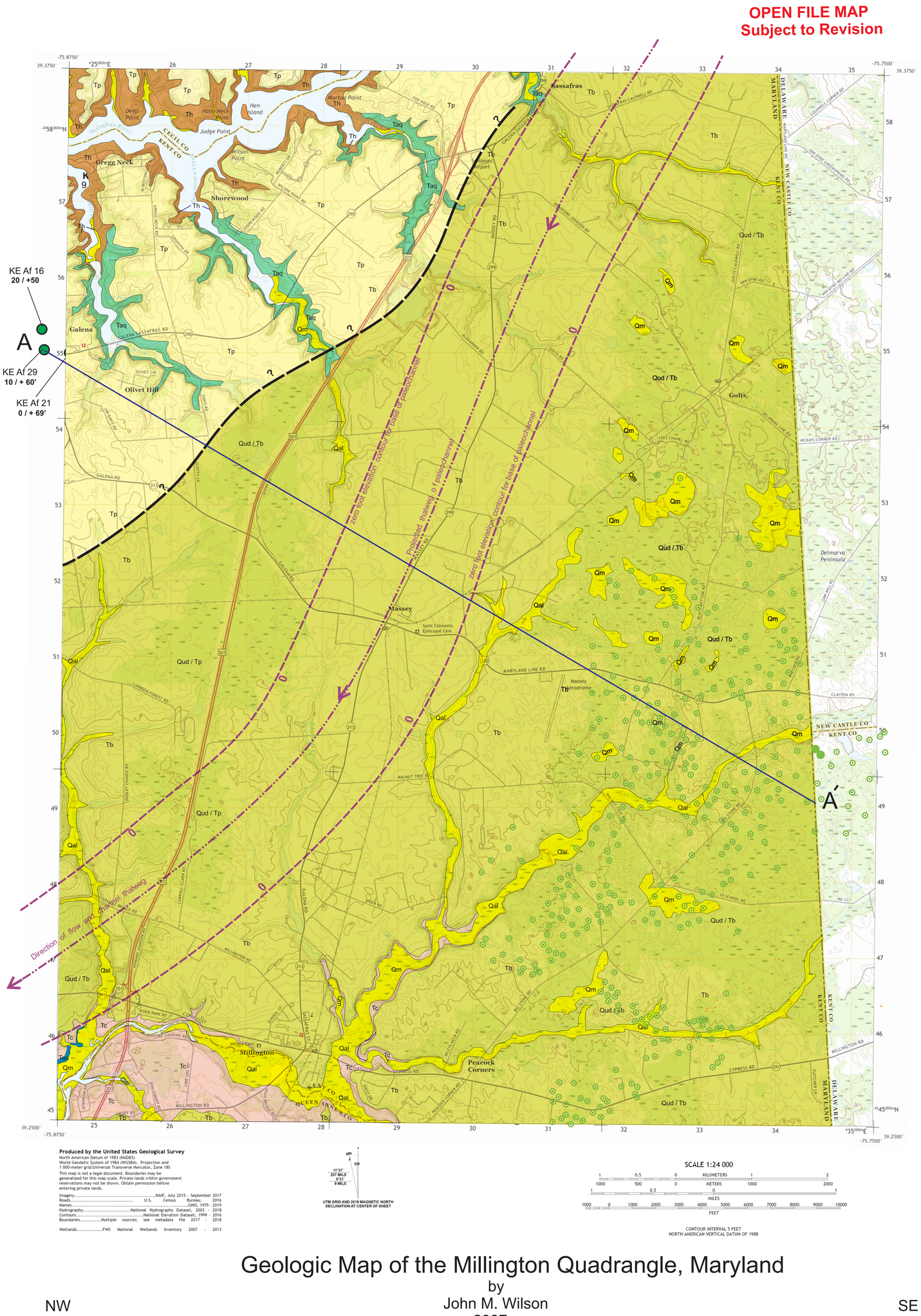


Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and 1 000-meter grid:Universal Transverse Mercator, Zone 18S
This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery.....NAIP, July 2015 - September 2017
Roads.....U.S. Census Bureau, 2016
Names.....GNIS, 1979 - 2019
Hydrography.....National Hydrography Dataset, 2003 - 2018
Contours.....National Elevation Dataset, 1999 - 2016
Boundaries.....Multiple sources; see metadata file 2017 - 2018

