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December 21, 2010

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

BELL BEND NUCLEAR POWER PLANT
BBNPP PLOT PLAN CHANGE COLA
SUPPLEMENT, PART 3 (ER); SECTION 2.6
BNP-2010-338 Docket No. 52-039

References: 1) BNP-2010-175, T. L. Harpster (PPL Bell Bend, LLC) to U.S. NRC, "July 2010 BBNPP Schedule Update", dated July 16, 2010

2) BNP-2010-246, R. R. Sgarro (PPL Bell Bend, LLC) to U.S. NRC, "BBNPP Plot Plan Change Supplement Schedule Update," dated September 28, 2010

In Reference 1, PPL Bell Bend, LLC (PPL) provided the NRC with schedule information related to the intended revision of the Bell Bend Nuclear Power Plant (BBNPP) footprint within the existing project boundary which has been characterized as the Plot Plan Change (PPC). As the NRC staff is aware, the plant footprint relocation will result in changes to the Combined License Application (COLA) and potentially to new and previously responded to Requests for Additional Information (RAIs). PPL declassified this docketed schedule information from regulatory commitment status in Reference 2, with an agreement to update the staff via weekly teleconferences as the project moves forward.

PPL has committed to provide the NRC with COLA supplements, consisting of revised COLA Sections and associated RAI responses/revisions, as they are developed. These COLA supplements will only include the changes related to that particular section of the COLA and will not include all conforming COLA changes. Conforming changes for each supplement necessary for other COLA sections will be integrated into the respective COLA supplements and provided in accordance with the schedule, unless the supplement has already been submitted. In the latter case, the COLA will be updated through the normal internal change process. The revised COLA supplements will also include all other approved changes since the submittal of Revision 2. All COLA supplements and other approved changes will ultimately be incorporated into the next full COLA revision.

The enclosure to this letter provides the revised BBNPP COLA Supplement, Part 3 (Environmental Report), Section 2.6, Revision 2b. The revised BBNPP COLA section supersedes previously submitted information in its entirety.

No open RAIs are associated with the enclosed COLA section. No previously submitted responses to RAIs are affected by the changes shown in the enclosed COLA section. No departures and/or exemptions from the U.S. EPR FSAR for this BBNPP COLA section have been created or revised as a result of the PPC. No new or revised RAI responses are included in this transmittal.

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NRO

The only new regulatory commitment is to include the revised COLA section (Enclosure 1) in the next COLA revision.

If you have any questions, please contact the undersigned at 570.802.8102.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on December 21, 2010

Respectfully,

Rocco R. Sgarro

RRS/kw

Enclosure: Revised BBNPP COLA Part 3 (ER); Section 2.6, Revision 2b cc: (w/o Enclosures)

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Enclosure

Revised BBNPP COLA Part 3 (ER); Section 2.6, Revision 2b

2.6 GEOLOGY

This section contains a brief description of the geologic conditions that are present at and in the vicinity of the BBNPP site. Groundwater and surface water are discussed in Section 2.3. The BBNPP Final Safety Analysis Report (FSAR) presents detailed geological, seismological and geotechnical site evaluations in FSAR Section 2.5.

2.6.1 Geologic Setting

The BBNPP site area lies within the Ridge and Valley Physiographic Province (Inners, 1978) as shown in Figure 2.6-1 ~~(Fenneman,~~(USGS, 2002).

The BBNPP site area is mostly blanketed by glacio fluvial deposits, and was subjected to both glacial and periglacial events during the Quaternary ~~period.~~ period, although the upland location of the site itself is primarily devoid of glacial sediments. The overburden at the site location is composed of residual soils that formed from weathering of the underlying Devonian shale bedrock, with only isolated patches of glacial till present in some places. However, at lower elevations, below the break in slope of this upland region (such as the location of the ESWEMS pond), the overburden transitions into all glaciofluvial sediment. Underneath this ~~glacio fluvial~~ glaciofluvial and residual soil overburden lies ~~middle~~Middle Devonian bedrock. Erosion and downcutting from the Susquehanna River, and its tributary streams, have dissected the overburden, leaving many isolated Middle Devonian Mahantango Shale outcrops throughout much of the site area. Topographic relief of the Ridge and Valley varies from about 440 to 2,775 ft (134 to 846 m) msl throughout the 50 mi (80 km) region, but the average elevation at the BBNPP site is approximately ~~660~~734 ft ~~(201~~(224 m). 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 approximately ~~2,342~~1,778 ft ~~(714~~(542 m) ~~(DeLorme,~~ (Figure 2.6-2 ~~2006).~~). The Susquehanna River elbows around the site area to the east and south and is approximately ~~7,000~~8,000 ft ~~(2,134~~(2438 m) from the site (at the closest ~~point).~~ point) (Figure 2.6-2). Its floodplain, on average, is about 0.75 mi (1.2 km) wide, with an average surface elevation of about 513 ft (156 ~~m) msl.~~ m). The nominal Susquehanna River level is 500 ft (152 m) ~~msl.~~(FEMA, 2008).

The area between the BBNPP site and the Susquehanna River is only slightly dissected by tributaries ~~due~~ due, in part, to the relatively thin layer of overburden. These tributaries include primarily an unnamed tributary south of the site and Walker Run, which traverses and drains the site, and has a gradient drop of almost 290 ft (88 m) within a distance of approximately 4 mi (6 km).

