HYDROGEOLOGIC FRAMEWORK OF THE NEW JERSEY COASTAL PLAIN

REGIONAL AQUIFER-SYSTEM ANALYSIS

U.S. GEOLOGICAL SURVEY
Open-File Report 84-730

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By Otto S. Zapecza

Open-File Report 84-730

Trenton, New Jersey
1984

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

Factors for converting inch-pound units to the International System (SI) units are given below:

Multiply	by	to obtain
ft (feet)	0.3048	m (meter)
mi (mile	1.609	km (kilometer)
mi^2 (square mile)	2.590	km^2 (square kilometer)

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ABSTRACT

This report presents the results of a water-resources-oriented subsurface mapping program within the Coastal Plain of New Jersey. The occurrence and configuration of 15 regional hydrogeologic units have been defined, based primarily on the interpretation of borehole geophysical data. The nine aquifers and six confining beds are composed of unconsolidated clay, silt, sand, and gravel and range in age from Cretaceous to Quaternary.

Electric and gamma-ray logs from more than 1,000 Coastal Plain wells were examined. Of these, interpretive data for 302 sites were selected on the basis of logged depth, quality of data, and data distribution to prepare structure contour and thickness maps for each aquifer, and a thickness map for each confining bed. These maps, together with 14 hydrogeologic sections, show the geometry, lateral extent, and vertical and horizontal relationships among the 15 hydrogeologic units.

The hydrogeologic maps and sections show that distinct lower, middle, and upper aquifers are present within the Potomac-Raritan-Magothy aquifer system near the Delaware River from Burlington County to Salem County. Although the lower aquifer is recognized only in this area, the middle aquifer extends into the northeastern Coastal Plain of New Jersey where it is stratigraphically equivalent to the Farrington aquifer. The upper aquifer extends throughout most of the New Jersey Coastal Plain and is stratigraphically equivalent to the Old Bridge aquifer in the northeastern Coastal Plain. The overlying Merchantville-Woodbury confining bed is the most regionally extensive confining bed within the Coastal Plain of New Jersey. Its thickness ranges from less than 100 feet near the outcrop to more than 450 feet along the coast. The Englishtown aquifer system acts as a single aquifer throughout most of its subsurface extent, but contains two water-bearing sands in parts of Monmouth and Ocean Counties. The overlying Marshalltown-Wenonah confining bed is a thin, leaky unit ranging in thickness from approximately 20 to 80 feet. The Wenonah-Mount Laurel aquifer is identified in the subsurface throughout the New Jersey Coastal Plain southeast of its outcrop area.

Sediments that overlie the Wenonah-Mount Laurel aquifer and that are subjacent to the major aquifers within the Kirkwood Formation and Cohansey Sand are described hydrologically as a composite confining bed. These include the Navesink Formation, Red Bank Sand, Tinton Sand, Hornerstown Sand, Vincentown Formation, Manasquan Formation, Shark River Formation, Piney Point

Formation, and the basal clay of the Kirkwood Formation. The Vincentown Formation functions as an aquifer within 3 to 10 miles downdip of its outcrop area. In areas farther downdip the Vincentown Formation functions as a confining bed. The Piney Point aquifer is laterally persistent from the southern New Jersey Coastal Plain northward into parts of Burlington and Ocean Counties. The Atlantic City 800-foot sand of the Kirkwood Formation can be recognized in the subsurface along coastal areas of Cape May, Atlantic, and southern Ocean Counties, but inland only as far west as the extent of the overlying confining bed. In areas west of the extent of the overlying confining bed, the Kirkwood Formation is in hydraulic connection with the overlying Cohansey Sand and younger surficial deposits and functions as an unconfined aquifer.

INTRODUCTION

Purpose and Scope

This report is the product of an intensive study of New Jersey Coastal Plain borehole geophysical data made, in part, to develop a hydrogeologic framework for use in the U.S. Geological Survey's Northern Atlantic Coastal Plain Regional Aquifer System Analysis (RASA) project. A 10-layer ground-water flow model of the New Jersey Coastal Plain aquifer system was constructed based on the information presented in this report. The same information forms part of the basis of the hydrogeologic framework for a 10-layer regional flow model of the northern Atlantic Coastal Plain from Long Island to North Carolina. Correlation of stratigraphic units in the various states of the Northern Atlantic Coastal Plain is shown in table 1.

