WELL 9	Permanent	180,000
2400054	FREELAND BORO MUNI WATER AUTH	C	4,610	Luzerne	WELL 10	Permanent	130,000
2400054	FREELAND BORO MUNI WATER AUTH	C	4,610	Luzerne	WELL 11	Permanent	360,000
2400054	FREELAND BORO MUNI WATER AUTH	C	4,610	Luzerne	WELL 12	Permanent	115,200
2400054	FREELAND BORO MUNI WATER AUTH	C	4,610	Luzerne	WELL 17 UPPER LEHIGH	Permanent	324,000
2400055	MAPLE LANE ESTATE	C	200	Luzerne	WELL 1	Permanent	52,000
2400055	MAPLE LANE ESTATE	C	200	Luzerne	WELL 2	Permanent	52,000
2400055	MAPLE LANE ESTATE	C	200	Luzerne	WELL 3	Permanent	52,000
2400060	SWEET VALLEY MHP	C	60	Luzerne	WELL 1	Permanent	17,000
2400060	SWEET VALLEY MHP	C	60	Luzerne	WELL 2	Permanent	17,000
2400063	WHIPPERWILL MHP	C	25	Luzerne	WELL 1	Permanent	21,000
2400066	AQUA PA WAPWALLOPEN	C	239	Luzerne	SPRING 1	Abandoned	0
2400066	AQUA PA WAPWALLOPEN	C	239	Luzerne	SPRING 2	Abandoned	0
2400066	AQUA PA WAPWALLOPEN	C	239	Luzerne	WELL	Abandoned	72,000
2400066	AQUA PA WAPWALLOPEN	C	239	Luzerne	WELL 2	Permanent	74,880
2400067	AQUA PA TAMBUR	C	90	Luzerne	WELL #1	Permanent	0

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 3 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400068	HYLAND MHP	C	75	Luzerne	WELL #1	Permanent	17,280
2400070	PAWC HILLCREST	C	123	Luzerne	WELL 1	Permanent	28,000
2400072	PAWC HOMESITE	C	55	Luzerne	WELL 1	Permanent	20,000
2400073	UNITED WATER BROWN MANOR	C	91	Luzerne	WELL #1	Permanent	25,000
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D1 SCHOOLEY	Permanent	244,800
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D2 SNYDER	Permanent	144,000
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D3 BUNN	Permanent	144,000
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D4 COUNTRY CLUB	Permanent	102,240
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D5 CENTER HILL	Abandoned	101,000
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D6 HADDONFIE LD	Permanent	40,320
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D7 42ND ST	Abandoned	40,000
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D8 DATTENER	Abandoned	0
2400076	UNITED WATER PA DALLAS	C	5,113	Luzerne	D9 GEPHART WELL	Permanent	216,000
2400078	AQUA PA FOREST PARK	C	420	Luzerne	WELL #1 WEST PARKWAY	Permanent	43,200
2400078	AQUA PA FOREST PARK	C	420	Luzerne	WELL #2 EAST PARKWAY	Abandoned	22,000
2400078	AQUA PA FOREST PARK	C	420	Luzerne	EAST PARKWAY WELL 2	Permanent	86,400
2400079	AQUA PA PENN LAKE	C	150	Luzerne	WELL #1	Permanent	92,160
2400082	OVERBROOK WATER COMPANY	C	475	Luzerne	WELL 1 WARREN AVE	Permanent	14,000
2400082	OVERBROOK WATER COMPANY	C	475	Luzerne	WELL 2 WARREN AVE	Permanent	21,000
2400082	OVERBROOK WATER COMPANY	C	475	Luzerne	ABANDOND WARREN AVE	Abandoned	36,000
2400082	OVERBROOK WATER COMPANY	C	475	Luzerne	WELL 3 OVERBROO K RD	Permanent	72,000
2400083	AQUA PA APPLEWOOD	C	82	Luzerne	WELL #1	Permanent	50,000
2400085	AQUA PA BARRETT	C	107	Luzerne	WELL #1	Permanent	0
2400086	INDIAN SPRINGS WATER CO	C	137	Luzerne	SPRING #1	Permanent	0
2400089	AQUA PA GARBUSH	C	200	Luzerne	WELL #1	Permanent	57,000
2400089	AQUA PA GARBUSH	C	200	Luzerne	WELL #2	Permanent	86,400
2400091	UNITED WATER PA SHAVERTOWN	C	3,035	Luzerne	SALLA S1	Permanent	288,000

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 4 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400091	UNITED WATER PA SHAVERTOWN	C	3,035	Luzerne	SOURCE 002 HASSOLD	Permanent	
2400095	AQUA PA OAKHILL	C	486	Luzerne	PARK DR WELL 1	Reserve	24,480
2400095	AQUA PA OAKHILL	C	486	Luzerne	MAPLE ST WELL 2	Permanent	86,400
2400095	AQUA PA OAKHILL	C	486	Luzerne	OAK DRIVE WELL 4	Permanent	144,000
2400096	TOWN & COUNTRY MANOR ASSOC	C	79	Luzerne	WELL 1 INSIDE	Permanent	60,000
2400096	TOWN & COUNTRY MANOR ASSOC	C	79	Luzerne	WELL 2 OUTSIDE	Permanent	60,000
2400101	AQUA PA RHODES TERRACE	C	68	Luzerne	RHODES TERRACE WELL	Permanent	65,000
2400102	AQUA PA WARDEN PLACE	C	175	Luzerne	WARDEN PLACE WELL 1	Permanent	0
2400102	AQUA PA WARDEN PLACE	C	175	Luzerne	WELL 2	Abandoned	0
2400103	UNITED WATER PA HARVEYS LAKE	C	200	Luzerne	CARPENTER RD NEW WELL	Permanent	43,200
2400103	UNITED WATER PA HARVEYS LAKE	C	200	Luzerne	ISLAND OLD WELL	Permanent	31,680
2400104	AQUA PA MIDWAY SYSTEM	C	1,793	Luzerne	MIDWAY INSIDE WELL	Permanent	216,000
2400104	AQUA PA MIDWAY SYSTEM	C	1,793	Luzerne	MIDWAY OUTSIDE WELL	Reserve	57,600
2400104	AQUA PA MIDWAY SYSTEM	C	1,793	Luzerne	DUG ROAD WELL	Permanent	78,000
2400104	AQUA PA MIDWAY SYSTEM	C	1,793	Luzerne	ELEV TANK WELL OLD	Permanent	86,400
2400107	ORCHARD EAST WATER ASSOC	C	125	Luzerne	WELL #1	Permanent	36,000
2400108	AQUA PA WHITE HAVEN	C	1,200	Luzerne	HILLTOP WELL	Permanent	115,000
2400108	AQUA PA WHITE HAVEN	C	1,200	Luzerne	WOODHAVEN EAST WELL	Permanent	94,000
2400108	AQUA PA WHITE HAVEN	C	1,200	Luzerne	WOODHAVEN WEST WELL	Permanent	173,000
2400108	AQUA PA WHITE HAVEN	C	1,200	Luzerne	LINESVILLE WELL 1	Abandoned	50,000
2400108	AQUA PA WHITE HAVEN	C	1,200	Luzerne	LINESVILLE WELL 2	Abandoned	50,000
2400108	AQUA PA WHITE HAVEN	C	1,200	Luzerne	LINESVILLE CREEK	Abandoned	0
2400108	AQUA PA WHITE HAVEN	C	1,200	Luzerne	SANTEE SPRING	Abandoned	0

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 5 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400109	WHITE HAVEN CENTER	C	659	Luzerne	WELL 11	Permanent	208,000
2400109	WHITE HAVEN CENTER	C	659	Luzerne	WELL 12	Permanent	216,000
2400109	WHITE HAVEN CENTER	C	659	Luzerne	WELL 13	Permanent	216,000
2400109	WHITE HAVEN CENTER	C	659	Luzerne	INDEPENDENCE HOUSE	Abandoned	2,000
2400110	COUNTRY CLUB APTS	C	240	Luzerne	WELL #1	Permanent	36,000
2400110	COUNTRY CLUB APTS	C	240	Luzerne	INTERCON DALLAS	Emergency	0
2400111	AQUA PA LAUREL LAKES VILLAGE	C	475	Luzerne	WELL #1	Permanent	8,000
2400111	AQUA PA LAUREL LAKES VILLAGE	C	475	Luzerne	WELL #2	Permanent	22,000
2400111	AQUA PA LAUREL LAKES VILLAGE	C	475	Luzerne	IWELL #3	Permanent	26,000
2400111	AQUA PA LAUREL LAKES VILLAGE	C	475	Luzerne	WELL #4	Permanent	24,000
2400111	AQUA PA LAUREL LAKES VILLAGE	C	475	Luzerne	SOURCE 005	Emergency	
2400113	ORCHARD WEST WATER ASSOC	C	90	Luzerne	WELL #1	Permanent	72,000
2400114	BEECH MOUNTAIN	C	2,311	Luzerne	WELL 1	Permanent	216,000
2400114	BEECH MOUNTAIN	C	2,311	Luzerne	WELL #2	Permanent	194,000
2400115	MEADOWS COMPLEX	C	628	Luzerne	WELL #1	Permanent	270,720
2400115	MEADOWS COMPLEX	C	628	Luzerne	DALLAS W INTERCONNEC	Emergency	0
2400115	MEADOWS COMPLEX	C	628	Luzerne	SISTERS OF MERCY INT	Emergency	0
2400116	FRITZINGERTOWN SR LIV COMM #1	C	66	Luzerne	WELL 1	Permanent	17,280
2400116	FRITZINGERTOWN SR LIV COMM #1	C	66	Luzerne	INTERCONNECTION	Reserve	
2400117	BUTLER VALLEY MANOR	C	90	Luzerne	WELL 1	Permanent	144,000
2400126	VALLEY GORGE MOBILE HOME PARK	C	61	Luzerne	WELL #1	Emergency	
2400126	VALLEY GORGE MOBILE HOME PARK	C	61	Luzerne	WELL 2	Permanent	8,640
2400126	VALLEY GORGE MOBILE HOME PARK	C	61	Luzerne	WELL 3	Emergency	14,400
2400128	PAWC SUTTON HILLS	C	275	Luzerne	WELL 1	Permanent	79,200
2400131	FERNWOOD MANOR	C	26	Luzerne	WELL 1	Permanent	
2400136	SANDY RUN ASSOC	C	47	Luzerne	WELL #1	Permanent	46,080
2400139	FRITZINGERTOWN SR LIV COMM #2	C	118	Luzerne	WELL 2	Permanent	14,400
2400139	FRITZINGERTOWN SR LIV COMM #2	C	118	Luzerne	SOURCE 002	Permanent	
2400140	SAND SPRINGS	C	840	Luzerne	WELL 01	Permanent	72,000
2400140	SAND SPRINGS	C	840	Luzerne	WELL 02	Permanent	
2400140	SAND SPRINGS	C	840	Luzerne	CAN DO WATER SYSTEM	Permanent	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 6 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400142	HILLSIDE CONDOMINIUMS	C	98	Luzerne	WELL	Permanent	21,600
2400142	HILLSIDE CONDOMINIUMS	C	98	Luzerne	ORCHARD EAST 2400107	Reserve	
2400142	HILLSIDE CONDOMINIUMS	C	98	Luzerne	ORCHARD WEST 2400113	Reserve	
2400144	AQUA PA ST JOHNS ESTATES	C	92	Luzerne	WELL #1	Permanent	57,600
2400145	SISTERS OF MERCY	C	240	Luzerne	WELL	Permanent	
2400146	PROVIDENCE PLACE OF HAZLETON	C	140	Luzerne	WELL	Permanent	64,800
2400147	AQUA PA GREENBRIAR	C	120	Luzerne	WELL # 1	Permanent	70,560
2400149	YALICK FARMS	C	7	Luzerne	WELL #1	Permanent	90,720
2400149	YALICK FARMS	C	7	Luzerne	WELL #2	Permanent	64,800
2400301	JACIES MID WAY	TN	50	Luzerne	WELL 1	Permanent	0
2400303	SALLY PURSELLS COUNTRY INN	TN	25	Luzerne	WELL 1	Permanent	28,800
2400304	SUGARLOAF GOLF CLUB	TN	75	Luzerne	CLUBHOUS E WELL	Permanent	0
2400304	SUGARLOAF GOLF CLUB	TN	75	Luzerne	TEE 7	Abandoned	0
2400304	SUGARLOAF GOLF CLUB	TN	75	Luzerne	TEE 14	Abandoned	0
2400305	MEL ROES RESTAURANT	TN	100	Luzerne	WELL 1	Permanent	0
2400308	DAMENTIS RESTAURANT	TN	50	Luzerne	WELL 1	Permanent	0
2400308	DAMENTIS RESTAURANT	TN	50	Luzerne	WELL 2	Permanent	0
2400309	STAGE COACH INN	TN	30	Luzerne	WELL 1	Permanent	10,080
2400313	EVANS ROADHOUSE	TN	55	Luzerne	WELL	Permanent	
2400314	DANOS BAR	TN	25	Luzerne	WELL 1	Permanent	0
2400319	BUTLER TWP FIRE CO	TN	40	Luzerne	WELL 1	Permanent	0
2400320	SNYDERS BACKSTREET PUB	TN	35	Luzerne	WELL 1	Permanent	0
2400323	WILKES BARRE MUNIC GOLF COURSE	TN	225	Luzerne	WELL #1	Permanent	2,500
2400326	BEAR CREEK INNE	TN	60	Luzerne	WELL #1	Permanent	0
2400327	CASINO COUNTRYSIDE INN	TN	44	Luzerne	WELL	Permanent	
2400327	CASINO COUNTRYSIDE INN	TN	44	Luzerne	SHALLOW WELL	Permanent	
2400332	VALLEY BOWLING LANES	TN	70	Luzerne	WELL 1	Permanent	0
2400333	DONAHUES FROGTOWNE GRILL	TN	60	Luzerne	WELL 1	Permanent	0
2400337	DORRANCE INN	TN	25	Luzerne	WELL 1	Permanent	0
2400340	SQUIGS PLACE	TN	25	Luzerne	WELL	Permanent	0
2400343	ALBERDEEN INN	TN	25	Luzerne	WELL	Permanent	0
2400349	DORRANCE SUNOCO	TN	100	Luzerne	WELL	Permanent	
2400351	AMER LEGION MTN POST 781	TN	25	Luzerne	WELL	Permanent	0
2400355	TRAILS END RESTAURANT	TN	50	Luzerne	WELL 1	Permanent	
2400356	SPENCERS WESTERN CAFE	TN	30	Luzerne	APT BLDG WELL	Permanent	
2400357	RICKETTS GLEN HOTEL	TN	100	Luzerne	WELL 1	Permanent	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	RTE 118 MAINT BLDG	Emergency	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 7 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	EVERGREEN PICNIC 2	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	RT 118 PICNIC 3	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	RT 118 PICNIC 4	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	RT 118 PICNIC 5	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	LK JEAN PICNIC417 06	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	USGS 417 07 WELL	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	SMALL CG 417 10 WELL	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	LARGE CG 417 11 WELL	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	LARGE CG 417 12 WELL	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	OLD PK OFF 417 13	Abandoned	0
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	GROUP AREA 417 14	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	BEACH WELL 417 15	Permanent	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	MAIN WAT SUPP 417 16	Permanent	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	W BOAT LAUNCH 417 20	Abandoned	0
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	VISITORS CENTER WELL	Permanent	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	OLD PK ENTRANCE 19	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	LK JEAN PICNIC417 07	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	BEACH TRAIL 8	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	LKE JEAN PICNIC4170 9	Abandoned	
2400358	RICKETTS GLEN STATE PARK	TN	950	Luzerne	MANAGERS RESIDENCE	Emergency	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 8 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400360	DEER OAK LOUNGE	TN	50	Luzerne	WELL	Permanent	
2400363	GOODS CAMPGROUND	TN	35	Luzerne	CAMPGROUND WELL	Permanent	
2400364	NEW BACK MOUNTAIN BOWL	TN	150	Luzerne	WELL 1	Permanent	0
2400364	NEW BACK MOUNTAIN BOWL	TN	150	Luzerne	NEW WELL AUGUST 2010	Permanent	
2400368	DALLAS SCH DIST ADMIN BLDG	NN	50	Luzerne	WELL	Permanent	
2400369	LAKE LEHMAN HIGH SCHOOL	NN	750	Luzerne	WELL 1	Permanent	36,000
2400370	LEHMAN JACKSON ELEMENTARY	NN	875	Luzerne	WELL 1	Permanent	28,800
2400374	ROSS ELEMENTARY SCHOOL	NN	130	Luzerne	WELL 1	Permanent	0
2400375	LAKE NOXEN ELEMENTARY SCHOOL	NN	450	Luzerne	WELL 1	Permanent	15,000
2400377	HUNLOCK CREEK TAVERN	TN	50	Luzerne	WELL	Permanent	0
2400379	JIM MIL	TN	25	Luzerne	WELL	Permanent	0
2400380	VILLAGE TAVERN	TN	25	Luzerne	WELL	Permanent	10,800
2400384	COUNTRY GENTLEMAN	TN	200	Luzerne	WELL	Permanent	0
2400388	LAKESIDE PIZZERIA & DELI	TN	25	Luzerne	WELL 1	Permanent	0
2400392	NINOS PIZZA	TN	50	Luzerne	WELL	Permanent	0
2400393	AMERICAN LEGION POST 495	TN	50	Luzerne	WELL	Abandoned	
2400393	AMERICAN LEGION POST 495	TN	50	Luzerne	NEW WELL	Permanent	
2400394	NORTHWEST SENIOR HIGH SCHOOL	NN	650	Luzerne	WELL 1	Permanent	0
2400395	HUNTINGTON MILLS PRIMARY SCH	NN	301	Luzerne	WELL 1	Permanent	60,000
2400396	HUNLOCK CREEK INTERMEDIATE SCH	NN	409	Luzerne	WELL 1	Permanent	57,600
2400401	BIG B DRIVE IN	TN	25	Luzerne	WELL	Permanent	0
2400404	MORGAN HILLS GOLF COURSE	TN	35	Luzerne	WELL	Permanent	0
2400406	TC RILEYS	TN	60	Luzerne	WELL 1	Permanent	0
2400407	FRANCES SLOCUM STATE PARK	TN	2,000	Luzerne	WELL 1	Permanent	624,000
2400407	FRANCES SLOCUM STATE PARK	TN	2,000	Luzerne	WELL 2	Permanent	257,000
2400408	IREM COUNTRY CLUB	TN	800	Luzerne	IREM WELL	Abandoned	0
2400408	IREM COUNTRY CLUB	TN	800	Luzerne	DERR WELL	Permanent	0
2400409	SHADYSIDE TAVERN	TN	30	Luzerne	WELL 1	Permanent	0
2400410	BEAUMONT INN	TN	50	Luzerne	WELL 1	Permanent	0
2400413	SPORTSMANS BAR	TN	25	Luzerne	WELL 1	Permanent	0
2400414	SUNFLOWER SPROUTS LEARNING CTR	TN	39	Luzerne	WELL 1	Permanent	0
2400421	RICH AND CHARLOTTES	TN	25	Luzerne	WELL 1	Permanent	0
2400423	MISERICORDIA UNIVERSITY	NN	2,400	Luzerne	ADMINSTRATION WELL	Permanent	216,000
2400423	MISERICORDIA UNIVERSITY	NN	2,400	Luzerne	MCAULEY WALSH WELL	Permanent	216,000
2400423	MISERICORDIA UNIVERSITY	NN	2,400	Luzerne	GILDEA HALL	Permanent	259,200
2400424	ROLLAWAY	TN	125	Luzerne	WELL 1	Permanent	0

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 9 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400428	CASTLE INN	TN	50	Luzerne	WELL 1	Permanent	0
2400429	COSCIAS HIGHLANDS AT NEWBERRY	TN	100	Luzerne	WELL 1	Reserve	0
2400429	COSCIAS HIGHLANDS AT NEWBERRY	TN	100	Luzerne	WELL 2	Permanent	
2400430	NEWBERRY ESTATE HOMEOWNERS	TN	50	Luzerne	WELL 1	Permanent	0
2400431	OVERBROOK PUB & GRILLE	TN	25	Luzerne	WELL 1	Permanent	0
2400434	FARMERS INN	TN	35	Luzerne	WELL 1	Permanent	0
2400437	LEHMAN GOLF CLUB	TN	25	Luzerne	MAIN WELL	Permanent	0
2400437	LEHMAN GOLF CLUB	TN	25	Luzerne	GOLF COURSE NP WELL	Emergency	0
2400439	SHELLYS DINER	TN	25	Luzerne	WELL 1	Permanent	
2400440	OUTPOST INN	TN	25	Luzerne	WELL 1	Permanent	0
2400446	SARAH J DYMOND ELEM SCHOOL	NN	240	Luzerne	WELL 1	Permanent	0
2400447	TWIN OAKS GOLF COURSE	TN	50	Luzerne	WELL 1	Permanent	0
2400449	APPLE TREE HOUSE	TN	50	Luzerne	WELL	Permanent	0
2400452	BEAR CREEK COMM CHARTER SCH	NN	300	Luzerne	WELL 1	Permanent	14,400
2400453	PLEASURE DOME	TN	30	Luzerne	WELL 1	Permanent	17,280
2400454	KIRBY EPISCOPAL HOUSE	TN	25	Luzerne	WELL	Permanent	0
2400456	COSENZA PIZZERIA	TN	25	Luzerne	WELL #1	Permanent	0
2400458	COUNTRY PUB	TN	25	Luzerne	WELL	Permanent	0
2400460	RICE ELEMENTARY SCHOOL	NN	838	Luzerne	SOURCE A	Permanent	28,800
2400461	UNI MART DRUMS	TN	550	Luzerne	WELL	Permanent	21,600
2400463	ANNE MCLAUGHLINS CHILD CARE	NN	50	Luzerne	WELL	Permanent	150
2400467	MAS FAMILY RESTAURANT	TN	250	Luzerne	WELL 1	Permanent	0
2400471	FOUR FELLAS BAR & GRILL	TN	50	Luzerne	WELL	Permanent	0
2400472	CHARLIE WEAVERS BAR AND REST	TN	50	Luzerne	WELL	Permanent	0
2400479	CLEARBROOK LODGE	TN	65	Luzerne	WELL 1	Permanent	
2400479	CLEARBROOK LODGE	TN	65	Luzerne	WELL 2	Permanent	
2400480	L & P BERWICK	NN	63	Luzerne	WELL 1 LEFT SIDE	Permanent	14,400
2400480	L & P BERWICK	NN	63	Luzerne	WELL 2 REAR BY TANKS	Permanent	14,400
2400485	ECONO LODGE	TN	35	Luzerne	BLDG A WELL	Permanent	0
2400485	ECONO LODGE	TN	35	Luzerne	BLDG B WELL	Permanent	0
2400501	CAMP ORCHARD HILL	TN	100	Luzerne	WELL 1	Permanent	0
2400501	CAMP ORCHARD HILL	TN	100	Luzerne	SOURCE 002	Permanent	
2400502	BARBACCI GROVE	TN	25	Luzerne	WELL	Permanent	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}

(Page 10 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400517	HUNTSVILLE CHRISTIAN CHURCH	TN	100	Luzerne	WELL 1	Permanent	0
2400521	PATTERSON GROVE CAMPMEETING	TN	300	Luzerne	BOARDING HOUSE WELL1	Permanent	
2400521	PATTERSON GROVE CAMPMEETING	TN	300	Luzerne	TABERNACLE WELL2	Permanent	
2400521	PATTERSON GROVE CAMPMEETING	TN	300	Luzerne	COURTYARD WELL3	Permanent	
2400523	NEW HIDDEN LAKE CAMPGROUND	TN	150	Luzerne	WELL	Permanent	
2400524	CALVARY BIBLE CHAPEL	NN	80	Luzerne	WELL	Permanent	
2400530	BEAR CREEK CAMP	TN	235	Luzerne	MAIN OFFICE WELL	Permanent	0
2400530	BEAR CREEK CAMP	TN	235	Luzerne	NORTH SITE WELL	Permanent	0
2400530	BEAR CREEK CAMP	TN	235	Luzerne	EAST SITE WELL	Reserve	0
2400532	WILKES BARRE TWP SETTLEMENT CP	TN	25	Luzerne	WELL #1	Permanent	0
2400537	SANDY VALLEY CAMPGROUND	TN	35	Luzerne	WELL 1	Permanent	
2400537	SANDY VALLEY CAMPGROUND	TN	35	Luzerne	WELL 2	Seasonal	
2400538	ST PAULS UNITED METHODIST CH	TN	60	Luzerne	WELL	Permanent	
2400543	MOYERS GROVE CAMPGROUND	TN	165	Luzerne	WELL	Permanent	0
2400546	LOOKOUT HOUSE	TN	25	Luzerne	WELL 1A	Permanent	7,200
2400546	LOOKOUT HOUSE	TN	25	Luzerne	WELL 2B	Abandoned	10,080
2400806	HUMBOLDT INDUSTRIAL PARK	NN	8,000	Luzerne	WELL 1	Permanent	288,000
2400806	HUMBOLDT INDUSTRIAL PARK	NN	8,000	Luzerne	WELL 3	Permanent	170,000
2400806	HUMBOLDT INDUSTRIAL PARK	NN	8,000	Luzerne	WELL 5	Reserve	72,000
2400806	HUMBOLDT INDUSTRIAL PARK	NN	8,000	Luzerne	WELL 6	Abandoned	72,000
2400806	HUMBOLDT INDUSTRIAL PARK	NN	8,000	Luzerne	WELL 7	Permanent	288,000
2400806	HUMBOLDT INDUSTRIAL PARK	NN	8,000	Luzerne	WELL 8	Permanent	266,400
2400806	HUMBOLDT INDUSTRIAL PARK	NN	8,000	Luzerne	WELL 9	Permanent	216,000
2400813	EDGEWOOD PINES GOLF CLUB	TN	150	Luzerne	WELL	Permanent	43,200
2400823	TOMS KITCHEN	TN	225	Luzerne	WELL	Permanent	0
2400824	BEAR MART 1	TN	400	Luzerne	WELL #1	Abandoned	17,280
2400824	BEAR MART 1	TN	400	Luzerne	WELL # 2	Permanent	43,200
2400825	SHINDIG INN	TN	50	Luzerne	WELL 1	Permanent	0
2400828	SAFETY REST AREA SITE #39	TN	860	Luzerne	WELL	Permanent	28,800
2400829	SAFETY REST AREA SITE #53	TN	840	Luzerne	WELL	Permanent	36,000
2400830	SAFTEY REST AREA SITE #54	TN	840	Luzerne	WELL	Permanent	14,400
2400835	JCC DAY CAMP & HOLIDAY HOUSE	TN	250	Luzerne	MAIN WELL HOUSE WELL	Permanent	0
2400835	JCC DAY CAMP & HOLIDAY HOUSE	TN	250	Luzerne	DOGHOUSE WELL	Permanent	0

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 11 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400835	JCC DAY CAMP & HOLIDAY HOUSE	TN	250	Luzerne	HOLIDAY HOUSE WELL	Permanent	
2400836	JOHN HEINZ REHAB	TN	40	Luzerne	WELL	Permanent	0
2400840	RED ROOSTER	TN	80	Luzerne	WELL 1	Permanent	0
2400841	TECH PACKAGING	NN	120	Luzerne	WELL 1	Permanent	72,000
2400848	GOULDS SUPERMARKET	TN	500	Luzerne	WELL 1	Permanent	0
2400848	GOULDS SUPERMARKET	TN	500	Luzerne	SOURCE 002	Permanent	60
2400851	BURGER KING RESTAURANT	TN	900	Luzerne	WELL 1	Permanent	0
2400852	HAZLE TOWNSHIP COMMUNITY PARK	TN	25	Luzerne	WELL	Permanent	0
2400853	UNIMART 94338	TN	700	Luzerne	NEW WELL	Permanent	0
2400858	CARMENS COUNTRY INN	TN	200	Luzerne	WELL	Permanent	28,800
2400859	STEWARTS DRIVE IN	TN	500	Luzerne	WELL	Permanent	0
2400859	STEWARTS DRIVE IN	TN	500	Luzerne	COOKIES CAFE WELL	Reserve	
2400860	MILLERS BAR	TN	25	Luzerne	WELL	Permanent	0
2400862	COUNTRYSIDE QUIK MART	TN	50	Luzerne	WELL #1	Permanent	0
2400868	HARVEYS LAKE PFC ACCESS AREA	TN	200	Luzerne	RESTROOM WELL 1	Permanent	72,000
2400870	CLEARBROOK MANOR	NN	86	Luzerne	WELL #2	Permanent	14,400
2400870	CLEARBROOK MANOR	NN	86	Luzerne	WELL #3	Abandoned	5,760
2400870	CLEARBROOK MANOR	NN	86	Luzerne	WELL #1	Abandoned	11,520
2400870	CLEARBROOK MANOR	NN	86	Luzerne	NEW DETOX BLDG WELL	Permanent	
2400871	DALLAS SHOPPING CENTER	NN	350	Luzerne	WELL 1	Permanent	0
2400872	VILLA ROMA	TN	100	Luzerne	WELL	Permanent	0
2400883	HARVEYS LAKE YACHT CLUB	TN	25	Luzerne	WELL 1 GRASS	Permanent	0
2400883	HARVEYS LAKE YACHT CLUB	TN	25	Luzerne	SOURCE 002	Abandoned	
2400886	ZOLAS LAMP POST	TN	25	Luzerne	WELL	Permanent	0
2400887	GUS GENETTI HOTEL & RESTAURANT	NN	350	Luzerne	WELL A	Permanent	
2400887	GUS GENETTI HOTEL & RESTAURANT	NN	350	Luzerne	WELL B	Permanent	
2400887	GUS GENETTI HOTEL & RESTAURANT	NN	350	Luzerne	WELL C	Abandoned	
2400891	BROTHERS SHIMS	TN	25	Luzerne	SPRING #1	Abandoned	0
2400891	BROTHERS SHIMS	TN	25	Luzerne	SPRING #2	Abandoned	0
2400891	BROTHERS SHIMS	TN	25	Luzerne	SPRING #3	Abandoned	0
2400891	BROTHERS SHIMS	TN	25	Luzerne	SPRING #4	Abandoned	0
2400891	BROTHERS SHIMS	TN	25	Luzerne	WELL	Permanent	
2400894	HILLSIDE FARMS DAIRY	TN	200	Luzerne	PASTURE WELL	Permanent	16,000
2400897	ROCK GLEN PARK & POOL COMPLEX	TN	25	Luzerne	WELL	Permanent	0
2400898	CAMP KRESGE ON BEAVER LAKE	TN	40	Luzerne	WELL 1	Permanent	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 12 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400898	CAMP KRESGE ON BEAVER LAKE	TN	40	Luzerne	WELL 002	Permanent	
2400899	MEATING HOUSE	TN	35	Luzerne	WELL	Permanent	0
2400901	UNI MART MOUNTAINTOP	TN	500	Luzerne	WELL	Permanent	0
2400903	DYMONDS FARM MARKET	TN	100	Luzerne	WELL 1	Permanent	0
2400906	VALLEY TENNIS & SWIM CLUB	TN	200	Luzerne	WELL 1	Permanent	0
2400910	TURKEY HILL STORE #180	TN	350	Luzerne	WELL 1	Permanent	0
2400911	PEN MART PIKES CREEK	TN	150	Luzerne	WELL 1	Permanent	
2400919	HAZLE PARK PACKING	NN	50	Luzerne	WELL	Permanent	0
2400919	HAZLE PARK PACKING	NN	50	Luzerne	HCA	Reserve	
2400920	J L MARKET	TN	115	Luzerne	WELL	Permanent	0
2400921	LOOKOUT MOTOR LODGE	TN	25	Luzerne	WELL 1	Permanent	0
2400921	LOOKOUT MOTOR LODGE	TN	25	Luzerne	WELL 2	Permanent	
2400922	PANTRY QUIK	TN	291	Luzerne	WELL 1	Permanent	0
2400925	RITTENHOUSE PLACE WATER SYS	TN	279	Luzerne	WELL 1	Permanent	0
2400926	PEN MART SUBWAY	TN	50	Luzerne	WELL 1	Permanent	
2400930	GENERAL JACKSONS DELI	TN	50	Luzerne	WELL 1	Permanent	7,000
2400933	RED ROCK GENERAL STORE	TN	50	Luzerne	WELL #1	Permanent	
2400934	PETRO QUICK	TN	25	Luzerne	WELL	Permanent	0
2400935	AMERICAS BEST VALUE INN	TN	35	Luzerne	WELL 1	Permanent	129,600
2400935	AMERICAS BEST VALUE INN	TN	35	Luzerne	WELL 2	Permanent	129,600
2400938	PPL WEST BUILDING	TN	35	Luzerne	WELL EOF	Permanent	43,200
2400939	CEASE TERRACE WATER ASSOC	TN	40	Luzerne	MAIN WELL 1	Permanent	0
2400939	CEASE TERRACE WATER ASSOC	TN	40	Luzerne	EMERGENCY WELL 2	Emergency	
2400940	COUNCIL CUP CAMPGROUND	TN	25	Luzerne	SHOWER HOUSE 2 WELL1	Permanent	14,400
2400940	COUNCIL CUP CAMPGROUND	TN	25	Luzerne	SHOWER HOUSE 3 WELL2	Permanent	
2400941	PILOT TRAVEL CENTER #298	TN	400	Luzerne	WELL	Permanent	144,000
2400946	COOKS VARIETY STORE	TN	75	Luzerne	WELL	Permanent	5,000
2400947	MARINAS 309 DINER	TN	30	Luzerne	WELL #1	Permanent	1,000
2400948	ANDYS MINI MARKET	TN	160	Luzerne	WELL	Permanent	2,880
2400949	GEORGE ERNST MEMORIAL POOL	TN	150	Luzerne	WELL	Permanent	0
2400953	COOLBAUGHS FOOD MART	TN	40	Luzerne	WELL #1	Permanent	0
2400954	MOUNTAIN FRESH SUPERMARKET	TN	100	Luzerne	WELL 1	Permanent	36,000
2400956	SITKOS BARN	TN	60	Luzerne	WELL #1	Permanent	3,000
2400957	JACKIES RESTAURANT AND DELI	TN	25	Luzerne	WELL	Permanent	36,000
2400958	HUNTSVILLE GOLF CLUB	TN	400	Luzerne	CLUBHOUSE WELL #2	Permanent	43,000
2400959	MARYS RESTAURANT	TN	108	Luzerne	WELL 1	Permanent	144,000
2400960	REDS SUBS & PIZZA	TN	100	Luzerne	WELL 1	Permanent	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}

