DELAWARE GEOLOGICAL SURVEY
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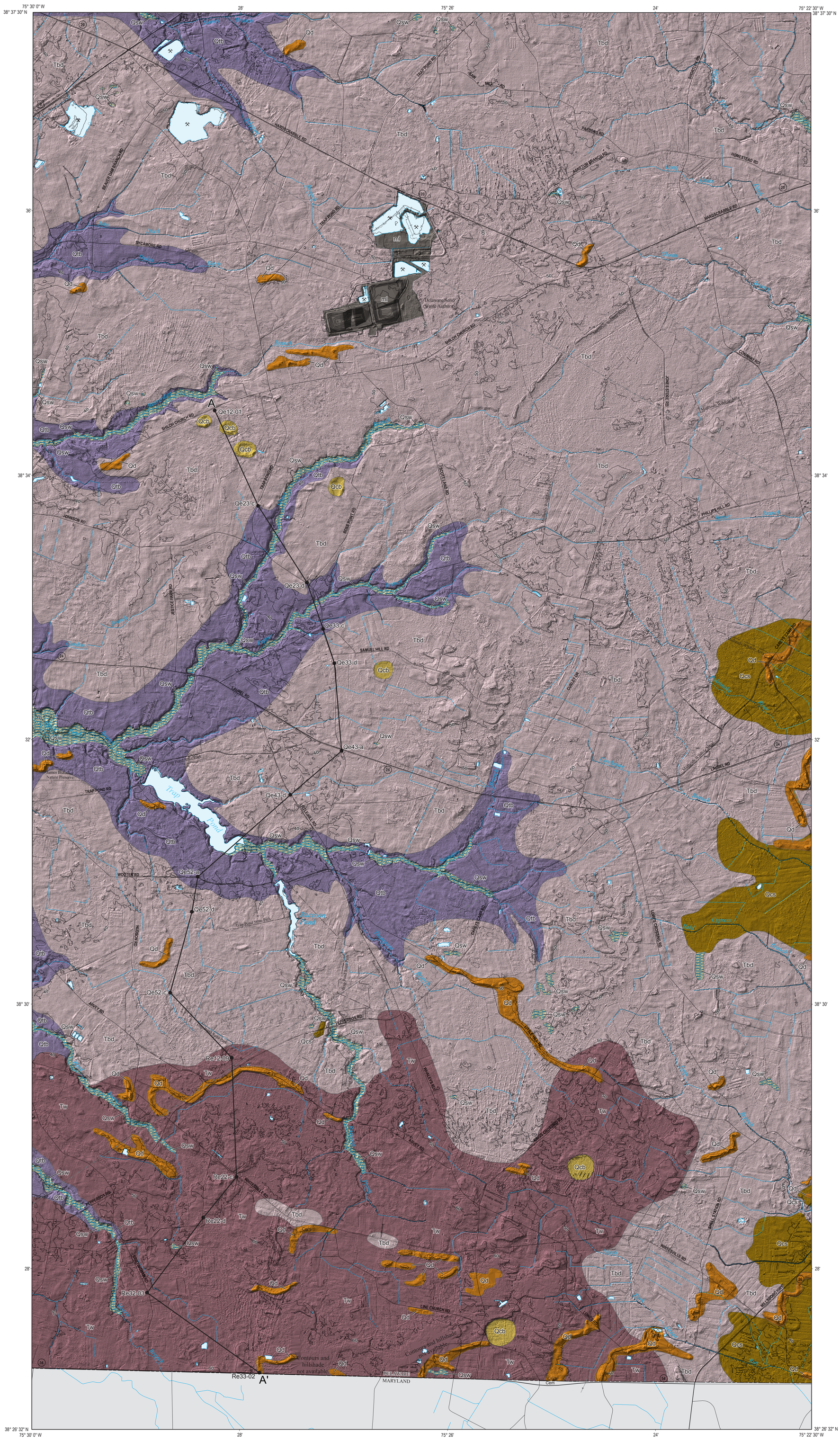
DELAWARE GEOLOGICAL SURVEY
GEOLOGIC MAP OF THE TRAP POND AND PITTSVILLE QUADRANGLES, DELAWARE
GEOLOGIC MAP SERIES NO. 21



EXPLANATION

MODIFIED LAND — ml

Areas of land where the surficial deposits have been modified due to human activity to the point that surficial deposits can no longer be reliably determined. The unit is shown in areas large enough to be identified at the map scale but does not include local disturbances on the scale of an individual housing lot or shallow disturbances such as large parking lots or retail areas. An example of modified land is a landfill where numerous ponds and mounds have been constructed.

