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2.6 GEOLOGY

This section contains a brief description of the geologic conditions that are present at and in the vicinity of the {Calvert Cliffs Nuclear Power Plant (CCNPP) site}. Groundwater and surface water are discussed in Section 2.3. The {CCNPP Unit 3} Final Safety Analysis Report (FSAR) presents detailed geological, seismological and geotechnical site evaluations in FSAR Section 2.5.

2.6.1 GEOLOGIC SETTING

{The CCNPP site is located in the Coastal Plain Physiographic Province as shown in Figure 2.6-1 (USGS, 1946). The CCNPP site and vicinity topography consists of gently rolling hills with elevations ranging from about sea level to nearly 130 ft (40 m) msl. The CCNPP site is well drained by short, ephemeral streams that form a principally dendritic drainage pattern. The longest stream nearest the CCNPP site is John's Creek, which is approximately 3.5 mi (5.6 km) long and drains into St. Leonard Creek. The ephemeral streams on the CCNPP site are either tributaries to John's Creek or flow directly to Chesapeake Bay.

The Chesapeake Bay shoreline forms the eastern boundary of the CCNPP site and generally consists of steep cliffs with narrow beaches at their base. The cliffs reach an elevation of about 100 ft (30 m) msl along the eastern portion of the CCNPP site's shoreline. Observations indicate that the exposed cliff face erodes along near vertical, irregular surfaces. The erosion is primarily caused by the undercutting action of waves along the base of the cliffs. Shoreline processes and slope failure along Chesapeake Bay are discussed in FSAR Section 2.4.9. Approximately 2,500 ft (762 m) of the shoreline east of the CCNPP site, extending from the existing CCNPP Units 1 and 2 intake southward to the existing barge jetty, is stabilized against shoreline erosion.

CCNPP Unit 3 will be constructed at a grade elevation of approximately 85 ft (26 m) msl and will be set back approximately 900 ft (274 m) from the Chesapeake Bay shoreline. The bearing layer on which structural fill will be placed to form the foundation for the plant structures is in the Chesapeake Group Choptank formation. The Chesapeake Group is considered to be a confining unit with respect to groundwater conditions (MGS, 1997).}

2.6.2 STRATIGRAPHY

{The CCNPP site is located on Coastal Plain sediments ranging in age from Lower Cretaceous to Recent, which, in turn, rest on a pre-Cretaceous basement. The basement rock beneath the site likely consists of rocks similar to those found west of the CCNPP site in the Piedmont Physiographic Province (MGS, 1986). The Piedmont rocks range in age from Precambrian to Paleozoic. Figure 2.6-3 is a generalized stratigraphic column showing the geologic formations present beneath the CCNPP site and vicinity (Ward, 2004) (MGS, 1997).

The coastal plain sediments form a wedge which thickens from 0 ft (0 m) at its contact with the Piedmont Province southeastward to approximately 8,000 ft (2,438 m) along the Maryland coast. The surficial sediments (alluvium and beach deposits, terrace and lowland deposits, and upland deposits) at the CCNPP site consist of Quaternary alluvium in stream valleys and Tertiary Upland deposits consisting of sands and gravels above an elevation of 100 ft (30 m) msl as shown in Figure 2.6-3 (MGS, 2003) (SDC, 2006). Underlying the Upland deposits is the sand-clay sequence of the Chesapeake Group, consisting of the St. Mary's, Choptank and Calvert formations in descending order. The St. Mary's and Choptank formations are exposed in the cliffs along Chesapeake Bay east of the CCNPP site. They, along with the underlying Calvert formation, have a combined thickness of approximately 245 to 280 ft (75 to 85 m).

The base of the Chesapeake Group is marked by the top of the Piney Point Formation, which is about 20 ft (6 m) thick and is recognized by a distinctive, natural-gamma signature on borehole geophysical logs. The Piney Point together with the upper sandy section of the underlying Nanjemoy formation comprises the Piney Point-Nanjemoy aquifer. The Nanjemoy formation is approximately 180 ft (55 m) thick beneath the CCNPP site.

The Nanjemoy formation is underlain by the Marlboro clay; a thin (approximately 15 to 20 ft (4.6 to 6 m)), maroon clay overlying the Aquia formation, a major aquifer in the area. The Aquia formation is approximately 150 ft (46 m) thick beneath the CCNPP site

The lowermost Tertiary strata beneath the site is the Brightseat formation; a sandy, glauconitic clay approximately 10 to 20 ft (3 to 6 m) thick, and unconformably overlies the Cretaceous strata.

