DEPARTMENT OF ENVIRONMENTAL PROTECTION
WATER RESOURCE MANAGEMENT
NEW JERSEY GEOLOGICAL SURVEY

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U. S. GEOLOGICAL SURVEY
NATIONAL GEOLOGIC MAPPING PROGRAM

BEDROCK GEOLOGY OF THE RUNNEMEDE QUADRANGLE CAMDEN AND GLOUCESTER COUNTIES, NEW JERSEY

OPEN FILE MAP SERIES OFM 86

INTRODUCTION

Bedrock of the Runnemede quadrangle consists of unconsolidated sand, silt, clay, and glauconite laid down in coastal, nearshore-marine, and continental-shelf settings 100 to 10 million years ago (Ma). The sediments are divided into 14 formations. Lithology, age, and contact relationships of the formations are provided in the *Description of Map Units*. Ages of the formations and their bounding unconformities are summarized in the *Correlation of Map Units*. Geologic cross sections AA' and BB' show the subsurface geometry of the sediments along the line of section. Surficial sand and gravel, peat, and organic silt and clay, of late Miocene (10-5.3 Ma), Pliocene (5.3-2.6 Ma), and Quaternary (2.6 Ma to present) age, overlie the bedrock throughout much of the quadrangle. These deposits were mapped by Stanford (2003). They are shown by overprint pattern on the map only where they are more than five feet thick.

DESCRIPTION OF MAP UNITS

Tch COHANSEY FORMATION--Quartz sand, locally gravelly, typically cross-stratified (trough and planar-tabular). Medium-grained to very coarse-grained sand; gravel is commonly concentrated at the base of channels. Dominantly a quartzitic sand with traces of weathered feldspar and chert. Detrital heavy minerals may be abundant (2 to 3 percent) and ilmenite dominates among the opaque minerals. Contains local concentrations of small to large clay-lined burrows of the trace fossil *Ophiomorpha nodosa*. Iron-oxidized replaced shell-"hash" concentrates are visible in the formation in the adjacent Clementon quadrangle (to the east of this quadrangle). Sand is light in color and typically weathers to various shades of red and orange.

It unconformably overlies the Kirkwood Formation.

No dateable material has been recovered from the Cohansey in this quadrangle. Owens and others (1989) considered the Cohansey to be middle Miocene, owing to the similarity of its palynomorphs to those of the Kirkwood Formation. Strontium isotope age estimates for the upper part of the Kirkwood Formation (Sugarman and others, 1993) indicate that the Cohansey Formation is no older than about 12 Ma (middle Miocene).

Tkw KIRKWOOD FORMATION--Quartz sand, fine to very fine grained, micaceous, with extensive iron oxide (Liesegang) banding. Typically massive bedded, although partially preserved trough cross-bedding and flaser beds occur locally. *Ophiomorpha* burrows approximately 1 inch in diameter common in some beds (fig. 1). In one outcrop fine Kirkwood sand is interbedded with pale yellowish-orange clay. Locally may contain minor ilmenite. Deeply weathered in outcrop to shades of orange (dark yellowish-orange, grayish-orange), yellow, white, reddish-brown, and light gray.

In the subsurface, the Kirkwood grades downward into a darker (grayish-brown) clayey, micaceous, fine to very fine-grained quartz sand and silt that contains peaty material.

The Kirkwood here correlates with the Shiloh Marl member of the Kirkwood Formation, and is lower Miocene (21-20 Ma; Sugarman and others, 1993).

It unconformably overlies several older formations here; a wavy pebble layer marks the contact zone.

Tmq MANASQUAN FORMATION--Quartz sand, medium to dark gray, very silty and clayey, glauconitic (as much as 5%), a trace of phosphate pellets. Foraminifera are common. Occurs in subsurface only, see cross-sections AA' and BB'. The Manasquan is lower Eocene (54-49 Ma; Owens and others, 1989; Sugarman and others, 1991).

Tvt VINCENTOWN FORMATION--Quartz sand, calcarenite, and quartz glauconite sand are the three distinct lithofacies of the Vincentown in the quadrangle. Colors vary from greenish-gray, grayish-green and yellowish-green to dusky-yellow to pale yellowish-orange where weathered; calcarenite is commonly moderate olive brown. The quartz sand is typically medium-grained and contains minor feldspar and glauconite. The calcarenite (calcareous sand) is very fossiliferous, containing foraminifera and bryozoan fragments. The basal 5 feet of the Vincentown is a quartz glauconite sand which may contain a bioherm consisting of shells of *Oleneothyris harlani* (Morton) and *Gryphaea dissimilaris* (Minard and others, 1964; Bernstein, 1987).