SWAMP DEPOSITS — Qsw

Gray to brown silty and clayey gravelly sand overlain by organic-rich fine to coarse sand. Swamp deposits are found in the upper reaches of the modern stream valleys and are also associated with the modern Cypress Swamp. In the stream valleys, deposits consist of 1 to 3 ft of gray to brown, silty and clayey gravelly sand at the base overlain by organic-rich, fine to coarse sand. In some of the larger stream valleys, deposits (up to 15 ft thick) are capped by several ft of organic silt. Holocene.

CAROLINA BAY DEPOSITS — Qcb

Well-sorted, medium to fine sand in raised rims (dunes) with silty sand in the interior of the circular features. The deposits are less than 5 ft thick in their interiors and up to 10 ft thick where the sand rims are best developed. Latest Pleistocene to Holocene.

CYPRESS SWAMP FORMATION — Qcs

Dark grayish-brown, organic-rich, very fine silty sand to sandy silt with organic silt and peat beds overlain by a pale-yellow, fine to very fine, clean to slightly silty sand with scattered light-gray silt and grayish-brown organic silt laminae. The basal organic sand ranges from 5 to 15 ft thick, with scattered 1- to 5-ft thick beds of peat (with plant fragments) to organic silt. In some areas, the lower sand overlies a 1- to 3-ft thick bed of light-gray to grayish-brown sand that ranges from very fine, slightly silty sand to clean, coarse sand with granules and pebbles. The fine to very fine clean sand that overlies the unit is 5 to 10 ft thick. Late Pleistocene to early Holocene.

DUNE DEPOSITS — Qd

White to pale-yellow, well-sorted, medium to fine sand. Laminae of coarse sand are common. Thin, brown soil lamellae are commonly found at depths of 1 to 3 ft. Dune deposits are up to 6 ft thick. Dunes that have well-developed and deep (>3 ft) soil profiles may be older than latest Pleistocene and are middle to late Pleistocene in age. Middle Pleistocene to Holocene.

TURTLE BRANCH FORMATION — Qtb

Clean, well-sorted, white to pale-yellow, fine sand grading down to interlaminated fine to coarse sand with opaque heavy mineral laminae, granules, and pebbles at its base. Rare to common scattered light-gray clayey silt laminae occur in the sand beds. In the map area, it is commonly less than 10 ft thick. The Turtle Branch Formation is distinguished from the adjacent Beaverdam Formation by better sorting and the absence of the white, silty matrix, which is characteristic of the Beaverdam (Ramsey and Tomlinson, 2011). It is distinguished from adjacent and overlying dune deposits by having a better developed soil profile and the common presence of opaque heavy mineral laminae. Middle Pleistocene.

WALSTON FORMATION — Tw

Slightly to moderately silty, very fine to medium olive-brown to gray sand underlain by compact, gray to light-gray mottled clayey silt to silty clay. The Walston Formation consists of 1 to 25 ft of dry, compact gray silty clay to clayey silt with yellow to olive-yellow mottles. Thin laminae of light-gray to olive-yellow, fine to coarse silty sand are common. The clay and silt are often overlain by 1 to 3 ft of slightly to moderately silty, very fine to fine olive-brown to gray sand. The thickness of the formation ranges from a few ft along its surficial contact with the Beaverdam Formation to 30 ft along the Delaware-Maryland state line. The Walston Formation overlies the Beaverdam Formation. Late Pliocene.

BEAVERDAM FORMATION — Tbd

Heterogeneous unit ranging from very coarse sand with pebbles to silty clay. The predominant lithologies at the land surface are white to mottled light-gray and reddish-brown, silty to clayey, fine to coarse sand. Laminae and beds of very coarse sand with pebbles to gravel are common. Laminae and beds of bluish-gray to light-gray silty clay are also common. In a few places near the land surface, but more commonly in the subsurface, beds from 2 to 20 ft thick of finely laminated, very fine sand and silty clay are present. The sands of the Beaverdam Formation have a white silt matrix that gives samples a milky appearance when wet. This white silt matrix is the most distinguishing characteristic of the unit and readily differentiates the Beaverdam Formation from the adjacent cleaner sands of the Turtle Branch Formation and the upper sands of the Walston Formation, where in lateral contact. The Beaverdam Formation ranges from 50 to 100 ft thick in the map area (Groot et al., 1990; Ramsey, 2010a, b). Late Pliocene.