(Page 13 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2400961	LUZERNE COUNTY FAIRGROUNDS	TN	1,000	Luzerne	WELL	Permanent	0
2400962	RODS DELI	TN	45	Luzerne	WELL	Permanent	0
2400963	GERRIES FITNESS CENTER	TN	100	Luzerne	WELL	Permanent	43,200
2400964	SUGARLOAF TWP MUNIC BUILDING	TN	25	Luzerne	WELL	Permanent	50,400
2400967	CHECKERBOARD INN	TN	50	Luzerne	WELL 1	Permanent	72,000
2400970	SONRAE MARKET	TN	30	Luzerne	WELL	Permanent	
2400971	RAINBOW HILL SCHOOL	TN	35	Luzerne	WELL	Permanent	1,100
2400973	FUEL ON	TN	150	Luzerne	WELL 1	Permanent	
2400974	TURNPIKE MOBIL	TN	50	Luzerne	DRILLED WELL	Permanent	
2400975	BLUE RIDGE PLAZA	TN	100	Luzerne	WELL	Permanent	28,800
2400976	PAMELAS	TN	60	Luzerne	DRILLED WELL	Permanent	
2400979	BALIETS COUNTRY CORNERS STORE	TN	400	Luzerne	WELL	Permanent	28,800
2400982	BEAR CREEK CAFE	TN	25	Luzerne	WELL #1	Permanent	30
2400983	SMITHS MKT	TN	30	Luzerne	WELL	Permanent	
2400985	PUMP N PANTRY PIKES CREEK	TN	250	Luzerne	WELL 1	Permanent	
2400986	RANCH WAGON PIKES CREEK	TN	25	Luzerne	WELL	Permanent	
2400989	GROWING YEARS CHILD CARE CTR	NN	83	Luzerne	WELL 1	Permanent	21,600
2400991	BLUE RIDGE TRAIL GOLF CLUB	TN	100	Luzerne	DRILLED WELL	Permanent	
2400994	PPL SUSQUEHANNA SES	NN	2,200	Luzerne	WELL 1 TW#2	Permanent	216,000
2400994	PPL SUSQUEHANNA SES	NN	2,200	Luzerne	WELL 2 TW#1	Permanent	72,000
2400995	PPL RIVERLANDS RECREATION CNTR	TN	504	Luzerne	WELL	Permanent	43,200
2400999	PPL ENERGY INFORMATION CENTER	TN	50	Luzerne	WELL	Permanent	0
2401000	TWIST N SHAKE	TN	100	Luzerne	THOMAS HOUSE WELL	Permanent	
2401001	BLUE RIDGE PIZZA AND SUBS	TN	50	Luzerne	WELL #1	Permanent	
2401002	BEAR MART 2 EXXON	TN	400	Luzerne	WELL # 1	Permanent	
2401002	BEAR MART 2 EXXON	TN	400	Luzerne	WELL# 2	Abandoned	
2401003	J & N MINI MART	TN	500	Luzerne	WELL	Permanent	25,920
2401007	DAVES CATERING PIKES CREEK BEV	TN	25	Luzerne	WELL	Permanent	
2401009	FOUR CORNERS MARKET & DELI	TN	26	Luzerne	SOURCE 001	Permanent	
2401010	NEW DRUMS ELEMENTARY SCHOOL	NN	400	Luzerne	NORTH WELL	Permanent	86,400
2401010	NEW DRUMS ELEMENTARY SCHOOL	NN	400	Luzerne	SOUTH WELL	Permanent	36,000
2401011	WENDYS RESTAURANT DRUMS	TN	1,000	Luzerne	WELL	Permanent	17,280

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 14 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2401020	VESUVIOS PIZZERIA	TN	100	Luzerne	WELL	Permanent	
2401021	CAN DO CORPORATE CENTER	C	930	Luzerne	WELL	Permanent	432,000
2401022	THE ICE HOUSE PUB	TN	25	Luzerne	WELL	Permanent	
2401023	STONE MEADOWS GOLF COURSE	TN	200	Luzerne	SOURCE 001	Permanent	
2401025	BIG TEN SUBS AND PIZZA	TN	50	Luzerne	WELL 1	Permanent	
2401029	VFW 6615	TN	25	Luzerne	WELL	Permanent	
2401030	ITS A LIFESAVER	TN	25	Luzerne	WELL	Permanent	
2401032	ROCK RECREATION CENTER	TN	71	Luzerne	WELL	Permanent	
2401034	APPLEWOOD GOLF COURSE	TN	50	Luzerne	SOURCE 001	Permanent	
2401035	HOT DIGGITTY DOG	TN	25	Luzerne	SOURCE 001	Permanent	
2401038	ST PAULS LUTHERAN CHURCH	TN	200	Luzerne	SOURCE 001	Permanent	
2401039	COUNTRY PLACE RETREAT	TN	25	Luzerne	WELL	Reserve	
2401039	COUNTRY PLACE RETREAT	TN	25	Luzerne	SOURCE 002	Permanent	
2401040	LAKE BISTRO	TN	25	Luzerne	WELL	Permanent	
2401042	VALLEY SUBS AND DELI	TN	25	Luzerne	WELL	Permanent	
2401047	NESCOPECK STATE PARK	TN	50	Luzerne	SOURCE 001	Permanent	
2401051	SORBERS CATERING	TN	25	Luzerne	WELL	Permanent	
2401052	MOMMY DOOZ INC	TN	25	Luzerne	DAVIS RESIDENCE WELL	Permanent	
2401053	THE KRAZY KONE	TN	25	Luzerne	HOUSE WELL	Permanent	
2401055	SWEET VALLEY DO IT BEST	TN	25	Luzerne	REAR OF STORE	Permanent	
2401062	PARADISE CAMPGROUND	TN	25	Luzerne	SOURCE 001	Permanent	
2401065	SHADY RILL FARM & BAKERY	TN	25	Luzerne	HOUSE WELL	Permanent	
2401066	WHEELS BAR AND GRILL	TN	25	Luzerne	WELL #1	Permanent	
2401067	HOLY PROTECTION MONASTERY	TN	25	Luzerne	SOURCE 001	Permanent	
2401068	LIBERTY EXXON	TN	25	Luzerne	WELL	Permanent	
2401070	COOKIES CAFE	TN	25	Luzerne	WELL	Permanent	
2401070	COOKIES CAFE	TN	25	Luzerne	SOURCE 002	Reserve	
2401071	THE BENJAMIN HARVEY INN	TN	25	Luzerne	SOURCE 001	Permanent	
2401072	151 MEMORIAL CONVENIENCE INC	TN	25	Luzerne	SOURCE 001	Permanent	
2401074	WHITETAIL PRESERVE	TN	25	Luzerne	WELL	Permanent	
2401076	COUNTRY CHARM DAY CARE	NN	98	Luzerne	WELL 1	Permanent	
2401077	BOSSMANS BAR B Q	TN	25	Luzerne	SOURCE 001	Permanent	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 15 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
2401080	BROYANS FARM MARKET & COUNTRY	TN	25	Luzerne	OUTSIDE REAR WELL	Permanent	
2401081	THE AMISH PANTRY	TN	25	Luzerne	WELL 1	Permanent	
2401082	THE BELLHOUSE CAFE	TN	25	Luzerne	WELL	Permanent	
2401084	WEE CARE FOUNDATIONS	TN	25	Luzerne	DAY CARE WELL	Permanent	
2401085	239 LUNCH	TN	25	Luzerne	SHICK JOES WELL	Permanent	
2401087	WESTERN INTERNATIONAL GAS	NN	30	Luzerne	WAREHOUS E WELL	Permanent	
2401088	TRAVEL TWIST	TN	25	Luzerne	GARAGE WELL	Permanent	
2401090	LADNERS ACRES	TN	25	Luzerne	WELL	Permanent	
2401091	GINOS	TN	25	Luzerne	WELL	Permanent	
2401092	HIGH POINT BAPTIST CHURCH	TN	50	Luzerne	WELL 001	Permanent	
2406006	GLEN SUMMIT SPRINGS WATER	BW	5,500	Luzerne	SPRING 1	Permanent	0
2406006	GLEN SUMMIT SPRINGS WATER	BW	5,500	Luzerne	SPRING 2	Emergency	0
2406006	GLEN SUMMIT SPRINGS WATER	BW	5,500	Luzerne	SPRING 3	Permanent	0
2406006	GLEN SUMMIT SPRINGS WATER	BW	5,500	Luzerne	BOREHOLE 1	Permanent	
2406035	THREE SPRINGS BW	BW	3,500	Luzerne	ARTESIAN WELL	Permanent	30,000
2406258	MONROE BOTTLING CO	BW	3,500	Luzerne	WELL 1	Permanent	17,280
2406272	SUTTON SPRINGS	BW	555	Luzerne	SPRING	Permanent	25,000
2406498	NATURES WAY SPRINGS	BWH	5,000	Luzerne	BOREHOLE 1	Permanent	
2406524	HAZLETON AREA WATER CO	BWH	25	Luzerne	WELL 001	Permanent	
2406524	HAZLETON AREA WATER CO	BWH	25	Luzerne	WELL 004	Permanent	
2406545	WHITE HAVEN MOUNTAIN SPRINGS	BWH	25	Luzerne	WELL 1	Permanent	61,920
2406545	WHITE HAVEN MOUNTAIN SPRINGS	BWH	25	Luzerne	WELL 2	Permanent	77,760
2408007	HCA DELANO PARK PLACE	C	1,017	Luzerne	DELANO WELL 1	Permanent	273,600
2408007	HCA DELANO PARK PLACE	C	1,017	Luzerne	PARK PLACE WELL 1	Permanent	280,000
2408007	HCA DELANO PARK PLACE	C	1,017	Luzerne	PARK PLACE WELL 2	Permanent	129,700
2408011	HCA TOMHICKEN	C	123	Luzerne	WELL 1	Reserve	36,000
2408011	HCA TOMHICKEN	C	123	Luzerne	WELL #2	Permanent	60
2408012	HCA DERRINGER FERN GLEN	C	276	Luzerne	WELL 1	Permanent	
2408012	HCA DERRINGER FERN GLEN	C	276	Luzerne	WELL 2	Permanent	38,880
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	UPPER HOFFMAN SPRING	Abandoned	0
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	LOWER HOFFMAN SPRING	Abandoned	0
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	WELL #3	Abandoned	50,000

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}

(Page 16 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	WELL #4	Abandoned	50,000
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	WELL #5	Permanent	22,000
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	WELL #6	Permanent	180,000
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	WELL #7	Permanent	65,000
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	WELL #8	Permanent	72,000
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	WELL #9	Permanent	72,000
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	GENSEL SPRING	Abandoned	0
4190011	CATAWISSA MUNICIPAL WATER AUTH	C	1,644	Columbia	CATAWISSA CREEK	Reserve	
4190012	ORANGEVILLE MUNICIPAL WATER AU	C	480	Columbia	DRILLED WELL #1	Permanent	40,000
4190012	ORANGEVILLE MUNICIPAL WATER AU	C	480	Columbia	SPRING AT RESERVOIR	Abandoned	0
4190013	PA AMERICAN WATER BERWICK	C	16,000	Columbia	WELL #1	Permanent	1,512,000
4190013	PA AMERICAN WATER BERWICK	C	16,000	Columbia	WELL #2	Permanent	1,512,000
4190013	PA AMERICAN WATER BERWICK	C	16,000	Columbia	WELL #3	Permanent	1,512,000
4190013	PA AMERICAN WATER BERWICK	C	16,000	Columbia	WELL #4	Permanent	1,771,000
4190015	WONDERVIEW WATER CO	C	350	Columbia	WELL 1	Abandoned	0
4190015	WONDERVIEW WATER CO	C	350	Columbia	WELL 2-SKI LODGE	Permanent	20,000
4190015	WONDERVIEW WATER CO	C	350	Columbia	WELL 2A	Permanent	18,000
4190015	WONDERVIEW WATER CO	C	350	Columbia	WELL 3	Permanent	23,000
4190015	WONDERVIEW WATER CO	C	350	Columbia	WELL 4	Permanent	25,900
4190016	MIFFLIN TWP WATER AUTHORITY	C	900	Columbia	WELL #1	Reserve	0
4190016	MIFFLIN TWP WATER AUTHORITY	C	900	Columbia	WELL #2	Reserve	0
4190016	MIFFLIN TWP WATER AUTHORITY	C	900	Columbia	WELL #3	Permanent	430,000
4190019	BROOKSIDE VILLAGE MHP	C	475	Columbia	WELL 1	Permanent	72,000
4190019	BROOKSIDE VILLAGE MHP	C	475	Columbia	WELL 2	Permanent	16,000
4190019	BROOKSIDE VILLAGE MHP	C	475	Columbia	WELL 3	Permanent	14,000
4190020	STONY BROOK CIRCLE MHP	C	400	Columbia	WELL 1	Reserve	47,000
4190020	STONY BROOK CIRCLE MHP	C	400	Columbia	WELL 3	Permanent	36,000
4190021	MOUNTAIN VIEW ESTATES	C	80	Columbia	WELL #1	Permanent	0
4190021	MOUNTAIN VIEW ESTATES	C	80	Columbia	WELL #2	Permanent	0
4190021	MOUNTAIN VIEW ESTATES	C	80	Columbia	WELL 3	Permanent	15
4190026	BALANCED CARE AT BLOOMSBURG II	C	60	Columbia	WELL 1	Permanent	54,720
4190285	ORANGEVILLE N & R CENTER	C	118	Columbia	WELL 2	Permanent	37,000
4190286	HELLERS MOBILE HOME PARK	C	47	Columbia	WELL LOWER	Permanent	14,000

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}

(Page 17 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
4190286	HELLERS MOBILE HOME PARK	C	47	Columbia	WELL UPPER	Permanent	16,000
4190289	HERITAGE HILLSIDE ESTATES	C	90	Columbia	WELL 1	Permanent	34,000
4190296	PLEASANT VIEW ESTATES	C	390	Columbia	WELL 1	Permanent	16,000
4190296	PLEASANT VIEW ESTATES	C	390	Columbia	WELL 2	Permanent	34,000
4190296	PLEASANT VIEW ESTATES	C	390	Columbia	WELL 3	Permanent	11,000
4190298	COUNTRY TERRACE ESTATES	C	61	Columbia	UPPER WELL 2	Permanent	25,920
4190300	CENTRAL PARK HOTEL	TN	25	Columbia	WELL 1	Permanent	
4190303	CASTAWAYZ RESTAURANT	TN	25	Columbia	WELL 1	Permanent	
4190306	WHISPERING PINES CAMPING EST	TN	55	Columbia	WELL 1	Permanent	
4190309	DIGGERS DIVERSION	TN	25	Columbia	WELL 1	Permanent	
4190311	CREEKSIDE FAMILY RESTAURANT	TN	25	Columbia	WELL 1	Permanent	
4190312	COLONEL KIRKS AUCTION GALLERY	TN	25	Columbia	WELL #1	Permanent	
4190313	STREVIGS RESTAURANT	TN	25	Columbia	WELL 1	Permanent	
4190314	THE INN UNDER	TN	25	Columbia	WELL 1	Permanent	
4190316	THE STANLEY CENTER	NN	70	Columbia	WELL #1	Permanent	
4190317	DEIHLS CAMPING RESORT	TN	100	Columbia	WELL 1 - OFFICE	Permanent	0
4190317	DEIHLS CAMPING RESORT	TN	100	Columbia	WELL 2 - CAMPGROU ND	Seasonal	0
4190317	DEIHLS CAMPING RESORT	TN	100	Columbia	WELL 3 - TRAILER	Reserve	0
4190318	HERITAGE HOUSE FAMILY REST	TN	25	Columbia	WELL 1	Permanent	
4190320	STATE HILL RESTAURANT	TN	25	Columbia	WELL 1	Permanent	
4190325	SCOREBOARD SPORTS TAVERN	TN	25	Columbia	WELL 1	Permanent	0
4190326	WONDER YEARS PRESCHOOL	NN	25	Columbia	WELL 1	Permanent	0
4190327	COBBLESTONE INN	TN	25	Columbia	WELL 1	Permanent	
4190333	TENNY TOWN MOTEL	TN	40	Columbia	WELL 1	Permanent	
4190334	KEMLERS RESTAURANT	TN	25	Columbia	WELL 1	Permanent	0
4190336	TAPS SPORTS BAR & GRILL	TN	25	Columbia	WELL 1	Permanent	0
4190341	FRANS DAIRY BAR	TN	25	Columbia	WELL 1	Permanent	
4190345	BASSETT'S	TN	25	Columbia	WELL 1	Permanent	
4190349	MAYS DRIVE IN	TN	25	Columbia	WELL 1	Permanent	
4190351	STONE CASTLE MOTEL	TN	80	Columbia	WELL 1	Permanent	
4190352	CATAWISSA AMERICAN LEGION	TN	25	Columbia	WELL 1	Permanent	
4190353	TOMS FAMILY RESTAURANT	TN	25	Columbia	WELL 1	Permanent	
4190355	LAKE GLORY CAMPSITES	TN	80	Columbia	LG 21	Permanent	
4190355	LAKE GLORY CAMPSITES	TN	80	Columbia	LG25	Permanent	
4190360	SOUTHERN COLUMBIA AREA SCHOOL	NN	1,650	Columbia	WELL 1 BUS BARN	Reserve	0
4190360	SOUTHERN COLUMBIA AREA SCHOOL	NN	1,650	Columbia	WELL 2 NEW WELL	Permanent	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}

(Page 18 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
4190360	SOUTHERN COLUMBIA AREA SCHOOL	NN	1,650	Columbia	WELL 3 ELEM. BUILD.	Permanent	
4190360	SOUTHERN COLUMBIA AREA SCHOOL	NN	1,650	Columbia	WELL 4 HIGH SCH. BLD	Reserve	
4190361	J & D CREE MEE FREEZE	TN	25	Columbia	WELL 1	Permanent	
4190364	SCOTCH VALLEY RESTAURANT	TN	25	Columbia	WELL 1	Permanent	
4190368	LIGHTSTREET HOTEL	TN	25	Columbia	WELL 1	Permanent	
4190370	DEL MONTE CORPORATION	NN	600	Columbia	WELL 2	Abandoned	120,000
4190370	DEL MONTE CORPORATION	NN	600	Columbia	WELL 3	Permanent	180,000
4190370	DEL MONTE CORPORATION	NN	600	Columbia	WELL 5	Abandoned	300,000
4190370	DEL MONTE CORPORATION	NN	600	Columbia	WELL 6	Permanent	0
4190370	DEL MONTE CORPORATION	NN	600	Columbia	WELL PW 7	Permanent	
4190372	ROLLING PINES GOLF COURSE	TN	25	Columbia	WELL 1	Permanent	
4190377	JERSEYTOWN TAVERN	TN	25	Columbia	WELL 1	Permanent	
4190379	TURNERS HIGH VIEW CAMPING AREA	TN	92	Columbia	WELL 1, OFFICE	Permanent	
4190379	TURNERS HIGH VIEW CAMPING AREA	TN	92	Columbia	WELL 2, SERVICE BLDG	Permanent	
4190381	CAMP LAVIGNE	TN	150	Columbia	WELL 1, WISE LODGE	Permanent	
4190381	CAMP LAVIGNE	TN	150	Columbia	WELL 2, KITCHEN	Seasonal	
4190381	CAMP LAVIGNE	TN	150	Columbia	WELL 3, POOL	Seasonal	
4190383	GRASSMERE PARK CAMPGROUND	TN	70	Columbia	WELL 1-SERVICE BLDG	Permanent	
4190383	GRASSMERE PARK CAMPGROUND	TN	70	Columbia	WELL 2-CAMPGR OUND	Permanent	
4190384	IDEAL PARK	TN	100	Columbia	WELL B	Permanent	
4190384	IDEAL PARK	TN	100	Columbia	WELL D	Permanent	
4190384	IDEAL PARK	TN	100	Columbia	WELL A	Permanent	
4190384	IDEAL PARK	TN	100	Columbia	WELL C	Permanent	
4190392	THE VILLAGE INN	TN	25	Columbia	WELL 1	Permanent	
4190398	KNOEBELS GROVE PARK	NN	4,000	Columbia	CG2	Permanent	
4190398	KNOEBELS GROVE PARK	NN	4,000	Columbia	CU16	Permanent	
4190398	KNOEBELS GROVE PARK	NN	4,000	Columbia	AF-23	Abandoned	
4190398	KNOEBELS GROVE PARK	NN	4,000	Columbia	KC 72	Permanent	
4190801	BENTON VFW	TN	25	Columbia	WELL	Abandoned	40
4190801	BENTON VFW	TN	25	Columbia	WELL 2	Permanent	
4190802	PONDUCE FARMS	TN	25	Columbia	WELL #1	Permanent	
4190803	PENNDOT-SITE 37 MODERN REST AR	TN	800	Columbia	WELL 1	Permanent	

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}

(Page 19 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
4190804	PENNDOT-SITE 38 MODERN REST AR	TN	800	Columbia	WELL 1	Permanent	
4190805	INDIAN HEAD CAMPGROUND	TN	25	Columbia	WELL	Permanent	30
4190808	SEASONS DADS	TN	25	Columbia	WELL 1	Permanent	
4190812	GREENWOOD FRIENDS SCHOOL	NN	100	Columbia	WELL 1	Permanent	0
4190815	J & D CAMPGROUND	TN	250	Columbia	WELL 1	Permanent	
4190815	J & D CAMPGROUND	TN	250	Columbia	WELL 2	Seasonal	
4190815	J & D CAMPGROUND	TN	250	Columbia	WELL 3	Seasonal	
4190815	J & D CAMPGROUND	TN	250	Columbia	WELL 4	Seasonal	
4190815	J & D CAMPGROUND	TN	250	Columbia	WELL 5	Seasonal	
4190815	J & D CAMPGROUND	TN	250	Columbia	WELL 6	Seasonal	
4190816	THE SURGERY CENTER	TN	25	Columbia	WELL #1	Permanent	
4190817	JDS INN	TN	25	Columbia	WELL 1	Permanent	
4190820	CAMP EPACHISECA	TN	50	Columbia	WELL 1-KITCHEN	Permanent	
4190820	CAMP EPACHISECA	TN	50	Columbia	WELL 2 BOYS DORM	Permanent	
4190821	CAMP LOUISE	TN	25	Columbia	WELL 1	Permanent	
4190821	CAMP LOUISE	TN	25	Columbia	BIRCHES WELL	Permanent	
4190822	BRIAR CREEK PARK	TN	25	Columbia	WELL 1	Permanent	
4190823	BERWICK GOLF CLUB	TN	25	Columbia	WELL 1	Permanent	
4190824	BER-VAUGHN PARK	TN	25	Columbia	WELL 1	Permanent	
4190825	BEAVER MAIN ELEM SCHOOL	NN	116	Columbia	WELL 1	Permanent	0
4190827	CHINA QUEEN	TN	25	Columbia	WELL 1	Permanent	
4190830	TERRAPINS CANTINA	TN	25	Columbia	WELL 1	Permanent	
4190831	SHADY REST CAMPGROUND	TN	86	Columbia	SPRING 1	Permanent	
4190834	BUSTERS OUTBACK BAR & GRILL	TN	25	Columbia	WELL	Permanent	
4190836	MILL RACE GOLF AND CAMP RESORT	TN	25	Columbia	RESTAURAN T WELL	Permanent	
4190836	MILL RACE GOLF AND CAMP RESORT	TN	25	Columbia	OLD CG. WELL	Seasonal	
4190836	MILL RACE GOLF AND CAMP RESORT	TN	25	Columbia	NEW CG. WELL	Seasonal	
4190837	TWIN BRIDGES PARK	TN	25	Columbia	WELL 1	Permanent	
4190838	TIKI LOUNGE	TN	25	Columbia	WELL 1	Permanent	
4190839	MORRIS FAMILY RESTAURANT	TN	25	Columbia	WELL 1	Permanent	
4190840	UNITED WATER PA COL CO IND PK	C	138	Columbia	MCGREGOR WELL 1	Permanent	0
4190840	UNITED WATER PA COL CO IND PK	C	138	Columbia	MCGREGOR WELL 2	Permanent	0
4190840	UNITED WATER PA COL CO IND PK	C	138	Columbia	SCENIC KNOLLS WELL 1	Abandoned	8,000
4190840	UNITED WATER PA COL CO IND PK	C	138	Columbia	SCENIC KNOLLS WELL 2	Abandoned	5,000

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 20 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
4190840	UNITED WATER PA COL CO IND PK	C	138	Columbia	SCENIC KNOLLS WELL 3	Abandoned	8,000
4190846	BERWICK AREA POOL	TN	25	Columbia	WELL 1	Permanent	
4190855	ARNOLDS GOLF COURSE	TN	25	Columbia	WELL 1	Permanent	
4190861	BRASS PELICAN	TN	25	Columbia	WELL #1	Permanent	
4190865	HESS MARKET	TN	25	Columbia	WELL #1	Permanent	
4190871	COLUMBIA MALL	NN	2,000	Columbia	WELL 1	Permanent	0
4190872	VALLEY KWIK MART	TN	25	Columbia	WELL 1	Permanent	
4190873	KENTUCKY FRIED CHICKEN	TN	25	Columbia	WELL 1	Permanent	
4190875	MILLVILLE AMERICAN LEGION	TN	25	Columbia	WELL 1	Permanent	
4190876	GEISINGER OFFICE BUILDING 2	NN	165	Columbia	WELL 1	Permanent	0
4190880	SHORT STOP MART	TN	25	Columbia	WELL #1	Permanent	0
4190882	SPRINGBROOK FAMILY CAMPGROUND	TN	40	Columbia	WELL 1	Permanent	0
4190883	MELONIES KOLD KUP	TN	25	Columbia	WELL 1	Permanent	0
4190884	COUNTRY FRESH MARKET	TN	25	Columbia	WELL 1	Permanent	0
4190889	KLEERDEX CO.	NN	93	Columbia	WELL 1	Permanent	0
4190892	WISE FOODS INC	NN	600	Columbia	WELL 1	Permanent	864,000
4190898	CAMP VICTORY	TN	150	Columbia	OLD WELL AT STAFF H.	Permanent	15
4190898	CAMP VICTORY	TN	150	Columbia	NEW WELL IN FIELD	Permanent	8
4190898	CAMP VICTORY	TN	150	Columbia	SOUTH WELL	Abandoned	28,800
4190900	WENDYS	TN	25	Columbia	WELL 1	Permanent	40
4190901	BENTON FOUNDRY INC	NN	175	Columbia	WELL 1	Permanent	
4190904	PENNA STATE POLICE BLOOMSBURG	TN	25	Columbia	WELL 1	Permanent	12
4190905	BLOOMSBURG CHRISTIAN SCHOOL	NN	80	Columbia	WELL 1	Permanent	
4190906	SAW MILL ROAD OFFICE BLDG	NN	150	Columbia	WELL 1	Permanent	
4190911	COLUMBIA CO CHRISTIAN SCHOOL	NN	270	Columbia	WELL 1	Permanent	
4190912	CINEMA CENTER	TN	25	Columbia	WELL 1	Permanent	
4190913	FRESH N QUIK	TN	25	Columbia	WELL 1	Permanent	
4190915	PORTABELLA CATERING	TN	25	Columbia	WELL 1	Permanent	
4190916	THE LINKS AT HEMLOCK CREEK	TN	75	Columbia	WELL 1 AT CLUBHOUS E	Permanent	
4190916	THE LINKS AT HEMLOCK CREEK	TN	75	Columbia	WELL 2 AT PRO SHOP	Permanent	
4190917	ACORN ACRES CAMPGROUND	TN	25	Columbia	WELL 1	Permanent	
4190918	RITAS ITALIAN ICE	TN	25	Columbia	WELL 1	Permanent	
4190920	MUSTANG SALLYS	TN	25	Columbia	WELL 1	Permanent	
4190999	PPL ELECTRIC UTILITIES CORP	NN	50	Columbia	WELL 1	Permanent	0

Notes:

Source: PADEP, 2010b

Table 2.4-53— {Public Water Supply Wells, Luzerne and Columbia County}
(Page 21 of 21)

Well ID	Site Name	Type(1)	Population Served	County	Source Name	Status	Capacity(2)
(1) C = Community, NN = non-transient non-community, TN = Transient Non-Community, BW = Bottled Water Supplier, BWH = Bulk Water Hauler (2) Well capacity in gallons per day (gpd)							

Table 2.4-54— {Horizontal Hydraulic Gradients and Groundwater Velocities, BBNPP Site, 2007-2008}

(Page 1 of 2)

Groundwater Flow Pathline[1]	Pathline Distance (ft)	Date	Head Loss Along Pathline (ft)	Horizontal Hydraulic Gradient (unitless)	Horizontal Hydraulic Conductivity[2] (ft/day)	Effective Porosity[3][4] (unitless)		Linear Groundwater Velocity[5] (ft/day)	
						Low	High	Low	High
Glacial Outwash Aquifer									
G01	1665	Nov. 2007	44.62	2.68E-02	1.86E+02	0.322		1.55E+01	
	1835	Jan. 2008	39.32	2.14E-02		0.322		1.24E+01	
	1835	Mar. 2008	47.11	2.57E-02		0.322		1.48E+01	
	1900	July 2008	33.54	1.77E-02		0.322		1.02E+01	
G02	665	Nov. 2007	5.35	8.05E-03		0.322		4.65E+00	
	600	Jan. 2008	5.21	8.68E-03		0.322		5.02E+00	
	665	Mar. 2008	6.79	1.02E-02		0.322		5.90E+00	
	700	July 2008	3.48	4.97E-03		0.322		2.87E+00	
G03	2300	Nov. 2007	35.94	1.56E-02		0.322		9.03E+00	
	2335	Jan. 2008	36.86	1.58E-02		0.322		9.13E+00	
	2465	Mar. 2008	38.01	1.54E-02		0.322		8.91E+00	
	2035	July 2008	39.86	1.96E-02		0.322		1.13E+01	
Shallow Bedrock Aquifer									
SB1	1445	Nov. 2007	50.00	3.46E-02	1.50E+00	0.01	0.10	5.20E-01	5.20E+00
	1605	Jan. 2008	50.00	3.12E-02		0.01	0.10	4.68E-01	4.68E+00
	1000	Mar. 2008	40.00	4.00E-02		0.01	0.10	6.01E-01	6.01E+00
	1840	July 2008	60.00	3.26E-02		0.01	0.10	4.90E-01	4.90E+00
SB2	1500	Nov. 2007	60.00	4.00E-02		0.01	0.10	6.01E-01	6.01E+00
	1315	Jan. 2008	60.00	4.56E-02		0.01	0.10	6.85E-01	6.85E+00
	1315	Mar. 2008	60.00	4.56E-02		0.01	0.10	6.85E-01	6.85E+00
	1350	July 2008	60.00	4.44E-02		0.01	0.10	6.68E-01	6.68E+00
SB3	2870	Nov. 2007	60.00	2.09E-02		0.01	0.10	3.14E-01	3.14E+00
	3050	Jan. 2008	60.00	1.97E-02		0.01	0.10	2.95E-01	2.95E+00
	2950	Mar. 2008	60.00	2.03E-02		0.01	0.10	3.06E-01	3.06E+00
	2950	July 2008	60.00	2.03E-02		0.01	0.10	3.06E-01	3.06E+00

Table 2.4-54— {Horizontal Hydraulic Gradients and Groundwater Velocities, BBNPP Site, 2007-2008}

(Page 2 of 2)

Groundwater Flow Pathline(1)	Pathline Distance (ft)	Date	Head Loss Along Pathline (ft)	Horizontal Hydraulic Gradient (unitless)	Horizontal Hydraulic Conductivity(2) (ft/day)	Effective Porosity(3)(4) (unitless)		Linear Groundwater Velocity(5) (ft/day)	
						Low	High	Low	High
Deep Bedrock Aquifer									
DB1	3290	Nov. 2007	60.00	1.82E-02	3.35E-01	0.01	0.10	6.11E-02	6.11E-01
	1550	Jan. 2008	25.00	1.61E-02		0.01	0.10	5.40E-02	5.40E-01
	1525	Mar. 2008	25.00	1.64E-02		0.01	0.10	5.49E-02	5.49E-01
	1025	July 2008	15.00	1.46E-02		0.01	0.10	4.90E-02	4.90E-01
DB2	3895	Nov. 2007	85.00	2.18E-02		0.01	0.10	7.31E-02	7.31E-01
	3525	Jan. 2008	70.00	1.99E-02		0.01	0.10	6.65E-02	6.65E-01
	3580	Mar. 2008	60.00	1.68E-02		0.01	0.10	5.61E-02	5.61E-01
	3290	July 2008	80.00	2.43E-02		0.01	0.10	8.15E-02	8.15E-01
DB3	3475	Nov. 2007	70.00	2.01E-02	3.35E-01	0.01	0.10	6.75E-02	6.75E-01
	3970	Jan. 2008	70.00	1.76E-02		0.01	0.10	5.91E-02	5.91E-01
	3950	Mar. 2008	60.00	1.52E-02		0.01	0.10	5.09E-02	5.09E-01
	3160	July 2008	55.00	1.74E-02		0.01	0.10	5.83E-02	5.83E-01

Notes:

(1) Groundwater flow pathline locations are provided in Figure 2.4-81 through Figure 2.4-92.