The BBNPP will be constructed at a grade elevation of approximately ~~674~~719 ft ~~(205 m) msl.~~ (219 m). The bearing layer over which the foundation of the plant will be placed is the Mahantango Formation, part of the Hamilton Group. This formation is characterized by dark gray, slightly fossiliferous, hard shale and was found to be at least ~~400~~420 ft ~~(122~~(128 m) thick based upon the BBNPP site geotechnical investigation (FSAR Section 2.5.4). A past report places the total thickness of the Mahantango Formation at approximately 1,500 ft (457 m) (Inners, 1978).

2.6.2 Stratigraphy

The sequence of overburden and lithified formations underlying the site area are shown on the site specific stratigraphic column ~~(Table 2.6-1).~~(Table 2.6-2). This column is based on data obtained from the Susquehanna Steam Electric Station (SSES) Units 1 and 2 FSAR borings

(SSES, 1975), the BBNPP FSAR borings in the site area, and on published literature. Sediments and rocks present at the site area range primarily from the Cambrian to Quaternary.

Superjacent the Precambrian metamorphic/igneous basement, the oldest inferred Cambrian formation underlying the site area is the Waynesboro Formation. The Waynesboro Formation consists of sandstone with interbedded red and green shales and has a thickness of approximately 1,000 ft (305 m) or more (Kauffman, 1999). Overlying the Waynesboro Formation is the Pleasant Hill Formation, which is primarily a limestone formation with interbedded sandy and silty layers throughout (Kauffman, 1999). Overlying the Pleasant Hill Formation is the Warrior Formation. ~~Defined~~ As defined by Kauffman (Kauffman, 1999), it is a dark, fossiliferous, fine grained limestone interbedded with silty dolomite with a thickness up to 1,340 ft (408 m). Overlying the Warrior Formation, and marking the Cambrian-Ordovician boundary, is the Gatesburg Formation. The Gatesburg consists of a series of sequential sandstone and dolomite units that are also fossiliferous (Ryder, 1992) with a thickness of approximately 1,211 ft (369 m) (Gold, 2003). Both the Warrior Formation and Gatesburg Formation likely represent a shallow-water carbonate bank or shelf that was subjected to periodic episodes of near-drying conditions (Kauffman, 1999).

Overlying the Gatesburg Formation are formations that comprise the Beekmantown Group. These Early Ordovician formations, from oldest to most recent, include the Stonehenge Formation, Nittany Dolomite, Axemann Limestone, and Bellefonte Dolomite. They are composed primarily of dolomite-limestone (Harper, ~~2004)~~2003) and reach a combined thickness of up to 4,200 ft (1,280 m) (Thompson, 1999). The Middle Ordovician age rock of the site area is best described as the Loysburg Formation. The Loysburg Formation is typically a dolomitic and stromatalite rich limestone underlying a coarse grained, fossiliferous limestone (Thompson, 1999) with a thickness of up to 475 ft (145 m). Overlying the Loysburg Formation, and representing the first unit (in ascending order) of the Upper Ordovician, is the Black River Group which mainly consists of Snyder and Linden Hall formations (Thompson, 1999) and attains a thickness of about 632 ft (193 m). These formations are composed primarily of siliciclastic clay and shale and ~~underlay~~underlie the fine-grained, black, limestone-shale with graded ~~limestone-shale~~bedding of the ~~Solona~~Salona and Coburn formations of the Trenton Group (Thompson, 1999). Rocks of the Beekmantown Group, Loysburg Formation, Black River Group, ~~Solona~~Salona Formation, and Coburn Formation were deposited in marine to marginal-marine environments ~~where~~on a ~~platform existed and the seas over top of this platform,~~ sub-marine carbonate platform. This submerged platform shallowed progressively ~~where~~ to the northwest causing depositional environments ~~became~~ to become more intertidal (Thompson, 1999). The upper most ~~units~~unit within the Trenton Group is the Antes Formation, a fossiliferous, generally black, shale (Thompson, 1999) that was likely deposited in shallow water, above the wave base. The Antes, Coburn, and Salona formations collectively attain a thickness of up to 850 ft (259 m).

Above the Trenton Group lies the Reedsville Formation. Overlying the Reedsville Formation are the Bald Eagle and Juniata formations (in ascending order). The Reedsville, Bald Eagle, and Juniata formations represent the uppermost units of the Upper Ordovician period. The Reedsville Formation, with a thickness of approximately 600-1800 ft (183-549 m) (Thompson, 1999) (Gold, 2003), is comprised mainly of interbedded shale and sandstone beds with some limestone (Thompson, 1999) and, like the Antes Formation underlying it, was likely deposited in shallow water. The Bald Eagle Formation and the Juniata Formation, which are 700 to 1,313 ft (213 to 400 m) and 600 to 1,125 ft (183 to 343 m) thick respectively (Gold, 2003) (Thompson, 1999), are both represented by nonfossiliferous sandstones, conglomerates, and mudstones but differ in color with the Bald Eagle Formation being gray and the Juniata Formation red

(Thompson, 1999). Unlike the Reedsville Formation, the Bald Eagle and Juniata formations are non-fossiliferous and non-marine, leading their depositional environment to likely be that of low sinuosity streams on alluvial fans (Thompson, 1999).