Based on its foraminifera, the Vincentown in this area is late Paleocene (59-56 Ma; Olsson and Wise, 1987).

Tht HORNERSTOWN FORMATION--Glauconite sand, slightly clayey to very clayey where weathered, dusky green to dusky blue green where fresh, dusky yellowish-green mottled with red where altered. Primarily fine to medium- grained glauconite sand, botryoidal in shape, also some accordion forms. Traces of quartz, mica, feldspar, and phosphatic material. Its dusky-green clay matrix, consisting largely of glauconite, distinguishes it from the underlying Navesink Formation.

The contact with the underlying Navesink Formation is heavily bioturbated and irregular, and marked by glauconite-filled burrows containing bright green Hornerstown glauconite in the upper 1-2 feet of the Navesink.

Based on its foraminifera, the Hornerstown is early Paleocene (65-62 Ma; Olsson and others, 1997).

Kns NAVESINK FORMATION--Clayey glauconite sand, massive-bedded, bioturbated (burrows as much as 1 inch in diameter), olive-gray (5Y 3/2), olive-black (5Y 2/1) and dark greenish-black (5GY 2/1) where fresh; shades of gray and brown where weathered (fig. 2). Glauconite is botryoidal and predominantly medium- to coarse-grained. Clay-silt content is as much as 30 percent. Accessory minerals include pyrite, mica, quartz sand, and phosphatic fragments.

Typically the Navesink is highly fossiliferous, but in the Runnemede quadrangle, only scattered weathered fossils of *Pycnodonte* sp. and *Exogyra* sp. occur in outcrop.

The contact with the underlying Mount Laurel Formation is unconformable. The basal few feet of the Navesink contain a thick-bedded glauconitic quartz sand with granules and sand-size lignite fragments (reworked from the underlying Mount Laurel), and black phosphate pebbles. This contact is readily recognized in the subsurface by its sharp positive gamma-ray response.

The Navesink is Late Cretaceous (Maastrichtian) in age based on the occurrence of the planktonic microfossils *Globotrucana gansseri* (Olsson, 1964) and *Lithraphidites quadratus* and the previously described macrofossils. Strontium-isotope age estimates for the Navesink range from 69-67 Ma (Sugarman and others, 1995).

Kml MOUNT LAUREL FORMATION--Quartz sand, massive to crudely bedded, mostly medium-grained, slightly glauconitic and feldspathic (5 to 10%), with scattered dark, ovoid-shaped medium-grained phosphate pellets. Generally weathered to a light brown, pale yellowish-brown or light gray (fig. 3). Coarser in the upper 5 feet, with granules and pebbles; this interval also contains reworked glauconite (from the overlying Navesink) concentrated in burrows. The Mount Laurel fines downward to clayey fine-to-medium-grained quartz sand, with a higher content of glauconite and mica. Burrows are common in outcrop. Fossils are rare in outcrop due to weathering, but are common in the subsurface.

The Mount Laurel grades downward into the underlying Wenonah Formation.

Kw WENONAH FORMATION--Quartz sand, fine- to very-fine-grained, massive, clayey, very micaceous, with abundant carbonaceous matter, and varied amounts of glauconite (3-20%; most abundant in the lower 3-5 feet). Colors include light olive-gray, brownish-gray, and light-brown where weathered; medium dark-gray to dark-gray where fresh. Grades downward into the Marshalltown Formation.

Kmt MARSHALLTOWN FORMATION--Quartz glauconite sand, massive, fine- to medium-grained, and clayey. Glauconite is very abundant in the lower few feet but is less common higher up in a nearly equal mixture of quartz and glauconite. Greenish-black weathering to greenish-gray, moderate olive-brown and light-brown. Although quartz and glauconite constitute the bulk of the formation, feldspar, mica, finely disseminated pyrite, and phosphatic fragments are present. Macrofossil assemblages containing the mollusks *Exogyra ponderosa* and *Ostrea falcata* are abundant locally.

The Marshalltown is the basal transgressive unit of an unconformity-bounded cycle of sedimentation that includes the overlying Wenonah and Mount Laurel.

