DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER RESOURCES MANAGEMENT
NEW JERSEY GEOLOGICAL AND WATER SURVEY

Prepared in cooperation with the
U.S. GEOLOGICAL SURVEY
NATIONAL GEOLOGIC MAPPING PROGRAM

INTRODUCTION

The Clementon quadrangle is situated in the Coastal Plain physiographic province of New Jersey. Elevation in the quadrangle ranges from approximately 50 to 220 feet with the highest hills in the central part of the quadrangle. Surficial units in this quadrangle were deposited from the late Miocene to present day (see Correlation of Map Units). These units include fluvial, wetland, and eolian deposits. Sediment lithologies are described below in the Description of Map Units. Cross-sections A-A', B-B' and C-C' show the thickness of these deposits, which can be as much 40 feet but generally between 3 and 20 feet in thickness. Geologic interpretations were made through use of new and old field data, well records, and soil boring records in conjunction with aerial photography and 1-meter resolution LiDAR.

GEOMORPHIC HISTORY

During the late Miocene to present day, sea level dropped in several steps causing rivers and their tributaries to form plains and then carve terraces into the pre-existing landscape. The oldest of these fluvial deposits is the Bridgeton Formation (Tb), which formed a broad plain of braided rivers and streams across the southern New Jersey Coastal Plain. This formation is composed of clayey sand and gravel that may make it more resistant to weathering compared to surrounding outcropping units, thus protecting the topograpic highs at which it sits on from erosion and setting the stage for the drainage patterns of future deposits. Stratigraphic position and petrologic correlations to marine deposits in the Delmarva Peninsula suggest a late Miocene age (Owens and Minard, 1979; Pazzaglia, 1993).

Decline in sea level during the latest Miocene, Pliocene, and early Pleistocene (between 6 Ma and 800 ka; "Ma" = million years before present day, "ka" = thousand years before present day) caused regional river systems to erode into and rework sediments of the Bridgeton Formation before being redeposited in floodplains, channels, and pediments. These deposits are mapped as the upland gravels (Tg and TQg).

Further incision of the landscape and redeposition of older sediments (Tb, Tg, and TQg) with an addition of sediments from underlying unconsolidated bedrock formations (Qwcp) continued during the middle and late Pleistocene (between 800 ka and 11 ka). These deposits are mapped as upper and lower terrace deposits (Qtuo, Qtu, and Qtl) and colluvium (Qco). Deposition of some sediments may have been influenced by periods of cold climate during the Wisconsinan glacial stage (between 115 and 80 ka) and possibly the Illinoian glacial stage (between 200 and 150 ka). During these periods, permafrost could have impeded soil infiltration causing more slope eorsion and groundwater seepage that resulted in an influx of sediment in the valleys of the map area. Deposition of eolian sediments (Qe), which include dunes (outlined in red on the map), and the development of shallow topographic basins resulting from wind erosion and the melting of permafrost (blue diagonal ruling pattern on the map) also formed during this time span.

During the Holocene (11 ka to present), deposition has occurred within active floodplains and wetlands (Qals). Radiocarbon dates collected from basal peat located in the Pine Barrens support ages as old as 10 ka (Stanford, 2000). Man-made deposits (black diagonal ruling pattern on the map) have been emplaced in road and railroad grades, dams, dikes, and landfills. Man-made excavations including sand and gravel pits and stormwater management basins are outlined in purple on the map. Surficial deposits are underlain by weathered and unconsolidated bedrock formations (Qwcp) that consist of marine and marginal marine sediments of Late Cretaceous to middle Miocene age. These unconsolidated bedrock formations are described in Carone (2021).

DESCRIPTION OF MAP UNITS

ARTIFICIAL FILL – Gravel, sand, silt, clay; organic material, construction debris, and trash in places. Grey, brown, and yellow in color. Unstratified. As much as 30 feet thick. Typically occurs in roadway and railroad fills, dams, dikes, landfills, and infilled mined areas.