The purpose of this report is to define, on a regional basis, the subsurface occurrence and configuration of hydrogeologic units (aquifers and confining beds) in the New Jersey part of the Atlantic Coastal Plain. This multilayer system is shown in a series of structure contour maps, isopach maps, and hydrogeologic sections based primarily on the interpretation of geophysical logs. Past efforts to understand the hydrology of the Coastal Plain's ground-water resources have been limited by the lack of a regional hydrogeologic framework. Documentation of the occurrence and geometry of the major aquifers and confining beds provides a firmer basis for more realistic water-management decisions.

Location and Extent

The New Jersey Coastal Plain extends from Delaware Bay in the southwest to Raritan Bay in the northeast, and from the Fall Line in the west to the Atlantic Ocean in the east (fig. 1). It is approximately 4,200 mi^2 and is part of the larger Atlantic Coastal Plain that extends from Florida to Newfoundland and eastward to the edge of the Continental Shelf. The area of study includes all of Monmouth, Burlington, Ocean, Camden, Gloucester,

Table 1.--Generalized stratigraphic-correlation chart of the Northern Atlantic Coastal Plain.

ERA	SYSTEM	SERIES	NORTH CAROLINA	VIRGINIA	MARYLAND	DELAWARE	NEW JERSEY	NEW YORK
Cenozoic	Quaternary	Pleistocene	Unnamed	Undifferentiated deposits	Undifferentiated deposits	Undifferentiated deposits	Cape May Formation Undifferentiated deposits	Upper Pleistocene deposits Gardners Clay Jameco Gravel
Cenozoic	Teritary	Pliocene	Chowan River Fm Yorktown Formation	Chesapeake Group: Chowan River Fm Yorktown Formation	Chesapeake Group: Yorktown Formation	Undifferentiated deposits		Mannetto Gravel (Pliocene?)
Cenozoic	Teritary	Miocene	Pungo River Formation Belgrade Formation	Chesapeake Group: Eastover Formation St. Marys Formation Choptank Formation Calvert Formation	Chesapeake Group: Eastover Formation / Brandywine Formation St. Marys Formation Choptank Formation Calvert Formation	Chesapeake Group undivided	Pensauken Formation Bridgeton Formation Cohansey Sand Kirkwood Formation	
Cenozoic	Teritary	Oligocene	River Bend Formation	Unnamed				
Cenozoic	Teritary	Eocene	Castle Hayne Formation	Chickahominy Formation Piney Point Formation Nanjemoy Formation Marlboro Clay	Piney Point Formation Nanjemoy Formation	Piney Point Formation Nanjemoy Formation	Piney Point Formation Shark River Formation Rancocas Group: Manasquan Formation	
Cenozoic	Teritary	Paleocene	Beaufort Formation	Aquia Formation Brightseat formation	Aquia Formation Brightseat Formation	Rancocas Group: Vincentown Formation Hornerstown Fm	Rancocas Group: Vincentown Formation Hornerstown Sand	
Mesozoic	Cretaceous	Upper Cretaceous	Peedee Formation Black Creek Formation Middendorf Formation Cape Fear Formation	Mattaponi Formation	Severn Formation Matawan Formation Magothy Formation	Severn Formation Mount Laurel Sand Marshalltown Formation Englishtown Formation Woodbury Clay Merchantville Formation Magothy Formation	Monmouth Group: Tinton Sand Red Bank Sand Navesink Formation Mount Laurel Sand Matawan Group: Wenonah Formation Marshalltown Fm Englishtown Fm Woodbury Clay Merchantville Fm Magothy Formation Raritan Formation	Monmouth Group Matawan Group Magothy Formation Raritan Formation: Clay member, Lloyd Sand member
Mesozoic	Cretaceous	Lower Cretaceous	Unnamed	Potomac Group: Patapsco Formation Patuxent Formation	Potomac Group: Patapsco Formation Arundel Formation Patuxent Formation	Potomac Group	Potomac Group	
Mesozoic	Jurassic (?)	Upper Jurassic(?)	Unnamed					

modified from Meisler, 1980, fig. 4.