The Marshalltown has been assigned to the middle Campanian (79-76 Ma) based on nannofossil Zone CC 20-21 in southwestern New Jersey (Sugarman and others, 1995). No fossils have been found in the formation in the Runnemede quadrangle.

The Marshalltown unconformably overlies the Englishtown Formation; along the contact, the Englishtown is extensively bioturbated and its burrows filled with glauconite sand from the overlying Marshalltown.

Ket ENGLISHTOWN FORMATION--Quartz sand, loose, fine- to coarse-grained, locally interbedded with thin to thick beds of dark clay and silt. Outcrops are deeply weathered to shades of light brown, yellowish-gray, and dark yellowish-orange. Sand contains considerable carbonaceous matter, mica and glauconite; carbonaceous matter and pyrite are common in the clays (imparting a dark-gray color where unweathered).

Wolfe (1976) assigned an early Campanian (84-81 Ma) age to the Englishtown on the basis of a distinctive assemblage of palynomorphs.

Kwb WOODBURY FORMATION--Clay, grayish-black to black, weathers pale yellowish-brown and dark yellowish-orange, massive, and sandy (very fine grained quartz). Conspicuously micaceous with minor amounts of finely dispersed pyrite and carbonaceous material; locally contains minor glauconite. Iron oxides fill fractures or occur in layers in most weathered beds.

Kmv MERCHANTVILLE FORMATION--Thick-bedded sequence of glauconitic sand and silt, and intercalated micaceous clayey silt. The glauconitic sand is grayish-olive, greenish-black, or dark greenish-gray; the clay-silt is shades of black and gray. Quartz and glauconite are the major sand components; feldspar, mica (colorless and green), and pyrite are minor constituents. Siderite-cemented layers are common. The formation is highly bioturbated.

The Merchantville is the basal transgressive bed of the unconformity-bounded coarsening-upward cycle that includes the overlying Woodbury and Englishtown formations.

The Merchantville is lower Campanian (84-81 Ma) based on the ammonite *Scaphites hippocrepis III* (Owens and others, 1977).

Subsurface Units (shown only on cross-sections)

Kmg MAGOTHY FORMATION--Quartz sand and intercalated clay, thin- to thick-bedded. Sand is light- to medium-gray or brownish-gray; clay is olive-black to grayish-black. Bedding is horizontal (laminated) and cross-stratified. The sand is fine to very coarse, well sorted within each bed, predominantly quartz, but includes minor feldspar and mica. Pyrite-cemented and pyrite-coated sand concretions are common. Carbonaceous material is abundant in beds as much as 0.5-foot thick.

The Magothy is Upper Cretaceous (Santonian, 86-84 Ma) based on Zone V pollen (Christopher, 1977).

Kp POTOMAC FORMATION, UNIT 3--Sand, fine to coarse, light-colored, cross-bedded, somewhat gravelly, interbedded with white or variegated red and yellow clays. Beds of dark gray woody clays are rare.

Pollen from the upper Potomac is assigned to Zone III (early Cenomanian; 100-96 Ma; Doyle and Robbins, 1977).

MAP SYMBOLS

Contact—Approximately located. Triangle indicates contact observed in outcrop. Open triangle indicates contact formerly observed, as recorded in N. J. Geological Survey permanent notes.

Formation observed in exposure, excavation, or hand-auger hole.

Formation formerly observed in excavation—from N. J. Geological Survey permanent notes.

figure 1 Photograph location.

3 / 17 Auger hole—Number above indicates thickness of surficial deposit (in feet); number below, if present, indicates depth to base of formation (in feet).

⊙7-256 Well used to construct cross section—Identifiers of the form 7-xxx are U. S. Geological Survey Ground Water Site Inventory numbers.

Surficial deposits—Shown where continuous and more than 5 feet thick.