Discussion

The geological history of the surficial units of the Trap Pond and the Delaware portion of the Pittsville Quadrangle was the result of deposition of the Beaverdam Formation and its subsequent modification by erosion and deposition related to the sea-level fluctuations during the Pleistocene. The geology reflects this complex history by the cut and fill geometry of the Middle and late Pleistocene deposits into the Beaverdam Formation. The geology is further complicated by periglacial activity that produced dune deposits and Carolina Bays in the map area, which modified the land surface. Surficial geologic mapping was conducted using field maps at a scale of 1:12,000 with 2-foot contours. Stratigraphic boundaries drawn at topographic breaks reflect detailed mapping using contours not shown on this map.

The Beaverdam Formation is exposed at the surface throughout the majority of the Trap Pond Quadrangle, and in the northern and eastern portion of the Pittsville Quadrangle, and underlies all the younger deposits in the map area. The Beaverdam Formation consists of stacked fining-upward sequences that are typical of either fluvial or estuarine environments (Ramsey, 2010a, b). Rare burrows have been observed in the Beaverdam Formation elsewhere in Delaware that indicate at least a marginal estuarine setting (DGS unpublished data; Owens and Denny, 1979). The age of the Beaverdam Formation is uncertain due to the lack of age-definitive fossils within the unit. Stratigraphic relationships in Delaware indicate that it is no older than late Miocene and no younger than early Pleistocene, and is most likely late Pliocene (Ramsey, 2010a, b).

The Walston Formation covers the majority of the Pittsville Quadrangle. In the center of the Delaware portion of the Pittsville Quadrangle, the Walston Formation is nearly 30 ft thick. It thins to less than 5 ft thick at its surficial contact with the Beaverdam Formation. The Walston Formation overlies the Beaverdam Formation (cross section A-A'). Silts and clays of the Waltson Formation are distinguished from silt and clay beds found in the Beaveradam by their more densely compacted nature. They are also darker gray in color. Although the depositional environment and age are unclear, Owens and Denny (1979) believed the Walston Formation to be a back barrier deposit of Pliocene age or a regressive facies of the Beaverdam Formation. Warm flora pollen found in the Walston Formation indicate that it is late Pliocene in age (Sirkin and Owens, 1998).

The Turtle Branch Formation (Ramsey, 2010a) consists of clean, well-sorted sand with scattered clayey silt laminae grading down to interlaminated fine to coarse sand with opaque heavy mineral laminae, granules, and pebbles at its base. In the map area it is typically less than 10 ft thick and is found adjacent to modern drainages (cross section A-A'). The Turtle Branch Formation is interpreted to represent middle Pleistocene (425,000 yrs B.P. and/or 325,000 yrs B.P.; MIS 11 and 9) sea-level highstand deposits (Ramsey, 2010a). These deposits are the result of fluvial, tidal channel, and beach processes in the distal upstream reaches of an ancestral Nanticoke River estuary associated with the highstand. The scattered clay laminae become more common in the vicinity of the present Nanticoke River and are interpreted to be tidal flat deposits. Some of the sand mapped as Turtle Branch Formation is likely the result of late Pleistocene dune migration across the area, which left scattered sand sheets in low-lying locations. These late Pleistocene sands are texturally similar to the Turtle Branch Formation sands and cannot be differentiated in the field.