The Tuscarora Formation typically marks the boundary between Upper Ordovician and Silurian formations. The Lower Silurian Tuscarora Formation is quartzose, sublithic, and argillaceous sandstone with few shale beds throughout (Laughrey, 1999). The thickness of the Tuscarora Formation ranges between 400 ft (122 m) and 700 ft (213 m), is extremely resistant to erosional processes, and generally represents a fluvial depositional environment (Laughrey, 1999) (Gold, 2003). Overlying the Tuscarora Formation (in ascending order) are the Rose Hill, Keefer, Mifflintown, Bloomsburg, Wills Creek, Tonoloway, and Keyser formations.

Overlying the Tuscarora Formation (in ascending order) are the Rose Hill, Keefer, Mifflintown, Bloomsburg, Wills Creek, Tonoloway, and Keyser formations. The Rose Hill Formation is olive shale with interbedded layers of hematitic sandstone, purplish shale, and fossiliferous limestone (Laughrey, 1999). Above the Rose Hill Formation lies the Keefer Formation, a quartzose and hematitic sandstone with some mudstone. The Rose Hill and Keefer formations combine for a thickness that ranges between 670 ft (204 m) and 1,070 ft (326 m) (Gold, 2003). The Mifflintown Formation reaches a thickness of about 336 ft (103 m) (Gold, 2003) and is composed of mudrocks and limestone of a shallow marine setting (Laughrey, 1999). The likely depositional environment for the Rose Hill, Keefer, and Mifflintown formations is that of a submarine ramp that deepened from the proximal basin margin (Laughrey, 1999) during the Taconic Orogeny.

Conformably overlying the Mifflintown Formation is the Bloomsburg Formation, a grayish-red clay-siltstone with some interbedded fine to coarse grained sandstone that attains an average thickness of about 464 ft (142 m). The Bloomsburg Formation is very slightly fossiliferous and probably represents sediments deposited in deltaic waters with a high enough salinity to allow some fauna to exist (Laughrey, 1999). This formation also represents the end of the Lower Silurian strata within the site area. The Upper Silurian is represented by the Wills Creek, Tonoloway and Keyser formations. The Wills Creek Formation, conformably overlying the Bloomsburg Formation, is mostly a claystone to silty claystone with some argillaceous limestone and has an approximate thickness of 750 ft (229 m) (Inners, 1978). The Tonoloway Formation is primarily a thinly-bedded limestone with a few thin beds of calcareous shale (Laughrey, 1999) with a thickness of about 100 ft (30 m) (Inners, 1978). Both the Wills Creek and Tonoloway formations represent numerous shallowing-upward cycles that have been interpreted as repeated progradational events on very large tidal flats (Laughrey, 1999).

The Keyser Formation conformably overlies the Tonoloway Formation and is mainly a gray, fossiliferous limestone with some dark gray cherty nodules present toward the upper part of the formation. The Keyser Formation straddles the boundary between the Late Silurian and Early Devonian as the formation represents representing continuous carbonate sedimentation from both periods and has with a thickness of about 125 ft (38 m) (Inners, 1978).

The Devonian system of rocks is described by Harper (Harper, 1999) (1999) as a westward-thinning wedge of sediments with a thickness of almost 11,000 ft (3,353 m) through much of Pennsylvania, though considerably less at the BBNPP site (average approximately 2,150 ft (655 m)). The Upper Keyser Formation, about 125 ft (38 m) thick, makes up the basal unit for the Devonian period formations. Overlying the Keyser is the Old Port Formation which consists of (in ascending order) the Corriganville Limestone, the Mandata Shale, Shriver Chert, and Ridgeley Sandstone (Harper, 1999). The Corriganville Limestone, which consists of finely crystalline, thick to thinly bedded limestone, ranges from 10 ft (3 m) to 30 ft (9 m) thick (Harper, 1999). The Mandata Shale is dark gray to black, thinly bedded, siliceous, and ranges in thickness from 20 ft (6 m) to 100 ft (30 m) (Harper, 1999). Light colored cherty, mudstones and calcareous siltstones characterize the Shriver Chert (Harper, 1999), which ranges in thickness from 80 ft (24 m) to 170 ft (52 m). The Ridgeley Sandstone ranges in thickness from 8 ft (2 m) to 150 ft (46 m) and is generally white to light-gray, medium grained, quartzose sandstone (Harper, 1999). These units of the Old Port Formation represent the gradual deepening of the Appalachian basin and range in overall thickness within the site from 100 ft (30 m) to 150 ft (46 m) (Inners, 1978). Disconformably overlying the Old Port Formation is the Onondaga Formation which reaches a thickness of about 175 ft (53 m) (Inners, 1978). The Onondaga Formation consists of silty, shaley, and cherty limestones, in ascending order, and likely represents a shelf margin depositional environment (Harper, 1999).

The middle unit of the Middle Devonian rock system is the Marcellus Formation. The Marcellus Formation, the lower part of the Hamilton Group, consists of approximately 350 ft (107 m) (Inners, 1978) of dark-gray to black shales that are carbonaceous, containing pyrite and few fossils (Harper, 1999). The Marcellus Formation, likely deposited in a variety of shallow-water anoxic environments (Harper, 1999), underlies the Mahantango ~~Formation, which~~ Formation. The Mahantango Formation is the upper unit of the Hamilton Group and comprises the uppermost bedrock of the BBNPP site. Harper ~~(Harper, 1999)~~ (1999) describes the Mahantango Formation as "a complex series of interbedded shales, siltstones, and sandstones ranging from 1,200 ft (366 m) to 2,200 ft (671 m)" although Inners ~~(Inners, 1978)~~ (1978) reports a site specific thickness of approximately 1,500 ft (457 m). The shales and siltstones encountered during the BBNPP site investigation were typically dark gray, ranged in hardness from soft to moderately hard, increased progressively in the level of calcareous content with depth, and were slightly pyritic and fossiliferous throughout. Harper ~~(Harper, 1999)~~ (1999) suggests that the Mahantango Formation was deposited as a prograding marine shoreline during the early stages of the Catskill delta. While the Mahantango Formation is the uppermost bedrock of the site, younger formations that were deposited after the Mahantango exist near the site area. These formations comprise many of the outcrops and bedrocks of Lee Mountain, to the north of the site, and Nescopeck Mountain, to the south of the site. Because these formations are not present at the BBNPP site, they have not been included on Table 2.6-1. However, because these formations are present in the vicinity of the BBNPP site, they are described below.