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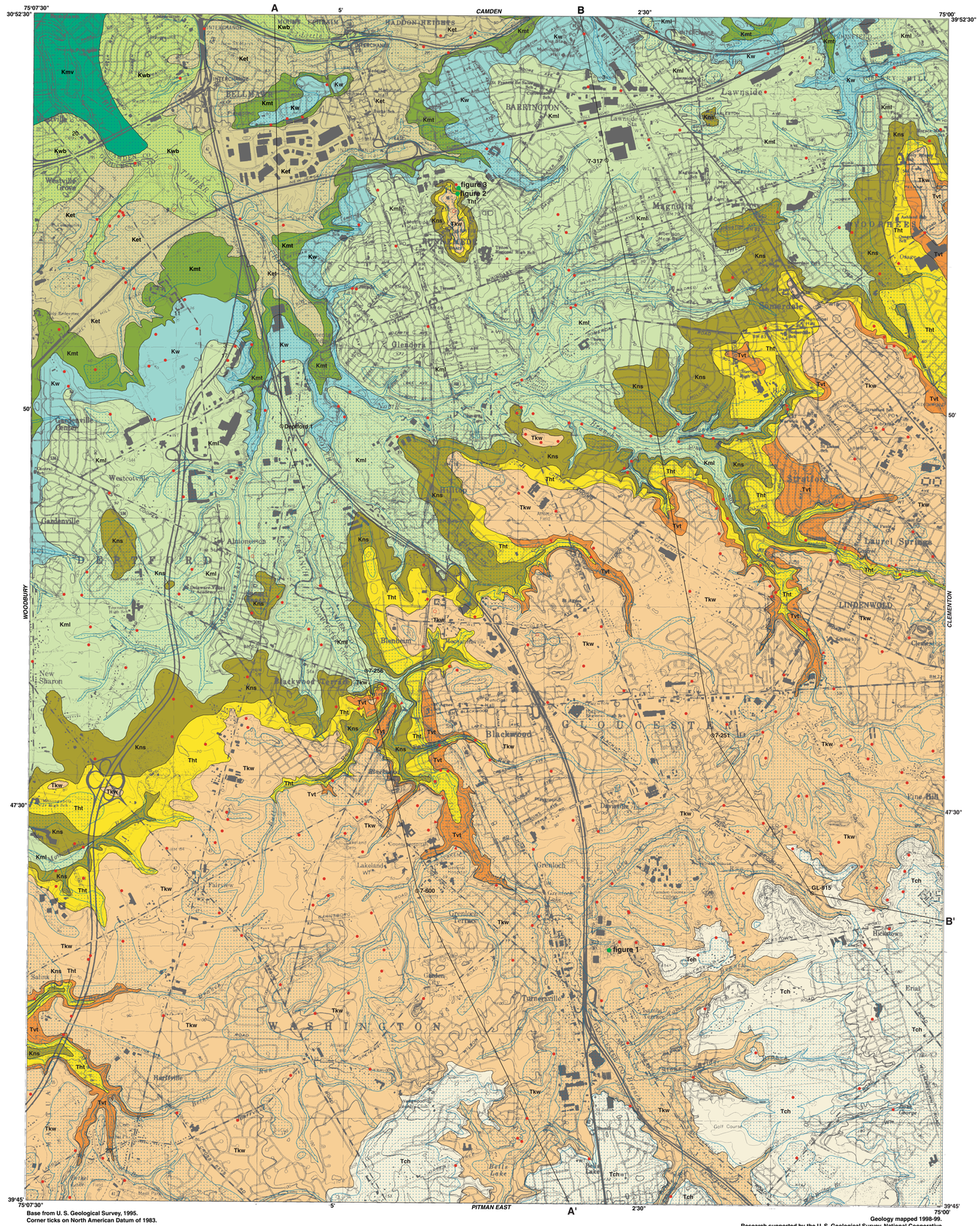
CORRELATION OF MAP UNITS

Tch	middle	Miocene	Neogene
UNCONFORMITY			
Tkw	early	Miocene	Neogene
UNCONFORMITY			
Tmq	early	Eocene	Paleogene
Tvt	late	Paleocene	Paleogene
Tht	early	Paleocene	Paleogene
UNCONFORMITY			
Kns	Maastrichtian		Late Cretaceous
UNCONFORMITY			
Kml, Kw, Kmt	Campanian		Late Cretaceous
UNCONFORMITY			
Ket, Kwb, Kmv			Late Cretaceous
UNCONFORMITY			
Kmg	Santonian		Late Cretaceous
UNCONFORMITY			
Kp	Cenomanian		Late Cretaceous



Base from U. S. Geological Survey, 1995.
Corner ticks on North American Datum of 1983.

Geology mapped 1998-99.