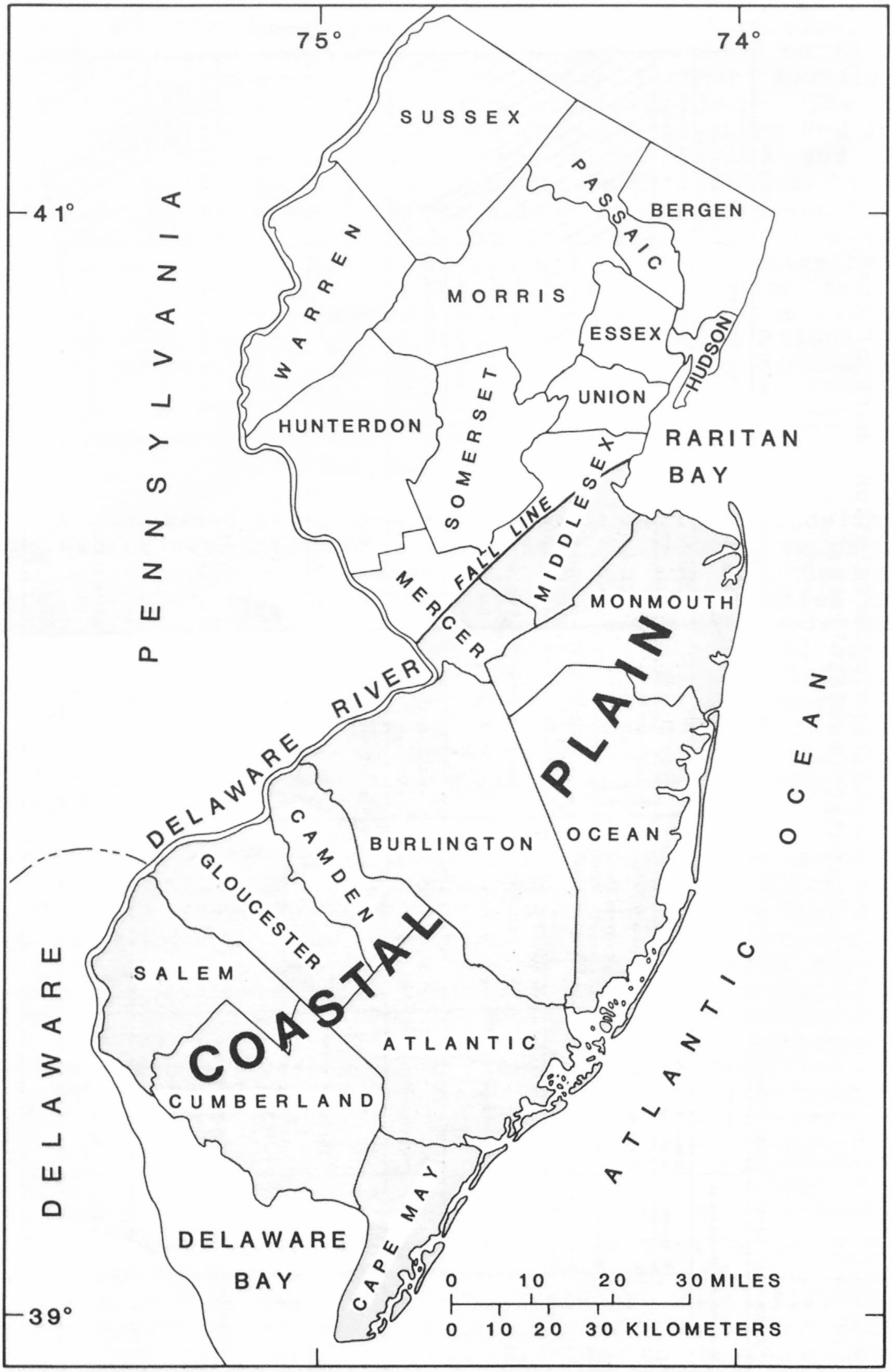

Figure 1.--Location of study area.

Salem, Atlantic, Cumberland, and Cape May Counties, and parts of Middlesex and Mercer Counties.

Previous Investigations

Subsurface stratigraphic relationships within the Coastal Plain of New Jersey have been documented in a number of previous studies. Richards (1945) presented a series of geologic cross sections outlining the subsurface stratigraphy of the Atlantic Coastal Plain. Richards and others (1962) produced generalized structure contour maps of geologic units of the New Jersey Coastal Plain. Detailed Cretaceous subsurface stratigraphy has been delineated by Perry and others (1975) and Petters (1976). Brown, Miller, and Swain (1972) presented structural contour maps, geohydrologic maps, and cross sections for 17 chronostratigraphic units in the Coastal Plain from North Carolina to New York.