Qals **ALLUVIUM** – Sand, silt, clay, and peat with some gravel. Light to dark grey, brown, and dark brown in color. Sand is fine- to coarse- grained sub-rounded to well rounded quartz. Overlain by dark brown and black peat in places. Gravel consists of well rounded to sub-angular white, yellow, orange, pink, and smoky grey quartz and some quartzite. Gravel size ranges from fine- to very coarse- pebbles (4-64 mm). Sediments are moderately to poorly sorted. As much as 9 feet thick but typically 3 feet and less. Deposited in floodplains and wetlands.

Qe **EOLIAN SAND** – Sand. Light brown, yellow, and white in color. Very fine- to medium- grained, well rounded quartz. Sediment is very well sorted. As much as 15 feet thick. Deposited in the form of dune ridges and dunefields. Dunes are linear and parabolic in shape and range from 3 to 10 feet in thickness. Dunes can be approximately a mile long but are typically less.

Qtl **LOWER TERRACE DEPOSITS** – Sand and gravel with some silt and clay. Light to dark grey and brown in color. Sand is fine- to coarse- grained, sub-rounded to well rounded quartz. Gravel consists of sub-rounded to well rounded white, yellow, and grey quartz and some quartzite. Gravel size ranges from very fine- to very coarse- pebbles (2-64 mm). As much as 5 feet thick especially in the low-lying areas surrounding the Great Egg Harbor River and its floodplains found in the southern portion of the quadrangle. Forms terraces and pediments with top surfaces that are within 5 feet above the modern-day floodplain.

Qco **COLLUVIUM** – Sand with some silt and gravel in places. Light brown to yellowish-brown in color. Sand is fine- to coarse- grained, sub-rounded to well rounded quartz. Gravel consists of sub-rounded to well rounded white, yellow, and grey quartz. Gravel size ranges from very fine pebbles to small cobbles (2-128 mm). Generally less than 5 feet thick as illustrated in cross section A-A'. Rests on slopes that grade to upper terrace deposits.

Qtu, Qtuo **UPPER TERRACE DEPOSITS** – Sand and gravel with some silt (fig. 1). Light to dark yellow and brown in color. Sand is fine- to coarse- grained, sub-rounded to well rounded quartz. Gravel consists of sub-rounded to well rounded, yellow, white, and grey quartz and some quartzite. Gravel size ranges from very fine pebbles to small cobbles (2-128 mm). Forms terraces and pediments with top surfaces that are 5 to 20 feet above the modern-day floodplain. Typically 1 to 5 feet thick but can be as much as 15 feet thick as illustrated in cross-section A-A'. An older phase (Qtuo) of deposits, consisting of the same materials as described above, forms terraces with surfaces 5 to 10 feet above younger upper terrace deposits and are as much as 20 feet thick as illustrated in cross-section A-A'.

TQg, Tg **UPLAND GRAVEL** – Sand and gravel. Orange and brown in color. Consists of lower phase (TQg) and high phase (Tg). Sand is fine- to coarse- grained and consists of quartz with minor amounts of weathered chert. Gravel (2-64 mm) consists of sub-rounded to well rounded, yellow, white and grey quartz and quartzite. High phase sediments (Tg) contain trace amounts of weathered feldspar. Lower phase sediments (TQg) occur at elevations between 70 to 170 feet. Thickness is as much as approximately 38 feet thick, as reported in well record 31-57671 (located approximately 1.5 miles southeast of Berlin near Bishops). Base of the upland gravel, low phase sediments decline from 140 to 150 feet in elevation at their upland limit to as low as 70 feet in elevation at their downstream limits, suggesting a drainage during deposition that generally follows the same directions as modern drainage. High phase deposits (Tg) occur at elevations between 90 to 150 feet and are only present in the northern part of the quadrangle. Thickness is as much as approximately 30 feet, as illustrated in cross section A-A'. An exposure in these deposits near Haines Corner, described by Newell (2005), showed 3 to 4 feet of pebbly sand with some horizontal stratification overlying cross-bedded medium sand (here interpreted as Cohansey Formation, a Miocene bedrock unit) and laminated, cryoturbated fine sand (here interpreted as Kirkwood Formation, another Miocene bedrock unit). An undeformed ice-wedge cast penetrated both the upland gravel and Kirkwood Formation. The ice-wedge cast indicates that the upland gravel pre-dates the development of permafrost here.