Wetlands.....FWS National Wetlands Inventory 2007 - 2013

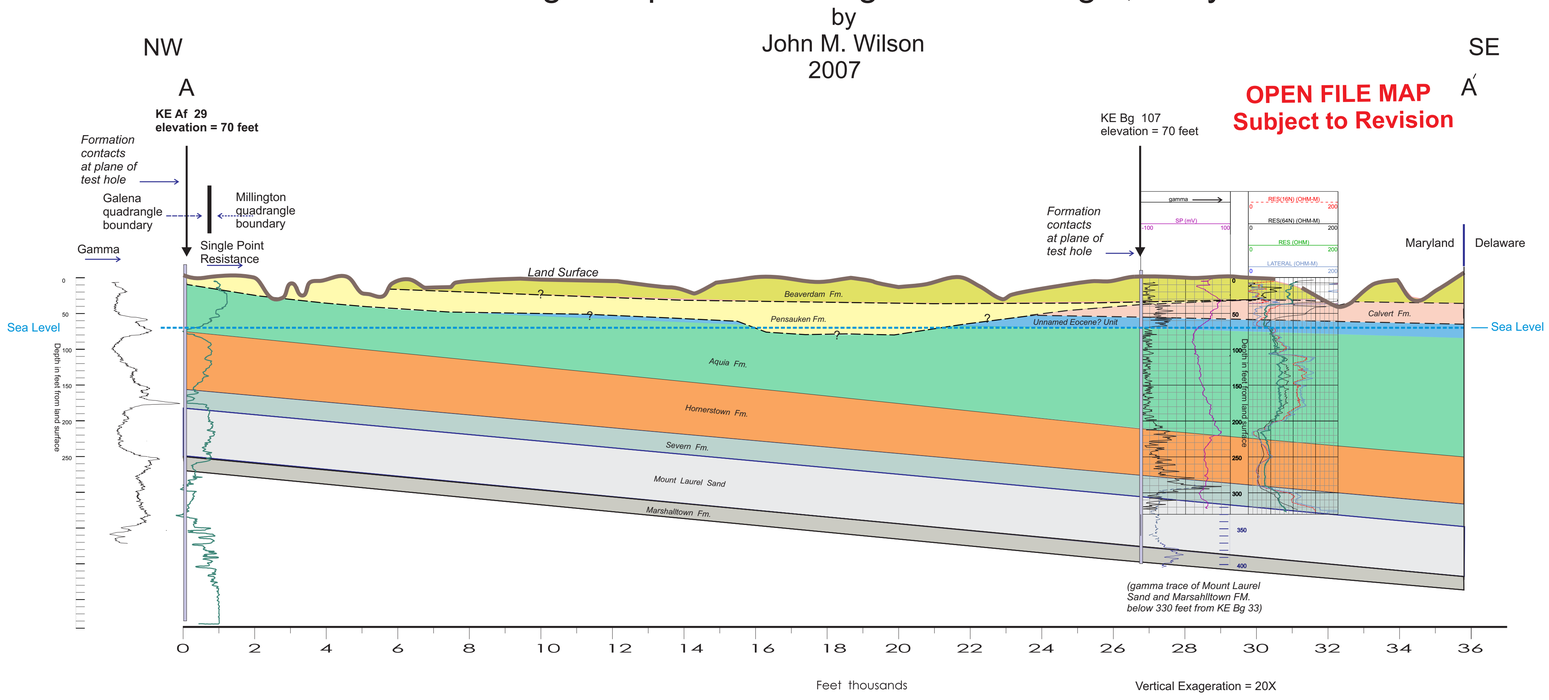
UTM GRID AND 2019 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 5 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

Geologic Map of the Millington Quadrangle, Maryland

by
John M. Wilson
2007



Adjoining 7.5-minute quadrangles
(Millington quadrangle shaded)

1	2	3
4		5
6	7	8

1 Earleville
2 Cecilton
3 Middletown
4 Galena
5 Clayton
6 Church Hill
7 Sudlersville
8 Kenton

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

DEPARTMENT OF NATURAL RESOURCES
Jeannie Haddaway-Riccio
Secretary

MARYLAND GEOLOGICAL SURVEY
Richard A. Ortt
Director

MARYLAND

STATE OF MARYLAND
Lawrence J. Hogan
Governor

Boyd K. Rutherford
Lieutenant Governor

DESCRIPTION OF MAP UNITS AND SYMBOLS

Quaternary

Qud

Undrained Depression Deposits - *(Holocene)* - - Numerous small, generally elliptical, shallow, undrained depressions. Depressions range from less than 50 feet to 1,000 feet in diameter with the largest forming swamps, most range from 200 to 500 feet in diameter. Depressions contained organic-rich woody material, silts, and fine- to medium-grained, quartz sands. Some have a sandy rims or margins. Ramsey (2005) mapped these depressions in nearby New Castle County, Delaware, to the east of the Millington Quadrangle, and considers their origin as periglacial. Ramsey (2005) indicates that the age of these deposits range from 11,000 years ago to the present, based on radiocarbon dates by Webb (1990).

In the Millington Quadrangle, these depressions originally extended across most of the central and southeastern portions of the quadrangle as shown by the overprint. However, farming practices have drained about the half of that area by lowering the water table and leaving only a dark organic rich elliptical marks on the surface of the farmed land. The relict depressions in the farm fields are recognizable on digital orthophoto quarter quadrangles (1:12000) of the area.