Conformably overlying the Mahantango Formation, and marking the initial unit of the Upper Devonian within the site area, is the Harrell Formation. The Harrell Formation is typically represented by dark colored, organic-rich shales (Harper, 1999) which reach about 120 ft (37 m) in thickness (Inners, 1978). The Trimmers Rock Formation, referred to as the Brallier Formation by Harper (1999), is primarily medium to dark gray, thinly bedded siltstones with some fine grained sandstones and few layers of subfissle shale (Inners, 1978) (Harper, 1999). The Trimmers Rock Formation has a calculated thickness of approximately 3,000 ft (914 m) (Inners, 1978) and likely represents a delta fed submarine slope of the Appalachian Basin. Above the Trimmers Rock Formation, within the site area, lie the members of the Catskill Formation including (in ascending order) the Irish Valley, Sherman Creek, and Duncannon members. Each member of the Catskill Formation ranges in thickness from 150 ft (46 m) to 3,700 ft (1,128 m) and generally consists of gray to red mudstones, claystones, siltstones, and conglomerates that were deposited in mixed continental, fluvial-deltaic, and marginal-marine environments (Harper, 1999). The uppermost unit of Devonian age rocks in the site area is the Spechty Kopf Formation, which also spans into, and identifies the beginning of the Carboniferous Period. The Spechty Kopf Formation has a thickness of about 575 ft (175 m) (Inners, 1978) and is comprised mainly of medium gray to olive sandstone with other components including siltstone, shale, and conglomerates (Berg, 1999). The likely depositional environment of the Spechty Kopf Formation was that of ephemeral lakes formed on the surface of the Catskill alluvial plain (Berg, 1999).

Carboniferous formations in the United States are ~~commonly~~ broken down into the Mississippian Epoch and the Pennsylvanian Epoch. While Mississippian rocks of the site area represent a transition from the prograding deltas of the Late Devonian (Brezinski, 1999), Pennsylvanian rocks primarily represent the sedimentation within an elongate basin aligned in a northeast to southwest direction (Edmunds, 1999).

The Mississippian Period is marked by the presence of the Spechty Kopf Formation. Unconformably overlying the Spechty Kopf Formation is the Pocono Formation, which was likely deposited on a high-gradient alluvial plain or alluvial ~~fan,~~ fan. The Pocono Formation is represented by the ~~non-red~~ beds of medium to coarse grained sandstone, siltstone, and conglomerates (Brezinski, 1999) with a thickness of about 600 to 650 ft (183 to 198 m) (Inners, 1978). Overlying the Pocono Formation, within the 5 mi (8 km) site area radius, is the Mauch Chunk Formation, easily recognizable by it's red to reddish-brown mudstone and siltstone with reddish-brown and greenish-gray sandstones and conglomerates (Brezinski, 1999). The Mauch Chunk Formation ranges in thickness throughout the site area but has been estimated to be between 3,000 ft (914 m) and 4,000 ft (1,219 m) (Brezinski, 1999). The depositional environment of the Mauch Chunk Formation was likely that of a broad alluvial plain in which sediments came from two distinct sources. The first source was red clastics, likely derived from the taconic highlands, and the second was the non-red, quartz sand from the erosion of the previously deposited sandstones (Brezinski, 1999).

The Mississippian-Pennsylvanian boundary in the site area is generally the top of the Mauch Chunk Formation and bottom of the Pottsville Formation. The Pennsylvanian Pottsville Formation overlies the Mauch Chunk Formation conformably and ranges in thickness from 100 ft (30 m) to 1,600 ft (488 m) (Edmunds, 1999). The Pottsville Formation consists mainly of a cobble and pebble conglomerate with some sandstones and finer clastics and coal (Edmunds, 1999). The youngest rock formation within a 5 mi (8 km) radius of the site area and overlying the Pottsville Formation is the Llewellyn Formation. The Llewellyn Formation reaches a thickness of approximately 3,500 ft (1,067 m) and generally consists of subgraywacke clastics, ranging from conglomerates to clay shale and containing numerous coal beds (Edmunds, 1999). The Llewellyn Formation forms the uppermost geologic unit within the 5 mile radius of the site, appearing at the peak of Lee Mountain near the town of the Shickshinny.

Quaternary deposits of the site area are primarily the result of glacial deposits from at least three known glacial events that are believed to have impacted the site area. Of these three events, Quaternary deposits from two of them comprise the majority of the soil overburdens present within the site area. The earliest deposit is of Late Illinoian age and can be stratigraphically correlated to that of the Titusville Till in Northwestern Pennsylvania. The Titusville Till is described as a thin, gray to brown and grayish-red clay and sand (Sevon, 2000). This was almost entirely eroded away during the next period of glaciation through the site, the Wisconsinan (Crowl, 1999). The resulting glacial deposits from the Wisconsinan event is known as Olean Till, which is described as moderately thick, gray to grayish-red sandy till (Sevon, 2000).