Numerous county ground-water reports contain subsurface information, including contour maps and cross sections for local hydrogeologic systems. These include Monmouth County (Jablonski, 1968), Ocean County (Anderson and Appel, 1969), Burlington County (Rush, 1968), Camden County (Farlekas and others, 1976), Gloucester County (Hardt and Hilton, 1969), Salem County (Rosenau and others, 1969), and Cape May County (Gill, 1962).

Structure-contour maps for the pre-Cretaceous basement, Potomac-Raritan-Magothy aquifer system, and the Merchantville-Woodbury confining bed were presented by Gill and Farlekas (1976). Previously mapped hydrogeologic units in the northern part of the New Jersey Coastal Plain include the Farrington aquifer (Farlekas, 1979), the Englishtown aquifer (Nichols, 1977b), and the Wenonah-Mount Laurel aquifer (Nemickas, 1976). Nemickas and Carswell (1976) presented stratigraphic and hydrogeologic data for the Piney Point aquifer in the southern Coastal Plain of New Jersey.

Well-numbering System

The well-numbering system on the index map, tables, and hydrogeologic sections in this report is based on the numbering system used by the U.S. Geological Survey in New Jersey since 1978. The well number consists of a county code number and a sequence number assigned to the well within the county. Code numbers for the New Jersey Coastal Plain counties are:

1......	Atlantic	21......	Mercer
5......	Burlington	23......	Middlesex
7......	Camden	25......	Monmouth
9......	Cape May	29......	Ocean
11......	Cumberland	33......	Salem
15......	Gloucester		

A representative well number is 15-137 for the 137th well inventoried in Gloucester County.

Acknowledgments

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SUMMARY OF NEW JERSEY COASTAL PLAIN GEOLOGY

Structural Setting

The New Jersey Coastal Plain is a seaward-dipping wedge of unconsolidated sediments that range in age from Cretaceous to Holocene (table 2). These sediments, for the most part, are composed of clay, silt, sand, and gravel and are classified as continental, coastal, or marine-type deposits. The Cretaceous and Tertiary sediments generally strike northeast-southwest and dip gently to the southeast from 10 to 60 ft/mi. Overlying deposits of Quaternary age, where present, are essentially flat lying. The Coastal Plain deposits thicken seaward from a featheredge at the Fall Line to more than 6,500 ft at the southern tip of Cape May County (Gill and Farlekas, 1976).

The initial deposition of Coastal Plain sediments began during the Late Jurassic or Early Cretaceous after the formation of the early Atlantic Ocean (Sheridan, 1974a, p. 465). During the Mesozoic and Cenozoic Eras, block-faulting of the basement created highs and lows on the basement surface along the Atlantic Continental Margin (Sheridan, 1974a, p. 401). These basement highs and lows had a direct influence on sediment accumulation and dispersal patterns (Owens and Sohl, 1969, p. 237). Three basement tectonic features recognized in the New Jersey Coastal Plain are the Raritan embayment, South Jersey uplift, and the Salisbury embayment (pl. 1). Individual units generally are thicker in the embayment areas and depositional facies changes are common between adjacent tectonic features (Olsson, 1978, p. 941).

The pre-Cretaceous basement-bedrock complex that lies unconformably beneath the unconsolidated Coastal Plain deposits consists mainly of Precambrian and lower Paleozoic rocks. Locally, along the Fall Line (fig. 1) in Mercer and Middlesex Counties, Triassic rocks underlie the unconsolidated sediments. The altitude of the top of the bedrock surface is shown on plate 1. Contours showing the basement surface in areas where the depth to bedrock is 1,000 ft or less are based primarily on well and test hole data, whereas in downdip areas the primary control is based on seismic data (Gill and Farlekas, 1976).

Depositional History

The oldest group of sediments deposited on the basement surface within the Coastal Plain of New Jersey consists of Cretaceous continental deposits of the Potomac Group (table 2). This unit consists of alternating clay, silt, sand, and gravel and

Table 2.--Geologic and hydrogeologic units in the Coastal Plain of New Jersey.