On the map, the areas where unaltered depressions are present is indicated by the regions colored green on the topographic base map. These are present within the area covered by the overprint. The green areas of the map base correspond to these areas because the green areas indicate vegetated land cover such as wooded areas that have not been developed or modified for farming. These depressions overlie the Pliocene ? - Pleistocene age Beaverdam Formation in this quadrangle, and are known as "Delmarva Bays" of "Carolina Bays." They are not related to the "Carolina Bays" of the North Carolina Coastal Plain.

Qm

Marsh deposits - *(Holocene)* - Interbedded fine-grained sand, silt, and silty clay rich in organic matter and peat. Grades upstream and is often indiscernible from into alluvium. Thickness generally ranges from a few feet to less than 30 feet.

Qal

Alluvium - *(Holocene)* - Stream deposits, consisting of sand, silt and clay, gravel and organic matter. Locally contains cobbles, and boulders and other colluvial deposits. Near the mouth of stream this material is often contiguous with and indistinguishable from marsh deposits. Thickness is generally less than 40 feet.

Tertiary

Tb

Beaverdam Sand - Light gray to very pale bluish white, yellowish tan and orange-tan, fine- to coarse-grained, silty, feldspathic sand. Gravel layers and stringers are common. Thickness ranges from 0 to possibly more than 55 feet in areas where channels occur. Average thickness is about 35 feet in the Millington Quadrangle.

This unit overlies the Pensauken Formation in test hole KE Bg 107 and is comprised of a basal lag gravel. The Beaverdam is believed to represent fluvial deposit probably created by an ancestral Delaware River. The westward extent of the Beaverdam Formation in the Millington Quadrangle is uncertain, but the unit appears to be present in most of the central and southeastern parts of the quadrangle. The age of this unit is uncertain, but possibly late Pliocene to Pleistocene.

Tp

Pensauken Formation - Light yellow to orange-tan, feldspathic, fine- to coarse-grained, cross-bedded sand, with thin to thick beds of gravel. In places unit is oxidized to deep reddish brown. Base of formation is characterized by gravel-rich channel-lag. Upper part of the formation is generally a fine- to medium-gained sand and loam, but may include gravel beds and stringers. Clasts include vein quartz, igneous and metamorphic rocks, sandstone, and siltstone. The Pensauken Formation originated as a fluvial deposit that was deposited by an ancestral Delaware River. In this quadrangle the thickness of the formation ranges from 0 to possibly as much 50 feet. In other regions of Maryland's Eastern Shore thicknesses of up to 100 feet.

Paleochannel Inferred Course - A paleochannel filled with Pensauken sediments is projected to traverse the quadrangle near the town of Massey where drill hole data indicate a thickness of 45 feet for Pensauken sands that are in turn overlain by 30 feet of Beaverdam sediments. At Massey, the base of the channel is at 10 feet below sea level. The respective thicknesses of the Pensauken Formation and the overlying Beaverdam Formation is not known at Massey, as geophysical logs are ambiguous as to where the contact lies. At core hole KE Bg 107, the base of the channel is 30 feet above sea level with 7 feet of Pensauken sands and gravels that are overlain by 33 feet of Beaverdam sediments. South of Massey the channel thalweg appears to swing to southwestward and exits the quadrangle northwest of Millington. This paleochannel is probably the continuation of the channel mapped in the southeastern portion of the Cecilton Quadrangle (Wilson 2005; Conant, 1990). This feature is most likely a northern extension of the paleochannels that run through the towns of Barclay in Queen Anne's County, and Ridgely in Caroline County (Bachman and Wilson, 1984).

A topographic high occurs in the northwestern part of the Millington Quadrangle with sediments of the Paleocene Aquia and Hornerstown formations occurring from 45 to as high as 70 feet above sea level and exhibiting a thin cover of 5 to 15 feet of Pensauken sediments. This suggests that this part of the quadrangle was a drainage divide between two paleochannels. The intervening channels were subsequently filled by the Pensauken and Beaverdam formations.

Tp / Tb

Pensauken-Beverdam contact - Inferred contact between the Pensauken and Beaverdam formations. Line represents the likely northwestern extent of the Beaverdam Formation. Contact is based on the lack of Beaverdam sediments in drill holes and outcrops along the bluffs of the Sassafras River.

Tc

Calvert Formation - (Miocene) - Medium greenish gray (5GY 4/2), silty, plastic clay. The unit is beveled and truncated by the Pensauken and Beaverdam formations. Approximately 12 feet of this formation in the form of medium greenish gray silty clay occurs in test hole KE Bg 107.