In addition to glacial till, the site area has also been impacted by stratified drift. Stratified drift, as defined by Sevon ~~(2000)~~(2000), is sand and gravel in eskers, kame terraces, and outwash. Stratified drift has been impacting the site area since the Late Illinoian (Sevon, 2000), during glacial melts/retreats, and continues to deposit along the banks of the Susquehanna River from upstream (Inners, 1978).

The soil overburden present beneath the location of the safety related structures located on top of a hill is, however, mostly not comprised of glacially derived sediment. Current investigations found that glacial outwash and glacial till deposits are constricted to the location of the Essential Service Water Emergency Makeup System (ESWEMS), below the break in slope of the hill. Above the break in the slope, glacial deposits are sparse with the majority of the overburden described as residual soil. The thickness of what could be associated with till deposits is no more than 3 ft (0.9 m). The overburden soils on this hill are composed of mostly residual silty to clayey sand to poorly graded sand with gravel and poorly graded gravel or silty to clayey gravel with sand. This soil was formed from weathering and decomposition of the Mahantango Shale. The superficial deposits in the site were disturbed for agricultural purposes and the surface was cleared of the very sparse glacial erratics, which were plowed and then used to build the stone walls found in the site. The result of glacial erosion above the break in the slope is found to have only partially removed the top of the weathered bedrock. Below the soil is a zone of soft weathered rock typically followed by harder, competent shale that is very fractured. Due to the abundance of fracturing in this zone, these incompetent rock layers are also unsuitable for founding of safety related structures.

2.6.3 Geologic Hazard Evaluation

Potential geologic hazards of interest to the site area (within 5-mi (8-km) radius) include rock dissolution features (caves and karst features), landslides, abandoned underground mine cavities, active tectonic zones, and volcanism.

There are no caves or recognized karst features in the site area, and none were discovered during the investigations for BBNPP and SSES. Small- to medium-scale dissolution features occur in the site area where carbonate bedrock formations occur. Formations containing carbonate beds in the area include the Wills Creek, Tonoloway, Keyser, Old Port, and Onondaga formations of Silurian and Lower Devonian strata. These formations are at least 1,600 ft (488 m) below ground surface (bgs) at the BBNPP site and have not been penetrated by any borings at the site. These formations crop out or are located closer to the ground surface approximately 3 to 8 miles (5 to 13 km) southwest of BBNPP. Water wells in the Berwick area (southwest of BBNPP) are screened in the limestone formations and obtain ground water from dissolution features located along joints, fractures, and bedding planes (Inners, 1978). Data from Williams (1987) shows that wells screened at more shallow depths produce much more water than those drilled to great depths at the same location. This example supports the general belief that fractures, dissolution features, and secondary permeability of the rock decreases with depth because the confining pressure within the rock increases with depth and causes the fractures to be closed. This is discussed in greater detail in the FSAR. Because the carbonate formations are located at least 1,600 ft (488 m) bgs, the frequency and magnitude of fracturing and dissolution features should be minimal.

Inventories of caves and karst features in Pennsylvania show no caves or karst to be present in Luzerne or Columbia counties; all significant caves and karst features are located in southeast, central, and southwestern Pennsylvania. The nearest significant cave is Crystal Cave near Kutztown, Pennsylvania, located approximately 46 mi (74 km) from BBNPP. Furthermore, major springs, defined as having flow rates of 100 gallons per minute (gpm) (379 liters per minute (lpm)) or more, can be an indicator of carbonate formations and karst features. An inventory of major springs in the Ridge and Valley Province of Pennsylvania by the USGS (Saad, 1990) identified only one major spring in Luzerne or Columbia counties; this spring discharges from the Mauch Chunk Formation, approximately 10 miles (16 km) southeast of BBNPP (Saad, 1990). The Mauch Chunk Formation, which does not underlie the BBNPP site, consists of clastic sedimentary rocks ranging from claystone to conglomeratic sandstones with no carbonate strata. In summary, based on the absence of limestone dissolution features and major springs in the 0.6-mile (1 km) site radius, and the depth of 1,600 ft (488 m) to limestone, karst is not considered a geologic hazard at the BBNPP site.

Because there are steep slopes and high topographic relief present in this portion of the Ridge and Valley Physiographic Province, landslides and other mass movements (e.g., soil slumping) can occur. Approximately 7.5 miles (12 km) north-northeast of the BBNPP site, is the location of one of the largest landslides in Pennsylvania. Approximately 4,000 years ago (Ka), a rock block landslide on the south side of Shickshinny Mountain caused 20,260,000-27,450,000 yd^3 (15,490,000-20,987,000 m^3) of rock to move 1,250 ft (381 m) onto the Susquehanna River floodplain and partially diverted the Susquehanna River (Inners, 1988). Another much smaller landslide located 2 miles (3.2 km) northeast of the first (9.5 miles (15.3 km) northeast of BBNPP), was witnessed in 1947 in which rainfall, that deposited 6 inches of rain within 2 hours, likely caused approximately 122,000 yd^3 (93,277 m^3) to move downslope within a minute or two (Inners, 1988). Including the aforementioned landslides, thirteen rock block slides have been mapped between West Nanticoke, PA and Shickshinny, PA (a distance of approximately 9 miles (14.5 km)) along the south side of Shickshinny Mountain, with a total volume of about 56,000,000 yd^3 (42,815,000 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 (Inners, 1988). These landslides, particularly the larger ones, are attributed to a longer 'wet' season and/or multiple year high moisture conditions (Inners, 1988). All of these rockslides occurred at least 7.5 miles (12 km) upstream along the banks of the Susquehanna River. No landslides (historic or pre-historic) of this proportion have been recognized or mapped in the BBNPP site area.