Tb **BRIDGETON FORMATION** – Clayey sand and gravel (fig. 2). Strong brown, reddish-brown, and yellow-brown in color. Sand is medium- to coarse- grained quartz with minor amounts of feldspar and chert. Gravel consists of well rounded to sub-rounded, yellow, orange, pink, and white quartz and grey and white chert with minor amounts of quartzite. Gravel is iron-stained and occurs in thin- to thick-beds. Chert pebbles are highly weathered. Gravel size ranges from very fine- to very coarse- pebbles (2-64 mm) with lesser amounts of cobble-sized materials (64-256 mm). In northwestern areas of the quadrangle, deposits cap areas of generally 160 to 170 feet in elevation and higher. However, in southeastern areas of the quadrangle, deposits cap areas of generally 140 feet in elevation and higher. Such base elevations suggest a southeastern drainage which matches observations previously made by Stanford (2003), Owens & Minard (1979), and Martino (1981). Thickness is as much as approximately 45 feet as illustrated in cross section A-A'. Owens & Minard (1979) and Pazzaglia (1993) used stratigraphic position and petrologic correlations to marine deposits to suggest a late Miocene age.

Qwcp **WEATHERED COASTAL PLAIN BEDROCK FORMATIONS** - Exposed unconsolidated bedrock formations that are Late Cretaceous to middle Miocene in age. Formations were variably oxidized and weathered during the Neogene and Quaternary periods. Crop out on hillsides, uplands, and a few high hills above the Bridgeton plain.

REFERENCES

Carone, A.C., 2021, Bedrock geology of the Clementon quadrangle, Burlington and Camden Counties, New Jersey: New Jersey Geological Survey Geologic Map Series GMS 21-5, scale 1:24,000.

Martino, R.L., 1981, The sedimentology of the late Tertiary Bridgeton and Pensauken formations in southern New Jersey: unpublished Ph.D. dissertation, Rutgers University, New Brunswick, N.J., 229 p.

Newell, W.L., 2005, Evidence of cold climate slope processes from the New Jersey Coastal Plain: debris flow stratigraphy at Haines Corner, Camden County, New Jersey: U.S. Geological Survey Open-file Report 05-1296, http://pubs.usgs.gov/of/2005/1296, unpaginated.

Owens, J.P., and Minard, J.P., 1979, Upper Cenozoic sediments of the lower Delaware valley and northern Delmarva Peninsula, New Jersey, Pennsylvania, Delaware, and Maryland: U.S. Geological Survey Professional Paper 1067D, 47 p.

Pazzaglia, F.J., 1993, Stratigraphy, petrography, and correlation of the late Cenozoic middle Atlantic Coastal Plain deposits: implications for late-stage passive margin geologic evolution: Geological Society of America Bulletin, v. 105, p. 1617-1634.

Stanford, S. D., 2000, Geomorphology of selected Pine Barrens savannas: report prepared for N.J. Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, 10 p. and appendices.

Stanford, S.D., 2003, Surficial geology of the Runnemede quadrangle, Camden and Gloucester Counties, New Jersey: New Jersey Geological Survey Open File Map Series OFM 52, scale 1:24,000.

EXPLANATION OF MAP SYMBOLS

Contact of surficial deposit - Solid where well-defined on LiDAR and aerial photographs; dashed where approximately located.

5Qtuo, 2Qe/5Qtu — Material observed in exposure, excavation, or hand auger hole - Identifiers represent depth and abbreviation of surficial unit observed. Slash mark present if more than one surficial unit was observed. If no identifier is indicated, no surficial units were found.

5Tb — Material formerly observed in outcrop or excavation - Identifier represents depth and abberviation of surficial unit if present and distinguishable in logs. Field notes on file at N.J. Geological and Water Survey.

31-04781 5Qtu, E201502167, P200901845 — Wells with geophysical and lithologic logs - Upper identifier is the well permit number issued by the N.J Department of Environmental Protection. Lower identifier indicates depth and abbreviation of surficial unit if present and distinguishable in logs. Locations accurate to within 500 feet.