(2) Horizontal hydraulic conductivity estimates represent the geometric mean values resulting from pumping tests for the glacial outwash and shallow bedrock aquifers and slug tests for the deep bedrock aquifer.

(3) The effective porosity value for the glacial outwash aquifer is based on pumping test data.

(4) Range of effective porosity values for the shallow and deep bedrock aquifers are based on literature values (Freeze, 1979).

(5) Linear groundwater velocity (i.e., seepage velocity) was calculated as the product of the horizontal hydraulic gradient and horizontal hydraulic conductivity, divided by the effective porosity.

Table 2.4-55— {Vertical Hydraulic Gradients and Flow Directions, 2007-2008}

(Page 1 of 2)

Well Pair(1)	Date	Gradient 1(2)	Gradient 2(2)	Gradient 3(2)	Flow Direction
MW301A - MW301B1	11/29/2007	-0.0182			upward
	1/26/2008	-0.0330			upward
	3/24/2008	-0.0111			upward
	7/23/2008	-0.0147			upward
MW302A1 - MW302B	11/29/2007		-0.0376		upward
	1/26/2008		-0.0330		upward
	3/24/2008		-0.0201		upward
	7/23/2008		-0.0499		upward
MW303A - MW303B	11/29/2007	-0.0860			upward
	1/26/2008	-0.0514			upward
	3/24/2008	-0.0490			upward
	7/23/2008	-0.0332			upward
MW303B - MW303C	11/29/2007			0.0900	downward
	1/26/2008			0.0876	downward
	3/24/2008			0.1013	downward
	7/23/2008			0.1145	downward
MW304A - MW304B	11/29/2007	0.0017			downward
	1/26/2008	0.0031			downward
	3/24/2008	0.0042			downward
	7/23/2008	0.0040			downward
MW304B - MW304C	11/29/2007			0.0148	downward
	1/26/2008			0.0008	downward
	3/24/2008			0.0020	downward
	7/23/2008			0.0007	downward
MW305A1 - MW305B	11/29/2007	0.0026			downward
	1/26/2008	0.0153			downward
	3/24/2008	0.0094			downward
	7/23/2008	0.0032			downward
MW305A2 - MW305B	11/29/2007	0.0012			downward
	1/26/2008	0.0014			downward
	3/24/2008	0.0022			downward
	7/23/2008	0.0050			downward
MW306A - MW306C	11/29/2007		-0.0023		upward
	1/26/2008		-0.0031		upward
	3/24/2008		-0.0027		upward
	7/23/2008		-0.0075		upward
MW307A - MW307B(1)	11/29/2007		0.2921		downward
	1/26/2008		0.2506		downward
	3/24/2008		0.2094		downward
	7/23/2008		0.3113		downward
MW308A - MW308B	11/29/2007	1.3143			downward
	1/26/2008	1.2232			downward
	3/24/2008	1.4998			downward
	7/23/2008	1.4089			downward

Table 2.4-55— {Vertical Hydraulic Gradients and Flow Directions, 2007-2008}

(Page 2 of 2)

Well Pair(1)	Date	Gradient 1(2)	Gradient 2(2)	Gradient 3(2)	Flow Direction
MW309A - MW309B	11/29/2007	0.0176			downward
	1/26/2008	0.0196			downward
	3/24/2008	0.0241			downward
	7/23/2008	0.0029			downward
MW310A - MW310B	11/29/2007	-0.0732			upward
	1/26/2008	-0.0862			upward
	3/24/2008	-0.0799			upward
	7/23/2008	-0.0920			upward
MW310B - MW310C (2)	11/29/2007			-0.1355	upward
	1/26/2008			-0.1300	upward
	3/24/2008			-0.1162	upward
	7/23/2008			-0.1491	upward

Notes:

(1) Monitoring wells MW302B and MW307B were drilled deeper than originally planned; as a result, the wells have been reclassified as Deep Bedrock wells (i.e., "C" wells). Monitoring well MW310C is artesian with water flowing from the well. Hydraulic head for well MW310C was set at the top of riser pipe for purposes of calculating vertical gradients.

(2) Gradient 1 = vertical groundwater flow between glacial outwash and shallow bedrock, Gradient 2 = vertical groundwater flow between glacial outwash and deep bedrock, Gradient 3 = vertical groundwater flow between shallow bedrock and deep bedrock

Table 2.4-56— {Hydraulic Conductivity Values, K_h, for the BBNPP Site Based on Slug Tests}
(Page 1 of 2)

Well ID	Slug Test Method	K_h (ft/day)	K_h (ft/s)	K_h (cm/s)
Glacial Outwash Wells				
MW301A	Falling Head	3.39E+01	3.92E-04	1.20E-02
MW302A1	Falling Head	7.36E+01	8.52E-04	2.60E-02
MW302A2	Falling Head	5.69E+01	6.59E-04	2.01E-02
MW302A3	Falling Head	7.25E+01	8.39E-04	2.56E-02
MW302A4	Falling Head	7.92E+01	9.17E-04	2.79E-02
MW303A	Falling Head	3.70E-02	4.28E-07	1.31E-05
MW304A	Falling Head	3.07E+01	3.55E-04	1.08E-02
MW305A1	Falling Head	6.04E+00	6.99E-05	2.13E-03
MW305A2	Falling Head	7.18E+00	8.31E-05	2.53E-03
MW306A	Falling Head	9.63E+01	1.11E-03	3.40E-02
MW307A	Falling Head	3.38E-02	3.91E-07	1.19E-05
MW308A	Falling Head	3.43E+00	3.97E-05	1.21E-03
MW309A	Falling Head	1.51E+01	1.75E-04	5.33E-03
MW310A	Falling Head	2.38E+01	2.75E-04	8.40E-03
MW410	Falling Head	3.80E+00	4.40E-05	1.34E-03
	Rising Head	5.94E+00	6.88E-05	2.10E-03
	Mean	4.87E+00	5.64E-05	1.72E-03
Geometric Mean		9.84E+00	1.14E-04	3.47E-03
Shallow Bedrock Wells				
MW301B1	Falling Head	1.05E+00	1.22E-05	3.70E-04
MW303B	Falling Head	6.99E+00	8.09E-05	2.47E-03
MW304B	Falling Head	3.85E+01	4.46E-04	1.36E-02
MW305B	Falling Head	2.80E+00	3.24E-05	9.88E-04
MW309B	Falling Head	2.23E+00	2.58E-05	7.87E-04
MW310B	Falling Head	2.36E+00	2.73E-05	8.33E-04
MW401	Falling Head	1.57E+00	1.82E-05	5.54E-04
	Rising Head	1.71E+00	1.98E-05	6.03E-04
	Mean	1.64E+00	1.90E-05	5.79E-04
MW402	Falling Head	1.44E-01	1.67E-06	5.08E-05
	Rising Head	1.33E-01	1.54E-06	4.69E-05
	Mean	1.39E-01	1.60E-06	4.89E-05
MW403	Falling Head	2.72E-01	3.15E-06	9.60E-05
	Rising Head	3.53E-01	4.09E-06	1.25E-04
	Mean	3.13E-01	3.62E-06	1.10E-04
MW404	Falling Head	2.50E+00	2.89E-05	8.82E-04
	Rising Head	3.75E+00	4.34E-05	1.32E-03
	Mean	3.13E+00	3.62E-05	1.10E-03
MW405	Falling Head	1.77E+00	2.05E-05	6.24E-04
	Rising Head	1.87E+00	2.16E-05	6.60E-04
	Mean	1.82E+00	2.11E-05	6.42E-04
MW406	Falling Head	1.05E+00	1.22E-05	3.70E-04
	Rising Head	1.19E+00	1.38E-05	4.20E-04
	Mean	1.12E+00	1.30E-05	3.95E-04
Shallow Bedrock Wells				

Table 2.4-56— {Hydraulic Conductivity Values, K_h, for the BBNPP Site Based on Slug Tests}
(Page 2 of 2)

Well ID	Slug Test Method	K_h (ft/day)	K_h (ft/s)	K_h (cm/s)
MW407	Falling Head	1.26E+00	1.46E-05	4.45E-04
	Rising Head	1.54E+00	1.78E-05	5.43E-04
	Mean	1.40E+00	1.62E-05	4.94E-04
MW408	Falling Head	2.70E-01	3.13E-06	9.53E-05
	Rising Head	2.30E-01	2.66E-06	8.11E-05
	Mean	2.50E-01	2.89E-06	8.82E-05
MW409	Falling Head	8.93E-01	1.03E-05	3.15E-04
	Rising Head	1.04E+00	1.20E-05	3.67E-04
	Mean	9.67E-01	1.12E-05	3.41E-04
Geometric Mean		1.54E+00	1.78E-05	5.43E-04
Deep Bedrock Wells				
MW302B	Falling Head	3.94E-01	4.56E-06	1.39E-04
MW303C	Falling Head	1.48E+00	1.71E-05	5.22E-04
MW304C	Falling Head	5.19E-02	6.01E-07	1.83E-05
MW306C	Falling Head	3.25E-02	3.76E-07	1.15E-05
MW307B	Falling Head	4.27E+00	4.94E-05	1.51E-03
Geometric Mean		3.35E-01	3.87E-06	1.18E-04

Table 2.4-57— {Hydraulic Properties for the BBNPP Site Based on Pumping Tests}

Pumping Well ID	Observation Well ID	Test Type	Transmissivity		Hydraulic Conductivity		Storage Coefficient	Specific Yield
			(ft²/day)	(cm²/s)	(ft/day)	(cm/s)	(unitless)	(unitless)
Glacial Outwash Pumping Test								
MW302A1	MW302A2	Drawdown	1.98E+03	2.13E+01	1.10E+02	3.88E-02	NA	5.00E-01
		Recovery	3.00E+03	3.23E+01	1.67E+02	5.89E-02	NA	NA
	Arithmetic Mean		2.49E+03	2.68E+01	1.39E+02	4.89E-02	NA	5.00E-01
	MW302A3	Drawdown	1.85E+03	1.99E+01	1.03E+02	3.63E-02	NA	2.53E-01
		Recovery	6.43E+03	6.91E+01	3.57E+02	1.26E-01	NA	NA
	Arithmetic Mean		4.14E+03	4.45E+01	2.30E+02	8.12E-02	NA	2.53E-01
	MW302A4	Drawdown	2.03E+03	2.18E+01	1.13E+02	3.99E-02	NA	3.22E-01
		Recovery	5.26E+03	5.66E+01	2.92E+02	1.03E-01	NA	NA
	Arithmetic Mean		3.65E+03	3.92E+01	2.03E+02	7.15E-02	NA	3.22E-01
Geometric Mean			3.35E+03	3.60E+01	1.86E+02	6.57E-02	NA	3.44E-01
Median			3.65E+03	3.92E+01	2.03E+02	7.15E-02	NA	3.22E-01
Shallow Bedrock Pumping Tests								
MW301B1	MW301B2	Drawdown	1.31E+01	1.41E-01	2.38E-01	8.40E-05	8.37E-05	NA
		Recovery	1.38E+02	1.48E+00	2.51E+00	8.85E-04	5.50E-04	NA
	MW301B3	Drawdown	1.42E+01	1.53E-01	2.58E-01	9.10E-05	5.37E-05	NA
		Recovery	1.13E+02	1.22E+00	2.05E+00	7.23E-04	2.52E-04	NA
	MW301B4	Drawdown	3.01E+00	3.24E-02	5.46E-02	1.93E-05	1.25E-05	NA
		Recovery	3.17E+01	3.41E-01	5.77E-01	2.04E-04	7.41E-05	NA
	Arithmetic Mean		5.22E+01	5.61E-01	9.48E-01	3.34E-04	1.71E-04	NA
MW404	MW405	Drawdown	1.19E+02	1.28E+00	3.45E+00	1.22E-03	2.60E-04	NA
		Recovery	6.02E+01	6.47E-01	1.75E+00	6.17E-04	1.84E-04	NA
	MW407	Drawdown	1.12E+02	1.20E+00	3.25E+00	1.15E-03	1.15E-04	NA
		Recovery	8.36E+01	8.99E-01	2.42E+00	8.54E-04	2.14E-04	NA
	Arithmetic Mean		9.37E+01	1.01E+00	2.72E+00	9.60E-04	1.93E-04	NA
MW405	MW404	Drawdown	8.84E+01	9.51E-01	2.45E+00	8.64E-04	2.88E-04	NA
		Recovery	1.00E+01	1.08E-01	2.78E-01	9.81E-05	1.43E-04	NA
	MW406	Drawdown	5.30E+01	5.70E-01	1.47E+00	5.19E-04	2.33E-04	NA
		Recovery	2.37E+01	2.55E-01	6.59E-01	2.32E-04	1.91E-04	NA
	Arithmetic Mean		4.38E+01	4.71E-01	1.21E+00	4.28E-04	2.14E-04	NA
MW407	MW404	Drawdown	8.10E+01	8.71E-01	2.53E+00	8.93E-04	1.79E-04	NA
		Recovery	3.45E+01	3.71E-01	1.08E+00	3.81E-04	1.76E-04	NA
	MW409	Drawdown	5.24E+01	5.63E-01	1.64E+00	5.79E-04	7.27E-06	NA
		Recovery	4.04E+01	4.34E-01	1.26E+00	4.45E-04	6.42E-06	NA
	Arithmetic Mean		5.21E+01	5.60E-01	1.63E+00	5.75E-04	9.22E-05	NA
Geometric Mean			5.78E+01	6.21E-01	1.50E+00	5.30E-04	1.60E-04	NA
Median			5.21E+01	5.60E-01	1.42E+00	5.01E-04	1.82E-04	NA

Note:
NA = not applicable

Table 2.4-58— {Bedrock (Mahantango Shale) Hydraulic Conductivity Values Based on Packer Tests}
(Page 1 of 3)

Test Zone Top Depth (ft bgs)	Test Zone Bottom Depth (ft bgs)	Bedrock Zone(1)	Hydraulic Conductivity(2)(3)	
			(ft/day)	(cm/s)
Monitoring Well MW301C, Tested 11/6/2007				
55.7	76.7	Shallow	5.99E-02	2.11E-05
76.7	97.7	Shallow	<1.13E-03	<4.00E-07
97.7	118.7	Shallow	<1.13E-03	<4.00E-07
118.7	139.7	Shallow	<1.13E-03	<4.00E-07
139.7	160.7	Shallow	<1.13E-03	<4.00E-07
160.7	181.7	Shallow	<1.13E-03	<4.00E-07
181.7	202.7	Deep	<1.13E-03	<4.00E-07
202.7	223.7	Deep	<1.13E-03	<4.00E-07
223.7	244.7	Deep	<1.13E-03	<4.00E-07
244.7	265.7	Deep	<1.13E-03	<4.00E-07
265.7	286.7	Deep	<1.13E-03	<4.00E-07
286.7	307.7	Deep	5.78E-03	2.04E-06
307.7	328.7	Deep	5.23E-02	1.85E-05
328.7	349.7	Deep	1.05E-01	3.71E-05
349.7	370.7	Deep	5.78E-02	2.04E-05
370.7	391.7	Deep	4.54E-02	1.60E-05
391.7	397.7	Deep	1.43E-01	5.04E-05
Monitoring Well MW304C, Tested 11/2/2007 and 11/3/2007				
117.0	140.0	Shallow	<1.13E-03	<4.00E-07
140.0	163.0	Shallow	<1.13E-03	<4.00E-07
163.0	186.0	Shallow	2.95E-03	1.04E-06
230.0	253.0	Deep	2.35E-03	8.30E-07
253.0	276.0	Deep	<1.13E-03	<4.00E-07
290.0	313.0	Deep	<1.13E-03	<4.00E-07
347.0	370.0	Deep	6.93E-03	2.45E-06
370.0	393.0	Deep	1.24E-02	4.36E-06
442.0	465.0	Deep	<1.13E-03	<4.00E-07
522.0	545.0	Deep	3.11E.03	1.10E-06
Monitoring Well MW306C, Tested11/5/2007				
56.5	76.5	Shallow	3.24E-02	1.14E-05
76.5	96.5	Shallow	3.44E-03	1.21E-06
96.5	116.5	Shallow	4.11E-02	1.45E-05
116.5	136.5	Shallow	<1.13E-03	<4.00E-07
136.5	156.5	Shallow	<1.13E-03	<4.00E-07
156.5	176.5	Shallow	5.60E-02	1.98E-05
176.5	196.5	Deep	<1.13E-03	<4.00E-07
196.5	216.5	Deep	<1.13E-03	<4.00E-07
216.5	236.5	Deep	<1.13E-03	<4.00E-07
236.5	256.5	Deep	<1.13E-03	<4.00E-07
Monitoring Well MW306C, Tested11/5/2007				
256.5	276.5	Deep	4.42E-03	1.56E-06
276.5	296.5	Deep	4.83E-03	1.70E-06
296.5	316.5	Deep	4.50E-03	1.59E-06
317.5	327.5	Deep	<1.13E-03	<4.00E-07

Table 2.4-58— {Bedrock (Mahantango Shale) Hydraulic Conductivity Values Based on Packer Tests}
(Page 2 of 3)

Test Zone Top Depth (ft bgs)	Test Zone Bottom Depth (ft bgs)	Bedrock Zone(1)	Hydraulic Conductivity(2)(3)	
			(ft/day)	(cm/s)
Monitoring Well MW310C, Tested 11/4/2007				
68.5	88.5	Shallow	3.00E-01	1.06E-04
88.5	108.5	Shallow	<1.13E-03	<4.00E-07
108.5	128.5	Shallow	<1.13E-03	<4.00E-07
128.5	148.5	Shallow	1.73E-02	6.09E-06
148.5	168.5	Shallow	<1.13E-03	<4.00E-07
168.5	188.5	Deep	3.12E-01	1.10E-04
178.5	198.5	Deep	3.34E-01	1.18E-04
Monitoring Well MW313C, Tested 11/9/2007				
72.5	93.5	Shallow	4.63E-01	1.63E-04
93.5	114.5	Shallow	2.40E-02	8.47E-06
107.5	138.5	Shallow	<1.13E-03	<4.00E-07
114.5	135.5	Shallow	8.04E-02	2.84E-05
128.5	149.5	Shallow	<1.13E-03	<4.00E-07
149.5	170.5	Shallow	<1.13E-03	<4.00E-07
170.5	191.5	Deep	<1.13E-03	<4.00E-07
178.5	199.5	Deep	<1.13E-03	<4.00E-07
Monitoring Well MW401, Tested 4/27/2010, 4/28/2010 and 5/5/2010				
120.6	133.2	Shallow	1.12E-01	3.94E-05
131.6	144.2	Shallow	1.35E-01	4.78E-05
141.6	154.2	Shallow	1.08E+00	3.82E-04
152.6	165.2	Shallow	<1.13E-03	<4.00E-07
162.6	175.2	Shallow	1.13E-03	4.00E-07
183.6	196.2	Deep	2.25E-03	7.95E-07
204.6	217.2	Deep	1.69E-03	5.96E-07
225.6	238.2	Deep	1.74E-03	6.14E-07
Monitoring Well MW402, Tested 5/5/2010 and 5/6/2010				
91.1	103.7	Shallow	5.21E-03	1.84E-06
101.1	113.7	Shallow	1.67E-01	5.90E-05
112.1	124.7	Shallow	4.19E-03	1.48E-06
122.1	134.7	Shallow	3.14E-03	1.11E-06
130.2	142.8	Shallow	<1.13E-03	<4.00E-07
Monitoring Well MW403, Tested 4/21/2010 and 4/22/2010				
75.8	89.1	Shallow	<1.13E-03	<4.00E-07
86.8	100.1	Shallow	<1.13E-03	<4.00E-07
96.8	110.1	Shallow	<1.13E-03	<4.00E-07
107.8	121.1	Shallow	<1.13E-03	<4.00E-07
117.8	131.1	Shallow	<1.13E-03	<4.00E-07
128.8	142.1	Shallow	<1.13E-03	<4.00E-07
138.8	152.1	Shallow	3.85E-02	1.36E-05
149.8	163.1	Shallow	7.48E-03	2.64E-06
170.8	184.1	Deep	<1.13E-03	<4.00E-07
191.8	205.1	Deep	4.84E-03	1.71E-06
180.8	194.1	Deep	<1.13E-03	<4.00E-07
Monitoring Well MW408, Tested 5/6/2010				

Table 2.4-58— {Bedrock (Mahantango Shale) Hydraulic Conductivity Values Based on Packer Tests}

(Page 3 of 3)

Test Zone Top Depth (ft bgs)	Test Zone Bottom Depth (ft bgs)	Bedrock Zone(1)	Hydraulic Conductivity(2)(3)	
			(ft/day)	(cm/s)
70.6	83.2	Shallow	6.60E-03	2.33E-06
91.6	104.2	Shallow	<1.13E-03	<4.00E-07
101.6	114.2	Shallow	4.39E-03	1.55E-06
112.6	125.2	Shallow	2.75E-01	9.70E-05
122.6	135.2	Shallow	5.61E-03	1.98E-06
133.6	146.2	Shallow	4.39E-03	1.55E-06
154.6	167.2	Shallow	<1.13E-03	<4.00E-07
175.6	188.2	Deep	8.95E-03	3.16E-06
196.6	209.2	Deep	4.48E-03	1.58E-06
215.9	228.5	Deep	6.74E-03	2.38E-06
Shallow Bedrock	n		51	
	Minimum Value		<1.13E-03	<4.00E-07
	Maximum Value		1.08E+00	3.82E-04
	Geometric Mean(4)		5.49E-03	1.94E-06
	Median Value(4)		1.13E-03	4.00E-07
Deep Bedrock	n		39	
	Minimum Value		<1.13E-03	<4.00E-07
	Maximum Value		3.34E-01	1.18E-04
	Geometric Mean(4)		4.30E-03	1.52E-06
	Median Value(4)		2.25E-03	7.95E-07

Notes:

(1) The transition from shallow bedrock to deep bedrock occurs at approximately 175 ft bgs.

(2) The reported hydraulic conductivity values are the arithmetic means of all tests in each test zone.

(3) The lowest accurate estimate of hydraulic conductivity for the shallow and deep bedrock is considered to be 4.0E-07 cm/s (1.13E-03 ft/day). This hydraulic conductivity value is approximately equal to a flow rate of 0.02 gpm, which is considered to be the lowest reliable flow rate that can be measured while performing packer tests. For all tests where no flow conditions were assigned to an interval, or where flow rates of less than 0.02 gpm were measured, hydraulic conductivity values are assumed to be equal to <4.00E-07 cm/s (<1.13E-03 ft/day).

(4) For zones that were determined to have either no flow or flow less than 4.00E-07 cm/s, the hydraulic conductivity estimate was set equal to 4.00E-07 cm/s (1.13E-03 ft/day) for the purpose of calculating geometric mean and median values.

Table 2.4-59— {Summary of Existing Hydraulic Property Testing Completed at the SSES}
(Page 1 of 2)

Type of Test	Location of Test(s)	Geologic Material Tested	Hydraulic Conductivity			
			Horizontal		Vertical	
			(ft/day)	(cm/s)	(ft/day)	(cm/s)
Pumping Tests	Wells TW-1, TW2	Kame Terrace Deposits, lower 40 ft	3.3 to 15.0	1.16E-03 to 5.29E-03		
	Well C	Kame Terrace Deposits, lower 43 ft	200 (1)	7.06E-02(1)		
	Well CPW	Kame Terrace Deposits, 37 ft	194 (1)	6.84E-02 (1)		
	Well 1210	Kame Terrace Deposits and upper 2 to 3 ft of bedrock	7.8	2.75E-03		
	Well 1204	Kame Terrace Deposits and upper 2 to 3 ft of bedrock	21.7 to 29.2	7.66E-03 to 1.03E-02		
Slug Tests	Well 1208	Kame Terrace Deposits and upper 2 to 3 ft of bedrock	1.8	6.35E-04		
	Well 1210	Kame Terrace Deposits and upper 2 to 3 ft of bedrock	6.6	2.33E-03		
Packer Tests	Borings 929-935 and 937-940, near railway bridge over Rt. 11	Mahantango siltstone and black shale, upper 50 ft of rock (41 intervals tested)	0.013 to 0.76(median = 0.22)	4.59E-06 to 2.68E-04(median = 7.76E-05)		
	Reactor and Retention Pond Areas	Mahantango siltstone, less than 20 ft bgs	0.85	3.00E-04		
		Mahantango siltstone, more than 20 ft bgs	1.00E-06	3.53E-10		
	Boring 305	Mahantango siltstone, 7 to 52 ft bgs	0.0061 to 0.41	2.15E-06 to 1.45E-04		
	Well 1201	Mahantango siltstone, 6.7 to 35.3 ft bgs	0 to 0.063	0 to 2.22E-05		
	Well 1209A	Mahantango siltstone, 5.7 to 34 ft bgs	0 to 0.028	0 to 9.88E-06		
Open-End Tests In Borings	Retention Pond Area	Kame Terrace deposits; tests performed in 29 borings	5.7	0.00201	13 to 63	0.00459 to 2.22E-02
	Spray Pond Area	Kame Terrace deposits; tests performed in 7 borings	0.022 to 11.8+	7.76E-06 to 4.16E-03		
	Spray Pond Area (borings 1113 and 1114)	Kame Terrace Deposits and upper 2 to 3 ft of bedrock	1.0 to 3.8	3.52E-04 to 1.34E-03		
	Spray Pond Area (borings 1117)	Mahantango siltstone, 12 to 20 ft below top of rock	2.5	8.82E-04		

Table 2.4-59— {Summary of Existing Hydraulic Property Testing Completed at the SSES}
(Page 2 of 2)

Type of Test	Location of Test(s)	Geologic Material Tested	Hydraulic Conductivity			
			Horizontal		Vertical	
			(ft/day)	(cm/s)	(ft/day)	(cm/s)
Laboratory Permeability Tests	Approximately 1,500 ft (460 m) northeast of plant center	Upper Silty Soil			0.028	9.88E-06
	Boring 1200A at 27 ft bgs	Kame Terrace Deposits			2.3	8.11E-04

Notes:
(1) Based on specific capacity data, assuming wells were 85% efficient
bgs = below ground surface

Table 2.4-60— {Reactor Coolant Storage Tank Radionuclide Inventory}
(Page 1 of 2)

Parent [(1)]	Progeny [(1)]	$t_{1/2}$ [(2)] (days)	Activity [(3)] (μCi/cm^3)	Source of Activity Value [(4)]	ECL [(5)] (μCi/cm^3)
H-3		4.50E+03	1.0E+00	2.1-2; 11.2-14	1.00E-03
Na-24		6.23E-01	3.7E-02	2.1-2	5.00E-05
Cr-51		2.77E+01	2.0E-03	2.1-2; 11.2-14	5.00E-04
Mn-54		3.12E+02	1.0E-03	2.1-2; 11.2-14	3.00E-05
Mn-56		1.07E-01	0.0E+00	11.2-14	7.00E-05
Fe-55		1.00E+03	7.6E-04	2.1-2; 11.2-14	1.00E-04
Fe-59		4.45E+01	1.9E-04	2.1-2; 11.2-14	1.00E-05
Co-58		7.09E+01	2.9E-03	2.1-2; 11.2-14	2.00E-05
Co-60		1.93E+03	3.4E-04	2.1-2; 11.2-14	3.00E-06
Zn-65		2.44E+02	3.2E-04	2.1-2; 11.2-14	5.00E-06
Br-83		1.00E-01	3.2E-02	2.1-2	9.00E-04
	Kr-83m	7.63E-02	0.0E+00	n/a	n/a
Br-84		2.21E-02	1.7E-02	2.1-2; 11.2-14	4.00E-04
Br-85		2.01E-03	2.0E-03	2.1-2	n/a
	Kr-85m	1.87E-01	0.0E+00	n/a	n/a
	Kr-85	3.93E+03	0.0E+00	n/a	n/a
Rb-88		1.23E-02	1.0E+00	2.1-2; 11.2-14	4.00E-04
Rb-89		1.05E-02	4.7E-02	2.1-2	9.00E-04
	Sr-89	5.05E+01	6.4E-04	2.1-2; 11.2-14	8.00E-06
Sr-90		1.05E+04	3.3E-05	2.1-2; 11.2-14	5.00E-07
	Y-90	2.67E+00	7.7E-06	2.1-2	7.00E-06
Sr-91		4.01E-01	1.0E-03	2.1-2; 11.2-14	2.00E-05
	Y-91m	3.45E-02	5.2E-04	2.1-2; 11.2-14	2.00E-03
	Y-91	5.85E+01	8.1E-05	2.1-2; 11.2-14	8.00E-06
Sr-92		1.11E-01	1.7E-04	2.1-2	4.00E-05
	Y-92	1.48E-01	1.4E-04	2.1-2; 11.2-14	4.00E-05
Y-93		4.24E-01	6.5E-05	2.1-2; 11.2-14	2.00E-05
	Zr-93	5.59E+08	0.0E+00	n/a	4.00E-05
Zr-95		6.40E+01	9.3E-05	2.1-2; 11.2-14	2.00E-05
	Nb-95m	3.61E+00	0.0E+00	n/a	3.00E-05
	Nb-95	3.50E+01	9.4E-05	2.1-2; 11.2-14	3.00E-05
Mo-99		2.75E+00	1.1E-01	2.1-2; 11.2-14	2.00E-05
	Tc-99m	2.51E-01	4.6E-02	2.1-2; 11.2-14	1.00E-03
	Tc-99	7.71E+07	1.1E-09	11.2-14	6.00E-05
Ru-103		3.93E+01	7.8E-05	2.1-2; 11.2-14	3.00E-05
	Rh-103m	3.90E-02	6.8E-05	2.1-2	6.00E-03
Ru-106		3.74E+02	2.7E-05	2.1-2; 11.2-14	3.00E-06
	Rh-106	3.45E-04	2.7E-05	2.1-2	n/a
Ag-110m		2.50E+02	2.0E-07	2.1-2; 11.2-14	6.00E-06
	Ag-110	2.85E-04	0.0E+00	n/a	n/a
Te-127m		1.09E+02	4.4E-04	2.1-2	9.00E-06
	Te-127	3.90E-01	0.0E+00	n/a	1.00E-04
Te-129m		3.36E+01	1.5E-03	2.1-2; 11.2-14	7.00E-06
	Te-129	4.83E-02	2.4E-03	2.1-2; 11.2-14	4.00E-04
	I-129	5.73E+09	4.6E-08	2.1-2; 11.2-14	2.00E-07
I-130		5.15E-01	5.0E-02	2.1-2	2.00E-05

Table 2.4-60— {Reactor Coolant Storage Tank Radionuclide Inventory}
(Page 2 of 2)

Parent (1)	Progeny (1)	$t_{1/2}$ (2) (days)	Activity (3) (µCi/cm^3)	Source of Activity Value (4)	ECL (5) (µCi/cm^3)
Te-131m		1.25E+00	3.7E-03	2.1-2; 11.2-14	8.00E-06
	Te-131	1.74E-02	2.6E-03	2.1-2; 11.2-14	8.00E-05
	I-131	8.02E+00	7.4E-01	2.1-2; 11.2-14	1.00E-06
Te-132		3.20E+00	4.1E-02	2.1-2; 11.2-14	9.00E-06
	I-132	9.56E-02	3.7E-01	2.1-2; 11.2-14	1.00E-04
I-133		8.67E-01	1.3E+00	2.1-2; 11.2-14	7.00E-06
	Xe-133m	2.19E+00	0.0E+00	n/a	n/a
	Xe-133	5.24E+00	0.0E+00	n/a	n/a
Te-134		2.90E-02	6.7E-03	2.1-2	3.00E-04
	I-134	3.65E-02	2.4E-01	2.1-2; 11.2-14	4.00E-04
I-135		2.74E-01	7.9E-01	2.1-2; 11.2-14	3.00E-05
	Xe-135m	1.06E-02	0.0E+00	n/a	n/a
	Xe-135	3.81E-01	0.0E+00	n/a	n/a
Cs-134		7.54E+02	1.7E-01	2.1-2; 11.2-14	9.00E-07
Cs-136		1.32E+01	5.3E-02	2.1-2; 11.2-14	6.00E-06
Cs-137		1.10E+04	1.1E-01	2.1-2; 11.2-14	1.00E-06
	Ba-137m	1.77E-03	1.0E-01	2.1-2	n/a
Cs-138		2.32E-02	2.2E-01	2.1-2	4.00E-04
Ba-140		1.28E+01	6.2E-04	2.1-2; 11.2-14	8.00E-06
	La-140	1.68E+00	1.6E-04	2.1-2; 11.2-14	9.00E-06
Ce-141		3.25E+01	8.9E-05	2.1-2; 11.2-14	3.00E-05
Ce-143		1.38E+00	7.6E-05	2.1-2; 11.2-14	2.00E-05
	Pr-143	1.36E+01	8.8E-05	2.1-2	2.00E-05
Ce-144		2.85E+02	6.9E-05	2.1-2; 11.2-14	3.00E-06
	Pr-144m	5.00E-03	0.0E+00	n/a	n/a
	Pr-144	1.20E-02	6.9E-05	2.1-2	6.00E-04
W-187		9.88E-01	1.8E-03	2.1-2; 11.2-14	3.00E-05
	Re-187	1.50E+13	0.0E+00	n/a	8.00E-03
Np-239		2.36E+00	8.7E-04	2.1-2; 11.2-14	2.00E-05
	Pu-239	8.81E+06	0.0E+00	n/a	2.00E-08

Notes:
$t_{1/2}$ = half-life
µCi/cm^3 = microcuries per cubic centimeter
n/a = not applicable (not listed or not established)
ECL = Effluent Concentration Limit
(1) Parent radionuclides or progeny (daughter) radionuclides in the parent decay chain considered in the accidental release scenario. Any lowercase "m" designation following a mass number indicates that the radionuclide is a metastable nuclear isomer.
(2) Radionuclide half-life values from the International Commission on Radiological Protection (ICRP, 2008).
(3) U.S. Evolutionary Power Reactor (U.S. EPR) radionuclide inventory bounding values as listed in Table 2.1-2 or Table 11.2-14 (or both) of the U.S. EPR Final Safety Analysis Report (FSAR) (AREVA, 2011a; 2011b). Note that the activities reported for niobium-95 (Nb-95), ruthenium-103 (Ru-103), and strontium-89 (Sr-89) in Tables 2.1-2 and 11.2-14 differ by approximately 1.0E-06, 1.0E-6, and 1.0E-05 µCi/cm^3, respectively. The higher values from Table 11.2-14 are used here. Note also that initial concentrations (activities) were not listed for a number of progeny radionuclides in the U.S. EPR FSAR, or for manganese-56 (Mn-56), a parent identified in Table 11.2-14 of the U.S. EPR FSAR. Here, the initial concentrations of these radionuclides are assumed to equal zero.
(4) The U.S. EPR FSAR table or tables (specifically, Table 2.1-2 or Table 11.2-14 [AREVA, 2011a; 2011b]) that provide bounding values for a given radionuclide.
(5) Effluent Concentration Limit (ECL) values from the Code of Federal Regulations, Title 10, Chapter 1, Part 20, Appendix B (CFR, 2010). Note that the ECL values provided in 10 CFR 20 (CFR, 2010) are presented in units of microcuries per milliliter (µCi/mL) rather than microcuries per cubic centimeter (µCi/cm^3). These two units are equivalent (i.e., 1 µCi/mL equals 1 µCi/cm^3).