Underground coal mining has occurred in the Pennsylvania anthracite fields since the early 1800s. Hundreds of miles of underground workings are located in four different anthracite basins. While underground mining is currently very limited, the abandoned workings still result in mine subsidence immediately over the mine workings. However, the nearest portion of an anthracite basin is located about four miles (6.4 km) to the north of the BBNPP. Furthermore, all coal-bearing formations within the site area have been eroded long ago, making coal mining and mine subsidence inconsequential to the construction or operations of the BBNPP.

The last major tectonic events that generated large-scale earthquakes, faults, and deformation along the eastern coast of the United States occurred in the Mesozoic Era (Triassic and Jurassic, approximately 250 Ma). Active deformation processes, and seismic activity within the site region, have been minimal since the Mesozoic Era. The most significant seismic activity in the Eastern US has taken place in the Charlevoix Seismic Zone in Canada and the Charleston Seismic Zone in South Carolina, both outside of the site region. Thus, active deformation and seismic activity are not a source of significant geologic hazard at BBNPP.

Volcanism has also not occurred in the eastern United States since the Mesozoic Era, and volcanic activity during the past 2,000 years has only occurred in the Western United States. The area of greatest volcanic activity is associated with the Cascade Range in the states of

Washington, Oregon and California. The last eruption was Mount St. Helens in 1980. This is over 2,500 mi (4,023 km) away from the BBNPP site. Therefore, volcanism and related hazards are not a geologic hazard at the BBNPP site or vicinity.

Based on the discussion above, there are no geologic hazards that represent a risk to the construction or operation of the BBNPP.

2.6.4 Geologic Impact Evaluation

Based on the SSES site and vicinity geologic conditions described in the previous subsection, ~~long-termand~~ long-term and short-term adverse impacts on the geology are not anticipated as a result of construction or operation of the BBNPP site.

This conclusion is reached based upon evaluating several considerations including the following

Long-Term Impacts

- The drilling and geophysical investigation show no indication of capable faults (as discussed in FSAR Sections 2.5.1 and 2.5.3) at the BBNPP site, eliminating the possibility for a surface fault rupture as a result of construction or operation of the proposed facility.
- Surface settlement (as a result of facility construction) could affect the drainage of surface water. However, should such settlement occur, it will likely take place during construction and can be mitigated by re-grading the BBNPP site area.
- ~~Although there~~The facility is located in a ~~natural slope in proximity to the proposed facility, it is not steep enough to be adversely impacted by: foundation~~naturally sloped area with maximum slopes of 10°. Static and dynamic conditions have been considered to model slopes during excavation, ~~loading resulting from construction~~ construction and backfill operations. These models considered the natural slopes of the ~~proposed structures, or infiltration~~ surrounding areas, as well as the properties and characteristics of ~~precipitation as a result of surface modifications.~~ the excavated and backfilling materials. The excavated materials included the overburden and the bedrock. Resulting details for temporary and permanent slopes for planned excavation and backfill operation are described in FSAR Section 2.5.5.
- Any potentially negative impacts that could result from the placement of fill in the proposed plant area will be mitigated by the earthwork design.

Short-Term Impacts

- Some short-term geologic impacts could occur during construction. These impacts could be a result of excavation, or temporary dewatering.
- Disposal of excavated material will likely be required onsite. Generally accepted methods will be used to mitigate the potential for erosion of this material at the disposal site. Such methods may include the use of silt fences, seeding, and drainage control. Excavated soil surfaces exposed during construction will be protected to mitigate their erosion and control surface runoff.

- Temporary dewatering of foundation excavations could result in an impact on water levels in the water table aquifer. However, these impacts are not expected to be significant.

2.6.5 References

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Table 2.6-1 — Site Specific Stratigraphic Column

Era*	Period*	Epoch (1)	Age (Ma) (2)	Unit	Thickness (ft)
Cenozoic	Quaternary	Holocene	0.01	Stratified Drift	38.5
		Pleistocene	1.8		
Paleozoic	Devonian	Middle	370	Mahantango Formation	1,500
				Marcellus Formation	350
				Onondaga Formation	175
		Lower	391	Old Port Formation	100-150
	Silurian	Upper	417	Keyser Formation	125
				Tonoloway Formation	100
				Wills Creek Formation	750
		Lower	423	Bloomsburg Formation	464
				Mifflintown Formation	336
				Keefer Formation	670-1,070
				Rose Hill Formation	
				Tuscarora Formation	400-700
	Ordovician	Upper	443	Juniata Formation	600-1,125
				Bald Eagle Formation	700-1,313
				Reedsville Formation	600-1,800
		Middle	458	Trenton Group	842
				Antes Shale	
				Coburn Limestone	
				Salona Limestone	
				Black River Group	632
				Loysburg Formation	263-475
		Lower	470	Beekmantown Group	3,159-4,200
				Bellefonte Dolomite	
				Axemann Limestone	
				Nittany Dolomite	
				Stonehenge Formation	
	Cambrian	Upper	490	Gatesburg Formation	1,211
		Middle	510	Warrior Formation	400-1,340
				Pleasant Hill Formation	Not Reported
		Lower	520	Waynesboro Formation	1,000+
Neo-Proterozoic	Ediacaran	-	543	Metamorphic/Igneous	-