B0033567 4Qtuo — Soil boring with lithologic log - Upper identifier is the N.J. Department of Transportation Log ID number. Lower identifier indicates depth and abbreviation of surficial unit if present. Locations accurate to within 100 feet.

1 — Photograph location - Identifier refers to figure number.

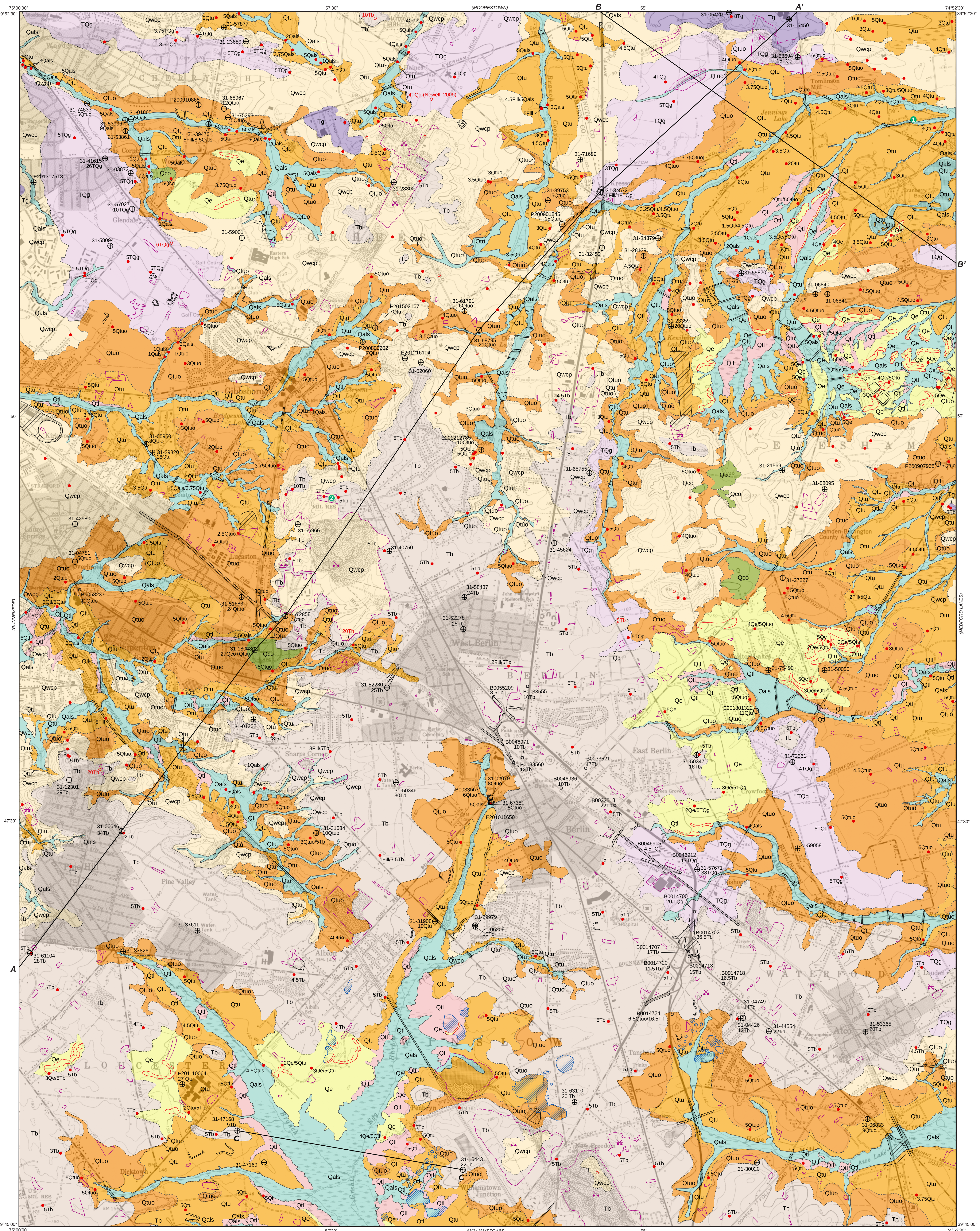
Dune and dune remnants - Outlined in red.