The Upper Cretaceous Magothy-Mattawan-Monmouth formations uncomformably underlie the Brightseat formation. These units are very thin beneath the site (possibly 30? ft (9? m)). Geologists use a question mark (?) as a standard symbol to explicitly identify uncertainty. The usage of a question mark or query, herein (in the ER) is consistent with usage by the cited documents. This usage is common for both U.S. Geologic Survey publications and Maryland Geologic Survey publications. Further to the north in Queen Anne County, the Magothy is an aquifer. Below the Magothy are the sands and clays of the Cretaceous Potomac Group. Uppermost in this group is the Patapsco formation, a sequence of gray, brown, and red variegated silts and clays interbedded with lenticular, cross-bedded clayey sands and minor gravels. A major aquifer near the Baltimore area, the Patapsco, is largely undeveloped in the vicinity of the CCNPP site. The Patapsco formation is described as being 1,000 to 1,100 ft (305 to 335 m) thick (MGS, 1997).

Underlying the Patapsco are the Lower Cretaceous Arundel/Patuxent formations (undivided). These two units are difficult to separate in the subsurface in the CCNPP site area because of the similarity of the clays in the two formations. This was described (MGS, 1984) by the upper portion of the (undivided) Arundel/Patuxent formations as variegated, silty clay with thin, very fine sand and silt interbeds that may be as thick as 150 to 200 ft (46 to 61 m) beneath the CCNPP site. The Arundel formation is not recognized in Southern Maryland (MGS, 1984). The Patuxent formation consists of a sequence of variegated sands and clays which form a major aquifer near Baltimore, but which have not been developed in the vicinity of the CCNPP site. The thickness of the Patuxent formation beneath the CCNPP site is estimated as 600 to 700 ft (183 to 213 m).

Underlying the Arundel/Patuxent formations is the basement rock. It has been indicated (MGS, 1986) that most of the borings that penetrate coastal plain sediments and extend to the underlying basement have encountered metamorphic or igneous rocks. Sparse geophysical and borehole data indicate that the basement likely consists of exotic crystalline magmatic arc material (MGS, 1986). The thickness of this unit is not known.}

2.6.3 GEOLOGIC IMPACT EVALUATION

{Based on the CCNPP site and vicinity geologic conditions described in the previous subsection, long-term adverse impacts on the geology are not anticipated as a result of construction or operation of CCNPP Unit 3. For example:

- The absence of capable faults (as discussed in FSAR Sections 2.5.1.2 and 2.5.3) at the CCNPP site eliminates 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 CCNPP Unit 3 area.
- The geologic units are not subjected to dissolution and permanent dewatering is not needed.
- There are no natural slopes in proximity to the proposed facility that could be adversely impacted by: foundation excavation, loading resulting from construction of the proposed structures, or infiltration of precipitation as a result of surface modifications.
- Any potentially negative impacts that could result from the placement of fill in the proposed plant area will be mitigated by the earthwork design.
- 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 either onsite or offsite. 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.}

2.6.4 REFERENCES

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USGS, 1946. Physical Divisions of the United States, U. S. Geological Survey, 1:7,000,000-scale map, N. M. Fenneman and D. W. Johnson, 1946.

Ward, 2004. Tertiary Lithology and Paleontology, Chesapeake Bay Region, Geology of the National Capital Region, Field Trip Guide Book, Chapter 9, 2004.}