Notes:
(1) USGS Geologic Time Scale
(2) Ma = Million years ago.
References: (Crangle, 2002) (Gold, 2003) (Inners, 1978) (Kauffman, 1999) (Laughrey, 1999) (McElroy, 2007) (Thompson, 1999)

Table 2.6-2— Site Specific Stratigraphic Column

Era	Period	Epoch [1]	Age (Ma) [2]	Unit		Thickness (ft)
Cenozoic	Quaternary	Holocene	0.01	**Stratified Drift**		38.5
		Pleistocene	1.8			
Paleozoic	Devonian	Upper	360	**Harrel Formation**		150
		Middle	370	Hamilton Group	**Mahantango Formation**	1,500
					Marcellus Formation	350
				Onondaga Formation		175
		Lower	391	**Old Port Formation**		100-150
	Silurian	Upper	417	**Keyser Formation**		125
				Tonoloway Formation		100
				Wills Creek Formation		750
		Lower	423	**Bloomsburg Formation**		464
				Mifflintown Formation		336
				Keefer Formation		670-1,070
				Rose Hill Formation		
				Tuscarora Formation		400-700
	Ordovician	Upper	443	**Juniata Formation**		600-1,125
				Bald Eagle Formation		700-1,313
				Reedsville Formation		600-1,800
		Middle	458	**Trenton Group** Antes Shale Coburn Limestone Salona Limestone		842
				Black River Group		632
				Loysburg Formation		263-475
		Lower	470	**Beekmantown Group** Bellefonte Dolomite Axemann Limestone Nittany Dolomite Stonehenge Formation		3,159-4,200
	Cambrian	Upper	490	**Gatesburg Formation**		1,211
		Middle	510	**Warrior Formation**		400-1,340
				Pleasant Hill Formation		Not Reported
		Lower	520	**Waynesboro Formation**		1,000+
Neo-Proterozoic	Ediacaran	-	543	Metamorphic/Igneous		-

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- -Crangle, 2002
- -Gold, 2003
- -Inners, 1978
- -Kauffman, 1999
- -Laughrey, 1999
- -McElroy, 2007
- -Thompson, 1999
- -SSES, 1975

(1) USGS Geologic Time Scale
(2) Million years ago.

Figure 2.6-1— ~~Map of Regional Physiographic Provinces~~Physiographic Provinces Within the Site Region 200 Mile (322 km) Radius