Shallow topographic basin - Includes thermokarst basins formed from the melting of permafrost and deflation basins formed by wind erosion.

Excavation perimeter of stormwater management basins or man-made ponds - Line encloses area of excavation.

Excavation perimeter of sand or gravel pits active in 2020 - Line encloses area of excavation.

Excavation perimeter of sand or gravel pits inactive in 2020 - Line encloses area of excavation.



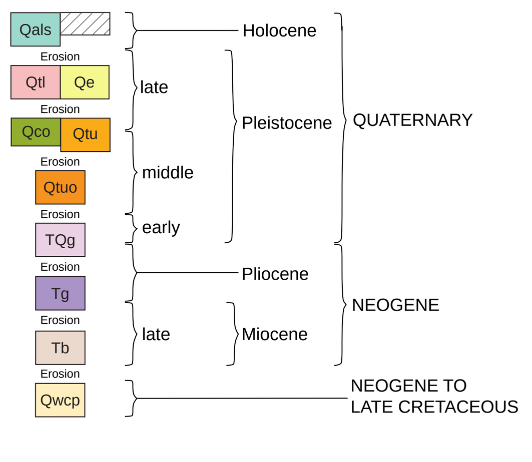
Basemap mapped, edited, and published by the U.S. Geological Survey, 1967; photorevised 1981. Coordinate tick marks are on 1927 North American datum.

SCALE 1:24 000
1/2 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETER
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped 2017-2019.
Cartography by Alexandra R. Carone. Assistance in data collection provided by NJGWS employee Colleen Lane. Helpful external reviews provided by Peter McLaughlin of the Delaware Geological Survey and Marcie Occhi of the Virginia Division of Geology and Mineral Resources.

Research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under U.S.G.S. award number G18AC00178. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