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	HYDROGEOLOGIC UNIT	HYDROLOGIC CHARACTERISTICS
Quaternary	Holocene	Alluvial deposits	Sand, silt, and black mud.	Undifferentiated	Surficial material, often hydraulically connected to underlying aquifers. Locally some units may act as confining beds. Thicker sands are capable of yielding large quantities of water.
		Beach sand and gravel	Sand, quartz, light-colored, medium- to coarse-grained, pebbly.		
	Pleistocene	Cape May Formation	Sand, quartz, light-colored, heterogeneous, clayey, pebbly.		
Tertiary	Miocene	Pensauken Formation			
		Bridgeton Formation			
		Beacon Hill Gravel	Gravel, quartz, light colored, sandy.	Kirkwood-Cohansey aquifer system	A major aquifer system. Ground-water occurs generally under water-table conditions. In Cape May County the Cohansey Sand is under artesian conditions.
		Cohansey Sand	Sand, quartz, light-colored, medium to coarse-grained, pebbly; local clay beds.		
		Kirkwood Formation	Sand, quartz, gray and tan, very fine- to medium-grained, micaceous, and dark-colored diatomaceous clay.	confining bed Rio Grande w-bz[1] confining bed[2]	Thick diatomaceous clay bed occurs along coast and for a short distance inland. A thin water-bearing sand occurs within the middle of this unit.
				Atlantic City 800-foot sand	A major aquifer along the coast.
				Composite confining bed	Alloway Clay member or equivalent
	Eocene	Piney Point Formation	Sand, quartz and glauconite, fine- to coarse-grained.	Piney Point aquifer	Yields moderate quantities of water locally.
		Shark River Formation	Clay, silty and sandy, glauconitic, green, gray and brown, fined-grained quartz sand.		Poorly permeable sediments.
		Manasquan Formation			
	Paleocene	Vincentown Formation	Sand, quartz, gray and green, fine- to coarse-grained, glauconitic, and brown clayey, very fossiliferous, glauconite and quartz calcarenite.	Vincentown aquifer	Yields small to moderate quantities of water in and near its outcrop area.
		Hornerstown Sand	Sand, clayey, glauconitic, dark green, fine- to coarse-grained.		Poorly permeable sediments.
Cretaceous	Upper Cretaceous	Tinton Sand	Sand, quartz, and glauconite, brown and gray, fine- to coarse-grained, clayey, micaceous.		
		Red Bank Sand		Red Bank sand[2]	Yields small quantities of water in and near its outcrop area.
		Navesink Formation	Sand, clayey, silty, glauconitic, green and black, medium- to coarse-grained.		Poorly permeable sediments.
		Mount Laurel Sand	Sand, quartz, brown and gray, fine- to coarse-grained, slightly glauconitic.	Wenonah-Mount Laurel aquifer	A major aquifer.
		Wenonah Formation	Sand, very fine- to fine-grained, gray and brown, silty, slightly glauconitic.		
		Marshalltown Formation	Clay, silty, dark greenish gray, glauconitic quartz sand.	Marshalltown-Wenonah confining bed	A leaky confining bed.
		Englishtown Formation	Sand, quartz, tan and gray, fine- to medium-grained; local clay beds.	Englishtown aquifer system	A major aquifer. Two sand units in Monmouth and Ocean Counties.
		Woodbury Clay	Clay, gray and black, micaceous silt.	Merchantville-Woodbury confining bed	A major confining bed. Locally the Merchantville Fm. may contain a thin water-bearing sand.
		Merchantville Formation	Clay, glauconitic, micaceous, gray and black; locally very fine-grained quartz and glauconitic sand.		
		Magothy Formation	Sand, quartz, light-gray, fine- to coarse-grained; local beds of dark-gray lignitic clay.	Potomac-Raritan-Magothy aquifer system: upper aquifer	A major aquifer system. In the northern Coastal Plain the upper aquifer is equivalent to the Old Bridge aquifer and the middle aquifer is the equivalent of the Farrington aquifer. In the Dela. River Valley three aquifers are recognized. In the deeper sub-surface, units below the upper aquifer are undifferentiated.
		Raritan Formation	Sand, quartz, light-gray, fine- to coarse-grained, pebbly, arkosic, red, white, and variegated clay.	conf bd middle aquifer	
	Lower Cretaceous	Potomac Group	Alternating clay, silt, sand, and gravel.	conf bd lower aquifer	
Pre- Cretaceous		Bedrock	Precambrian and lower Paleozoic crystalline rocks, metamorphic schist and gneiss; locally Triassic basalt, sandstone and shale.	Bedrock confining bed	No wells obtain water from these consolidated rocks, except along Fall Line.

[1] Rio Grande water-bearing zone.

[2] ------ Minor aquifer not mapped in this report.