Table 2.4-61— {Hydraulic Properties of Geologic and Engineering Backfill Materials}

Transporting Media [1]	Hydraulic Conductivity (K) [2]		Porosity (n) [3]	Dry Density (ρ_{dry}) [4]	
	(ft/day)	(m/day)	(unitless)	(pcf)	(g/cm^3)
Backfill	67.2	20.48	0.21	127	2.043
Shallow Bedrock	2.72	0.83	0.05	NM	NM
Glacial Outwash	190	57.91	0.36	NM	NM
Average	n/a	n/a	0.206	n/a	n/a

Notes:
ft/day = feet per day
m/day = meters per day
pcf = pounds per cubic foot
g/cm^3 = grams per cubic centimeter
NM = not measured
n/a = not applicable
(1) Transporting media at the BBNPP Site includes engineered backfill materials (compacted sand and gravel), glacial outwash deposits, and fractured shale in the shallow bedrock zone at the Site.
(2) Estimated horizontal hydraulic conductivity values for excavation backfill, shale bedrock, and glacial outwash at the BBNPP Site. Note that the hydraulic conductivity estimate for excavation backfill represents an average value from laboratory permeability tests on two samples of potential fill materials. Hydraulic conductivity values for the shale bedrock and glacial outwash deposits at the Site, in contrast, are based on the highest mean values determined by pumping tests.
(3) The porosity of backfill was calculated from laboratory-derived specific gravity and water content data for possible fill materials. Porosity of the shale bedrock was estimated from a range of values for shale provided by Freeze and Cherry (Freeze and Cherry, 1979). Specifically, this value represents the mid-point (median) of a range of porosity values between 0 and 10 percent. Porosity for the glacial outwash deposits is assumed to equal the mean of specific yield values determined by pumping tests in wells screened within glacial outwash deposits at the Site.
(4) Dry density of backfill materials was determined by laboratory testing.

Table 2.4-62— {Hypothetical Flowpaths and Flow Velocities for Radionuclide-Containing Groundwater at the BBNPP Site}

Flowpath (1)	$h_{initial}$ (2) (NAVD 88)		h_{final} (2) (NAVD 88)		x_{total} (3)		$i_{horizontal}$ (4)	$K_{harmonic}$ (5) (ft/day or m/day)		q (6) (ft/day or m/day)		$n_{average}$ (7)	vs (8)(ft/day or m/ day)		t_{total} (9) (days)
	(ft)	(m)	(ft)	(m)	(ft)	(m)		(ft)	(m)	(ft)	(m)		(ft)	(m)	
A	712.03	217.03	661.00	201.47	710	216	0.072	9.38	2.86	0.674	0.206	0.206	3.27	1.00	217
B	712.03	217.03	658.00	200.56	1040	317	0.052	15.47	4.71	0.804	0.245	0.206	3.90	1.19	267
C-1	712.03	217.03	655.00	199.64	1600	488	0.036	10.13	3.09	0.361	0.110	0.206	1.75	0.53	914
C-2	712.03	217.03	634.50	193.40	5315	1620	0.015	2.76	0.84	0.040	0.012	0.130	0.31	0.09	17,147

Notes:
ft NAVD 88 = feet North American Vertical Datum of 1988
m NAVD 88 = meters North American Vertical Datum of 1988
ft = feet
m = meters
ft/day = feet per day
m/day = meters per day
(1) Hypothetical groundwater effluent plume flowpaths are identified in Figure 2.4-98. Note that flowpaths C-1 and C-2 follow an identical migration pathway through engineered backfill materials at the Site, and through a short distance within the shallow bedrock (shale) zone. However, pathway C-1 assumes that flow ultimately enters the glacial outwash covering the bedrock at the Site, whereas flow along pathway C-2 is maintained within the shallow bedrock zone.
(2) The flowpath starting point hydraulic head ($h_{initial}$) value equals the maximum measured groundwater elevation at the BBNPP Site, recorded in April 2011. The flowpath termination point hydraulic head (h_{final}) for pathways A and B is the estimated surface water elevation of Walker Run at the pathway discharge point. For C-1, h_{final} is the approximate surface water elevation of Unnamed Tributary (UT) 1 at the pathway discharge point. For C-2, h_{final} was assumed to be approximately 40 ft (12.19 m) below the ground surface (634.50 ft, or 193.40 m NAVD 88). The difference in hydraulic head ($h_{difference}$) along a given flowpath is simply the difference between $h_{initial}$ and h_{final}.
(3) Total flowpath length.
(4) Horizontal hydraulic gradients ($i_{horizontal}$) for each pathway were determined by dividing a calculated $h_{difference}$ value by the estimated total length of a flowpath (x_{total}).
(5) Harmonic mean of the hydraulic conductivity values ($K_{harmonic}$) determined for the groundwater flowpaths at the BBNPP Site.
(6) Darcy velocity (q) for each pathway was calculated as the product of the horizontal hydraulic gradient ($i_{horizontal}$) and the harmonic mean of the flowpath hydraulic conductivity ($K_{harmonic}$) values.
(7) Average porosity determined for the ground water flowpaths at the BBNPP Site.
(8) Seepage velocity (v_s), for each pathway was calculated as the quotient of the Darcy velocity (q) and the average porosity ($n_{average}$) along the flowpath.
(9) Total travel time (t_{total}) was calculated as the quotient of the pathway length (i.e., the horizontal flow distance, x_{total}) and the seepage velocity (v_s).

Table 2.4-63— {Radionuclide-Containing Groundwater Plume Dimensions and Volumetric Flow Rates for Postulated Flowpath A}

Variable	Variable Dimension	
Reactor Coolant Storage Tank Volume (1)	4.061E+03 ft^3	1.150E+02 m^3
Spill Volume (2)	3.249E+03 ft^3	9.200E+01 m^3
Radionuclide-Containing Groundwater Plume Volume (3)	1.577E+04 ft^3	4.466E+02 m^3
Groundwater Plume Vertical Thickness (4)	1.200E+01 ft	3.658E+00 m
Groundwater Plume Width (5)	1.200E+01 ft^2	3.658E+00 m^2
Groundwater Plume Cross-Sectional Area (6)	1.440E+02 ft^2	1.338E+01 m^2
Groundwater Plume Length (7)	1.095E+02 ft	3.338E+01 m
Groundwater Flow Rate (8)	9.712E+01 ft^3/day	2.750E+00 m^3/day
	1.124E-03 ft^3/s	3.183E-05 m^3/s

Notes:
ft = feet
ft^2 = square feet
ft^3 = cubic feet
ft^3 /day = cubic feet per day
m = meters
m^2 = square meters
m^3 = cubic meters
m^3 /day = cubic meters per day
(1) Estimated total capacity of a reactor coolant storage tank associated with the U.S. Evolutionary Power Reactor (AREVA, 2011a).
(2) Spill volume associated with the postulated rupture of a reactor coolant storage tank. Here, the tank is assumed to rupture completely and release 80 percent of the contained liquid volume in accordance with NUREG 0800 Standard Review Plan (SRP) Section 2.4.13 (NRC, 2007a) and Branch Technical Position (BTP) 11-6 (NRC, 2007b).
(3) Volume of the groundwater plume determined as the quotient of the initial spill volume and the average porosity of the transporting media (engineered backfill, fractured shale bedrock, and glacial outwash deposits) for postulated flowpath A (0.206) (see Table 2.4-62).
(4) The groundwater plume is assumed to maintain a vertical height (thickness) that is approximately 50 percent of the average thickness of the glacial outwash deposits at the BBNPP Site.
(5) Width of the groundwater plume assuming a plume height to width ratio of 1:1.
(6) Plume cross-sectional area (normal to groundwater flow) calculated as the product of the assumed plume height and width.
(7) The length of the groundwater plume was calculated as the quotient of the total plume volume and the plume cross-sectional area.
(8) Volumetric flow rate of the plume at the point of discharge into Walker Run. Here, the flow rate is calculated as the product of the plume cross-sectional area and the Darcy velocity (*q*) for flowpath A.

Table 2.4-64— {Site-Specific and Literature-Based Partition Ratios (K_d Values)}

Element	Site-Specific K_d Values (L/kg)		Literature K_d Values (L/kg)					Lowest [8] (L/kg)
	Soils [1]	Backfill [2]	(3)	(4)	(5)	(6)	(7)	
Ag	n/a	n/a	1.10E+02	9.00E+01	9.00E+01	2.16E+02	1.30E+02	9.00E+01
Ba	n/a	n/a	n/a	n/a	5.20E+01	5.60E+02	4.00E-01	4.00E-01
Ce	9.86E+02	2.80E+03	1.10E+03	5.00E+02	5.00E+02	2.00E+03	4.00E+02	4.00E+02
Co	8.53E+01	3.01E+02	5.50E+01	6.00E+01	6.00E+01	2.35E+02	2.60E+02	5.50E+01
Cr	n/a	n/a	3.70E+01	7.00E+01	3.00E+00	1.03E+02	8.40E+00	3.00E+00
Cs	7.57E+03	3.71E+02	1.11E+03	2.80E+02	2.70E+02	4.46E+02	5.30E+02	2.70E+02
Fe	3.75E+02	1.70E+01	5.50E+01	2.20E+02	1.60E+02	2.09E+02	3.20E+02	1.70E+01
H	n/a	n/a	n/a	6.00E-02	0.00E+00	6.00E-02	1.00E-01	0.00E+00
I	n/a	n/a	n/a	1.00E+00	1.00E+00	4.60E+00	4.10E+00	1.00E+00
Mn	5.46E+01	9.87E+01	1.50E+02	5.00E+01	5.00E+01	1.58E+02	9.80E+02	5.00E+01
Nb	n/a	n/a	n/a	1.60E+02	1.60E+02	3.80E+02	1.50E+03	1.60E+02
Np	n/a	n/a	1.10E+01	5.00E+00	5.00E+00	1.70E+01	1.40E+01	5.00E+00
Pu	n/a	1.82E+03	1.80E+03	5.50E+02	5.50E+02	9.53E+02	4.00E+02	4.00E+02
Pr	n/a	n/a	n/a	n/a	2.40E+02	n/a	n/a	2.40E+02
Rb	n/a	n/a	n/a	5.50E+01	5.20E+01	n/a	2.10E+02	5.20E+01
Rh	n/a	n/a	n/a	n/a	5.20E+01	n/a	4.00E+00	4.00E+00
Ru	9.73E+01	1.27E+04	2.20E+02	5.50E+01	5.50E+01	1.59E+03	3.60E+01	3.60E+01
Sr	2.75E+01	7.60E+01	2.70E+01	1.50E+01	1.50E+01	3.20E+01	2.20E+01	1.50E+01
Te	n/a	n/a	n/a	1.25E+02	1.40E+02	3.80E+01	1.80E+02	3.80E+01
Y	n/a	2.63E+04	n/a	1.70E+02	1.90E+02	n/a	2.20E+01	2.20E+01
Zn	1.48E+02	7.57E+01	1.60E+01	2.00E+02	2.00E+02	1.08E+03	1.10E+02	1.60E+01
Zr	n/a	n/a	n/a	6.00E+02	5.80E+02	1.38E+03	3.20E+01	3.20E+01

Notes:
L/kg = liters per kilogram
n/a = not available (i.e., not measured or not reported)
(1) Lowest (minimum) average value for each element from laboratory testing of glacial outwash deposits at the BBNPP Site.
(2) Lowest (minimum) average value for each element from laboratory testing of possible backfill materials at the BBNPP Site.
(3) Estimates provided by Baes and Sharp (Baes and Sharp, 1983) for various elements in soils and clays of pH 4.5 to 9.0.
(4) Experimentally-derived partition ratio estimates for sand soils from Thibault (Thibault, 1990). Note that the listed Kd values for tellurium (Te) and yttrium (Y) were derived from plant/soil concentration ratios.
(5) Values for partition ratios from NRC (NRC, 1992) based on experimental data provided by Sheppard and Thibault (Sheppard and Thibault, 1990) for sand, loam, clay, and organic soils. Note that the values provided for niobium (Nb), praseodymium (Pr), rubidium (Rb), Te, Y, and zirconium (Zr) were estimated from soil to plant ratios using a correlation for sand soils derived from Thibault et al. (1990).
(6) Yu (Yu, 2000) obtained K_d values by reviewing and comparing published compilations and analyses, analyzing the compiled data, and using correlations between K_d values and root uptake transfer factors.
(7) Values from the IAEA (IAEA, 2009) were taken from field and laboratory experiments, and from approximately 80 literature references. Values used here are representative of sand or loam soils.
(8) The lowest mean K_d value identified through laboratory testing or provided by reported literature values.

Table 2.4-65— {Radionuclide Transport Analyses Considering Advection and Radioactive Decay}
(Page 1 of 3)

Parent (1)	Progeny (1)	d_{12} (2)	d_{13} (2)	d_{23} (2)	λ (3) (days^{-1})	Initial Activity (4) (µCi/cm^3)	K_1 (5)	K_2 (5)	K_3 (5)	Discharge Activity (6) (µCi/cm^3)	Activity/ECL (7)
H-3					1.54E-04	1.00E+00				9.67E-01	9.67E+02
Na-24					1.11E+00	3.70E-02				5.81E-107	1.16E-102
Cr-51					2.50E-02	2.00E-03				8.77E-06	1.75E-02
Mn-54					2.22E-03	1.00E-03				6.18E-04	2.06E+01
Mn-56					6.45E+00	0.00E+00				0.00E+00	0.00E+00
Fe-55					6.93E-04	7.60E-04				6.54E-04	6.54E+00
Fe-59					1.56E-02	1.90E-04				6.47E-06	6.47E-01
Co-58					9.78E-03	2.90E-03				3.47E-04	1.74E+01
Co-60					3.60E-04	3.40E-04				3.14E-04	1.05E+02
Zn-65					2.84E-03	3.20E-04				1.73E-04	3.46E+01
Br-83					6.93E+00	3.20E-02				0.00E+00	0.00E+00
	Kr-83m	9.98E-01			9.09E+00	0.00E+00	1.35E-01	-1.35E-01		0.00E+00	n/a
Br-84					3.14E+01	1.70E-02				0.00E+00	0.00E+00
Br-85					3.44E+02	2.00E-03				0.00E+00	n/a
	Kr-85m	9.98E-01			3.71E+00	0.00E+00	-2.18E-05	2.18E-05		0.00E+00	n/a
	Kr-85		2.21E-03	1.00E+00	1.76E-04	0.00E+00	8.89E-12	-1.03E-09	1.03E-09	9.87E-10	n/a
Rb-88					5.61E+01	1.00E+00				0.00E+00	0.00E+00
Rb-89					6.59E+01	4.70E-02				0.00E+00	0.00E+00
	Sr-89	1.00E+00			1.37E-02	6.40E-04	-9.79E-06	6.50E-04		3.31E-05	4.14E+00
Sr-90					6.59E-05	3.30E-05				3.25E-05	6.51E+01
	Y-90	1.00E+00			2.60E-01	7.70E-06	3.30E-05	-2.53E-05		3.25E-05	4.65E+00
Sr-91					1.73E+00	1.00E-03				1.58E-166	7.92E-162
	Y-91m	5.82E-01			2.01E+01	5.20E-04	6.37E-04	-1.17E-04		1.01E-166	5.05E-164
	Y-91		4.18E-01	1.00E+00	1.18E-02	8.10E-05	-7.28E-06	6.92E-08	8.82E-05	6.75E-06	8.43E-01
Sr-92					6.25E+00	1.70E-04				0.00E+00	0.00E+00
	Y-92	1.00E+00			4.70E+00	1.40E-04	-5.14E-04	6.54E-04		0.00E+00	0.00E+00
Y-93					1.63E+00	6.50E-05				6.44E-159	3.22E-154
	Zr-93	1.00E+00			1.24E-09	0.00E+00	-4.93E-14	4.93E-14		4.93E-14	1.23E-09
Zr-95					1.08E-02	9.30E-05				8.88E-06	4.44E-01
	Nb-95m	1.08E-02			1.92E-01	0.00E+00	1.06E-06	-1.06E-06		1.02E-07	3.39E-03

Table 2.4-65— {Radionuclide Transport Analyses Considering Advection and Radioactive Decay}

(Page 2 of 3)

Parent (1)	Progeny (1)	d_{12} (2)	d_{13} (2)	d_{23} (2)	λ (3) (days^{-1})	Initial Activity (4) (µCi/cm^3)	K_1 (5)	K_2 (5)	K_3 (5)	Discharge Activity (6) (µCi/cm^3)	Activity/ECL (7)
	Nb-95		9.89E-01	1.00E+00	1.98E-02	9.40E-05	2.05E-04	1.22E-07	-1.11E-04	1.81E-05	6.03E-01
Mo-99					2.52E-01	1.10E-01				1.84E-25	9.22E-21
	Tc-99m	8.77E-01			2.77E+00	4.60E-02	1.06E-01	-6.02E-02		1.78E-25	1.78E-22
	Tc-99		1.23E-01	1.00E+00	8.99E-09	0.00E+00	-4.26E-09	1.96E-10	4.07E-09	4.07E-09	6.78E-05
Ru-103					1.77E-02	7.80E-05				1.69E-06	5.64E-02
	Rh-103m	9.88E-01			1.78E+01	6.80E-05	7.71E-05	-9.11E-06		1.67E-06	2.79E-04
Ru-106					1.86E-03	2.70E-05				1.81E-05	6.02E+00
	Rh-106	1.00E+00			2.01E+03	2.70E-05	2.70E-05	-2.49E-11		1.81E-05	n/a
Ag-110m					2.78E-03	2.00E-07				1.10E-07	1.83E-02
	Ag-110	1.36E-02			2.43E+03	0.00E+00	2.72E-09	-2.72E-09		1.49E-09	n/a
Te-127m					6.36E-03	4.40E-04				1.11E-04	1.23E+01
	Te-127	9.76E-01			1.78E+00	0.00E+00	4.31E-04	-4.31E-04		1.08E-04	1.08E+00
Te-129m					2.06E-02	1.50E-03				1.71E-05	2.44E+00
	Te-129	6.30E-01			1.43E+01	2.40E-03	9.46E-04	1.45E-03		1.08E-05	2.69E-02
	I-129		3.70E-01	1.00E+00	1.21E-10	4.60E-08	-8.80E-12	-1.23E-14	4.60E-08	4.60E-08	2.30E-01
I-130					1.35E+00	5.00E-02				7.20E-129	3.60E-124
Te-131m					5.55E-01	3.70E-03				2.04E-55	2.55E-50
	Te-131	2.22E-01			3.99E+01	2.60E-03	8.33E-04	1.77E-03		4.59E-56	5.74E-52
	I-131		7.78E-01	1.00E+00	8.64E-02	7.40E-01	-6.85E-04	-3.83E-06	7.41E-01	5.31E-09	5.31E-03
Te-132					2.16E-01	4.10E-02				1.68E-22	1.86E-17
	I-132	1.00E+00			7.25E+00	3.70E-01	4.23E-02	3.28E-01		1.73E-22	1.73E-18
I-133					8.00E-01	1.30E+00				5.50E-76	7.86E-71
	Xe-133m	2.88E-02			3.17E-01	0.00E+00	-2.46E-02	2.46E-02		3.65E-32	n/a
	Xe-133		9.71E-01	1.00E+00	1.32E-01	0.00E+00	-2.45E-01	-1.76E-02	2.63E-01	9.13E-14	n/a
Te-134					2.39E+01	6.70E-03				0.00E+00	0.00E+00
	I-134	1.00E+00			1.90E+01	2.40E-01	-2.62E-02	2.66E-01		0.00E+00	0.00E+00
I-135					2.53E+00	7.90E-01				1.87E-239	6.25E-235
	Xe-135m	1.66E-01			6.53E+01	0.00E+00	1.36E-01	-1.36E-01		3.23E-240	n/a
	Xe-135		8.34E-01	1.00E+00	1.82E+00	0.00E+00	-2.03E+00	3.91E-03	2.03E+00	6.02E-172	n/a
Cs-134					9.19E-04	1.70E-01				1.39E-01	1.55E+05

Table 2.4-65— {Radionuclide Transport Analyses Considering Advection and Radioactive Decay}

(Page 3 of 3)

Parent (1)	Progeny (1)	d_{12} (2)	d_{13} (2)	d_{23} (2)	λ (3) (days^{-1})	Initial Activity (4) (µCi/cm^3)	K_1 (5)	K_2 (5)	K_3 (5)	Discharge Activity (6) (µCi/cm^3)	Activity/ECL (7)
Cs-136					5.27E-02	5.30E-02				5.76E-07	9.60E-02
Cs-137					6.29E-05	1.10E-01				1.09E-01	1.09E+05
	Ba-137m	9.44E-01			3.91E+02	1.00E-01	1.04E-01	-3.84E-03		1.02E-01	n/a
Cs-138					2.99E+01	2.20E-01				0.00E+00	0.00E+00
Ba-140					5.44E-02	6.20E-04				4.68E-09	5.84E-04
	La-140	1.00E+00			4.13E-01	1.60E-04	7.14E-04	-5.54E-04		5.38E-09	5.98E-04
Ce-141					2.13E-02	8.90E-05				8.71E-07	2.90E-02
Ce-143					5.04E-01	7.60E-05				2.68E-52	1.34E-47
	Pr-143	1.00E+00			5.11E-02	8.80E-05	-8.58E-06	9.66E-05		1.48E-09	7.41E-05
Ce-144					2.43E-03	6.90E-05				4.07E-05	1.36E+01
	Pr-144m	9.77E-03			1.39E+02	0.00E+00	6.74E-07	-6.74E-07		3.98E-07	n/a
	Pr-144		9.90E-01	1.00E+00	5.78E+01	6.90E-05	6.90E-05	4.82E-07	-4.84E-07	4.07E-05	6.78E-02
W-187					7.01E-01	1.80E-03				1.45E-69	4.83E-65
	Re-187	1.00E+00			4.61E-14	0.00E+00	-1.18E-16	1.18E-16		1.18E-16	1.48E-14
Np-239					2.94E-01	8.70E-04				1.66E-31	8.28E-27
	Pu-239	1.00E+00			7.87E-08	0.00E+00	-2.33E-10	2.33E-10		2.33E-10	1.16E-02

Notes:

µCi/cm^3 = microcuries per cubic centimeter

n/a = not applicable

(1) Parent radionuclides or progeny in the parent decay chain considered in this accidental release scenario (from Table 2.4-60).

(2) Fraction of parent radionuclide transitions that result in the production of first and second progeny radionuclides (d_{12} and d_{13}, respectively) and the fraction of first progeny transitions that result in the production of second progeny radionuclides (d_{23}). All values from ICRP (ICRP, 2008).

(3) Radioactive decay constant, λ, calculated as the quotient of the natural logarithm of 2 and the half-life value (in days) for a given radionuclide (Table 2.4-60).

(4) Radionuclide activities in the reactor coolant storage tank (see Table 2.4-60).

(5) Coefficients used in the decay chain equation. For details, see equations B.2 and B.4 (and subsequent equations) in NRC NUREG/CR-5512 (NRC, 1992) and Eqs. 2.4.13-22, 2.4.13-23, 2.4.13-31, 2.4.13-32, and 2.4.13-33, herein.

(6) Radionuclide activity at the point of groundwater discharge considering only advection and decay, as calculated from the general form of the decay equation. See equations B.1 and B.2, USNRC NUREG/CR-5512 (Kennedy and Strenge, 1992) and Eqs. 2.4.13-14, 2.4.13-20, and 2.4.13-29, herein.

(7) The ratio of a given Effluent Concentration Limit (ECL) value for a specific radionuclide (Table 2.4-60) and the calculated activity of the radionuclide at the point of groundwater discharge. Highlighted cell entries indicate that the ratio is greater than 0.01 (i.e., 1.00E-02).

Table 2.4-66— {Analysis of Radionuclide Transport in Groundwater Considering Advection, Decay, and Retardation}

(Page 1 of 2)

Parent (1)	Progeny (1)	d_{12} (1)	d_{13} (1)	d_{23} (1)	λ (1) (days^{-1})	Initial (2) (µCi/cm^3	*R* (3)	K_1 (4)	K_2 (4)	K_3 (4)	Discharge Activity (5) (µCi/cm^3	Activity/ ECL (6)
H-3					1.54E-04	1.00E+00	1.00E+00				9.67E-01	9.67E+02
Cr-51					2.50E-02	2.00E-03	3.08E+01				6.10E-76	1.22E-72
Mn-54					2.22E-03	1.00E-03	4.97E+02				1.02E-107	3.41E-103
Fe-55					6.93E-04	7.60E-04	1.70E+02				6.29E-15	6.29E-11
Fe-59					1.56E-02	1.90E-04	1.70E+02				1.96E-253	1.96E-248
Co-58					9.78E-03	2.90E-03	5.46E+02				0.00E+00	0.00E+00
Co-60					3.60E-04	3.40E-04	5.46E+02				9.79E-23	3.26E-17
Zn-65					2.84E-03	3.20E-04	1.60E+02				5.84E-47	1.17E-41
Rb-89					6.59E+01	4.70E-02	5.17E+02				0.00E+00	0.00E+00
	Sr-89	1.00E+00			1.37E-02	6.40E-04	1.50E+02	-2.84E-06	6.43E-04		1.59E-197	1.98E-192
Sr-90					6.59E-05	3.30E-05	1.50E+02				3.87E-06	7.75E+00
	Y-90	1.00E+00			2.60E-01	7.70E-06	2.19E+02	3.30E-05	-2.53E-05		3.87E-06	5.54E-01
Sr-91					1.73E+00	1.00E-03	1.50E+02				0.00E+00	0.00E+00
	Y-91m	5.82E-01			2.01E+01	5.20E-04	2.19E+02	6.19E-04	-9.88E-05		0.00E+00	0.00E+00
	Y-91		4.18E-01	1.00E+00	1.18E-02	8.10E-05	2.19E+02	-1.05E-05	-8.41E-08	9.14E-05	1.79E-249	2.24E-244
Zr-95					1.08E-02	9.30E-05	3.18E+02				0.00E+00	0.00E+00
	Nb-95m	1.08E-02			1.92E-01	0.00E+00	1.59E+03	1.02E-06	-1.02E-06		0.00E+00	0.00E+00
	Nb-95		9.89E-01	1.00E+00	1.98E-02	9.40E-05	1.59E+03	1.04E-04	1.17E-07	-1.06E-05	9.39E-26	3.13E-21
Ru-103					1.77E-02	7.80E-05	3.58E+02				0.00E+00	0.00E+00
	Rh-103m	9.88E-01			1.78E+01	6.80E-05	4.07E+01	7.77E-05	-9.71E-06		0.00E+00	0.00E+00
Ru-106					1.86E-03	2.70E-05	3.58E+02				6.74E-68	2.25E-62
	Rh-106	1.00E+00			2.01E+03	2.70E-05	4.07E+01	2.70E-05	-2.19E-10		6.74E-68	n/a
Ag-110m					2.78E-03	2.00E-07	8.94E+02				3.90E-241	6.51E-236
	Ag-110	1.36E-02			2.43E+03	0.00E+00	8.94E+02	2.72E-09	-2.72E-09		5.31E-243	n/a
Te-127m					6.36E-03	4.40E-04	3.78E+02				1.55E-230	1.72E-225
	Te-127	9.76E-01			1.78E+00	0.00E+00	3.78E+02	4.31E-04	-4.31E-04		1.52E-230	1.52E-226
Te-129m					2.06E-02	1.50E-03	3.78E+02				0.00E+00	0.00E+00
	Te-129	6.30E-01			1.43E+01	2.40E-03	3.78E+02	9.46E-04	1.45E-03		0.00E+00	0.00E+00
	I-129		3.70E-01	1.00E+00	1.21E-10	4.60E-08	1.09E+01	-2.54E-13	-1.18E-14	4.60E-08	4.60E-08	2.30E-01

Table 2.4-66— {Analysis of Radionuclide Transport in Groundwater Considering Advection, Decay, and Retardation}

(Page 2 of 2)

Parent (1)	Progeny (1)	d_{12} (1)	d_{13} (1)	d_{23} (1)	λ (1) (days^{-1})	Initial (2) (µCi/cm^3	*R* (3)	K_1 (4)	K_2 (4)	K_3 (4)	Discharge Activity (5) (µCi/cm^3	Activity/ ECL (6)
Cs-134					9.19E-04	1.70E-01	2.68E+03				1.60E-233	1.78E-227
Cs-136					5.27E-02	5.30E-02	2.68E+03				0.00E+00	0.00E+00
Cs-137					6.29E-05	1.10E-01	2.68E+03				1.45E-17	1.45E-11
	Ba-137m	9.44E-01			3.91E+02	1.00E-01	4.97E+00	1.04E-01	-3.85E-03		1.37E-17	n/a
Ce-141					2.13E-02	8.90E-05	3.97E+03				0.00E+00	0.00E+00
Ce-144					2.43E-03	6.90E-05	3.97E+03				0.00E+00	0.00E+00
	Pr-144m	9.77E-03			1.39E+02	0.00E+00	2.38E+03	6.74E-07	-6.74E-07		0.00E+00	n/a
	Pr-144		9.90E-01	1.00E+00	5.78E+01	6.90E-05	2.38E+03	6.90E-05	4.82E-07	-4.86E-07	0.00E+00	0.00E+00
Np-239					2.94E-01	8.70E-04	5.06E+01				0.00E+00	0.00E+00
	Pu-239	1.00E+00			7.87E-08	0.00E+00	3.97E+03	-1.83E-08	1.83E-08		1.71E-08	8.53E-01

Notes:
µCi/cm^3 = microcuries per cubic centimeter
n/a = not applicable
(1) Parent and progeny radionuclide branching fraction values and decay constants from Table 2.4-65.
(2) Initial radionuclide activities in the reactor coolant storage tank from Table 2.4-64.
(3) Retardation factors based on the lowest mean K_d values identified by literature review and laboratory testing at the BBNPP Site (see Table 2.4-64). Specifically, the retardation factor was calculated as the product of the dry density value for backfill materials at the BBNPP Site (2.043 g/cm^3) and the lowest mean K_d value for a given element divided by the average porosity along the flowpath (0.206), plus 1 (see Eq. 2.4.13-9, herein).
(4) Coefficients used in the decay chain equation. For details, see equations B.2 and B.4 in Kennedy and Strenge (1992) and Eqs. 2.4.13-22, 2.4.13-23, 2.4.13-31, 2.4.13-32, and 2.4.13-33, herein. Note that the values for K_1, K_2, and K_3 provided here may differ from the values reported in Table 2.4-64 because of the inclusion of the retardation factor.
(5) Radionuclide activities were calculated using Eqs. 2.4.13-14, 2.4.13-15, 2.4.13-20, 2.4.13-21, 2.4.13-29, and 2.4.13-30.
(6) The ratio of a given Effluent Concentration Limit (ECL) value for a specific radionuclide (Table 2.4-60) and the calculated activity of the radionuclide at the point of groundwater discharge. Highlighted cell entries indicate that the ratio is greater than 0.01 (i.e., 1.00E-02).