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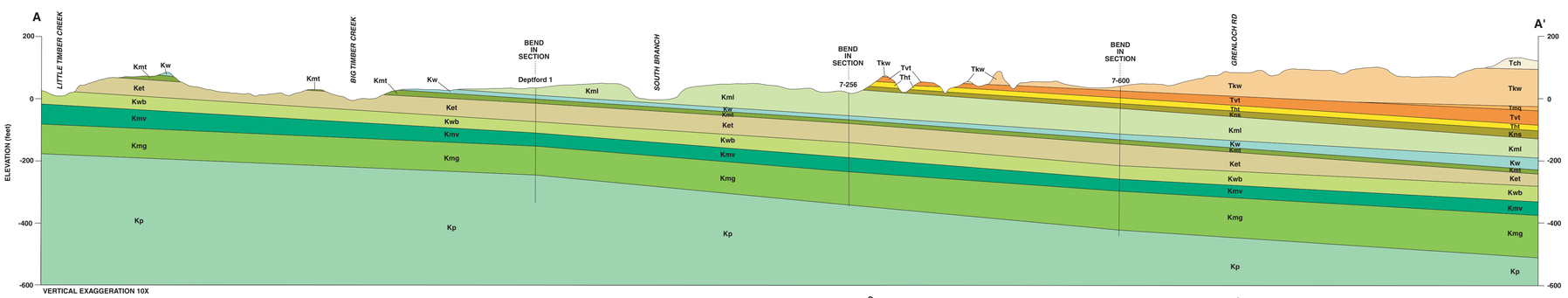
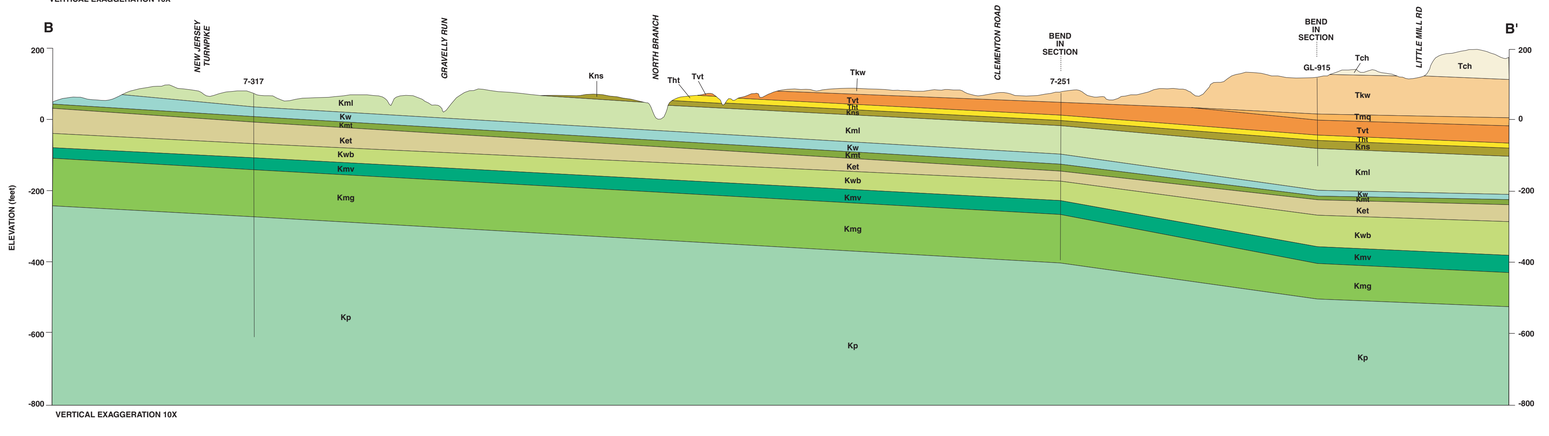
The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U. S. Government.





APPROXIMATE MEAN DECLINATION, 1999

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

LOCATION IN NEW JERSEY

BEDROCK GEOLOGY OF THE RUNNEMEDE QUADRANGLE CAMDEN AND GLOUCESTER COUNTIES, NEW JERSEY

by
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NEW JERSEY GEOLOGICAL SURVEY 1835

Figure 1. Fine quartz sand of the Kirkwood Formation. Vertical features to left of shovel are *Ophiomorpha* burrows. Location of photo shown on map and inset.

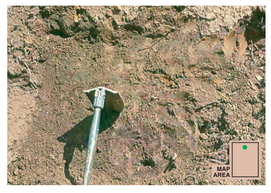

Figure 2. Weathered glauconite sand of the Navesink Formation. Location shown on map and inset.

Figure 3. Medium-grained burrowed glauconitic quartz sand of the Mount Laurel Formation. Wavy horizontal layers are ironstone crusts. Location shown on map and inset.