Modified from Seaber, 1965, table 3.

is a major part of the thick sedimentary wedge in the Salisbury embayment area of extreme southern New Jersey. The overlying Raritan Formation consists of fluvial-continental deposits in outcrop and in the shallow subsurface that are lithologically similar to the Potomac Group sediments. However, in downdip areas near the coast, glauconite and shell beds indicate that the Raritan Formation is mostly marine (Richards, 1961, p. 1755, and Petters, 1976, p. 92). The Magothy Formation unconformably overlies the Raritan Formation and is a sheetlike deposit composed primarily of coarse beach sand and other associated near-shore marine deposits (Perry and others, 1975, p. 1535).

Upper Cretaceous and most Tertiary sediments overlying the Magothy Formation were deposited in various shelf and beach environments caused by alternating transgressive and regressive seas. Glauconite is common in this part of the geologic section and is indicative of mid- to outer-shelf deposition (Owens and Sohl, 1969, p. 259). Silty and clayey glauconitic sands are generally considered to form in marine environments characterized by slow rates of clastic sedimentation (Owens and Sohl, 1973, p. 2833). According to Olsson (1975, p. 17), much of the glauconite originated from the fecal pellets of mud-burrowing organisms and formed in the mud substrates of these deeper offshore areas.

Heavy concentrations of glauconite in association with very fine grained sediments are recognized in the New Jersey Coastal Plain as transgressive deposits, which formed during major incursions of the sea. Such units include the Merchantville, Marshalltown, and Navesink Formations, the Hornerstown Sand, and the Manasquan Formation. In contrast, coarsening-upward sequences that overlie the major glauconitic units are termed regressive beds. These beds were deposited in inner-shelf, near-shore, and beach areas during the slow retreat of the sea. Such units include the Englishtown Formation, Wenonah Formation, Mount Laurel Sand, Red Bank Sand, Vincentown Formation, Kirkwood Formation, and the Cohansey Sand. Generally, transgressive deposits form confining beds within the Coastal Plain and the regressive deposits form aquifers.

The long period of marine deposition in the study area ended after the deposition of the Miocene Cohansey Sand (Carter, 1978, p. 934). Continental deposition returned to the Coastal Plain during late Tertiary and Quaternary times. The Beacon Hill, Bridgeton, Pensauken, and Cape May Formations are primarily composed of fluvial sands and gravels (Owens and Minard, 1979, p. D1).

HYDROGEOLOGIC FRAMEWORK

Methods of Correlation

Most regional subsurface mapping in the New Jersey Coastal Plain has been based on formal geologic (rock-stratigraphic) and chronologic (time-stratigraphic) units that have been defined by lithologic and biostratigraphic correlations from well samples. Definition of the regional hydrogeologic framework is necessary because, in many cases, hydrogeologic-unit boundaries differ from formal stratigraphic boundaries. For example, a geologic formation may contain more than one aquifer, a formation may function as an aquifer in one area and as a confining bed in another, or an aquifer or confining bed may be composed of several geologic formations.

Geophysical data for more than 1,000 sites were reviewed. Of these, 302 sites were selected for inclusion into the framework based on their location and the quality and pertinence of their associated geophysical data. Subsurface correlations are based primarily on the interpretation of electric and natural gamma-ray logs. Distinctive signatures or patterns on electric and gamma-ray logs were found to mark contacts between aquifers and confining beds more reliably than drillers' logs or geologists' descriptions of drill cuttings.

Log Interpretation

The response of electric and gamma-ray logs to lithology is illustrated in figure 2. The electric logs used in this report are dual-track logs that include the spontaneous-potential (SP) curve on the left-hand track and a conventional single-point resistance curve on the right-hand track. The electric log is obtained by lowering an electrode into a fluid-filled uncased borehole and simultaneously recording the corresponding electrical measurements at the surface.

The spontaneous-potential curve is a record of depth versus small changes in voltage, measured in millivolts, caused by electrochemical reactions that develop between the borehole fluid and the surrounding formation materials (Keys and McCary, 1971, p. 24). In general, sands cause negative deflections to the left and clays cause positive deflections to the right. However, if the borehole mud is more saline than the formation water, reversals of the spontaneous-potential curve can occur, causing negative deflections opposite the clay beds and positive deflections opposite the sands.