Table 2.4-67— {Mixing and Dilution of Radionuclide-Containing Groundwater in Walker Run}

Radionuclide (1)	Discharge Activity (2) ($\mu Ci/cm^3$)	Plume Flow Rate (3)		Walker Run Flow Rate (4)		Dilution Ratio (5)	Walker Run Activity (6) ($\mu Ci/cm^3$)	Activity/ECL (7)
		(ft^3/s)	(m^3/s)	(ft^3/s)	(m^3/s)			
H-3	9.67E-01	1.12E-03	3.18E-05	8.48E-01	2.40E-02	1.32E-03	1.28E-03	1.28E+00
Sr-90	3.87E-06	1.12E-03	3.18E-05	8.48E-01	2.40E-02	1.32E-03	5.13E-09	1.03E-02
Y-90	3.87E-06	1.12E-03	3.18E-05	8.48E-01	2.40E-02	1.32E-03	5.13E-09	7.33E-04
I-129	4.60E-08	1.12E-03	3.18E-05	8.48E-01	2.40E-02	1.32E-03	6.09E-11	3.04E-04
Pu-239	1.71E-08	1.12E-03	3.18E-05	8.48E-01	2.40E-02	1.32E-03	2.26E-11	1.13E-03

Notes:
$\mu Ci/cm^3$ = microcuries per cubic centimeter
ft^3/s = cubic feet per second
m^3/s = cubic meters per second
(1) Radionuclides from Table 2.4-66 with activity to ECL ratios exceeding 0.01 (1.00E-02).
(2) Calculated radionuclide activity at the point where the groundwater plume enters Walker Run (from Table 2.4-66).
(3) A flow rate for the radioactive effluent plume was calculated as the product of the Darcy velocity of the groundwater flowing along pathway A (Table 2.4-62) and the cross-sectional area of the plume. Note that the Darcy velocity listed in Table 2.4-62 (0.674 feet per day [ft/day], or 0.206 meters per day [m/day]) is equivalent to approximately 7.80E-06 feet per second (ft/s) or 2.38E-06 meters per second (m/s). Here, the cross-sectional area of the plume was assumed to be equal to 144 square feet (ft^2) or 13.38 square meters (m^2).
(4) Average flow rate in Walker Run measured on 03 October 2008 at three gauging stations downstream of the BBNPP. Note that the flow rates determined on 03 October 2008 represent typical low flow conditions in Walker Run.
(5) Dilution ratio associated with mixing of the radionuclide-containing groundwater plume and low flow condition waters of Walker Run. This ratio was calculated as the quotient of the plume flow rate and the combined flow of the plume and Walker Run.
(6) Radionuclide activities in Walker Run were calculated as the product of the radionuclide activity at the point of groundwater discharge and the calculated dilution ratio.
(7) Highlighted cell entry indicates ratio is greater than 0.01 (i.e., 1.0E-02).

Table 2.4-68— {Mixing and Dilution of Radionuclides in the North Branch of the Susquehanna River}

Radionuclide (1)	Walker Run Activity (2) ($\mu Ci/cm^3$)	Walker Run Flow Rate (3)		NBSR Flow Rate (4)		Dilution Ratio (5)	Activity in the NBSR (6) (µCi/cm3)	Activity/ECL (7)
		(ft^3/s)	(m^3/s)	(ft^3/s)	(m^3/s)			
H-3	1.28E-03	8.48E-01	2.40E-02	8.70E+02	2.46E+01	3.88E-03	4.97E-06	4.97E-03
Sr-90	5.13E-09						1.99E-11	3.98E-05

Notes:
$\mu Ci/cm^3$ = microcuries per cubic centimeter
ft^3/s = cubic feet per second
m^3/s = cubic meters per second
(1) Radionuclides from Table 2.4-67 with activity to ECL ratios exceeding 0.01 (1.00E-02).
(2) Calculated radionuclide activity following dilution within Walker Run (from Table 2.4-67).
(3) Flow rate within Walker Run under typical low flow conditions (from Table 2.4-67).
(4) Seven day, 10-year low flow conditions ($Q_{7,10}$) in the North Branch of the Susquehanna River (NBSR) estimated for the BBNPP Site using upstream gauging data from the NBSR at Wilkes-Barre.
(5) Dilution ratio associated with mixing of the radionuclide-containing waters in Walker Run with 25 percent of the flow in the NBSR. This ratio was calculated as the quotient of the Walker Run flow rate and the combined flow of 25 percent of the NBSR and Walker Run.
(6) Radionuclide activity in the NBSR following mixing, calculated as the product of the radionuclide activity in Walker Run and the estimated dilution ratio.
(7) Radionuclide activity to Effluent Concentration Limit (ECL) ratio in the NBSR.

Table 2.4-69— {Activity to ECL Ratios for each Transport and Dilution Calculation and Sum of Ratios}
(Page 1 of 3)

Parent [1]	Progeny [1]	Radionuclide Activity To Effluent Concentration Limit Ratio				
		Advection and Decay [2]	Advection, Decay, and Retardation [3]	Walker Run Dilution [4]	NBSR Dilution [5]	Overall Minimum [6]
H-3		9.67E+02	9.67E+02	1.28E+00	4.97E-03	4.97E-03
Na-24		1.16E-102				1.16E-102
Cr-51		1.75E-02	1.22E-72			1.22E-72
Mn-54		2.06E+01	3.41E-103			3.41E-103
Mn-56		0.00E+00				0.00E+00
Fe-55		6.54E+00	6.29E-11			6.29E-11
Fe-59		6.47E-01	1.96E-248			1.96E-248
Co-58		1.74E+01	0.00E+00			0.00E+00
Co-60		1.05E+02	3.26E-17			3.26E-17
Zn-65		3.46E+01	1.17E-41			1.17E-41
Br-83		0.00E+00				0.00E+00
	Kr-83m	n/a				n/a
Br-84		0.00E+00				0.00E+00
Br-85		n/a				n/a
	Kr-85m	n/a				n/a
	Kr-85	n/a				n/a
Rb-88		0.00E+00				0.00E+00
Rb-89		0.00E+00	0.00E+00			0.00E+00
	Sr-89	4.14E+00	1.98E-192			1.98E-192
Sr-90		6.51E+01	7.75E+00	1.03E-02	3.98E-05	3.98E-05
	Y-90	4.65E+00	5.54E-01	7.33E-04		7.33E-04
Sr-91		7.92E-162	0.00E+00			0.00E+00
	Y-91m	5.05E-164	0.00E+00			0.00E+00
	Y-91	8.43E-01	2.24E-244			2.24E-244
Sr-92		0.00E+00				0.00E+00
	Y-92	0.00E+00				0.00E+00
Y-93		3.22E-154				3.22E-154
	Zr-93	1.23E-09				1.23E-09
Zr-95		4.44E-01	0.00E+00			0.00E+00
	Nb-95m	3.39E-03	0.00E+00			0.00E+00
	Nb-95	6.03E-01	3.13E-21			3.13E-21

Table 2.4-69— {Activity to ECL Ratios for each Transport and Dilution Calculation and Sum of Ratios}

(Page 2 of 3)

Parent [1]	Progeny [1]	Radionuclide Activity To Effluent Concentration Limit Ratio				
		Advection and Decay [2]	Advection, Decay, and Retardation [3]	Walker Run Dilution [4]	NBSR Dilution [5]	Overall Minimum [6]
Mo-99		9.22E-21				9.22E-21
	Tc-99m	1.78E-22				1.78E-22
	Tc-99	6.78E-05				6.78E-05
Ru-103		5.64E-02	0.00E+00			0.00E+00
	Rh-103m	2.79E-04	0.00E+00			0.00E+00
Ru-106		6.02E+00	2.25E-62			2.25E-62
	Rh-106	n/a	n/a			n/a
Ag-110m		1.83E-02	6.51E-236			6.51E-236
	Ag-110	n/a	n/a			n/a
Te-127m		1.23E+01	1.72E-225			1.72E-225
	Te-127	1.08E+00	1.52E-226			1.52E-226
Te-129m		2.44E+00	0.00E+00			0.00E+00
	Te-129	2.69E-02	0.00E+00			0.00E+00
	I-129	2.30E-01	2.30E-01	3.04E-04		3.04E-04
I-130		3.60E-124				3.60E-124
Te-131m		2.55E-50				2.55E-50
	Te-131	5.74E-52				5.74E-52
	I-131	5.31E-03				5.31E-03
Te-132		1.86E-17				1.86E-17
	I-132	1.73E-18				1.73E-18
I-133		7.86E-71				7.86E-71
	Xe-133m	n/a				n/a
	Xe-133	n/a				n/a
Te-134		0.00E+00				0.00E+00
	I-134	0.00E+00				0.00E+00
I-135		6.25E-235				6.25E-235
	Xe-135m	n/a				n/a
	Xe-135	n/a				n/a
Cs-134		1.55E+05	1.78E-227			1.78E-227
Cs-136		9.60E-02	0.00E+00			0.00E+00
Cs-137		1.09E+05	1.45E-11			1.45E-11

Table 2.4-69— {Activity to ECL Ratios for each Transport and Dilution Calculation and Sum of Ratios}

(Page 3 of 3)

Parent [1]	Progeny [1]	Radionuclide Activity To Effluent Concentration Limit Ratio				
		Advection and Decay [2]	Advection, Decay, and Retardation [3]	Walker Run Dilution [4]	NBSR Dilution [5]	Overall Minimum [6]
	Ba-137m	n/a	n/a			n/a
Cs-138		0.00E+00				0.00E+00
Ba-140		5.84E-04				5.84E-04
	La-140	5.98E-04				5.98E-04
Ce-141		2.90E-02	0.00E+00			0.00E+00
Ce-143		1.34E-47				1.34E-47
	Pr-143	7.41E-05				7.41E-05
Ce-144		1.36E+01	0.00E+00			0.00E+00
	Pr-144m	n/a	n/a			n/a
	Pr-144	6.78E-02	0.00E+00			0.00E+00
W-187		4.83E-65				4.83E-65
	Re-187	1.48E-14				1.48E-14
Np-239		8.28E-27	0.00E+00			0.00E+00
	Pu-239	1.16E-02	8.53E-01	1.13E-03		1.13E-03
Total Sum of Radionuclide Activity to Effluent Concentration Limit Ratios						1.38E-02

Notes:
(1) Inventory of radionuclides (parent radionuclides and progeny in decay chain sequences) provided in Table 2.4-60.
(2) Radionuclide activity to Effluent Concentration Limit (ECL) ratio at the effluent plume discharge point in Walker Run considering only advection and decay during groundwater transport at the BBNPP Site (from Table 2.4-65).
(3) Activity to ECL ratio at the groundwater effluent plume discharge point in Walker Run considering the combined effects of advection, decay, and retardation (from Table 2.4-66).
(4) Activity to ECL ratio following mixing and dilution of the radionuclide-containing groundwater effluent plume in Walker Run (from Table 2.4-67).
(5) Activity to ECL ratio following mixing and dilution of radionuclides in the North Branch of the Susquehanna River (from Table 2.4-68).
(6) Lowest activity to ECL ratio identified in the groundwater transport and dilution calculations.

Table 2.4-70— {Time of Concentration and Lag Time for Site Drainage Areas}

Hydrologic Element/ Sub-Basin	T_c (hr)	T_c (min)	T_{lag} (min)
Basin 10.1	0.19	11	7
Basin 10.4A	0.00	0	0
Basin 10.4B	0.13	8	5
Basin 10.4C	0.00	0	0
Basin 12	0.33	20	12
Basin 13.1	0.12	7	4
Basin 13.2	0.04	2	1
Wetland Area	0.16	10	6
ESWEMS Pond	0.00	0	0

Table 2.4-71— {Monthly Groundwater Elevations, BBNPP Site, 2010-2011}

(Page 1 of 3)

Monitoring Well ID	Elevation (ft) [(1)]		Groundwater Elevation (ft) [(1)]												
	Ground Surface	Top of Riser Pipe Reference Point	May 6-7, 2010	May 20, 2010	June 29, 2010	July 27, 2010	August 24, 2010	September 14, 2010	October 15, 2010	November 24, 2010	December 14, 2010	January 13, 2011	February 22, 2011	March 21, 2011	April 20, 2011
Glacial Outwash Wells															
MW301A	662.48	664.54	656.81	NM	NM	654.77	654.37	653.90	654.98	655.36	656.63	655.82	656.63	659.21	660.36
MW302A1	665.18	667.41	660.24	NM	658.47	657.67	657.15	656.86	657.56	657.97	659.61	658.82	659.32	663.73	665.04
MW302A2	665.25	667.42	660.22	NM	658.44	657.65	657.11	656.84	657.53	657.95	659.58	658.79	659.29	663.69	665.01
MW302A3	665.34	667.70	660.14	NM	658.38	657.58	657.06	656.77	657.46	657.88	659.50	658.72	659.22	663.61	664.94
MW302A4	665.56	667.70	660.27	NM	658.49	657.70	657.17	656.89	657.58	658.00	659.57	658.84	659.33	663.74	665.07
MW303A	734.13	736.18	713.99	NM	713.22	712.68	712.46	712.12	713.76	714.02	715.07	713.82	715.34	716.41	721.17
MW304A	680.61	682.65	670.45	NM	668.92	668.16	667.75	667.16	668.18	668.51	669.50	669.13	669.81	671.98	672.81
MW305A1	715.30	717.35	706.02	NM	704.50	704.02	703.73	703.29	704.20	704.40	705.26	704.78	705.80	708.39	710.33
MW305A2	714.64	717.01	705.57	NM	704.24	703.76	703.57	703.15	704.05	704.23	705.00	704.54	705.45	707.40	708.89
MW306A	662.46	664.67	655.05	NM	653.98	653.59	653.48	653.06	654.28	654.65	655.73	654.57	655.65	657.41	658.37
MW307A	688.60	690.96	684.69	NM	682.22	680.55	679.40	678.72	683.01	684.58	685.34	682.81	685.48	685.19	686.37
MW308A	661.38	663.42	655.69	NM	654.45	653.88	653.70	653.13	654.60	655.00	656.02	655.08	656.04	657.19	658.19
MW309A	673.33	675.62	667.44	NM	665.33	664.47	664.00	662.13	665.62	666.70	669.12	667.37	669.53	671.14	672.31
MW310A	674.48	676.73	657.83	NM	NM	655.86	655.57	655.54	655.73	656.84	658.20	657.21	658.50	661.05	662.65
MW410	679.04	680.04	NM	658.91	657.55	656.58	655.95	655.66	656.46	656.91	658.69	657.93	658.44	662.44	663.91
Shallow Bedrock Wells															
MW301B1	662.40	664.39	659.05	NM	NM	656.99	656.72	656.30	657.48	657.91	659.23	658.07	659.30	661.35	662.78
MW301B2	664.18	666.48	656.83	NM	655.50	654.78	654.42	653.89	654.98	655.36	656.62	655.79	656.60	659.18	660.42
MW301B3	662.41	664.61	656.38	NM	655.16	654.58	654.28	653.79	654.88	655.23	656.39	655.56	656.38	658.62	659.76
MW301B4	658.46	660.51	656.90	NM	NM	654.94	654.66	654.16	655.37	655.76	656.99	656.09	656.98	658.99	660.01
MW303B	733.53	735.65	717.48	NM	715.85	715.28	715.07	714.54	716.81	717.67	719.23	716.57	720.19	720.64	724.03
MW304B	681.27	683.09	669.58	NM	668.55	667.48	667.42	666.77	668.05	668.37	669.26	668.59	669.62	671.41	672.29
MW305B	714.10	716.19	705.48	NM	704.20	703.71	703.55	703.15	704.05	704.19	704.85	704.47	705.42	707.21	708.90
MW308B*	661.00	663.36	606.77	NM	607.24	610.66	611.96	612.84	614.26	615.85	616.74	617.89	619.42	620.54	621.66
MW309B	673.16	675.31	665.17	NM	663.52	662.79	662.54	661.84	664.09	664.25	665.81	664.29	665.25	666.28	667.28

Table 2.4-71— {Monthly Groundwater Elevations, BBNPP Site, 2010-2011}

(Page 2 of 3)

Monitoring Well ID	Elevation (ft) [1]		Groundwater Elevation (ft) [1]												
	Ground Surface	Top of Riser Pipe Reference Point	May 6-7, 2010	May 20, 2010	June 29, 2010	July 27, 2010	August 24, 2010	September 14, 2010	October 15, 2010	November 24, 2010	December 14, 2010	January 13, 2011	February 22, 2011	March 21, 2011	April 20, 2011
MW310B	675.31	678.04	668.54	NM	667.17	666.40	665.96	665.61	666.68	667.25	669.01	667.94	669.63	671.72	673.84
MW311B	668.90	671.29	658.25	NM	NM	656.02	655.58	655.24	656.03	656.40	658.06	657.18	658.18	661.24	662.79
MW312B	656.90	659.00	655.77	NM	654.65	654.12	653.89	653.36	654.56	654.95	655.94	655.11	655.94	657.45	658.35
MW313B	657.68	659.97	656.89	NM	655.55	654.84	654.49	654.01	655.18	655.59	656.87	656.01	656.83	659.10	(2)
MW313C	657.24	659.42	656.84	NM	655.54	654.84	654.53	654.03	655.14	655.60	657.01	655.91	656.92	658.82	(2)
MW315B	720.08	719.82	717.15	NM	715.42	714.83	714.37	714.02	714.31	714.61	716.33	716.24	717.22	719.78	719.39
MW316B	702.37	702.08	696.68	NM	692.84	691.55	690.62	690.07	691.68	692.12	695.45	694.67	696.54	699.20	699.62
MW317B	681.17	683.30	659.47	NM	657.79	656.92	656.37	656.08	656.83	657.23	658.91	658.17	658.66	662.63	664.06
MW318B*	801.32	803.79	757.47	NM	754.66	751.35	751.07	750.64	754.74	755.02	760.41	756.36	763.04	761.25	764.51
MW319B*	790.57	793.04	715.06	NM	709.51	707.11	705.54	704.48	704.24	704.81	712.16	711.21	715.26	720.54	724.11
MW401	780.44	782.20	NM	696.70	693.78	692.47	691.58	691.05	691.54	692.61	694.55	694.76	694.87	700.10	702.22
MW402	785.24	787.51	NM	720.59	719.54	718.79	718.29	717.96	719.72	720.49	723.02	721.11	724.30	724.74	726.40
MW403	801.97	804.23	NM	700.27	699.08	696.65	695.64	694.74	696.25	696.85	699.80	698.56	700.94	703.52	705.26
MW404	735.42	738.02	NM	700.16	696.92	695.55	694.70	693.96	695.89	696.93	700.75	699.35	702.62	705.30	709.46
MW405	693.84	696.52	NM	680.51	680.08	679.99	680.08	679.49	680.30	680.67	681.84	680.77	682.34	682.16	682.99
MW406	712.51	715.04	NM	669.70	668.99	668.36	668.09	667.79	668.98	669.64	671.46	670.47	672.25	674.08	676.33
MW407	734.76	737.49	NM	697.34	693.99	692.59	691.81	691.14	692.84	693.74	696.90	695.66	698.47	700.79	704.40
MW408	767.00	768.96	NM	705.86	703.68	702.25	701.18	700.36	700.99	701.82	705.30	704.96	707.05	09.89	712.03
MW409	720.79	723.57	NM	696.92	693.64	692.23	691.40	690.73	692.47	693.31	696.32	695.04	697.79	699.93	703.30
Deep Bedrock Wells															
MW301C	666.38	668.79	667.28	NM	665.47	664.49	664.06	663.75	664.84	665.36	666.99	666.17	666.79	(2)	(2)
MW302B	665.29	667.42	666.95	NM	665.19	664.42	664.16	663.52	665.48	666.12	667.10	665.52	667.22	(2)	(2)
MW303C	732.94	734.98	698.39	NM	698.59	697.65	697.74	697.35	698.87	699.61	700.98	699.33	701.39	703.19	705.22
MW304C	680.57	682.44	670.45	NM	669.26	668.23	667.82	667.54	668.94	669.17	670.09	669.64	670.12	671.94	672.26
MW306C	662.47	664.70	657.42	NM	656.40	655.84	655.60	655.26	656.54	656.96	657.95	656.95	657.55	659.51	659.91
MW307B	688.33	690.85	625.42	NM	616.57	613.54	611.69	610.89	613.45	614.31	620.25	618.54	618.69	644.40	641.84

Table 2.4-71— {Monthly Groundwater Elevations, BBNPP Site, 2010-2011}
(Page 3 of 3)

Monitoring Well ID	Elevation (ft) [1]		Groundwater Elevation (ft) [1]												
	Ground Surface	Top of Riser Pipe Reference Point	May 6-7, 2010	May 20, 2010	June 29, 2010	July 27, 2010	August 24, 2010	September 14, 2010	October 15, 2010	November 24, 2010	December 14, 2010	January 13, 2011	February 22, 2011	March 21, 2011	April 20, 2011
MW310C	675.38	678.35	(2)	NM	(2)	(2)	(2)	683.06	(2)	684.53	678.37	NA	NA	NM	(2)
MW311C*	669.07	671.18	597.64	NM	600.54	601.99	603.44	604.45	606.11	608.92	611.42	612.95	614.90	616.25	617.67

Notes:
(1) Vertical datum NAVD88 feet
(2) Flowing artesian groundwater conditions encountered. Groundwater elevation was set equal to the top of PVC riser pipe (reference point).
NM = Not measured
NA = Groundwater elevation is not available - groundwater frozen at top of PVC riser pipe
* = Groundwater elevations are considered to be anomalous. Data are not used to construct potentiometric contours (when applicable)

Table 2.4-72— {Monthly Surface Water Elevations, BBNPP Site, 2010-2011}

Gauging Station ID	Elevation (ft)											
	Reference Point	June 30, 2010	July 27, 2010	August 24, 2010	September 14, 2010	October 15, 2010	November 23, 2010	December 14, 2010	January 12, 2011	February 21, 2011	March 21, 2011	April 20, 2011
Stream Gauging Stations												
G1	670.97	661.76	661.72	661.75	661.69	662.18	662.10	662.17	662.12	662.29	662.52	662.77
G2	656.81	646.01	646.04	646.11	645.92	646.42	646.55	647.31	646.39	647.22	647.64	647.86
G3	729.20	722.53	722.45	722.50	(1)	722.51	722.49	722.65	722.49	722.64	722.71	722.82
G5	608.10	601.65	601.82	601.62	(2)	601.75	601.65	602.00	601.87	601.90	602.20	602.09
G10	529.77	518.32	518.47	518.52	518.40	518.54	518.48	518.56	518.69	518.61	518.46	518.37
G12	661.25	(2)	(1)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
G13	649.12	638.01	637.99	638.02	637.94	638.27	638.34	638.59	638.26	638.88	639.27	639.44
Pond Gauging Stations												
G6	714.27	(2)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
G7	687.52	(2)	(4)	(4)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
G8	656.62	(2)	(1)	654.17	(1)	654.26	654.36	654.41	654.53	654.46	654.64	654.88
G9	667.75	(2)	665.85	665.83	665.55	665.92	665.95	666.53	666.31	666.67	667.07	667.33

Notes:
Vertical datum NAVD 88
(1) no measurement; dry conditions
(2) no measurement taken
(3) no measurement; staff gauge missing
(4) no measurement; water level below staff gauge zero point
(5) no measurement; pond intentionally drained

Table 2.4-73— {Horizontal Hydraulic Gradients and Groundwater Velocities, BBNPP Site, 2010-2011}
(Page 1 of 2)

Groundwater Flow Pathline(1)	Pathline Distance (ft)	Date	Head Loss Along Pathline (ft)	Horizontal Hydraulic Gradient (unitless)	Horizontal Hydraulic Conductivity(2) (ft/day)	Effective Porosity(3)(4) (unitless)		Linear Groundwater Velocity(5) (ft/day)	
						Low	High	Low	High
Glacial Outwash Aquifer									
G01	1765	June 2010	38.22	2.17E-02	1.86E+02	0.322		1.25E+01	
	1900	Sep. 2010	37.12	1.95E-02				1.13E+01	
	1795	Dec. 2010	40.07	2.23E-02				1.29E+01	
	1805	April 2011	46.17	2.56E-02				1.48E+01	
G02	800	June 2010	6.59	8.24E-03				4.76E+00	
	665	Sep. 2010	2.13	3.20E-03				1.85E+00	
	650	Dec. 2010	3.79	5.83E-03				3.37E+00	
	635	April 2011	7.77	1.22E-02				7.07E+00	
G03	2235	June 2010	34.50	1.54E-02				8.92E+00	
	2265	Sep. 2010	33.29	1.47E-02				8.50E+00	
	2365	Dec. 2010	35.26	1.49E-02				8.62E+00	
	2500	April 2011	40.33	1.61E-02				9.33E+00	
Shallow Bedrock Aquifer									
SB1	1575	June 2010	39.92	2.53E-02	1.50E+00	0.01	0.10	3.81E-01	3.81E+00
	1190	Sep. 2010	24.74	2.08E-02				3.12E-01	3.12E+00
	400	Dec. 2010	18.91	4.73E-02				7.10E-01	7.10E+00
	400	April 2011	27.01	6.75E-02				1.01E+00	1.01E+01
SB2	1210	June 2010	70.00	5.79E-02				8.69E-01	8.69E+00
	840	Sep. 2010	46.11	5.49E-02				8.25E-01	8.25E+00
	850	Dec. 2010	43.13	5.07E-02				7.62E-01	7.62E+00
	900	April 2011	50.03	5.56E-02				8.35E-01	8.35E+00
SB3	2215	June 2010	70.00	3.16E-02				4.75E-01	4.75E+00
	1450	Sep. 2010	70.00	4.83E-02				7.25E-01	7.25E+00
	3420	Dec. 2010	80.00	2.34E-02				3.51E-01	3.51E+00
	2810	April 2011	80.00	2.85E-02				4.28E-01	4.28E+00

Table 2.4-73— {Horizontal Hydraulic Gradients and Groundwater Velocities, BBNPP Site, 2010-2011}

(Page 2 of 2)

Groundwater Flow Pathline(1)	Pathline Distance (ft)	Date	Head Loss Along Pathline (ft)	Horizontal Hydraulic Gradient (unitless)	Horizontal Hydraulic Conductivity(2) (ft/day)	Effective Porosity(3)(4) (unitless)		Linear Groundwater Velocity(5) (ft/day)	
						Low	High	Low	High
Deep Bedrock Aquifer									
DB1	2430	June 2010	38.60	1.59E-02	3.35E-01	0.01	0.10	5.32E-02	5.32E-01
	1255	Sep. 2010	39.74	3.17E-02				1.06E-01	1.06E+00
	2545	Dec. 2010	42.05	1.65E-02				5.54E-02	5.54E-01
	2170	April 2011	40.09	1.85E-02				6.19E-02	6.19E-01
DB2	3430	June 2010	75.00	2.19E-02				7.33E-02	7.33E-01
	2760	Sep. 2010	80.00	2.90E-02				9.71E-02	9.71E-01
	3550	Dec. 2010	70.00	1.97E-02				6.61E-02	6.61E-01
	2690	April 2011	50.00	1.86E-02				6.23E-02	6.23E-01
DB3	3920	June 2010	75.00	1.91E-02	3.35E-01	0.01	0.10	6.41E-02	6.41E-01
	4485	Sep. 2010	82.35	1.84E-02				6.15E-02	6.15E-01
	4075	Dec. 2010	70.00	1.72E-02				5.75E-02	5.75E-01
	3360	April 2011	50.00	1.49E-02				4.99E-02	4.99E-01

Notes:

(1) Groundwater flow pathline locations are provided in Figure 2.4-113 to Figure 2.4-124.

(2) Horizontal hydraulic conductivity estimates represent the geometric mean values resulting from pumping tests for the glacial outwash and shallow bedrock aquifers and slug tests for the deep bedrock aquifer.

(3) The effective porosity value for the glacial outwash aquifer is based on pumping test data.

(4) Range of effective porosity values for the shallow and deep bedrock aquifers are based on literature values (Freeze, 1979)

(5) Linear groundwater velocity (i.e., seepage velocity) was calculated as the product of the horizontal hydraulic gradient and horizontal hydraulic conductivity, divided by the effective porosity.

Table 2.4-74— {Vertical Hydraulic Gradients and Flow Directions, 2010-2011}
(Page 1 of 5)

Well Pair(1)	Date	Gradient 1(2)	Gradient 2(2)	Gradient 3(2)	Flow Direction
MW301A - MW301B1	5/6/2010	-0.0193			upward
	6/29/2010	NA			NA
	7/27/2010	-0.0191			upward
	8/24/2010	-0.0202			upward
	9/14/2010	-0.0207			upward
	10/15/2010	-0.0215			upward
	11/24/2010	-0.0220			upward
	12/14/2010	-0.0224			upward
	1/13/2011	-0.0194			upward
	2/22/2011	-0.0230			upward
	3/21/2011	-0.0184			upward
	4/20/2011	-0.0208			upward
MW302A1 - MW302B	5/6/2010		-0.0378		upward
	6/29/2010		-0.0379		upward
	7/27/2010		-0.0381		upward
	8/24/2010		-0.0395		upward
	9/14/2010		-0.0375		upward
	10/15/2010		-0.0446		upward
	11/24/2010		-0.0459		upward
	12/14/2010		-0.0422		upward
	1/13/2011		-0.0378		upward
	2/22/2011		-0.0445		upward
	3/21/2011		-0.0208		upward
	4/20/2011		-0.0134		upward
MW303A - MW303B	5/6/2010	-0.0540			upward
	6/29/2010	-0.0407			upward
	7/27/2010	-0.0402			upward
	8/24/2010	-0.0404			upward
	9/14/2010	-0.0375			upward
	10/15/2010	-0.0472			upward
	11/24/2010	-0.0565			upward
	12/14/2010	-0.0644			upward
	1/13/2011	-0.0426			upward
	2/22/2011	-0.0751			upward
	3/21/2011	-0.0655			upward
	4/20/2011	-0.0443			upward

Table 2.4-74— {Vertical Hydraulic Gradients and Flow Directions, 2010-2011}
(Page 2 of 5)

Well Pair(1)	Date	Gradient 1(2)	Gradient 2(2)	Gradient 3(2)	Flow Direction
MW303B - MW303C	5/6/2010			0.1243	downward
	6/29/2010			0.1124	downward
	7/27/2010			0.1148	downward
	8/24/2010			0.1128	downward
	9/14/2010			0.1119	downward
	10/15/2010			0.1168	downward
	11/24/2010			0.1176	downward
	12/14/2010			0.1188	downward
	1/13/2011			0.1122	downward
	2/22/2011			0.1224	downward
	3/21/2011			0.1136	downward
	4/20/2011			0.1225	downward
MW304A - MW304B	5/6/2010	0.0061			downward
	6/29/2010	0.0026			downward
	7/27/2010	0.0047			downward
	8/24/2010	0.0023			downward
	9/14/2010	0.0027			downward
	10/15/2010	0.0009			downward
	11/24/2010	0.0010			downward
	12/14/2010	0.0017			downward
	1/13/2011	0.0038			downward
	2/22/2011	0.0013			downward
	3/21/2011	0.0040			downward
	4/20/2011	0.0036			downward
MW304B - MW304C	5/6/2010			-0.0041	upward
	6/29/2010			-0.0034	upward
	7/27/2010			-0.0036	upward
	8/24/2010			-0.0019	upward
	9/14/2010			-0.0037	upward
	10/15/2010			-0.0042	upward
	11/24/2010			-0.0038	upward
	12/14/2010			-0.0040	upward
	1/13/2011			-0.0050	upward
	2/22/2011			-0.0024	upward
	3/21/2011			-0.0025	upward
	4/20/2011			0.0001	downward

Table 2.4-74— {Vertical Hydraulic Gradients and Flow Directions, 2010-2011}
(Page 3 of 5)

Well Pair(1)	Date	Gradient 1(2)	Gradient 2(2)	Gradient 3(2)	Flow Direction
MW305A1 - MW305B	5/6/2010	0.0055			downward
	6/29/2010	0.0031			downward
	7/27/2010	0.0032			downward
	8/24/2010	0.0018			downward
	9/14/2010	0.0014			downward
	10/15/2010	0.0015			downward
	11/24/2010	0.0021			downward
	12/14/2010	0.0042			downward
	1/13/2011	0.0032			downward
	2/22/2011	0.0039			downward
	3/21/2011	0.0120			downward
	4/20/2011	0.0146			downward
MW305A2 - MW305B	5/6/2010	0.0014			downward
	6/29/2010	0.0006			downward
	7/27/2010	0.0008			downward
	8/24/2010	0.0003			downward
	9/14/2010	0.0000			NG
	10/15/2010	0.0000			NG
	11/24/2010	0.0006			downward
	12/14/2010	0.0023			downward
	1/13/2011	0.0011			downward
	2/22/2011	0.0005			downward
	3/21/2011	0.0029			downward
	4/20/2011	-0.0002			upward
MW306A - MW306C	5/6/2010		-0.0086		upward
	6/29/2010		-0.0088		upward
	7/27/2010		-0.0082		upward
	8/24/2010		-0.0077		upward
	9/14/2010		-0.008		upward
	10/15/2010		-0.0082		upward
	11/24/2010		-0.0084		upward
	12/14/2010		-0.0081		upward
	1/13/2011		-0.0087		upward
	2/22/2011		-0.0069		upward
	3/21/2011		-0.0077		upward
	4/20/2011		-0.0056		upward

Table 2.4-74— {Vertical Hydraulic Gradients and Flow Directions, 2010-2011}
(Page 4 of 5)

Well Pair(1)	Date	Gradient 1(2)	Gradient 2(2)	Gradient 3(2)	Flow Direction
MW307A - MW307B	5/6/2010		0.2568		downward
	6/29/2010		0.2845		downward
	7/27/2010		0.2904		downward
	8/24/2010		0.2934		downward
	9/14/2010		0.2939		downward
	10/15/2010		0.3014		downward
	11/24/2010		0.3045		downward
	12/14/2010		0.2821		downward
	1/13/2011		0.2785		downward
	2/22/2011		0.2894		downward
	3/21/2011		0.1768		downward
	4/20/2011		0.1930		downward
MW308A - MW308B	5/6/2010	1.0663			downward
	6/29/2010	1.0290			downward
	7/27/2010	0.9420			downward
	8/24/2010	0.9098			downward
	9/14/2010	0.8782			downward
	10/15/2010	0.8793			downward
	11/24/2010	0.8533			downward
	12/14/2010	0.8561			downward
	1/13/2011	0.8106			downward
	2/22/2011	0.7982			downward
	3/21/2011	0.7988			downward
	4/20/2011	0.7962			downward
MW309A - MW309B	5/6/2010	0.0169			downward
	6/29/2010	0.0135			downward
	7/27/2010	0.0125			downward
	8/24/2010	0.0109			downward
	9/14/2010	0.0022			downward
	10/15/2010	0.0114			downward
	11/24/2010	0.0182			downward
	12/14/2010	0.0246			downward
	1/13/2011	0.0229			downward
	2/22/2011	0.0319			downward
	3/21/2011	0.0362			downward
	4/20/2011	0.0374			downward

Table 2.4-74— {Vertical Hydraulic Gradients and Flow Directions, 2010-2011}
(Page 5 of 5)

Well Pair(1)	Date	Gradient 1(2)	Gradient 2(2)	Gradient 3(2)	Flow Direction
MW310A - MW310B	5/6/2010	-0.1648			upward
	6/29/2010	NA			NA
	7/27/2010	-0.1622			upward
	8/24/2010	-0.1599			upward
	9/14/2010	-0.1550			upward
	10/15/2010	-0.1685			upward
	11/24/2010	-0.1602			upward
	12/14/2010	-0.1664			upward
	1/13/2011	-0.1652			upward
	2/22/2011	-0.1713			upward
	3/21/2011	-0.1642			upward
	4/20/2011	-0.1722			upward
MW310B - MW310C	5/6/2010			-0.0939	upward
	6/29/2010			-0.1071	upward
	7/27/2010			-0.1144	upward
	8/24/2010			-0.1186	upward
	9/14/2010			-0.1671	upward
	10/15/2010			-0.1117	upward
	11/24/2010			-0.1655	upward
	12/14/2010			-0.0896	upward
	1/13/2011			NA	NA
	2/22/2011			NA	NA
	3/21/2011			NA	NA
	4/20/2011			-0.0432	upward

Notes:

NA = not available, NG = no gradient

(1) Monitoring wells MW302B and MW307B were drilled deeper than originally planned; as a result, the wells have been reclassified as Deep Bedrock wells (i.e., "C" wells). Monitoring well MW310C is artesian with water flowing from the well. Hydraulic head for well MW310C was set at the top of riser pipe for purposes of calculating vertical gradients.