Teu

Unamed clay unit - Eocene (?) - Dark olive gray (5Y 3/1), silty, micaceous clay, stiff and plastic. Eocene age is based on stratigraphic position and correlation with a probable Eocene-age clay to the west in the Galena Quadrangle. This clay unit may be equivalent to the Eocene-age Marlboro Clay based on correlations with geophysical logs from test holes to the southwest. To date, outcrops of the unit have not been found in the quadrangle. About 20 feet of this clay unit of probable Eocene age was cored in test hole KE Bg 60. The unit appears to be uniformly about 20 feet thick in the quadrangle

Ta

Aquia Formation - (Upper Paleocene - Thanetian) Fine- to medium-grained, glauconitic, quartz sand, clay-rich in places. Dark to light green and yellowish where fresh, weathering to yellow-brown and dusky dark-orange. Thickness ranges from 0 feet in the northwestern part of the quadrangle to about 145 feet in the southeastern part of the quadrangle. The Aquia Formation is beveled and truncated in the central and northern parts of the quadrangle by the Pensauken and Beaverdam formations.

Th

Hornerstown Formation - (Lower Paleocne - Danian) Basal 15 feet is generally olive black, fine-grained, silty, clay- and glauconitic-rich sand. Glauconite comprises 60 to 90 percent of the sand, and is dark green in color and composed of polylobate grains, sometimes altered to limonite. Middle part of the formation is a fine- to medium-grained, glauconitic quartz sand similar that of the Aquia Formation. The upper 5 to 10 feet of the Hornerstown Formation, just below the contact with the Aquia, is generally a green, glauconitic silty clay. The Hornerstown Formation has a maximum thickness of about 65 feet, based on subsurface borings.

Cretaceous

Present in Cross-Section Only

Severn Formation - (Upper Cretaceous - Maestrichtian) Olive-black to olive-brown, glauconitic sand with phosphate nodules. The Severn Formation occurs in the subsurface in the Millington Quadrangle, although it does outcrop to the west of the Millington Quadrangle along the Sassafras River. Thickness is approximatelyt 25 feet in the quadrangle. Fossils include *Belemnitella americana* and *Exogyra cancellata*.

Mount Laurel Sand - Upper Cretaceous - Maestrichtian) Medium light gray to light olive-gray, fine- to medium-grained, glauconitic, quartz sand, shelly and calcareous in places. Weathers yellow to yellow-brown. Unit only occurs in the subsurface in this quadrangle. Thickness ranges between 60 to 70 feet. Fossils include *Belemnitella americana* and *Exogyra cancellata.*

Marshalltown Formation - Upper Cretaceous - Maestrichtian) Greenish-black, fine-grained, silty, glauconitic sand. Glauconite makes up to 90 percent of the unit. Glauconite grains are dark green and polylobate. Thickness is approximately 18 feet.

Other Subsurface Units - Older units only occur in the subsurface of the Millington Quadrangle and were not studied nor penetrated by borings. These units include from stratigraphically highest to lowest, the upper Cretaceous Englishtown, Merchantville, and Magothy Formations, and the lower to upper Cretaceous Potomac Group.

MAP SYMBOLS

KE Bg 3 3 Well or test hole location and number

20' / + 43' Thickness and altitude of the subcroppiing unit below the base of Pensauken or Beaverdam Formations, or Quarternary lowland deposits.

Fill color indicates the subcropping unit at that bore hole.

- Calvert Formation
- Aquia Formation
- Hornerstown Formation

A — A' Line of section

References Cited:

Bachman, L.J., and Wilson, J.M., 1984. The Columbian aquifer of the Eastern Shore of Maryland: Maryland Geological Survey Report of Investigations 40, 144 p.

Hansen, H.J., and Edwards, J., 1986. The lithology and distribution of pre-Cretaceous basement rocks beneath the Maryland Coastal Plain: Maryland Geological Survey Report of Investigations 44, 27 p.

Miller, B.J., Stephenson, L.W., and Bibbins, A., 1915. Map of Queen Annes County showing the geologic formation: Maryland Geologic Survey County Geologic Maps, scale:1:62,500.

Overbeck, R.M., and Slaughter, T.H., 1958. The ground water resources, in The water resources of Cecil, Kent and Queen Annes Counties: Maryland Department of Geology, Mines, and Water Resources Bulletin 18, 465 p.

Ramsey, K.W., 2005. Geologic map of New Castle County, Delaware: Delaware Geological Survey, scale 1:100,000

Webb, R.S., 1990. Late Quaternary water-level: fluctuations in northeastern United States: Unpublished Ph.D. dissertation, Brown University, Providence, R.I., 351 p.

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Geologic field mapping conducted by author in 2006-2007. Original mapping was conducted utilizing the 1993 version of the Millington Quadrangle. Map layout and corrections were applied based on the 2019 version of the quadrangle by D.K. Brezinski, 2020.

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