The single-point resistance curve is a record of depth versus electrical resistance, measured in ohms, of formation materials penetrated by the borehole (Keys and MaCary, 1971, p. 35). It is directly related to the quality, quantity, and distribution of formation water (Guyod, 1957, p. 2). Sand and gravel are generally more resistant to the flow of electric current and cause sharp deflections to the right on the electric log. In contrast, silt and clay are less resistant materials and cause deflections to the left. The electric log is strongly affected by brackish water and saltwater in the formations. Salinity decreases the electrical resistance of the formation and causes baseline deflections to the left on the single-point resistance curve. However, the salty aquifer can generally be

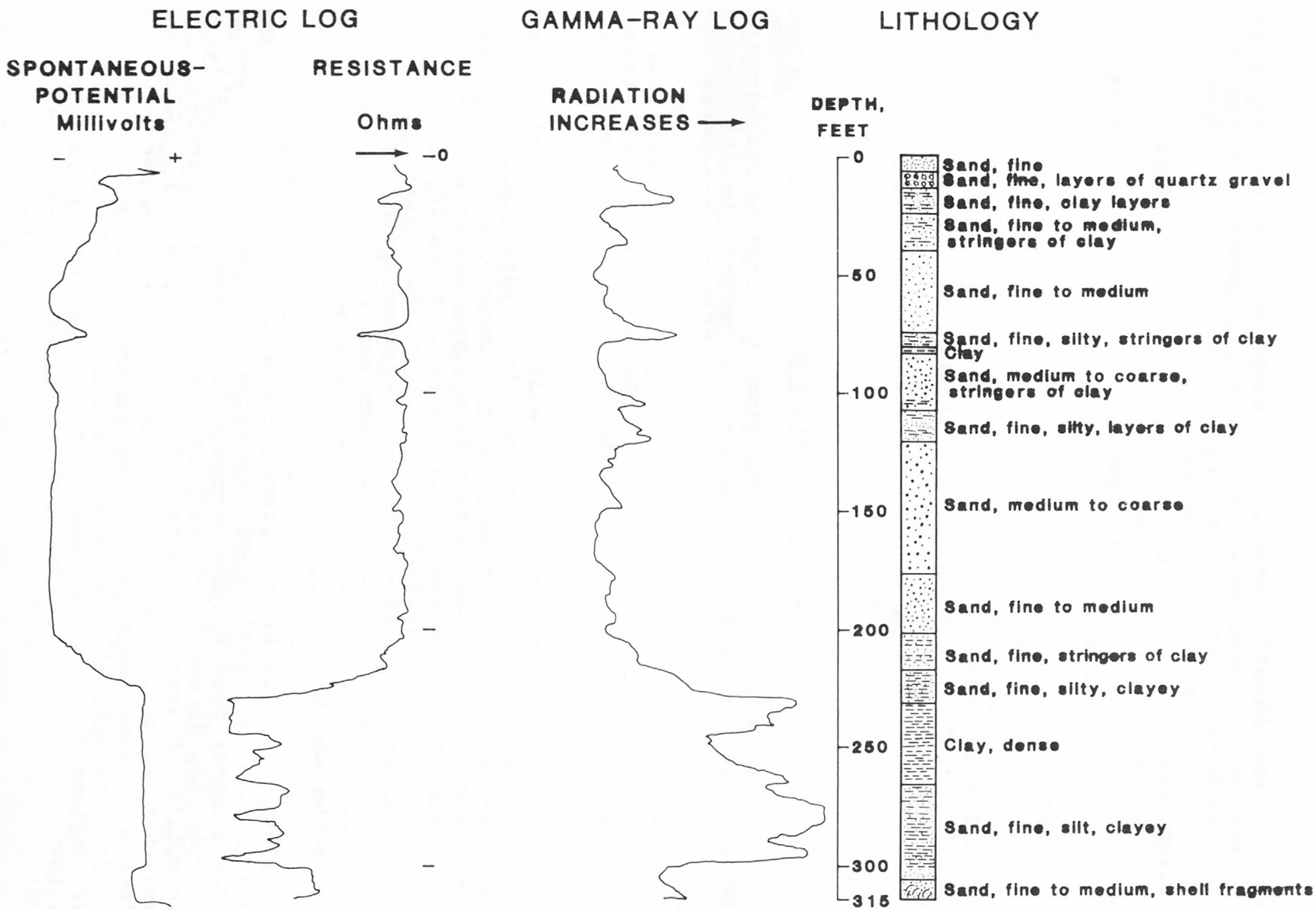

Figure 2.--Response of electric and gamma-ray logs to lithology.

determined by sharp negative-potential deflections on the spontaneous-potential log. Another extraneous factor that can affect the signature on electric logs results from changes in borehole diameter, which can be caused by drilling, caving, or mud-cake buildup on the borehole wall.