Figure 2.6-1—{Map of Regional Physiographic Provinces}

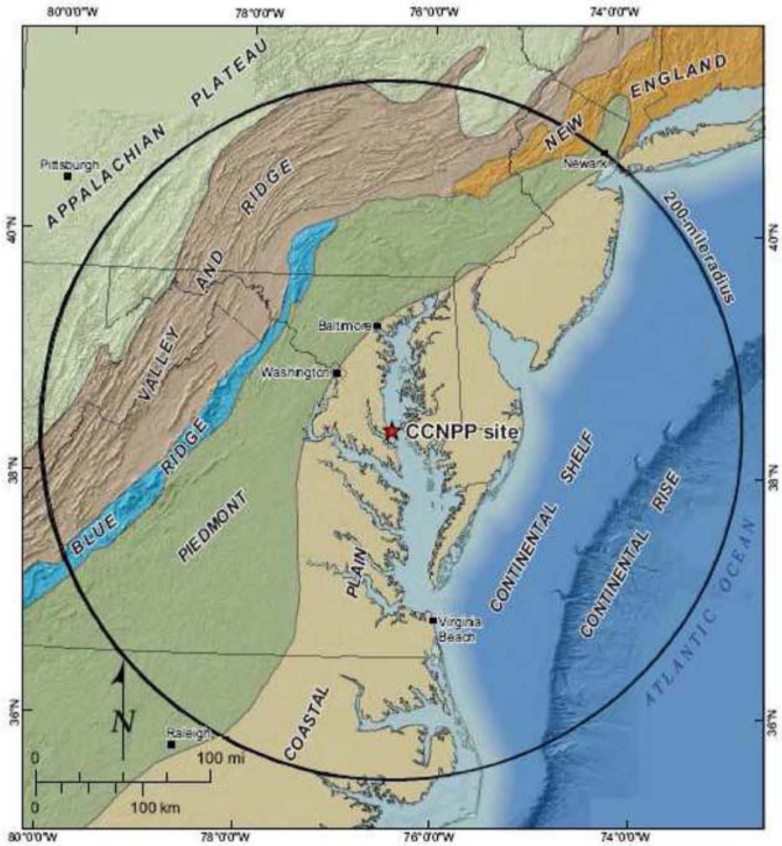
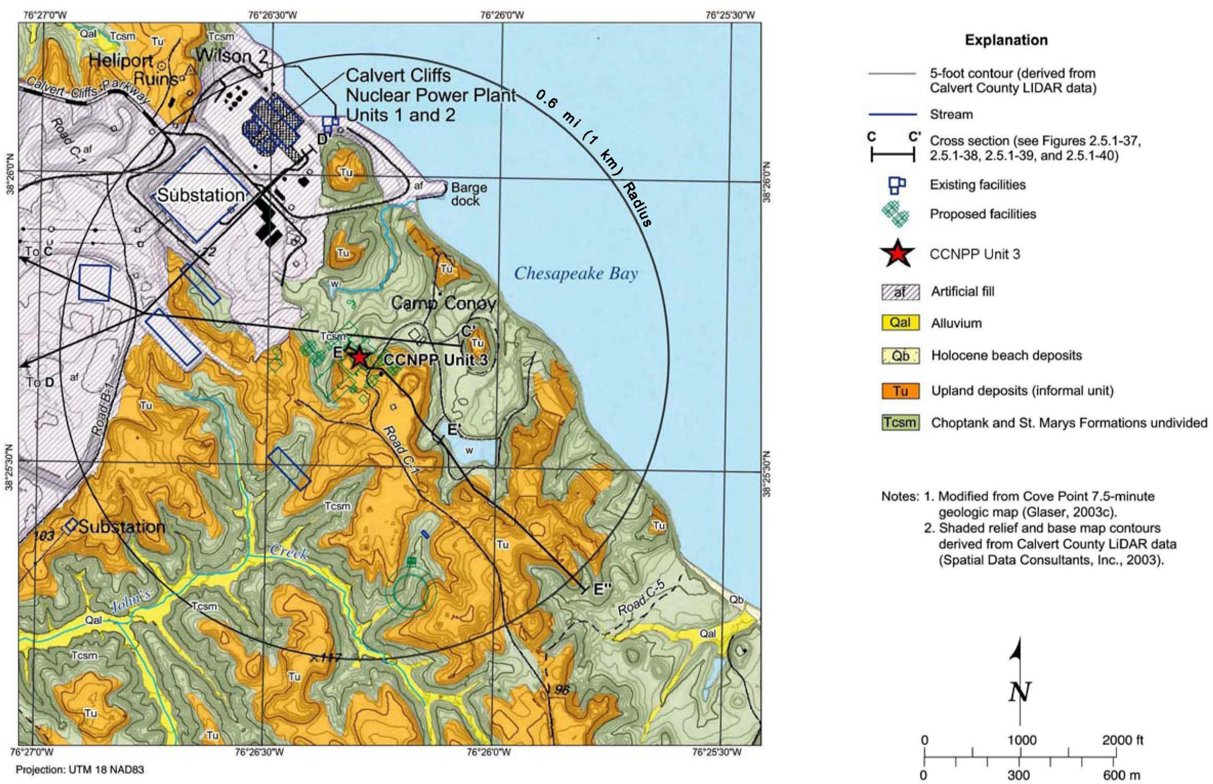


Figure 2.6-2—{CCNPP Site-Specific Stratigraphic Column}

ERA	PERIOD	EPOCH		AGE (Ma)	UNIT	THICKNESS (FT)
Cenozoic	Quarter-nary	Holocene		0.01	Alluvium & Beach Deposits	0-50
		Pleistocene		1.8	Terrace & Lowland Deposits	
	Tertiary	Pliocene		5.3	Upland Deposits	0-50
		Miocene	Upper	11.2		
			Middle	16.4	Chesapeake Group St. Marys Formation Choptank Formation Calvert Formation	245-280
		Eocene	Middle	49	Piney Point Formation	20
			Lower	54.8	Nanjemoy Formation	180
		Paleocene	Upper	61	Marlboro Clay Aquia Formation	165-170
			Lower	65	Brightseat Formation	10-20
Mesozoic	Cretaceous	Upper		99	Magothy, Monmouth, Matawan Formations undifferentiated	30?
		Lower		144	Potomac Group Patapsco Formation	1000-1100
					Arundel/Patuxent Formations (undivided)	750-900
Proterozoic/ Paleozoic				543+	Metamorphic/Igneous	Not Known

Figure 2.6-3—{CCNPP Site 0.6 MI (1KM) Geologic Map}



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