(2) Gradient 1 = vertical groundwater flow between glacial outwash and shallow bedrock, Gradient 2 = vertical groundwater flow between glacial outwash and deep bedrock, Gradient 3 = vertical groundwater flow between shallow bedrock and deep bedrock

Figure 2.4-1— {Susquehanna River Basin and Sub-basins}

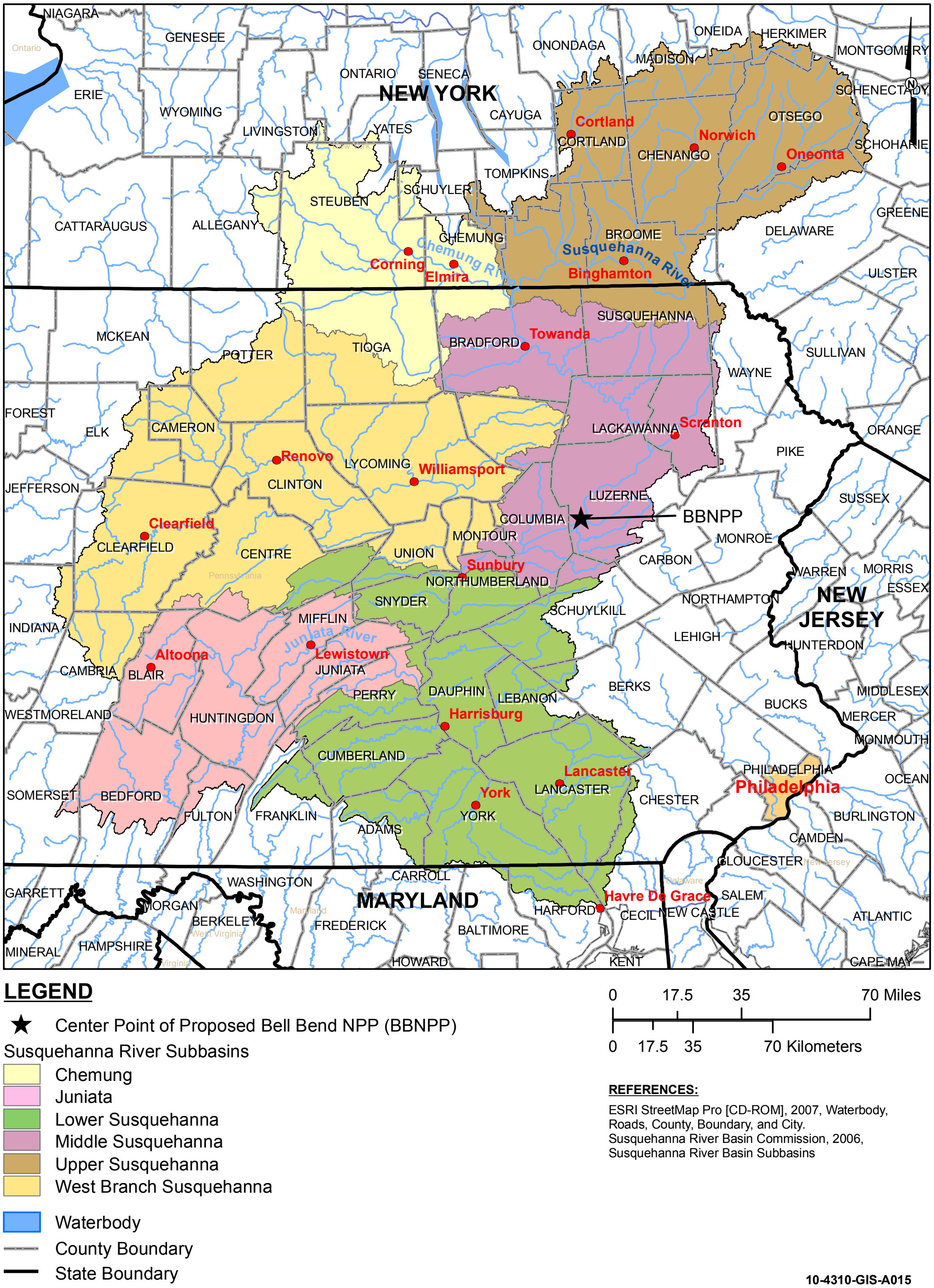
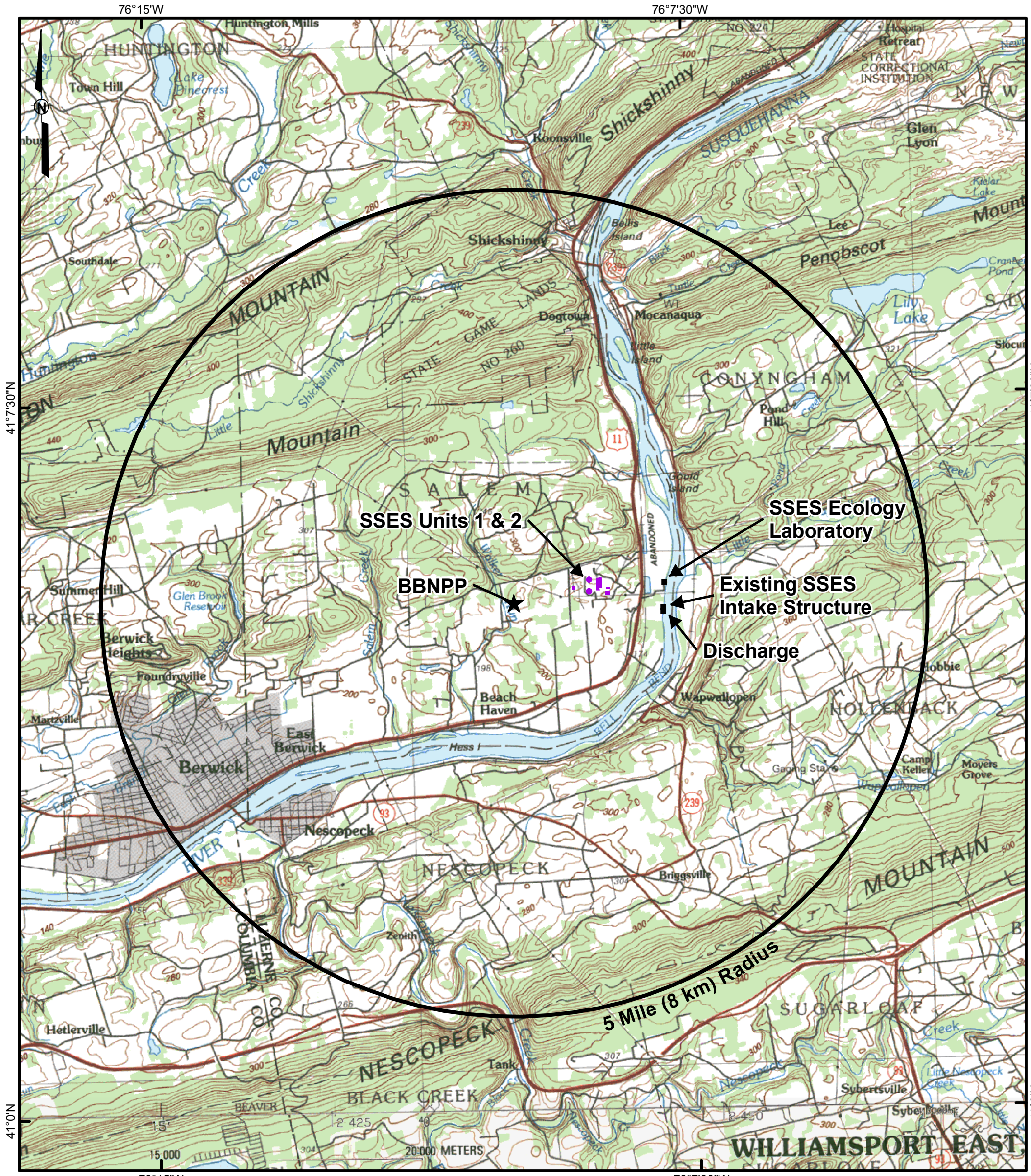


Figure 2.4-2— {Site Area Topographic Map 5 Mile (8 km) Radius}



LEGEND

★ Center Point of Proposed Bell Bend NPP (BBNPP)

○ BBNPP Reactor 5 Mile (8 km) Radius

0 0.5 1 2 Miles

0 0.5 1 2 Kilometers

NOTE:
Contour elevations are in meters.

REFERENCE:
USGS, 1984

10-4310-GIS-A002

Figure 2.4-3— {Walker Run Watershed}

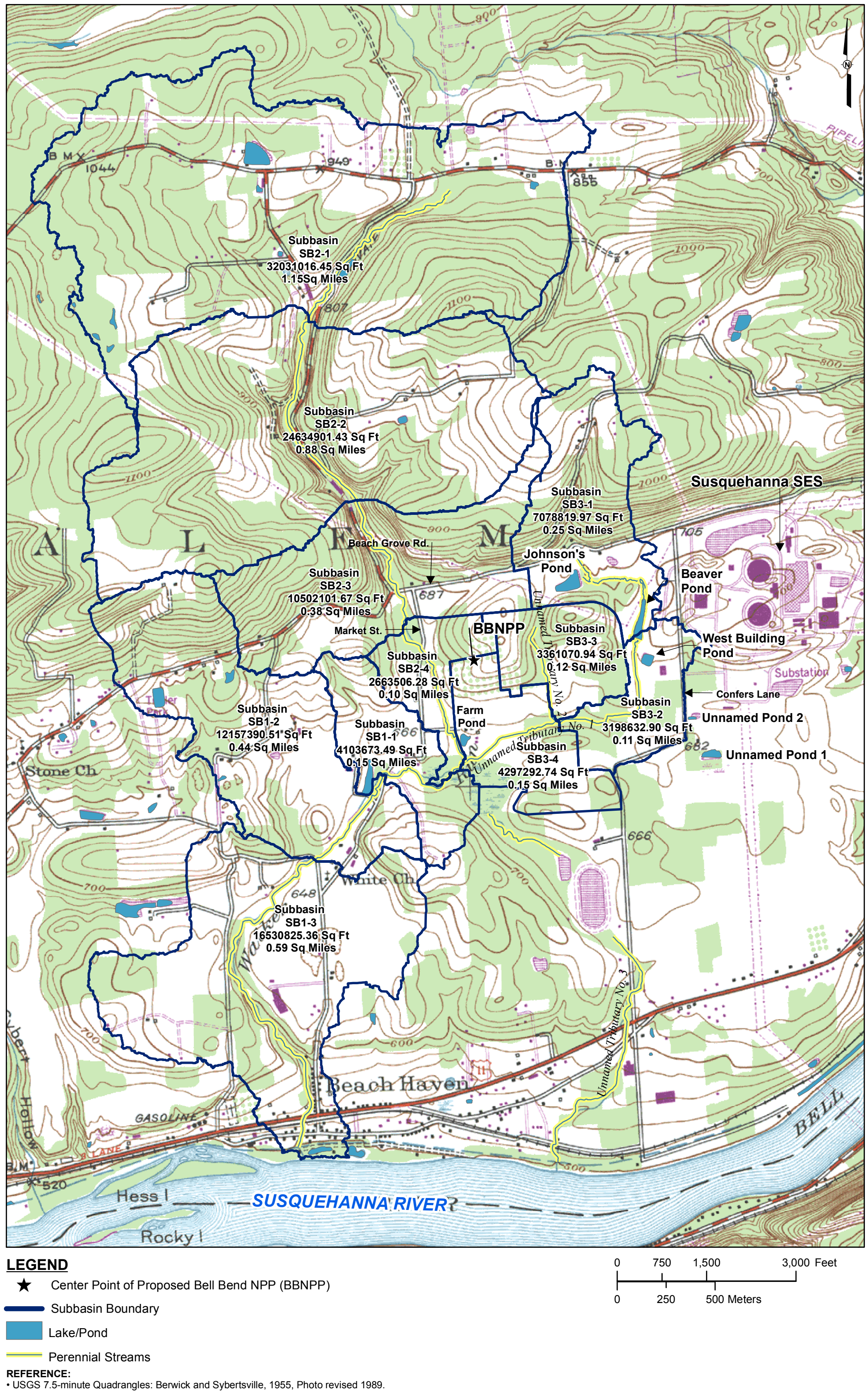


Figure 2.4-4— {Site Drainage Flow Pattern}

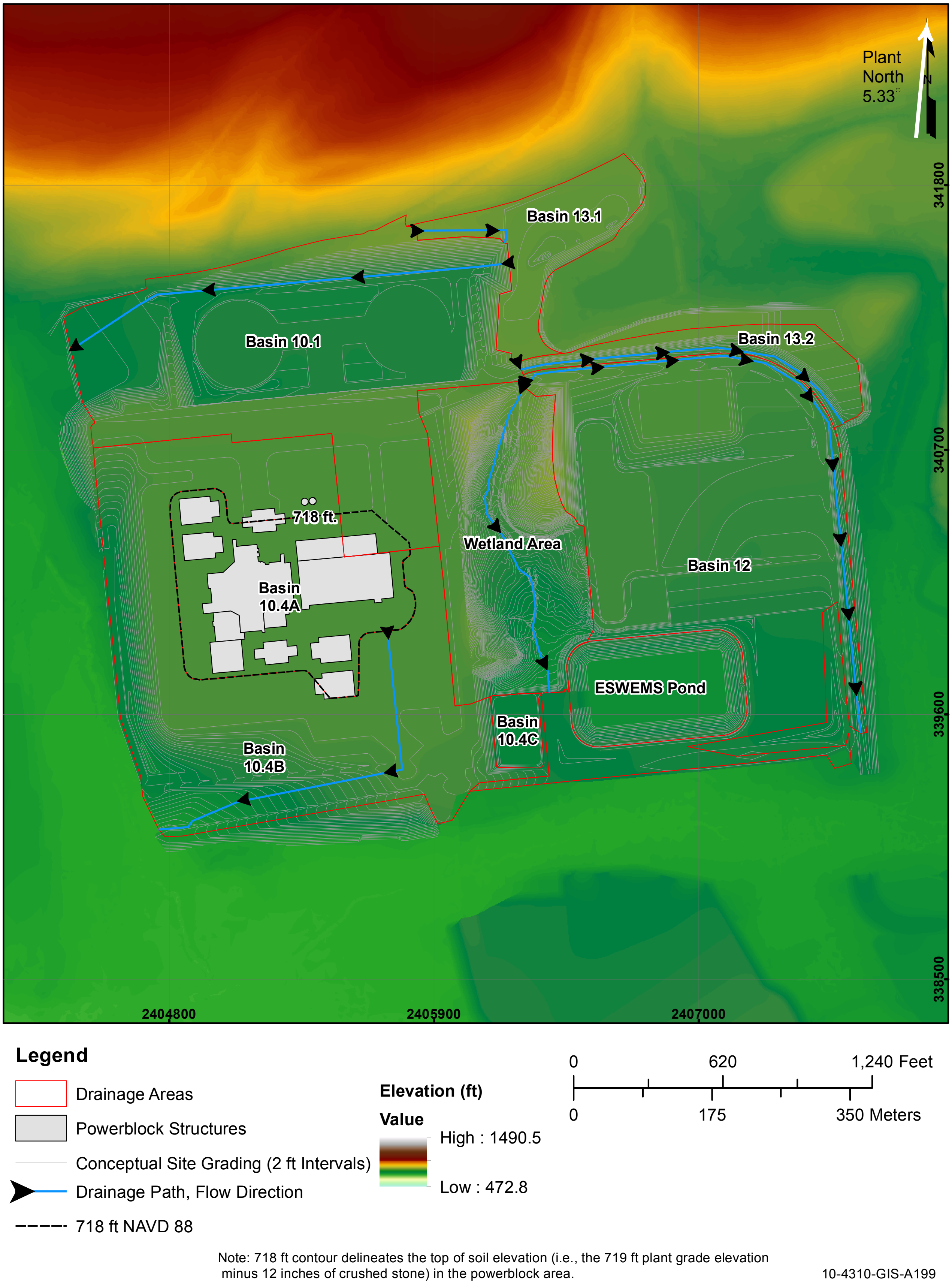


Figure 2.4-5— {Site Utilization Plant Layout}

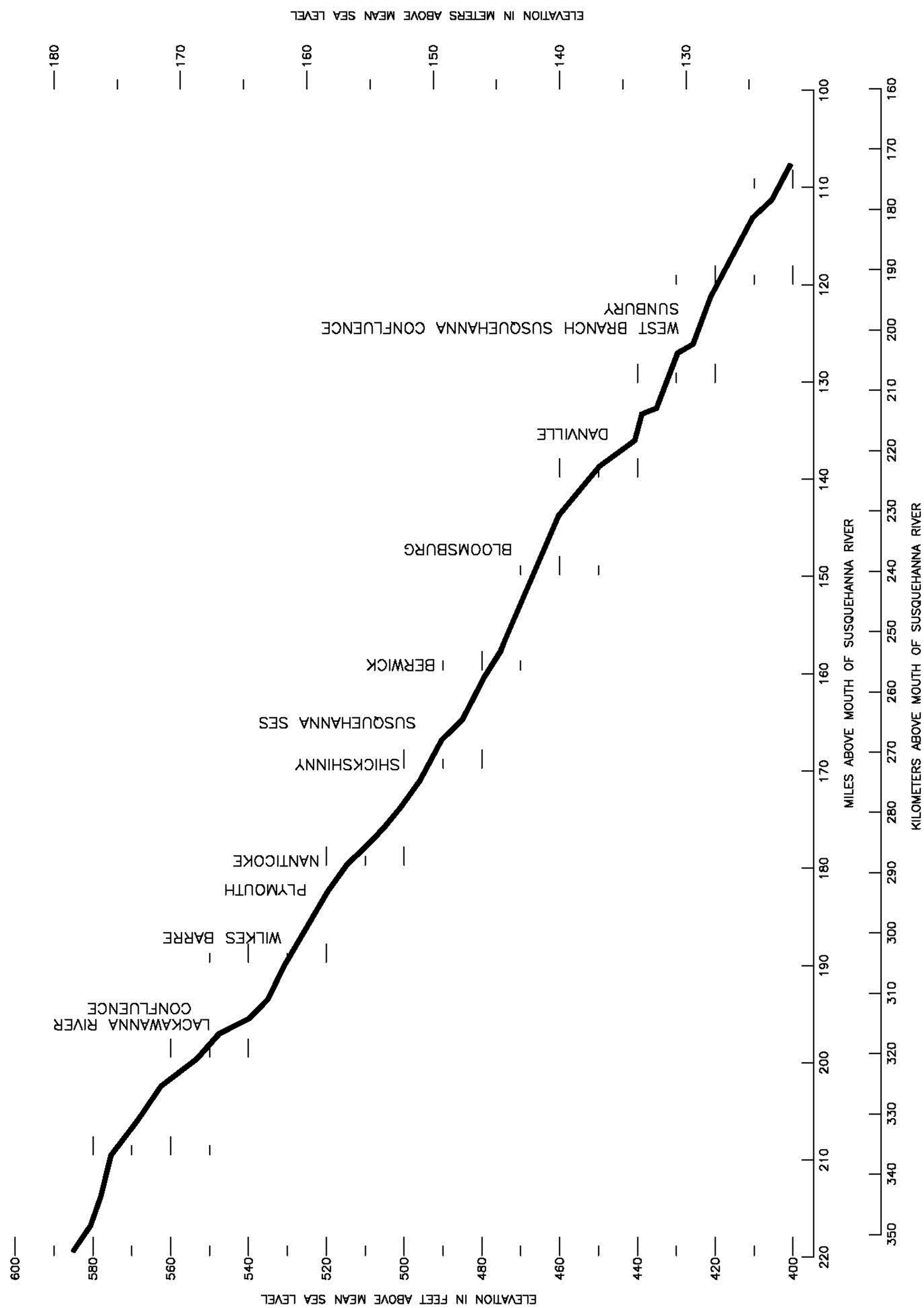


Figure 2.4-6— {Susquehanna River Profile}

Figure 2.4-7— {USGS Stream Gauges within a 50 Mile (80 Km) Radius}

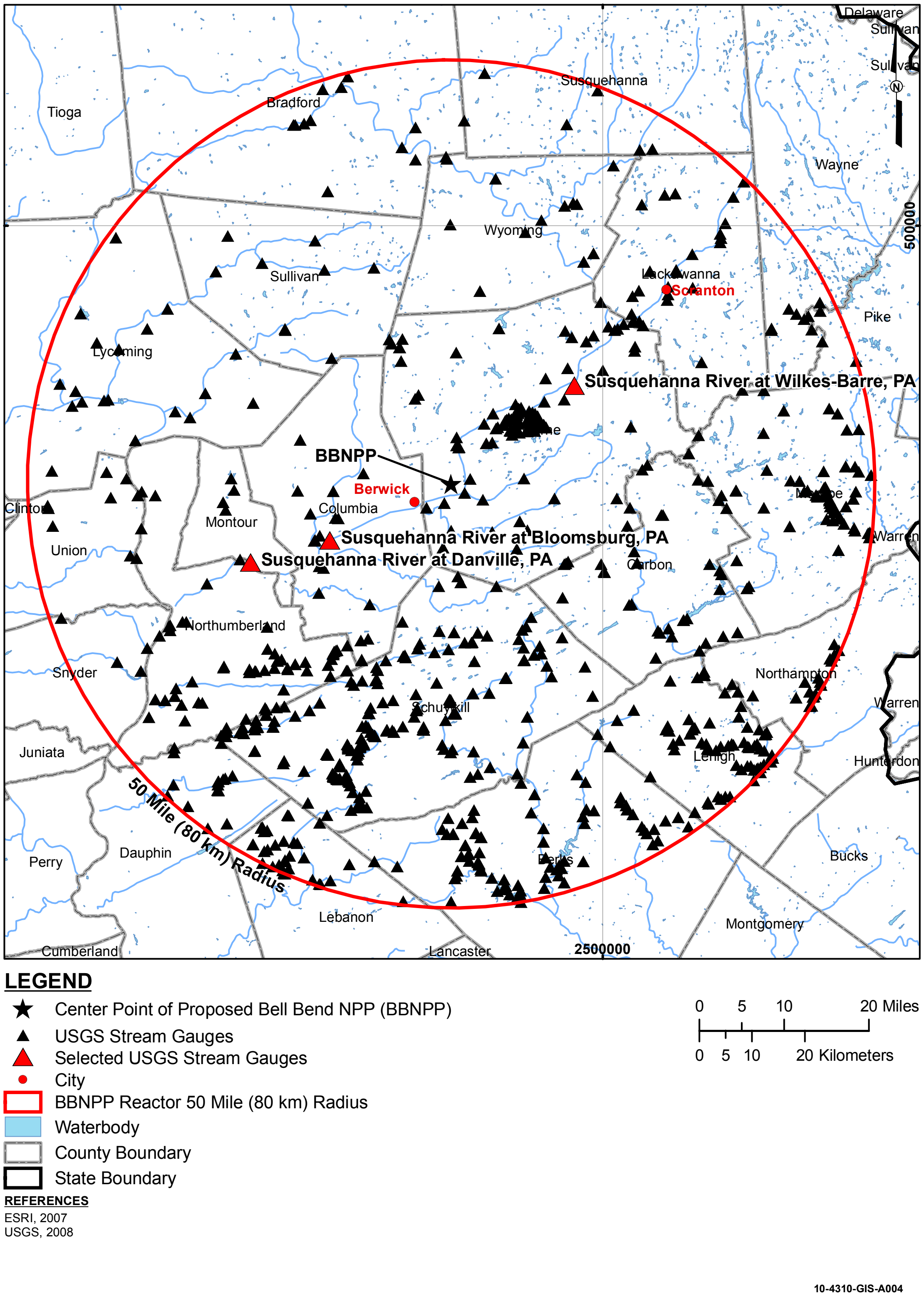
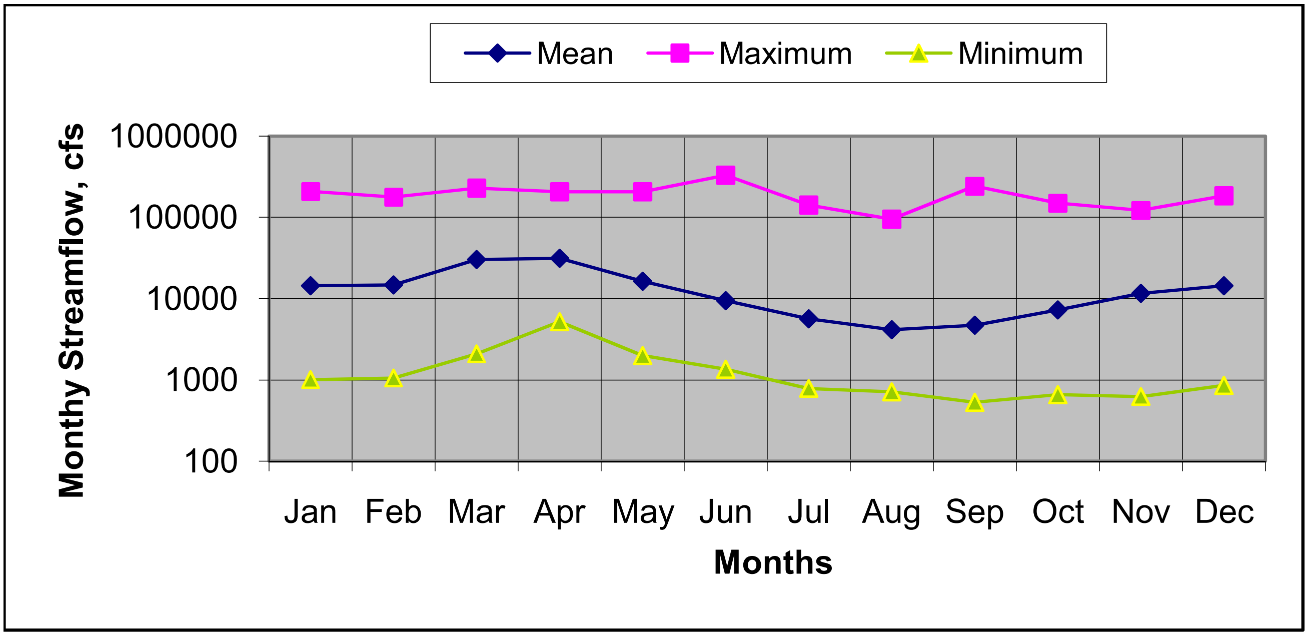
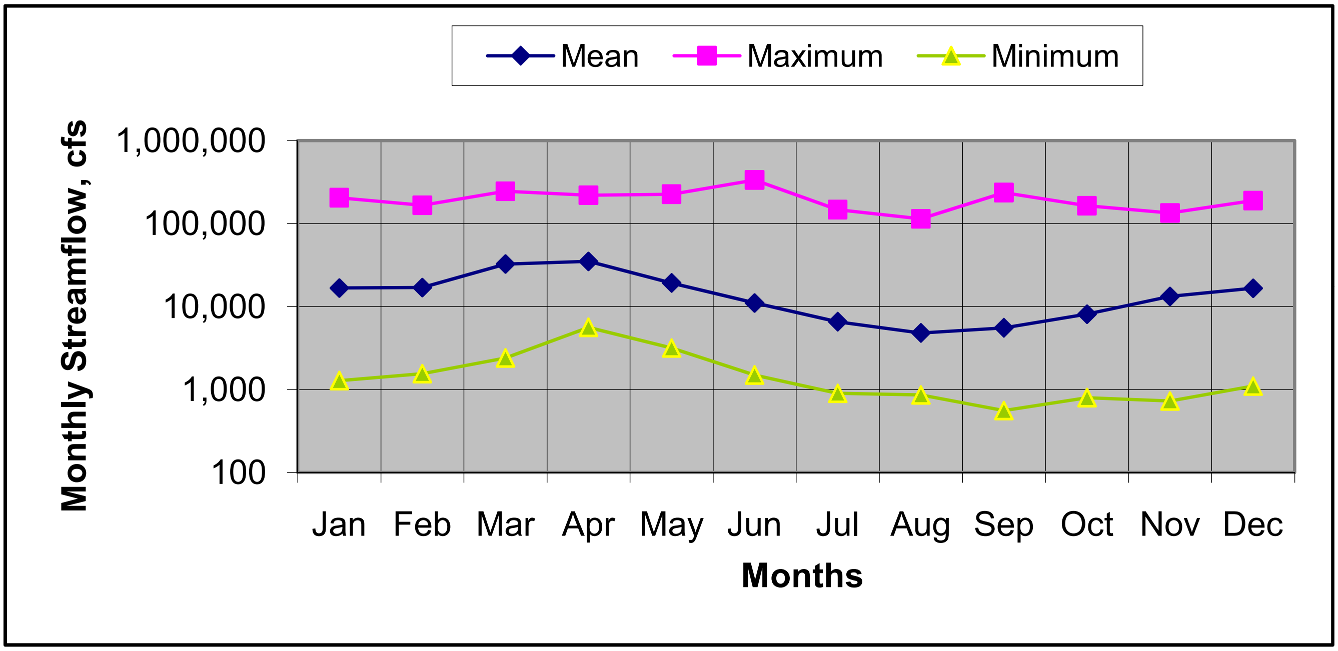


Figure 2.4-8— {Mean, Maximum & Minimum Monthly Streamflows for Wilkes-Barre, PA USGS 01536500, (1900 through 2007)}