The Cypress Swamp Formation (Andres and Howard, 2000; Ramsey and Tomlinson, 2014) consists of a lower very fine silty sand to sandy silt with beds of organic silt and peat overlain by a clean to slightly silty fine to very fine sand with scattered clayey silt and organic silt laminae. Along the eastern boundary of the map area where the Cypress Swamp Formation is found, the unit is commonly less than 10 ft thick. Radiocarbon dates from the organic beds east of the map area indicate that the lower sandy silt was deposited between 42,000 and 10,500 yrs B.P. with the majority of the dates ranging from 25,000 to 17,000 yrs B.P. (Ramsey and Tomlinson, 2014). An isolated organic-rich deposit was dated in the Pittsville Quadrangle on the north side of Pepperbox Road on the west bank of Raccoon Prong. Radiocarbon dates indicate its age is 41,060 yrs B.P. This deposit was mapped as Cypress Swamp because it is age-equivalent. The Cypress Swamp Formation unconformably overlies the Beaverdam Formation. Limited pollen data from the organic beds indicate that the Cypress Swamp Formation was deposited in cool to cold climate in a landscape with few trees (Andres and Howard, 2000) and is interpreted to have begun as deposition in swamps in stream valleys during the last interglacial (MIS 3). After a hiatus in deposition during the transition between the interglacial and the last glacial period, deposition of the lower organic silts resumed in sphagnum bogs, which filled the stream valleys with sediment. Once the stream valleys were filled, sand dunes migrated across the area depositing the upper portion of the Cypress Swamp Formation. Organic laminae in the upper sandy portion were deposited in ephemeral bogs between the dunes.

Dune deposits on the uplands consist of fine to medium, well-sorted sands found scattered throughout the map area. The dunes have a pronounced surficial expression as curvilinear features that rise above the surrounding landscape. Most of these dunes are latest Pleistocene to early Holocene in age (Andres and Howard, 2000; Ramsey and Tomlinson, 2014), but some could be as old as late Pleistocene. Dune features are also associated with the rims of Carolina Bays that are found in the southern portion of the map area. Both the dunes and the Carolina Bays are cold-climate related features located where winds moved sand across a landscape barren of forests (Denny and Owens, 1979; Ramsey, 1997; Ramsey and Tomlinson, 2012). The exact process by which the distinctive circular shape of the Carolina Bays was formed is unknown.

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by

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2014

Acknowledgements
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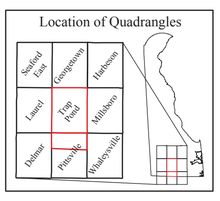
MAP CREDITS
Base Map
Delaware state plane coordinate system
Transverse mercator projection
North American Datum of 1983 (NAD83) HARN
The Delaware Department of Transportation Centerline for Delaware, 2009
The Delaware Office of State Planning Coordination Delaware Municipal Boundaries, 2009
USGS National Hydrography Dataset, 2009
USGS Delaware LiDAR Contours, 2005
USGS Delaware Miscellaneous Features, 1993
Delaware Department of Agriculture State Forest Areas, 2009
Delaware Division of Natural Resources and Environmental Control Park Areas, 2009
Other
Cartography by Lillian T. Wang, Delaware Geological Survey
Edited by Stefanie J. Baxter, Delaware Geological Survey

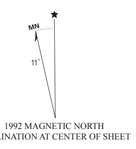
Location of Quadrangles



SCALE 1:24,000

1 0.5 0 1 2 Kilometers
1 0.5 0 1 Miles
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 Feet

10-foot Index with a 6-foot Intermediate Contour Interval
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)