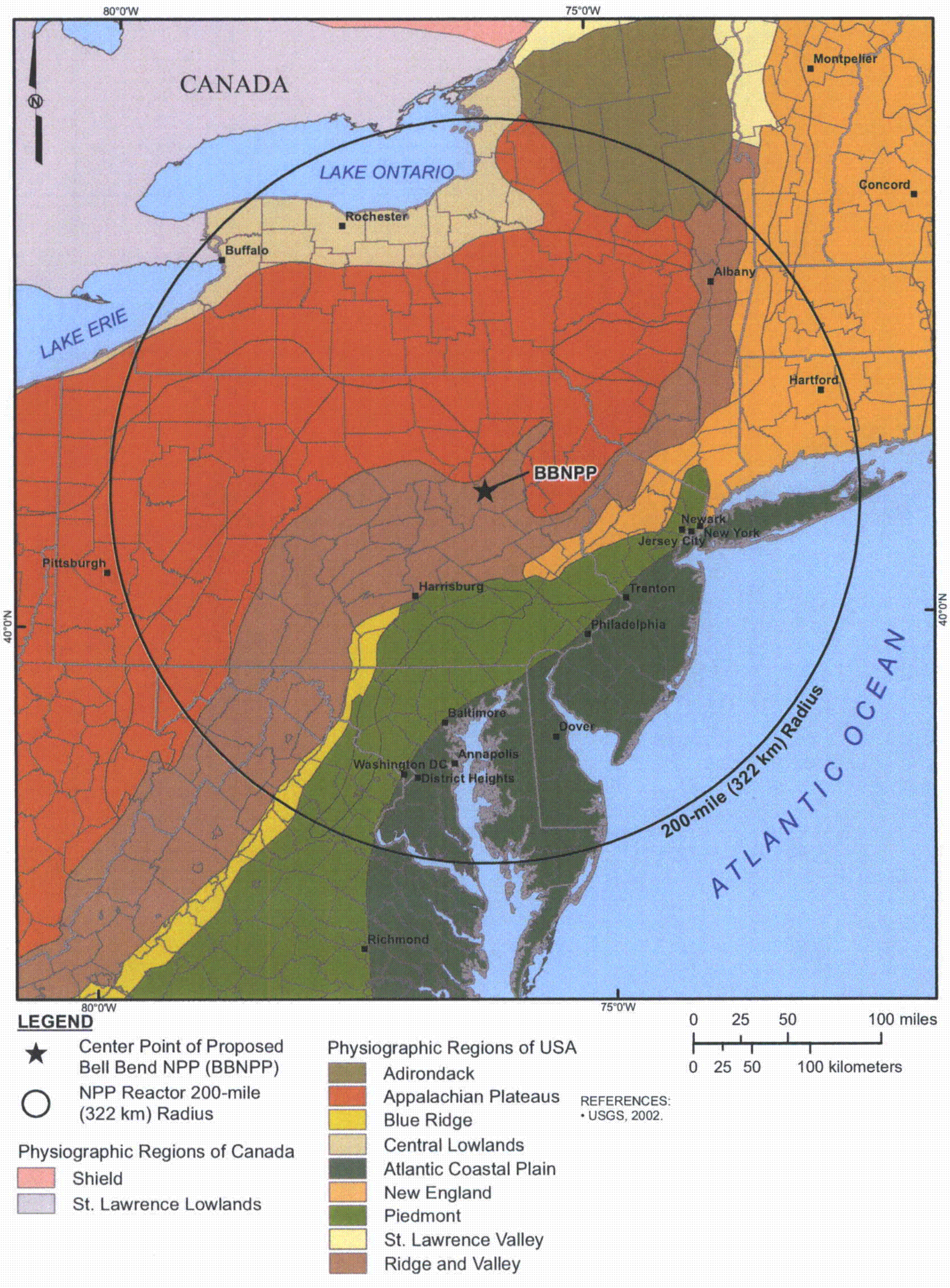
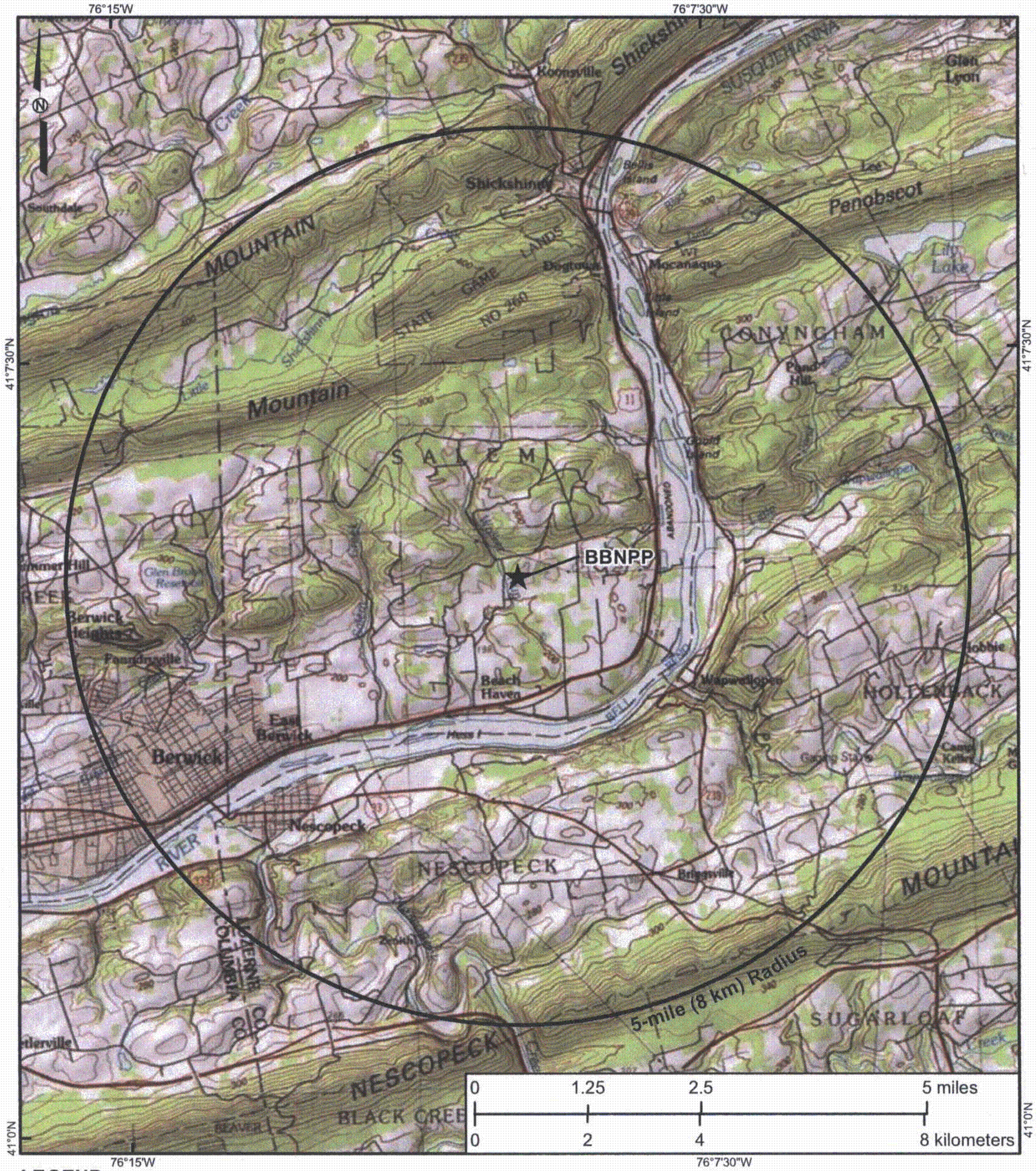


Figure 2.6-2— Site Area Topographic Map 5 Mile (8 km) Radius



LEGEND

★ Center Point of Proposed Bell Bend NPP (BBNPP)

○ NPP Reactor 5-mile (8 km) Radius

REFERENCE:
• NGS, 2009.