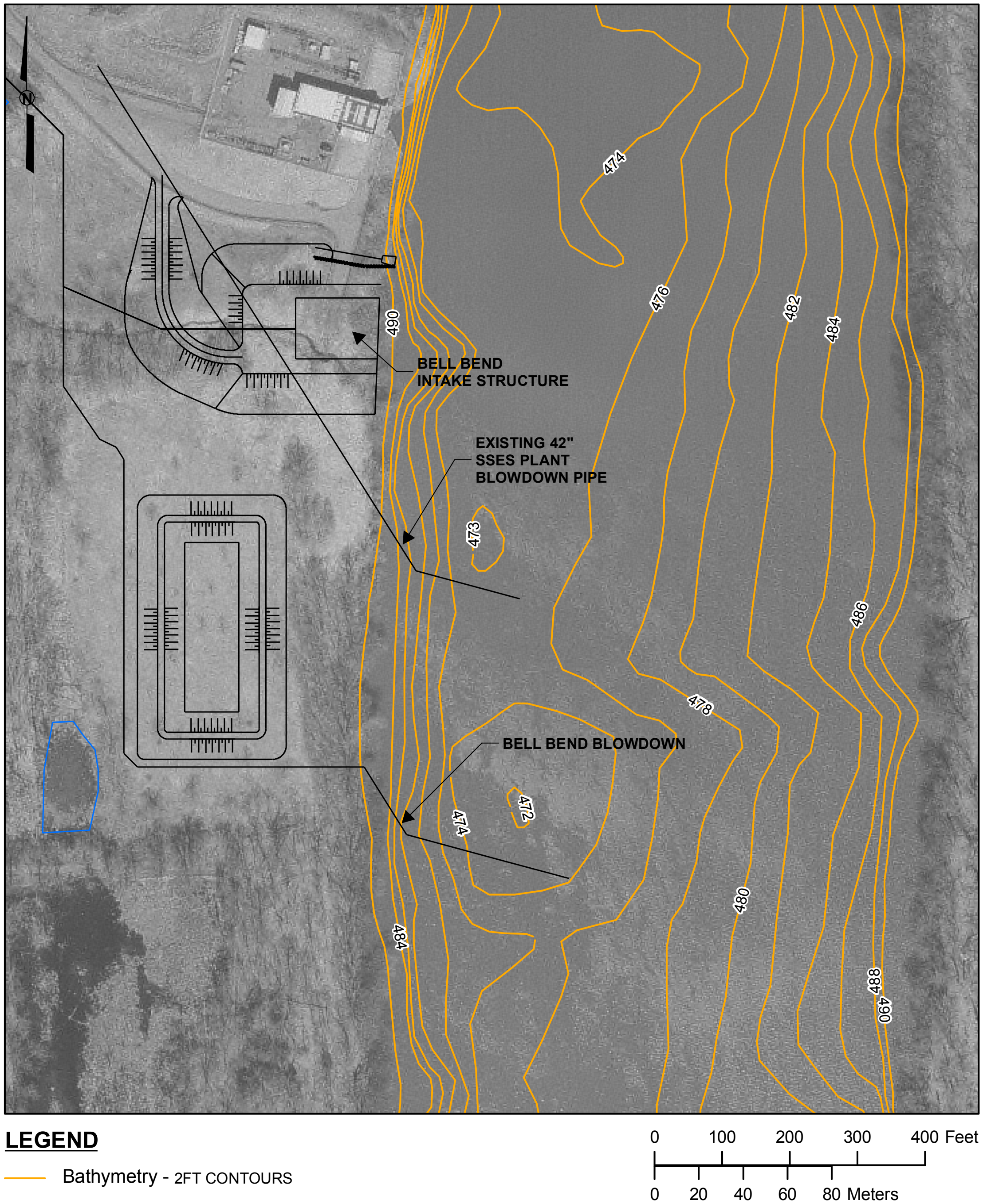
Source: USGS, 2008i

Figure 2.4-9— {Mean, Maximum & Minimum Monthly Streamflows for Danville, PA USGS 01540500 (1905 through 2007)}



Source: USGS, 2008h

Figure 2.4-10— {Susquehanna River Bathymetry near Intake & Blowdown Structures}



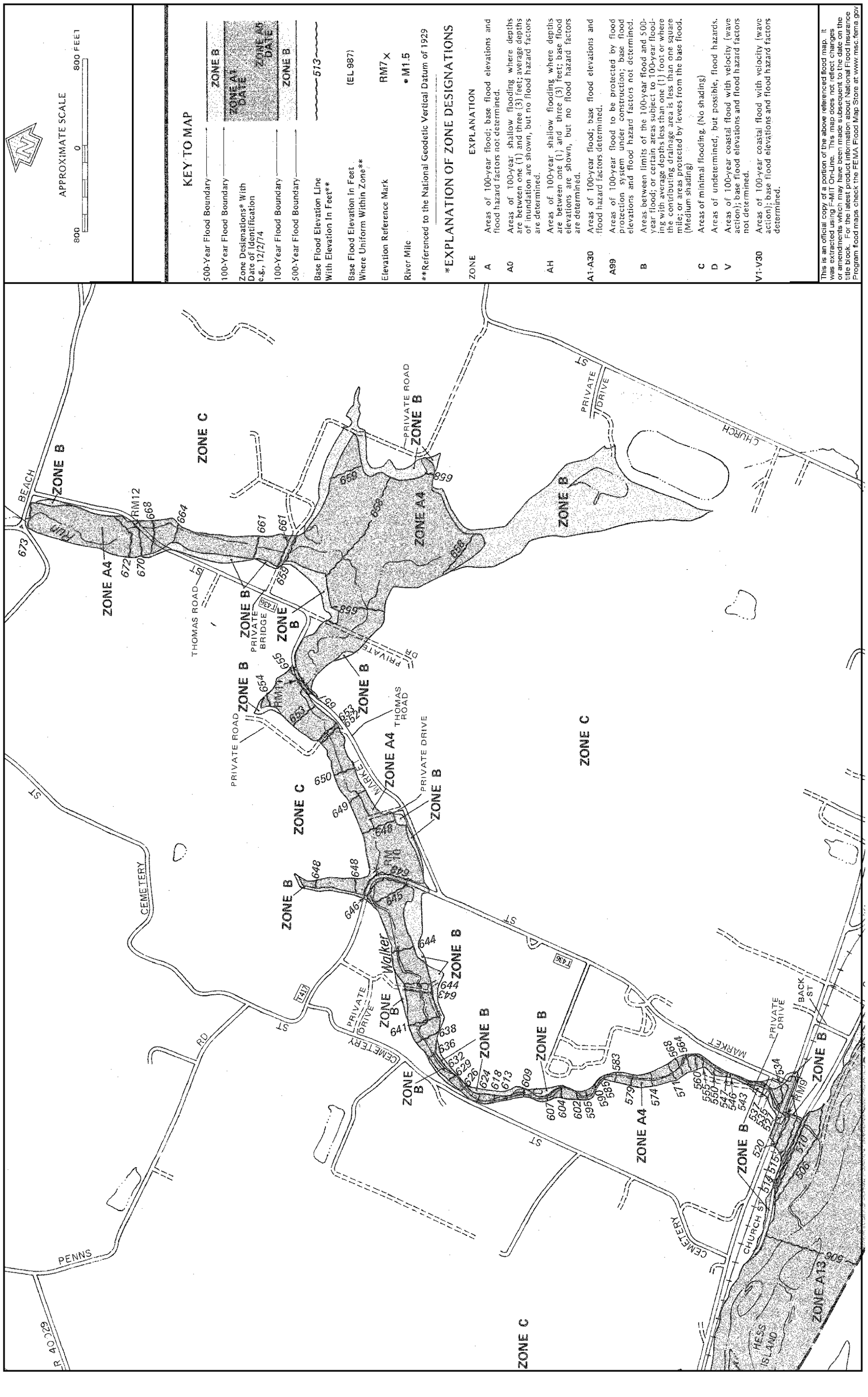


Figure 2.4-11— {Flood Insurance Map Panel 1 of 4}

Figure 2.4-12— {Flood Insurance Map Panel 2 of 4}

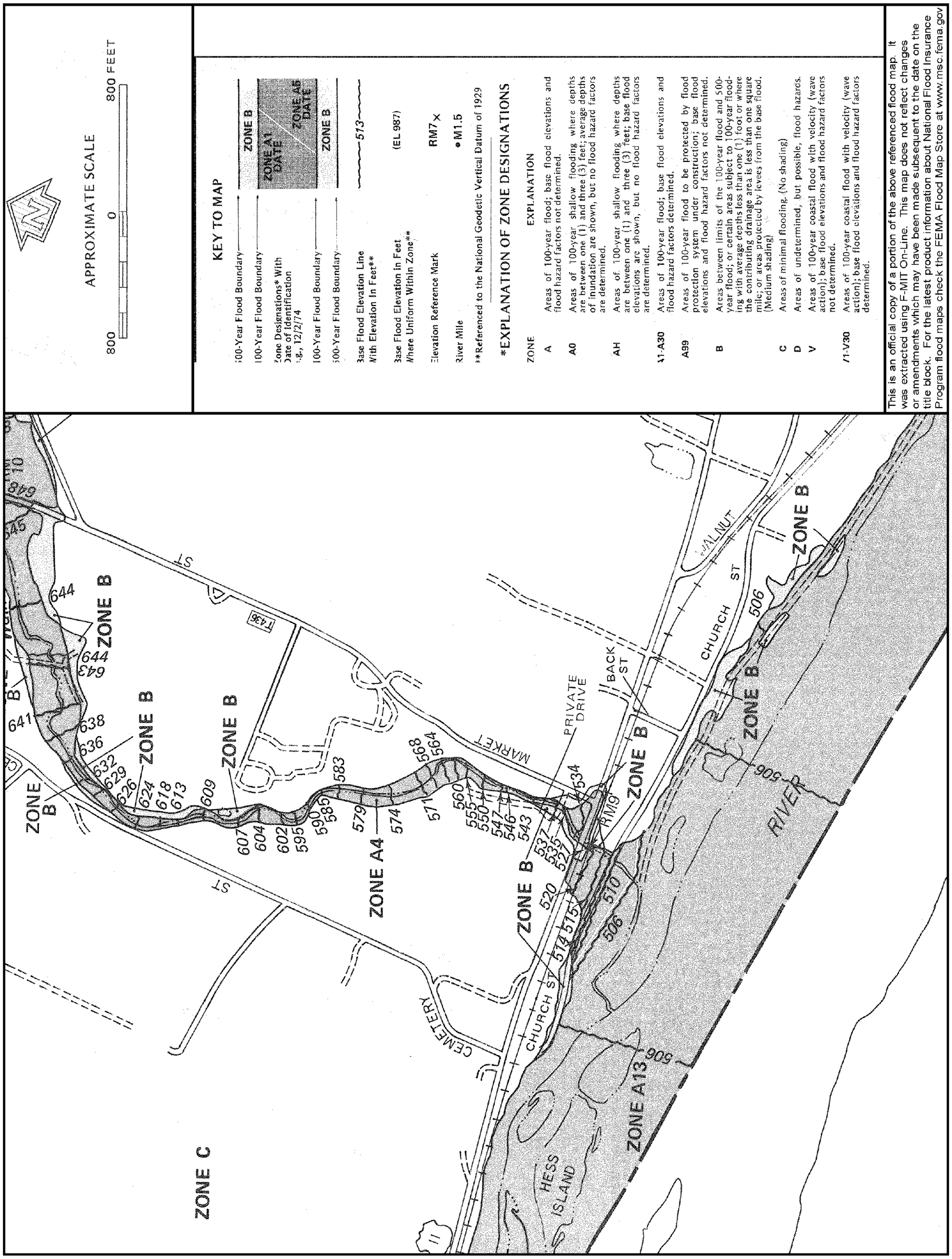


Figure 2.4-13— {Flood Insurance Map Panel 3 of 4}

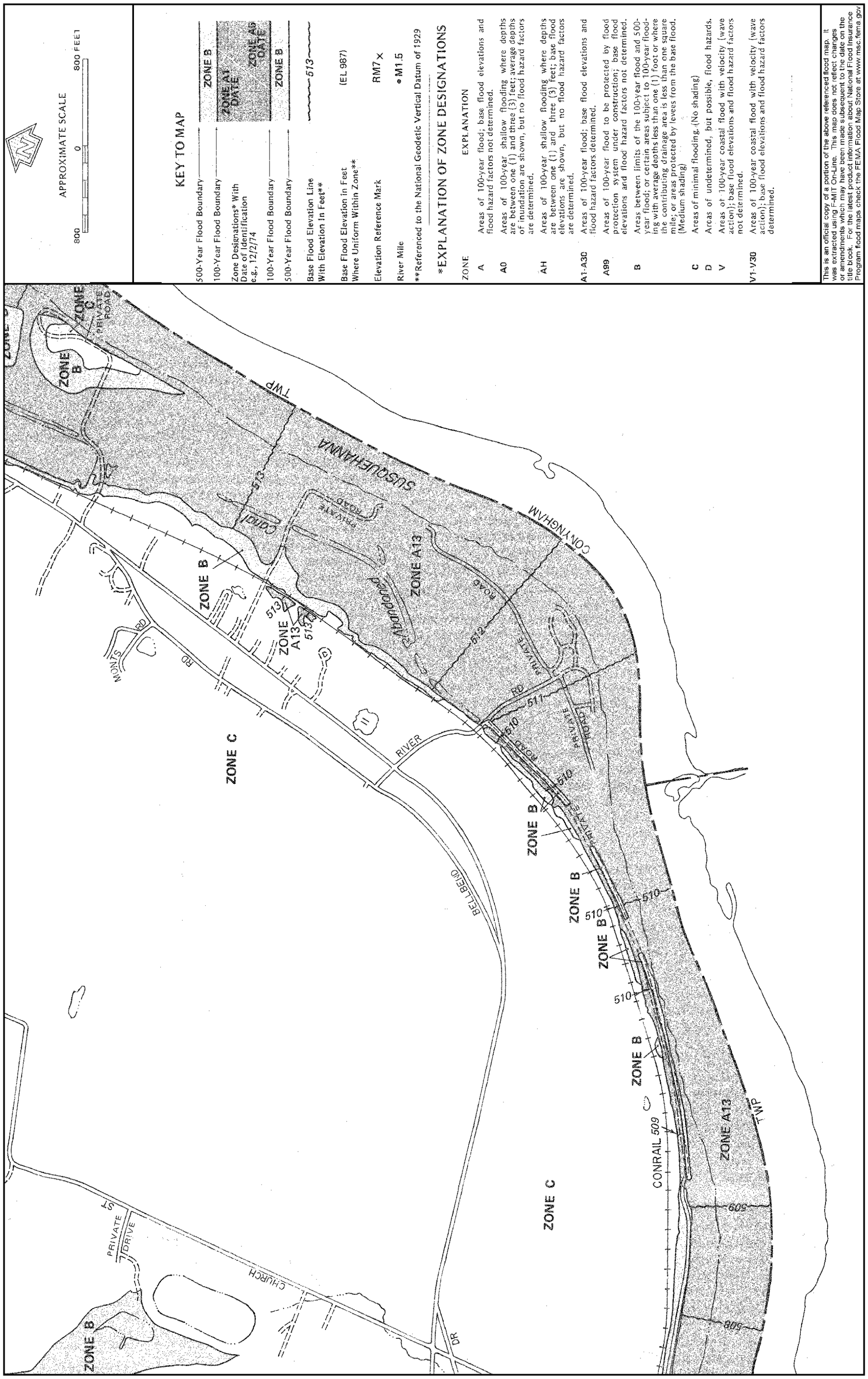


Figure 2.4-14— {Flood Insurance Map Panel 4 of 4}

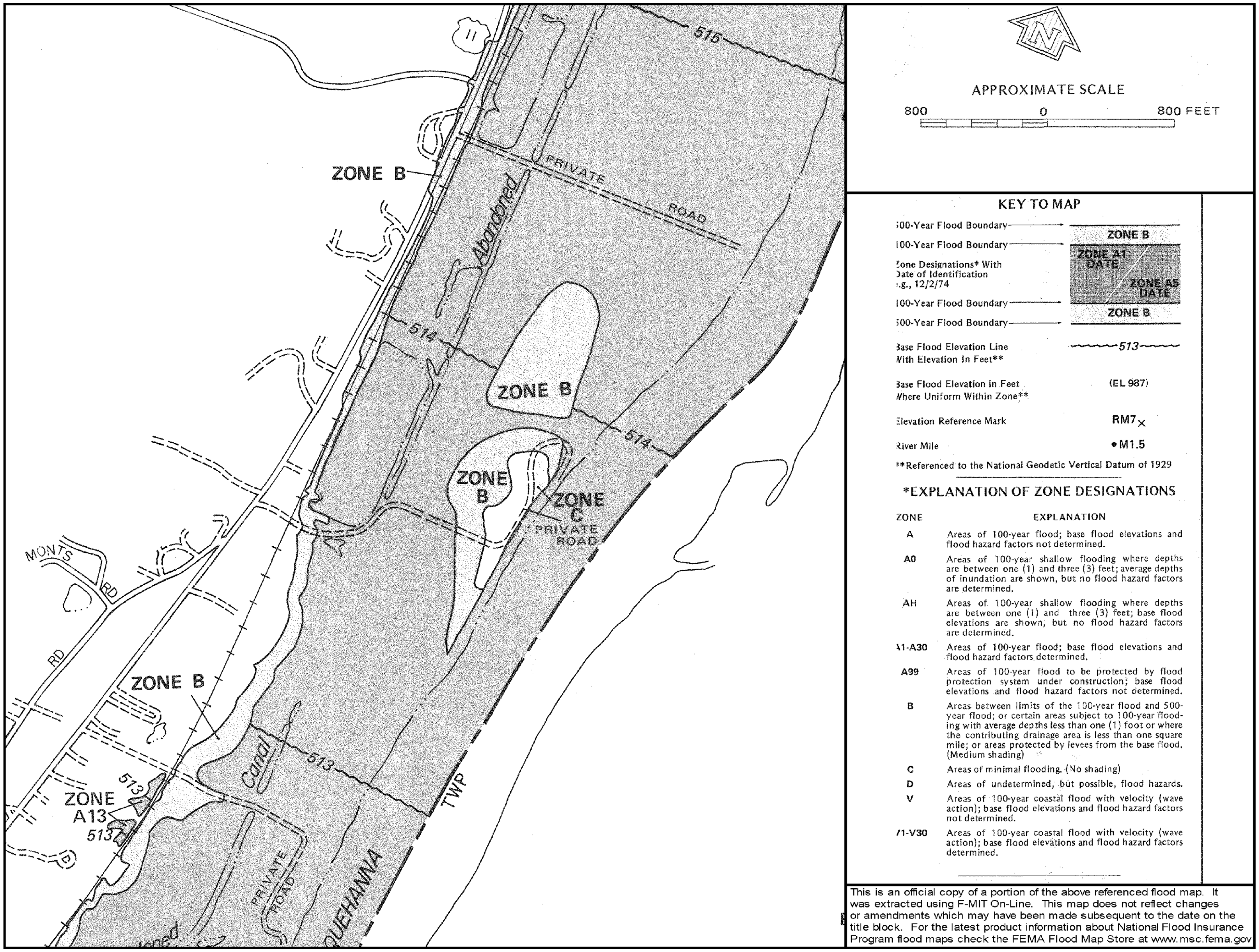


Figure 2.4-15— {Major and Minor Dams Upstream from BBNPP}

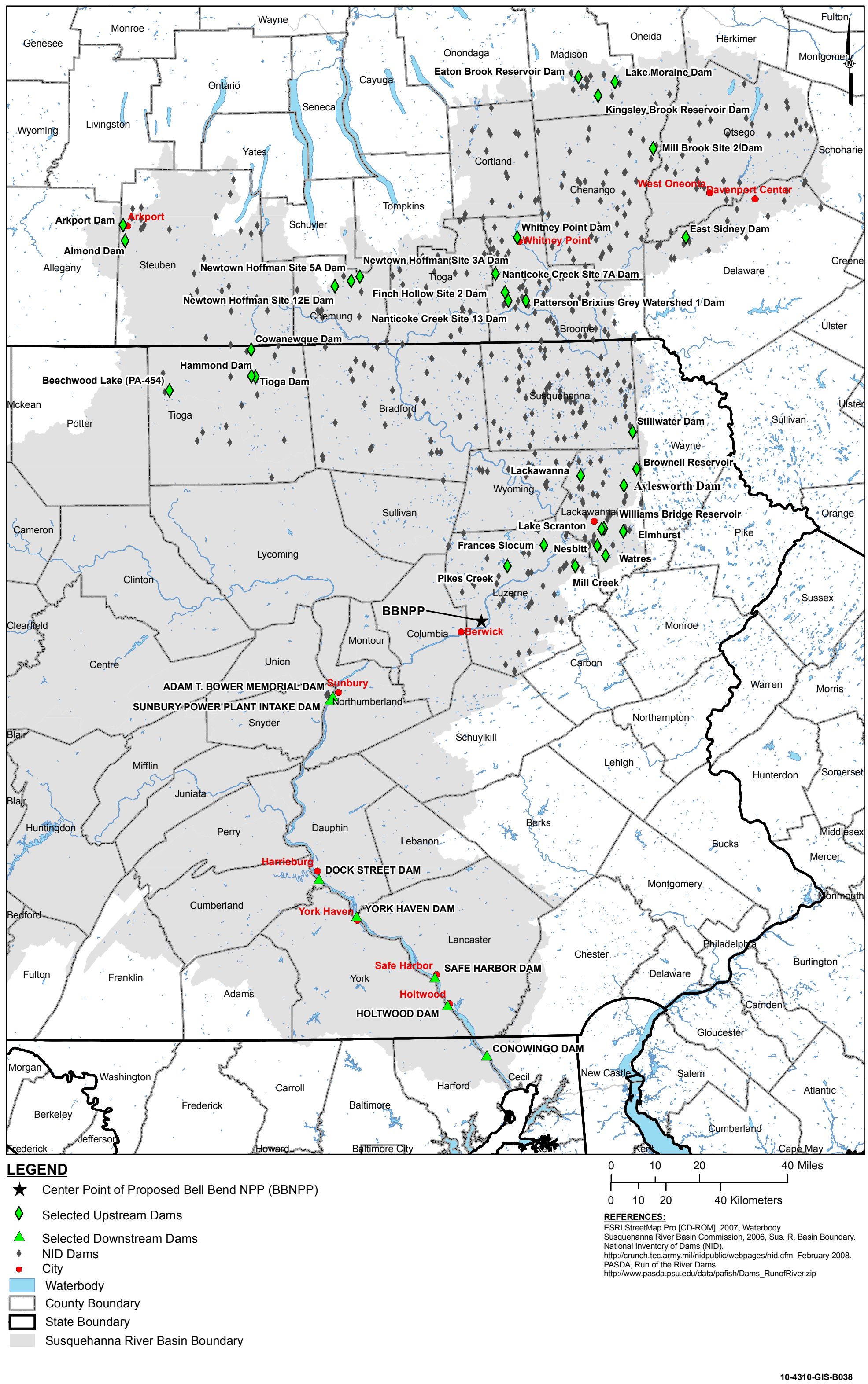


Figure 2.4-16— {Surface Water Withdrawal in Luzerne County}

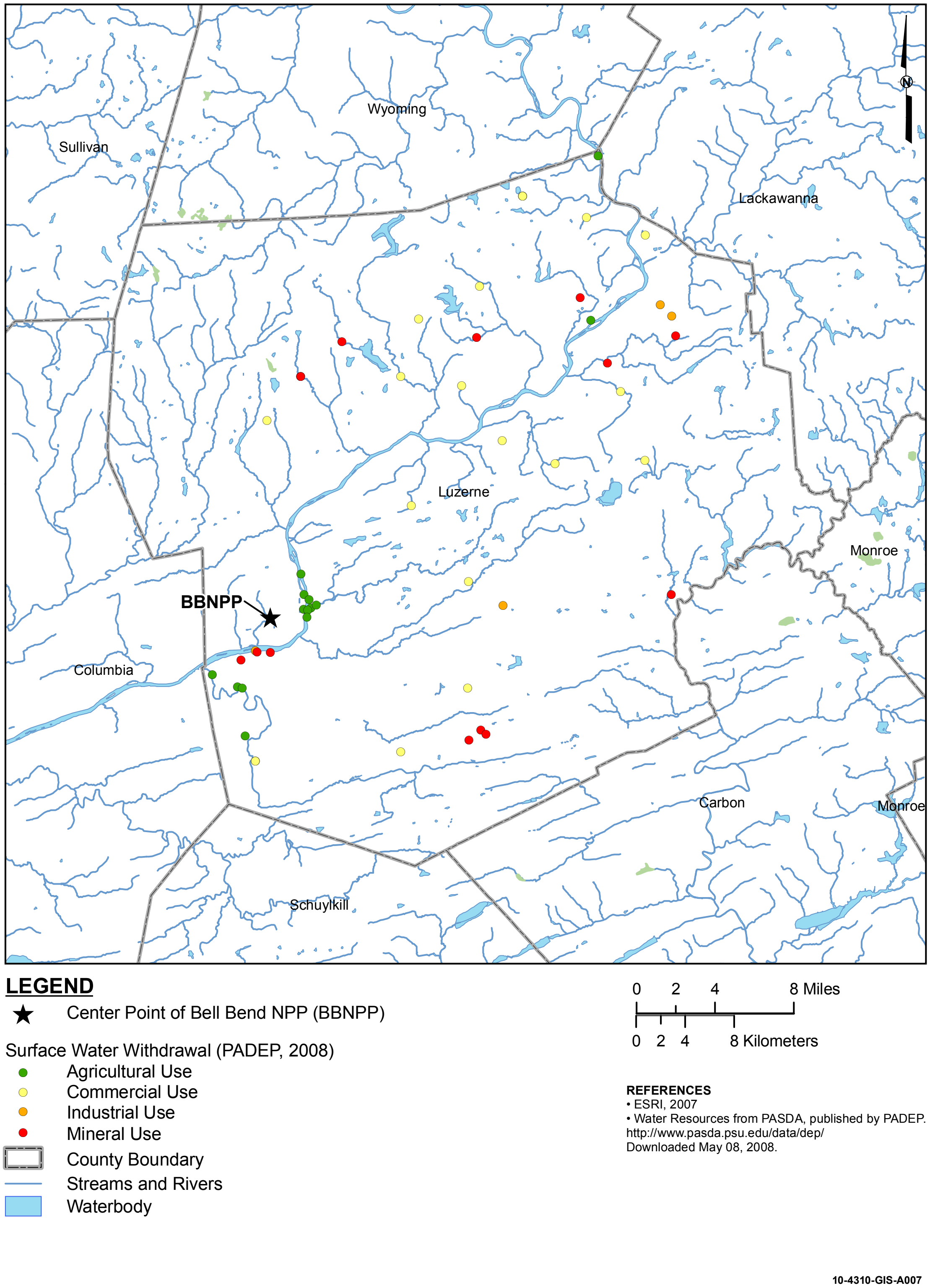


Figure 2.4-17— {Surface Water Withdrawal within 5-mile (8 km) Radius}

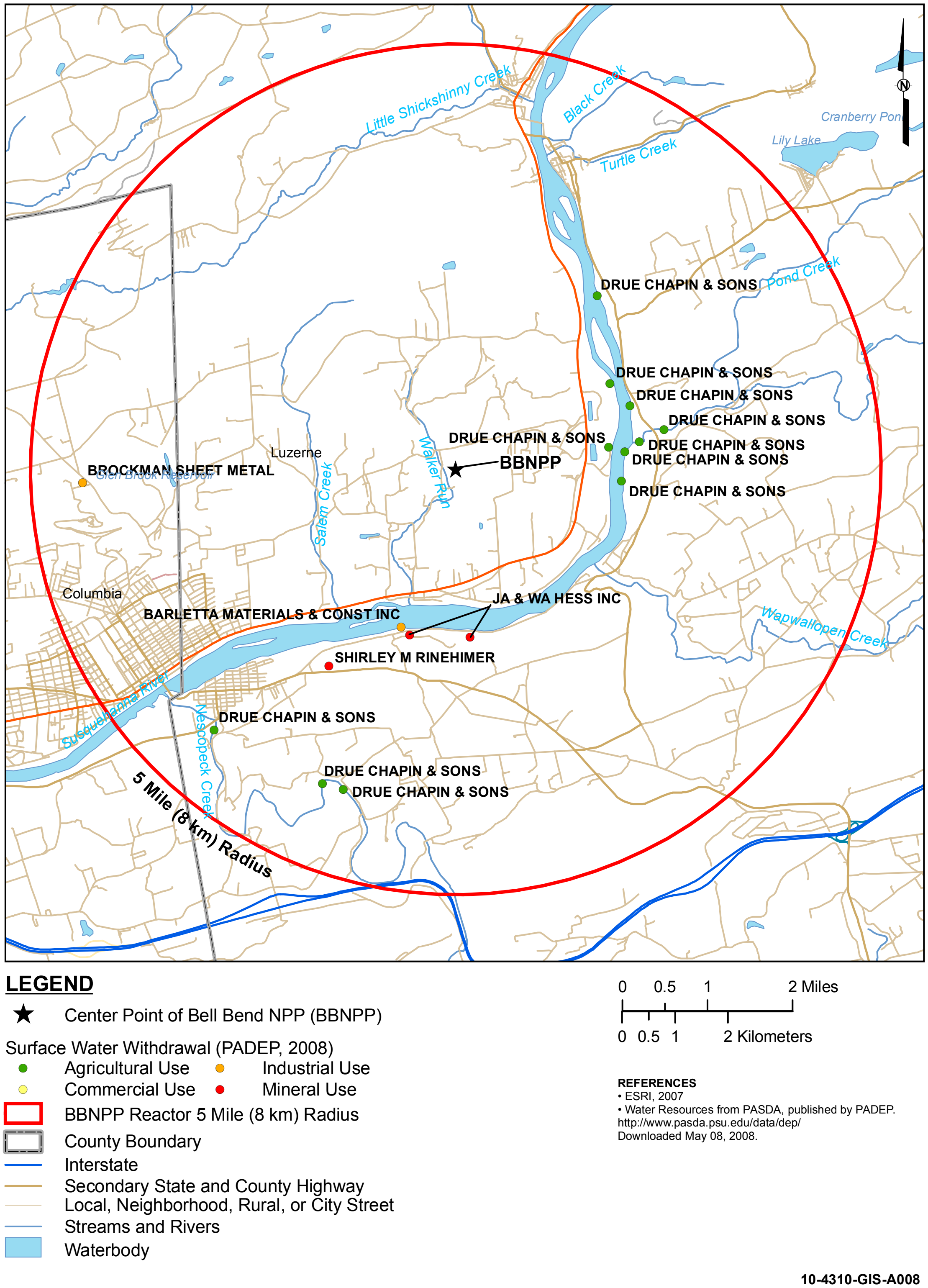


Figure 2.4-18— {Water Pollution Control Facilities Locations within a 5-mile (8-km) Radius}

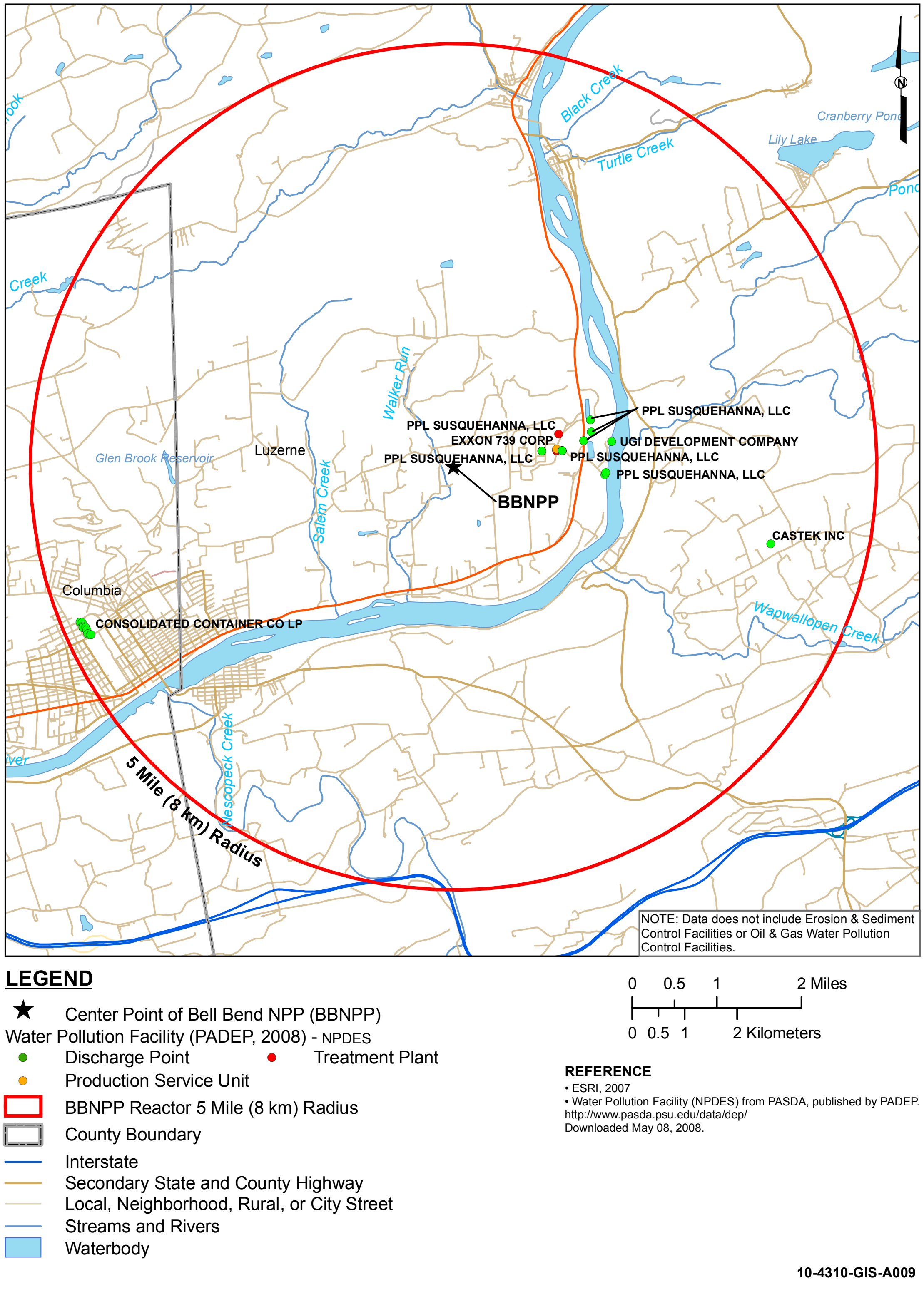


Figure 2.4-19— {Water Pollution Control Facilities Locations within Luzerne County}