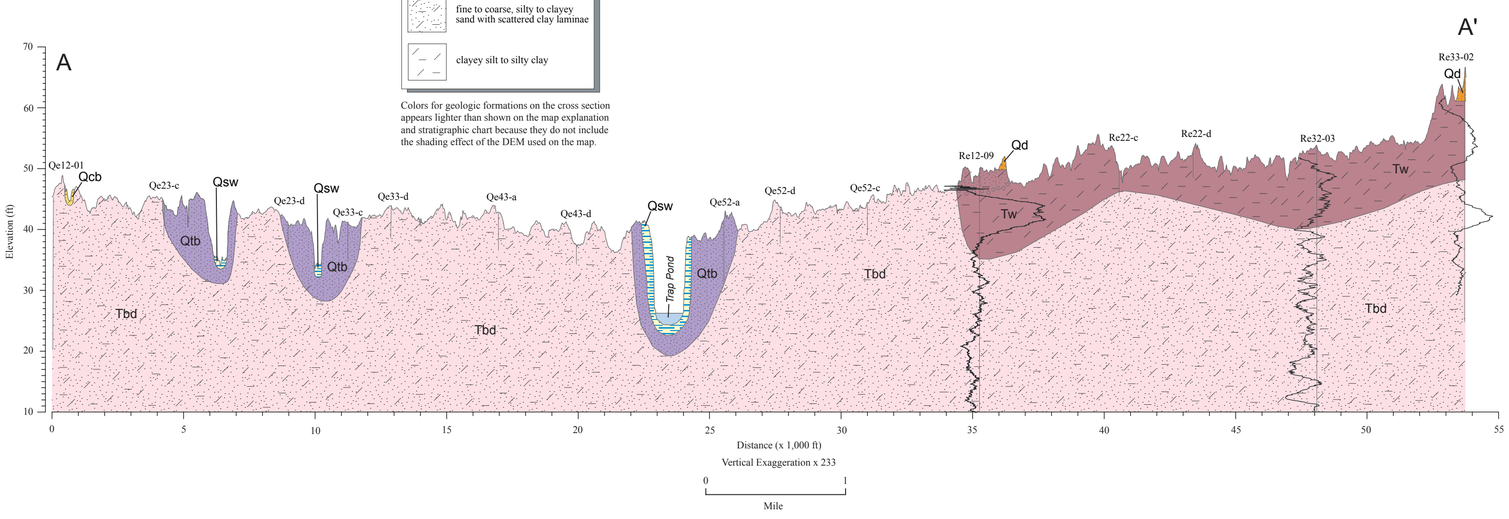


1992 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SYMBOLS *(on map)*
- Qe12-01 Well or borehole
- Qe23-c Soil auger boring
- Sandpit
- State Park and Wildlife Areas
- State Boundary
- Power Transmission Line
- Contact

SYMBOLS *(on cross section)*
- pebble
- clay
- silt
- gamma log
- clean sand
- fine to coarse, silty to clayey sand with scattered clay laminae
- clayey silt to silty clay

Colors for geologic formations on the cross section appears lighter than shown on the map explanation and stratigraphic chart because they do not include the shading effect of the DEM used on the map.



QUATERNARY
- Holocene: Qsw
- Pleistocene: Qcb, Qcs, Qd, Qtb

TERTIARY
- Pliocene: Tw, Tbd

References Cited

Andres, A.S., and Howard, C.S., 2000, The Cypress Swamp Formation, Delaware: Delaware Geological Survey Report of Investigations No. 62, 13 p.

Andres, A.S., and Klingbeil, A.D., 2006, Thickness and transmissivity of the unconfined aquifer of eastern Sussex County, Delaware: Delaware Geological Survey Report of Investigations No. 70, 19 p.

Denny, C.S., and Owens, J.P., 1979, Sand dunes on the central Delmarva Peninsula, Maryland and Delaware: U.S. Geological Survey Professional Paper 1067-C, 15 p.

Groot, J.J., Ramsey, K.W., and Wehmiller, J.F., 1990, Ages of the Bethany, Beaverdam, and Omar formations of Southern Delaware: Delaware Geological Survey Report of Investigations No. 47, 19 p.

Owens, J.P., and Denny, C.S., 1979, Upper Cenozoic deposits of the central Delmarva Peninsula, Maryland and Delaware: U.S. Geological Survey Professional Paper 1067-A, 28 p.

Ramsey, K.W., 1997, Geology of the Milford and Mispillion River Quadrangles, Delaware: Delaware Geological Survey Report of Investigations No. 55, 40 p.

_____, 2010a, Stratigraphy of the middle to late Pleistocene deposits of Delaware: Delaware Geological Survey Report of Investigations, 43 p.

_____, 2010b, Geologic map of the Georgetown Quadrangle, Delaware: Delaware Geological Survey Geologic Map Series No. 15, Scale 1:24,000.

Ramsey, K.W. and Tomlinson, J.L. 2011, Geologic map of the Harbeson Quadrangle, Delaware: Delaware Geological Survey Geologic Map Series No. 17, Scale 1:24,000.

_____, 2012, Geologic map of the Bethany Beach and Assawoman Bay Quadrangles, Delaware: Delaware Geological Survey Geologic Map Series No. 18, Scale 1:24,000.

_____, 2014, Geologic map of the Millsboro and Whaleysville Quadrangles, Delaware: Delaware Geological Survey Geologic Map Series No. 20, Scale 1:24,000.

Sirkin, L, and Owens, J.P., 1998, Palynology of the latest Neogene (Middle Miocene to Late Pliocene) strata in the Delmarva Peninsula of Maryland and Virginia: Northeastern Geology and Environmental Geology, v. 20, p. 117-132.