CORRELATION OF MAP UNITS



SURFICIAL GEOLOGY OF THE CLEMENTON QUADRANGLE BURLINGTON AND CAMDEN COUNTIES, NEW JERSEY

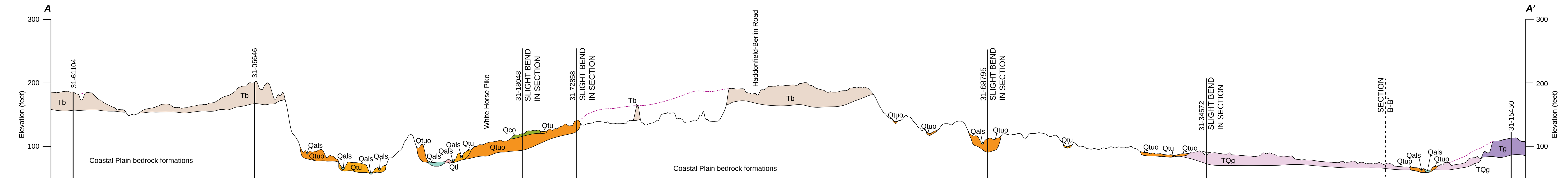
By

Alexandra R. Carone

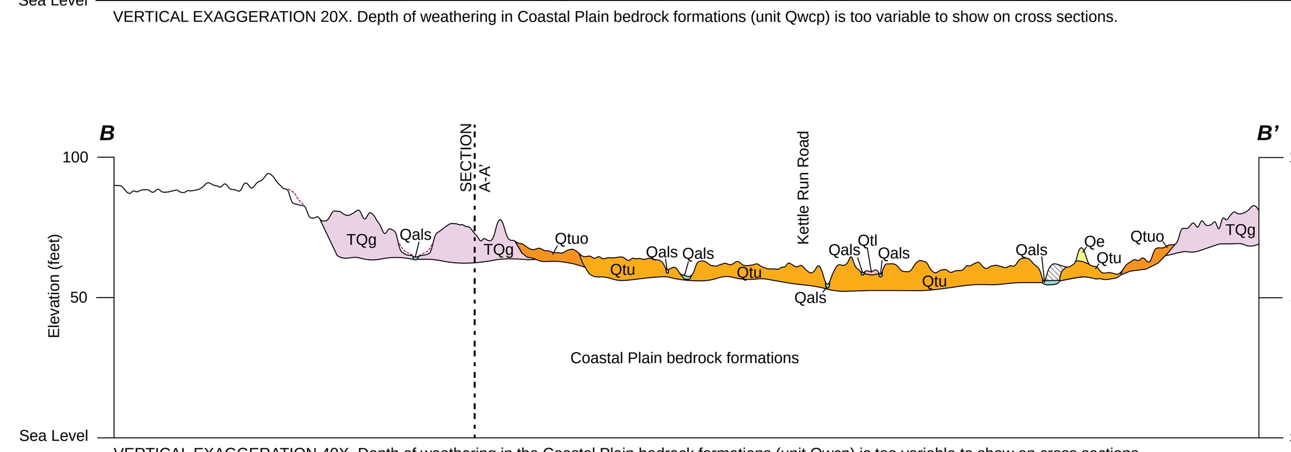
2021

APPROXIMATE MEAN DECLINATION, 2019

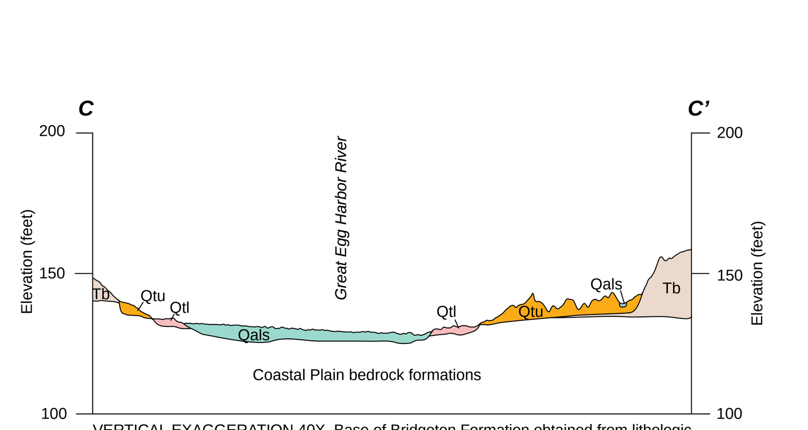
LOCATION IN NEW JERSEY



VERTICAL EXAGGERATION 20X. Depth of weathering in Coastal Plain bedrock formations (unit Qwcp) is too variable to show on cross sections.



VERTICAL EXAGGERATION 40X. Depth of weathering in the Coastal Plain bedrock formations (unit Qwcp) is too variable to show on cross sections.



VERTICAL EXAGGERATION 40X. Base of Bridgeton Formation obtained from lithologic records for wells 31-47168 and 31-16443. Depth of weathering in Coastal Plain bedrock formations (unit Qwcp) is too variable to show on cross sections.

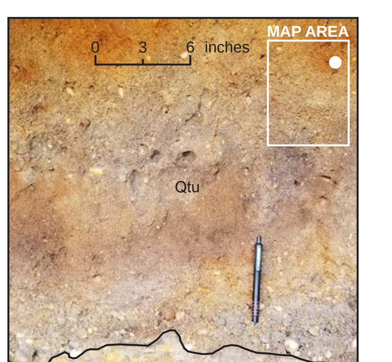


Figure 1. Gravelly, fine- to coarse- grained sand of upper terrace deposit (Qtu) over a weathered coastal plain bedrock formation (Qwcp). Contact traced in black. Inset shows location of this site on the map.

Figure 2. Gravelly coarse- grained sand overlain by crossbedded, medium- to very coarse-grained sand of the Bridgeton Formation (Tb). Inset shows location of this site on the map.

EXPLANATION OF CROSS SECTION SYMBOLS

Contact of surficial deposit - Approximately located.

Land surface before excavation - Based on basemap.

Artificial fill.

31-15450 — Approximate location of well - Identifier corresponds to well permit number issued by N.J. Department of Environmental Protection. Locations accurate to within 500 feet.