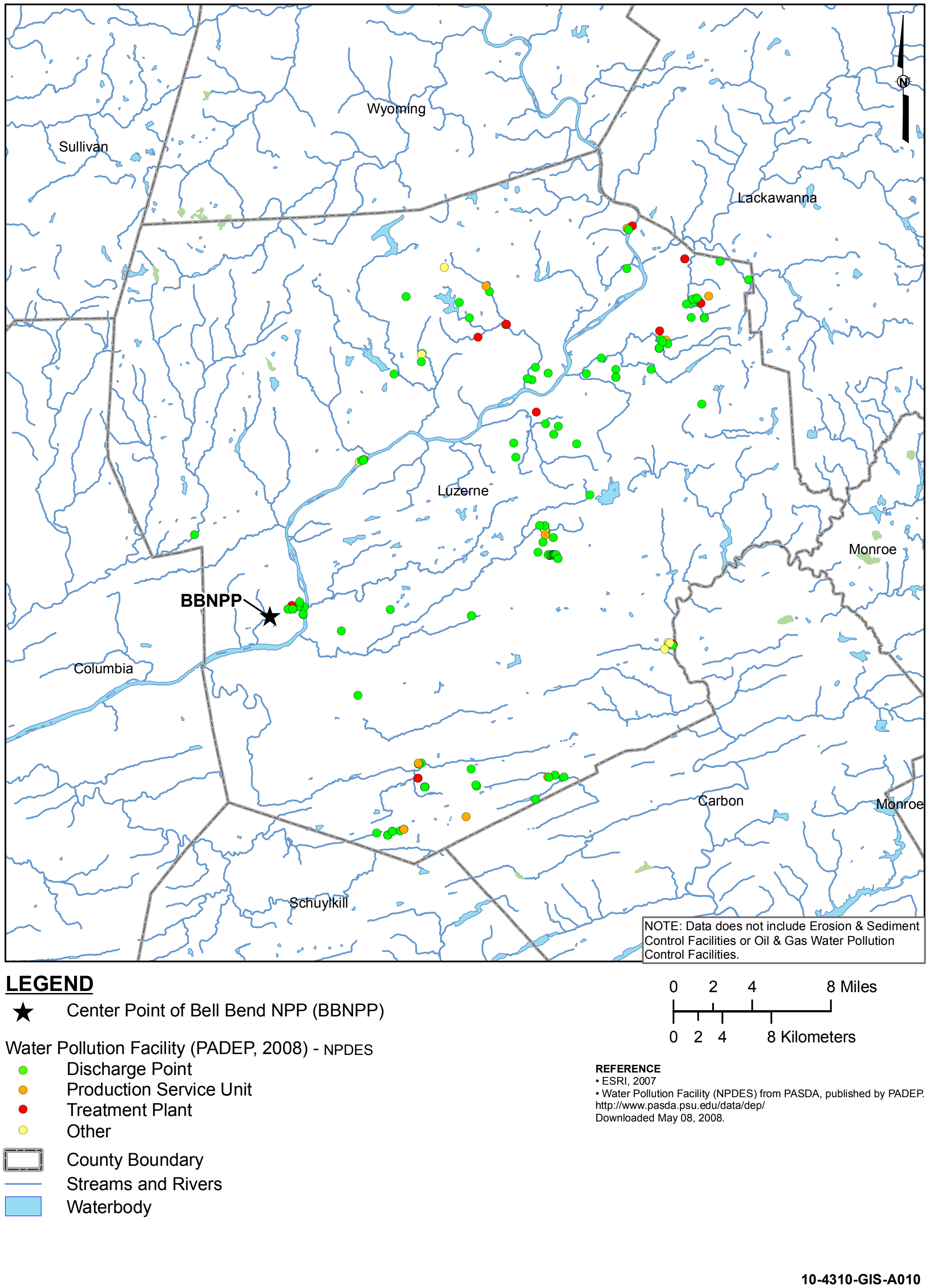
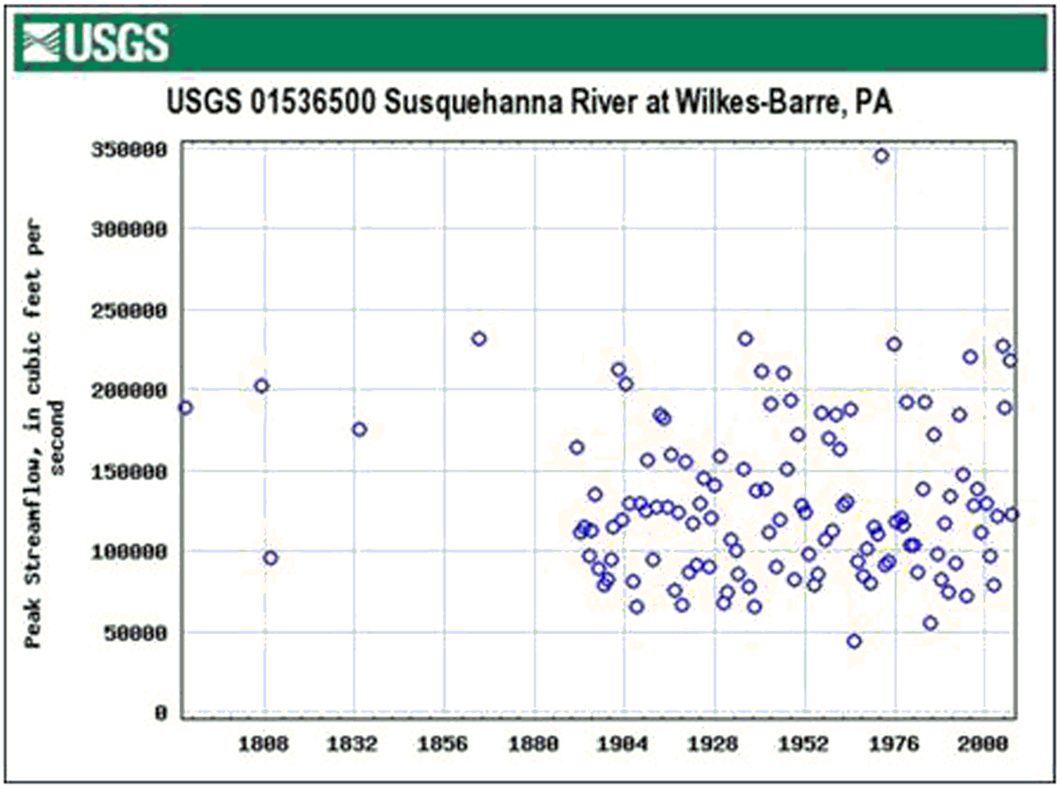
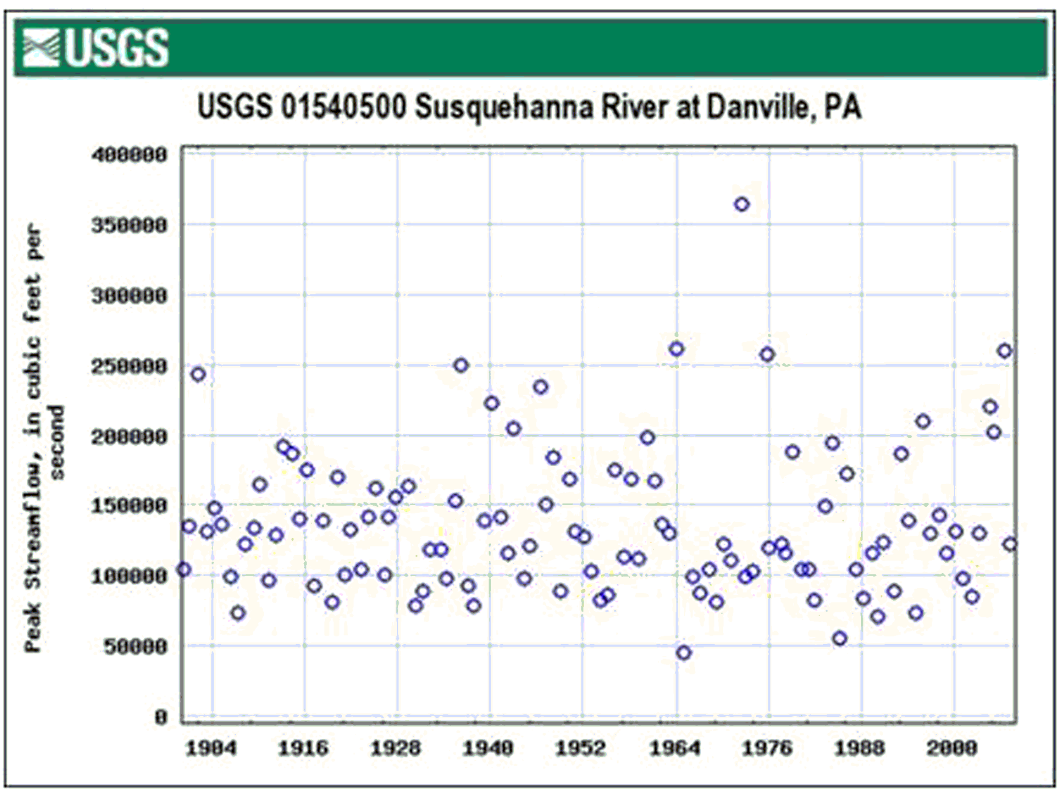


Figure 2.4-20— {Peak Streamflow at Wilkes-Barre and Danville Gauging Stations}



Source: USGS, 2008a



Source: USGS, 2008b

Figure 2.4-21— {HEC-HMS Hydrologic Diagram}

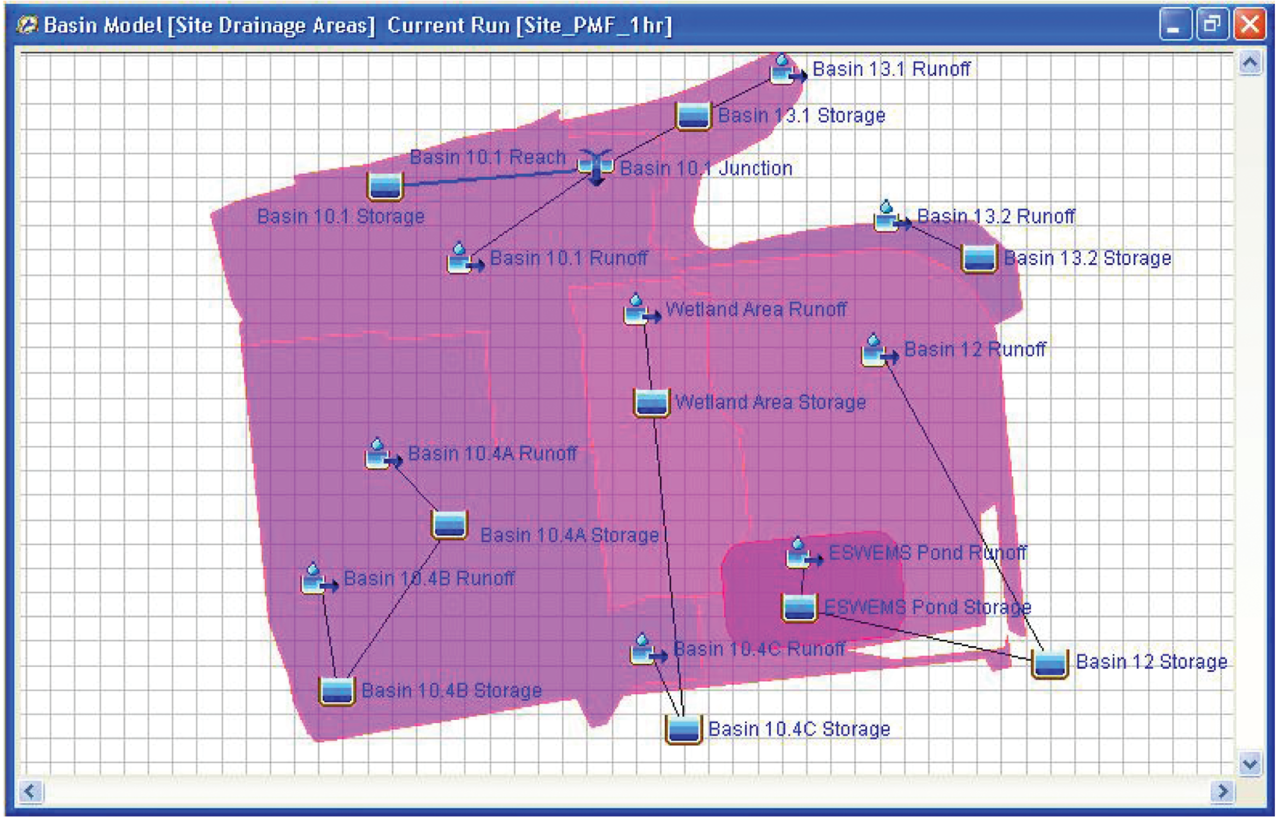


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Figure 2.4-22— {BBNPP Site Location}

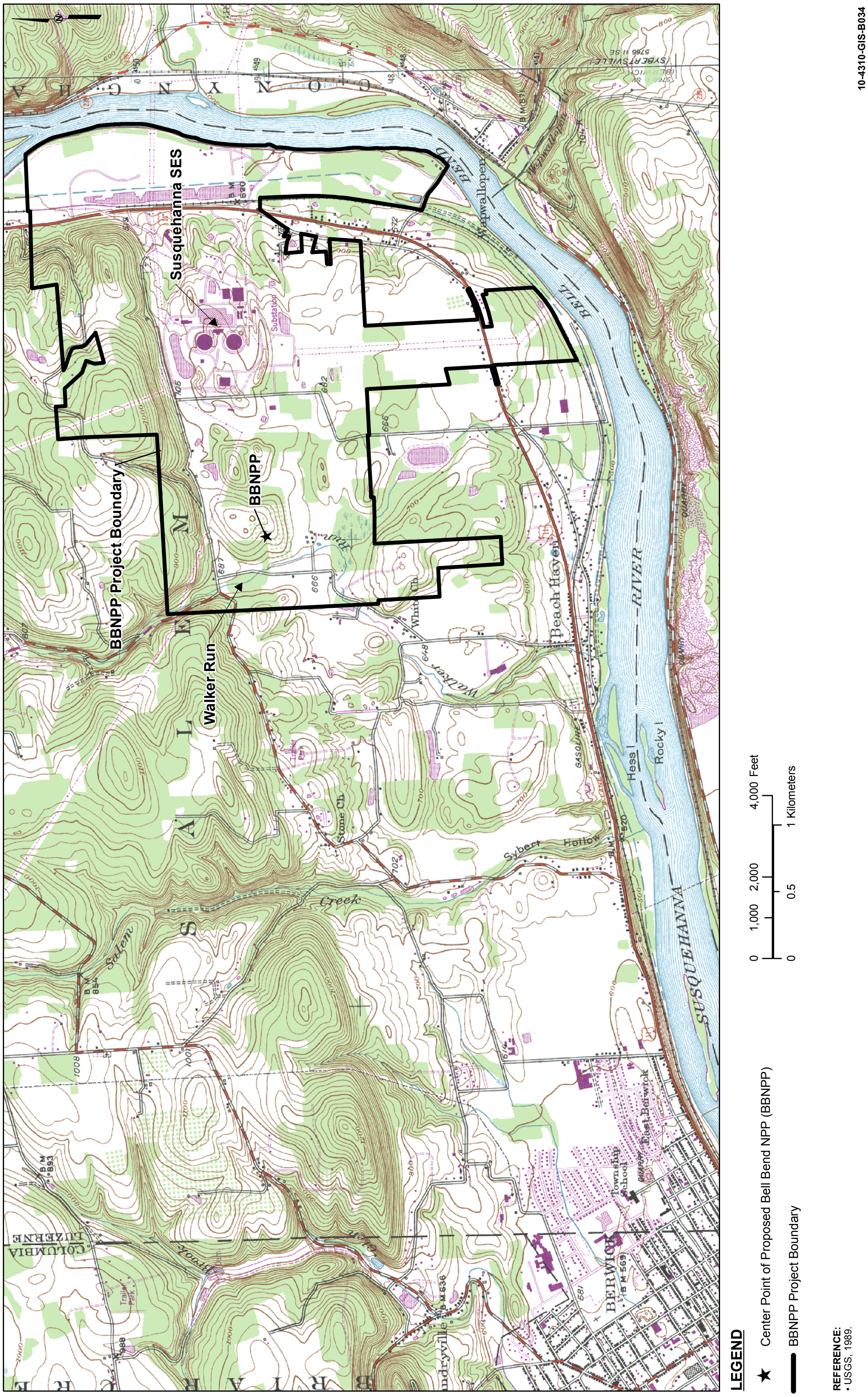

Figure 2.4-23— {HEC-HMS Model Setup of Walker Run Watershed}

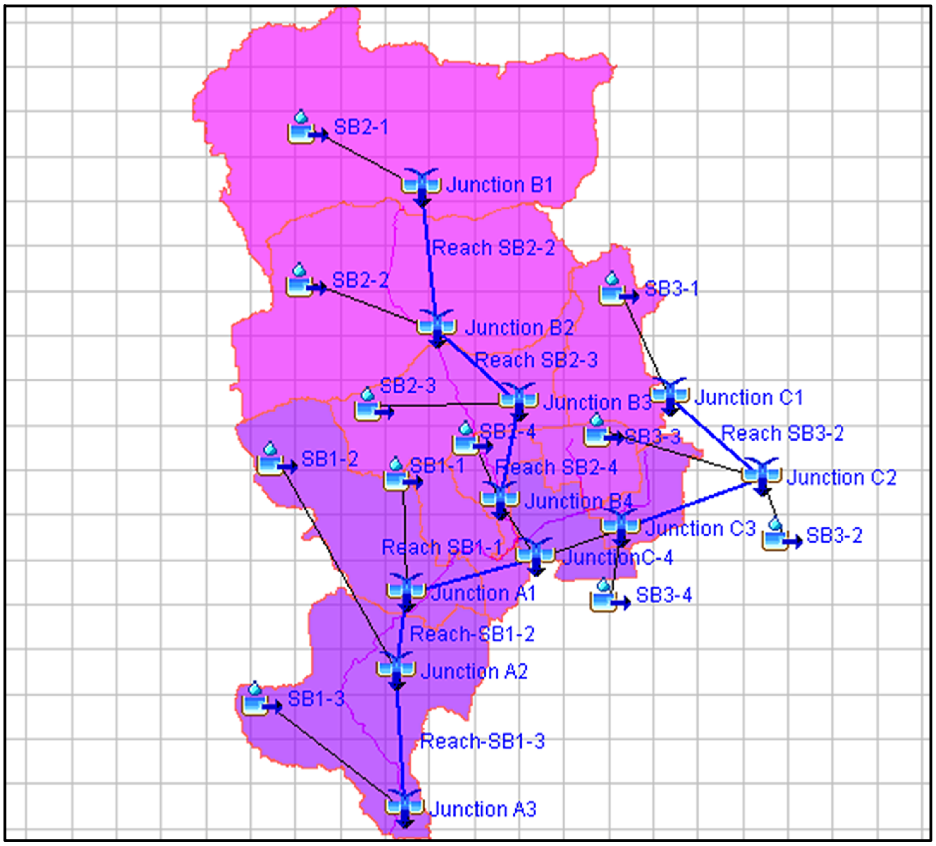

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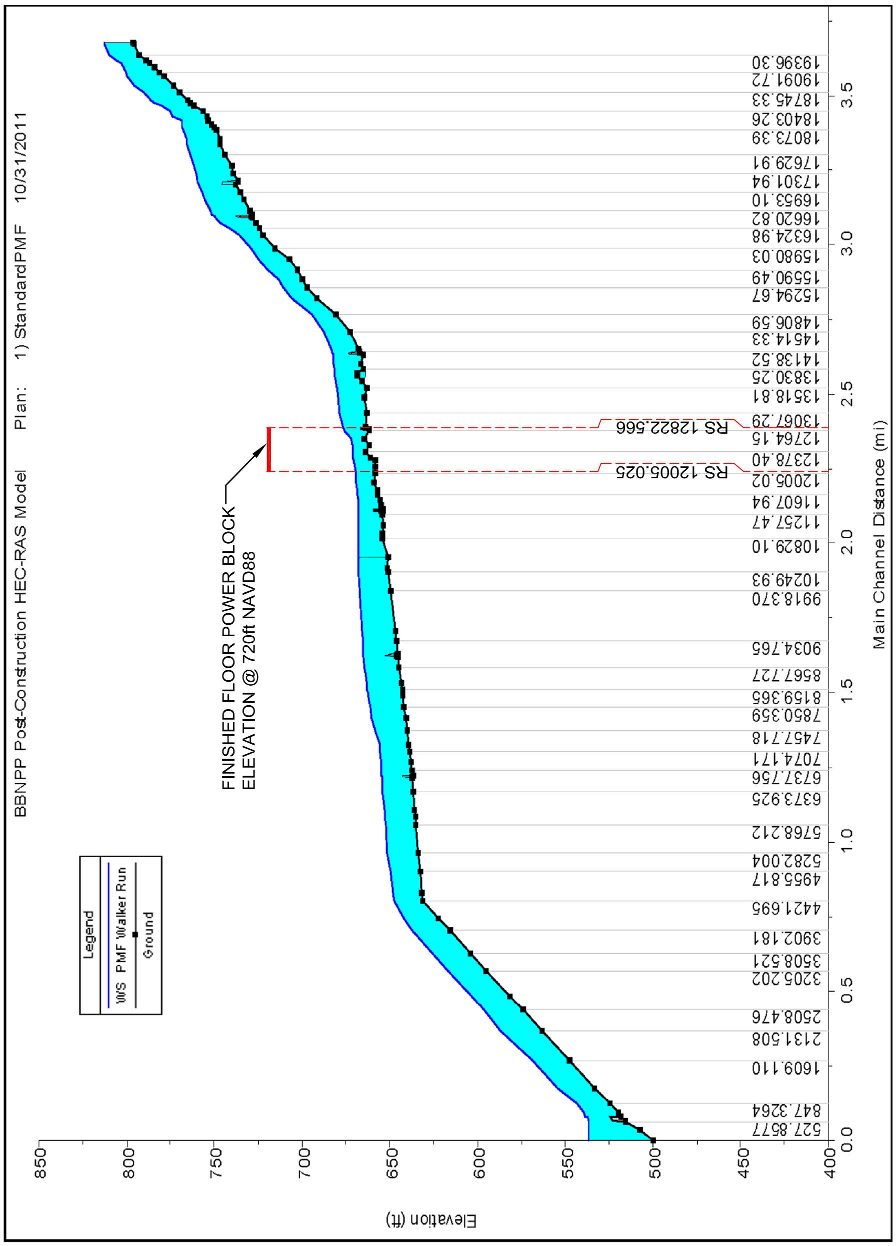
Figure 2.4-24— {Walker Run PMF Water Surface Profile}



NOT TO SCALE

10–4310–CADD–A018

Figure 2.4-25— {Junction B-4 Hydrograph}

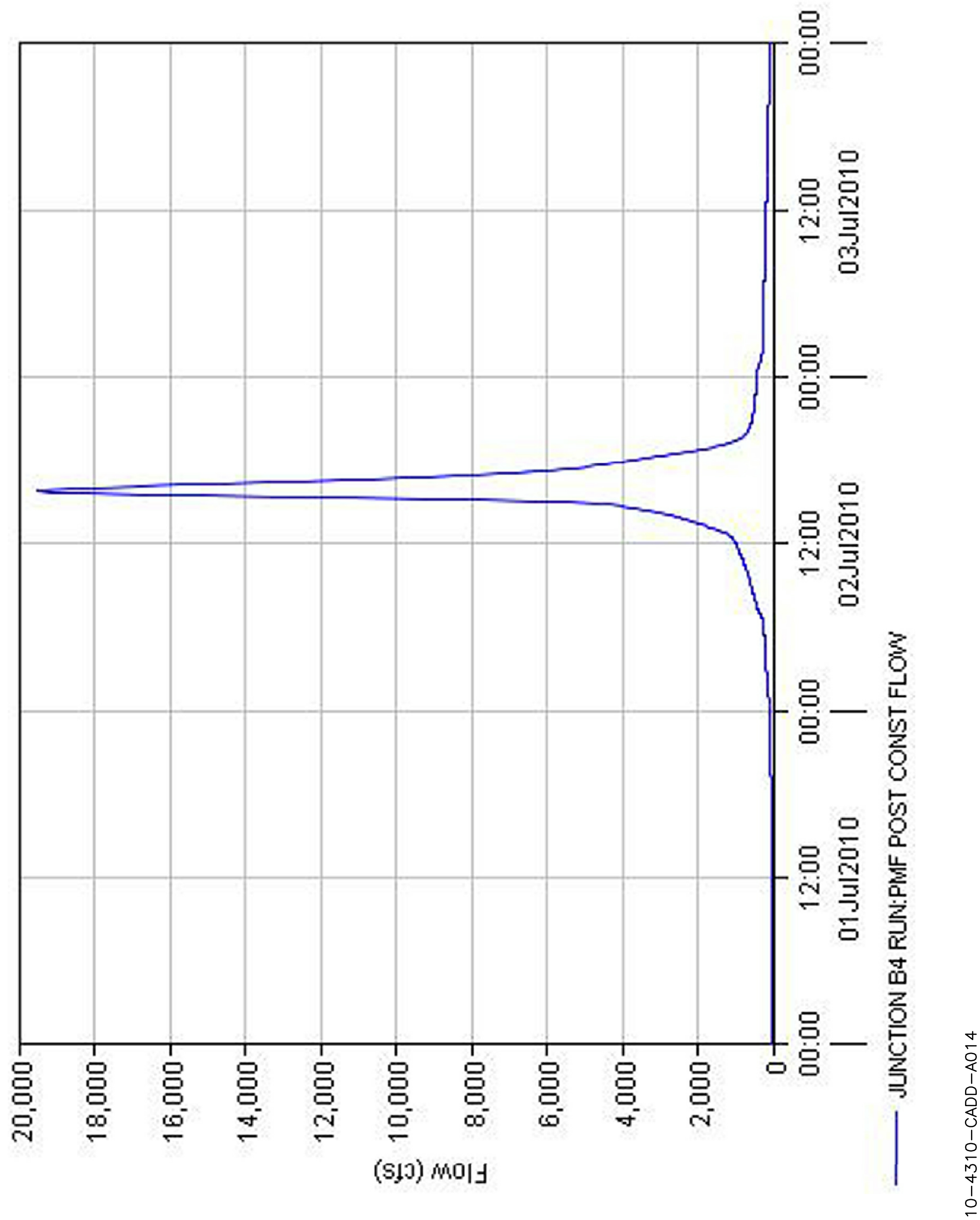


Figure 2.4-26— {Junction A-1 Hydrograph}

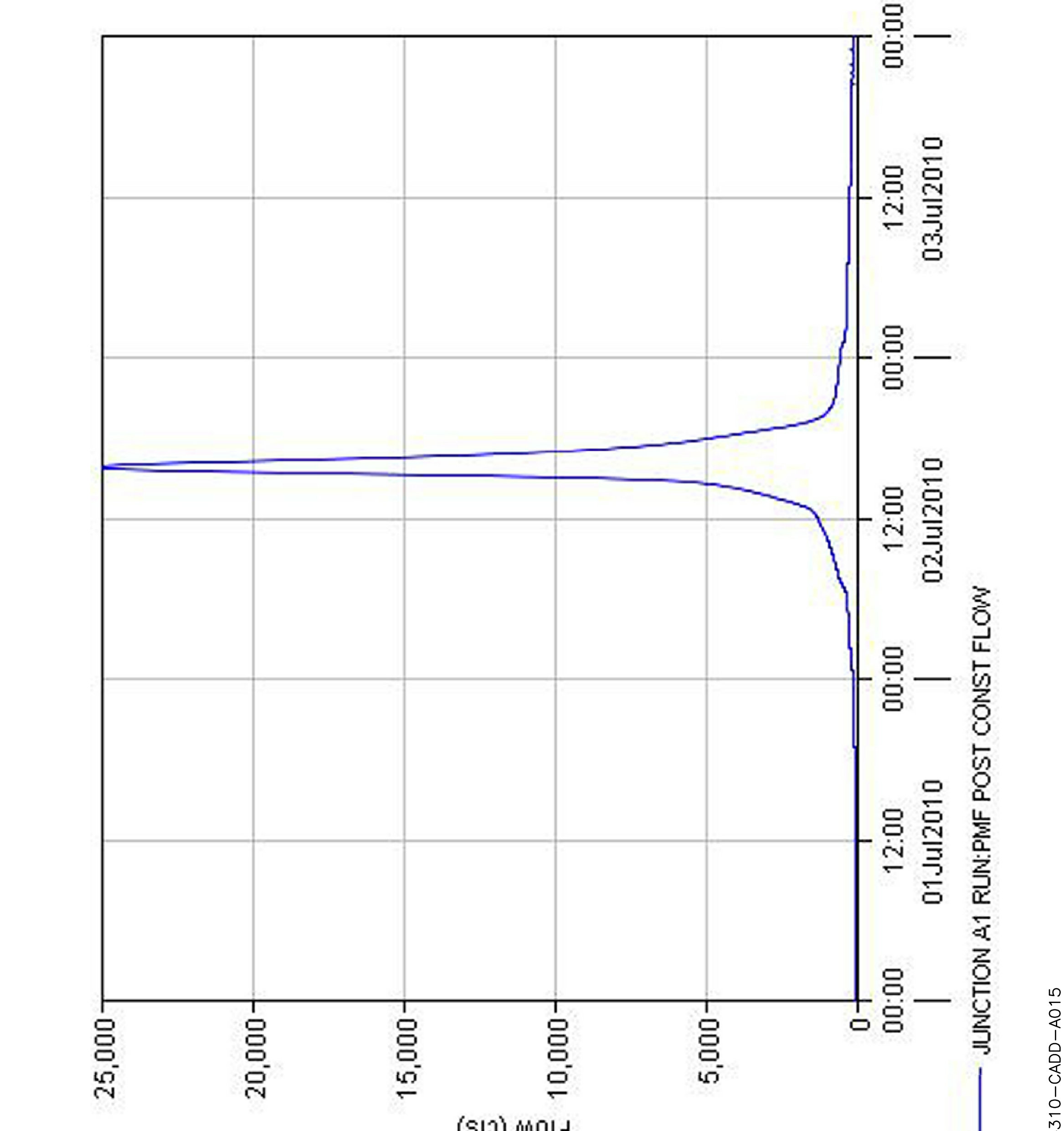


Figure 2.4-27— {Junction C-3 Hydrograph}

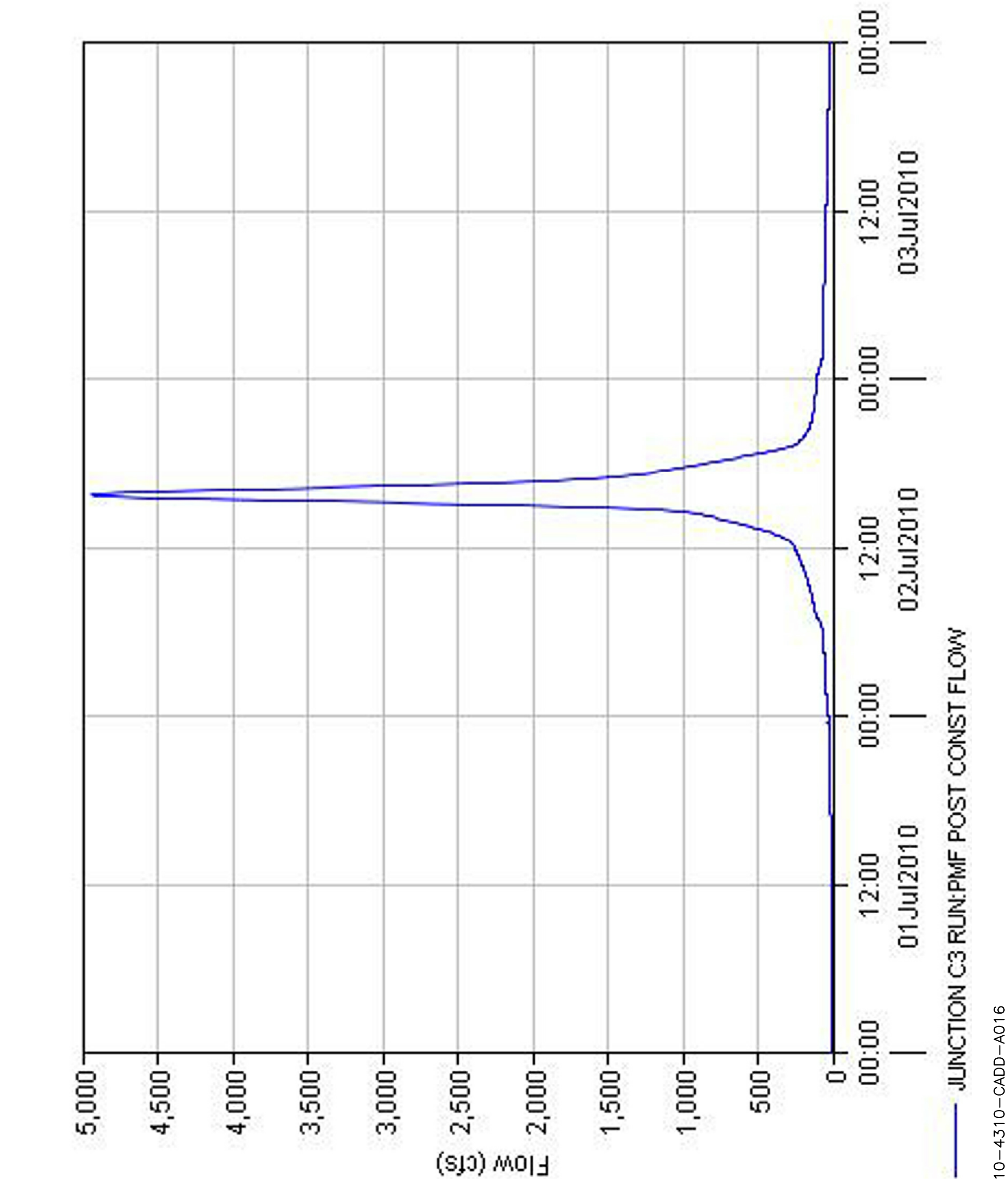


Figure 2.4-28— {SB3-3 Runoff Hydrograph}