Natural gamma-ray logs are graphical plots of the rate of emission of gamma rays emitted by the formations penetrated by the borehole. Unlike the electric log, the gamma-ray log can be obtained in a cased hole, without borehole fluid, and is unaffected by the occurrence of saltwater within formations. In general, silt- and clay-bearing sediments show much higher natural gamma activity than clean quartz sands and carbonates. This is due to the ability of clays to concentrate radioactive elements through ion exchange and adsorption. Feldspars and micas, which readily decompose into clay, also contain small proportions of the gamma-emitting radioisotope potassium-40 (Keys and McCary, 1971, p. 65). Gamma radiation increases to the right on the gamma-ray log. Therefore, permeable sediments such as sand and gravel, generally have low radioactivity, and cause log deflections toward the left, whereas relatively higher radioactive silt and clay cause log deflections toward the right. Additional factors that must be considered in natural gamma-ray log interpretation are related to well construction. These include changes in borehole diameter, type of casing, multiple or single casing, gravel pack, grout along the outside wall of the casing, and well development. All of these factors can cause shifts on natural gamma-ray logs that are not necessarily related to changes in lithology.

The alternating sequences of clay, silt, sand, and gravel that occur within the unconsolidated sediments of the Coastal Plain make the use of electric and gamma-ray logs ideal for lithologic correlation. More detailed information regarding the application of borehole geophysics to water-resources investigations can be found in Keys and McCary (1971).

Data Presentation

The hydrogeologic framework of the New Jersey Coastal Plain is illustrated in a series of structure contour and isopach maps. The maps, together with 14 hydrogeologic sections, show vertical and horizontal relationships among the 15 regional hydrogeologic units mapped. The maps are produced at a scale of 1:250,000 to show stratigraphic control data and detail in contouring. The objective in producing these maps at this scale is to provide the needed information for water-resources investigations within the New Jersey Coastal Plain.

Outcrop areas shown on the hydrogeologic maps were modified from those compiled by J. P. Owens in Miscellaneous Geologic Investigations Map I-514-B (U.S. Geological Survey, 1967). In places hydrogeologic units mapped in the subsurface constitute only the sandy or clayey parts of specific geologic formations, and make up an undefined part of the outcrop. Therefore it should be noted that the outcrop areas shown on the structure contour and thickness maps can not be considered the outcrop areas for these hydrogeologic units. The outcrop areas , however, can generally be used to estimate updip limits of aquifers and confining beds, and to approximate lines of zero thickness.

Information on the wells used to construct the framework is shown in table 3 which is attached to the back of the report. The information for each well includes the U.S. Geological Survey well number, latitude, longitude, local well identifier, municipality, and the total depth logged. If a geophysical log of the well appears in a hydrogeologic section, the name of the section is given in the last column.

The location of the wells listed in table 3 and the lines of the hydrogeologic sections shown on plates 3, 4, and 5 are shown on plate 2. The hydrogeologic sections shown on plates 3, 4, and 5 are referenced throughout the section on Aquifers and Confining Beds.

The hydrogeologic control data for each site are listed in table 4 which is attached to the back of the report. Table 4 contains the U.S. Geological Survey well number, the altitude of land surface, and the top and bottom of each aquifer unit penetrated in each well. This table facilitates a rapid view of the hydrogeologic section at any site and is useful for calculating thicknesses if alternative divisions of hydrogeologic units are required.

Aquifers and Confining Beds

Potomac-Raritan-Magothy Aquifer System

In New Jersey, sediments of the Cretaceous Potomac Group, Raritan, and Magothy Formations have generally been combined and described as a single hydrologic unit (Barksdale and others, 1958, p. 92) or as an aquifer system (Gill and Farlekas, 1976 and Luzier, 1980). This approach has been widely used because the individual formations are lithologically indistinguishable from one another over large areas of the Coastal Plain. In addition to the problems encountered in differentiating these sediments, Barksdale and others (1958, p. 91) considered the major aquifers within these units to be interconnected over some distance, although in many areas they were locally distinct.

In the outcrop area of the Raritan and Magothy Formations near Raritan Bay, nine distinct units have been recognized (fig. 3). The lithologic subdivision of the Raritan Formation reported by Ries and others (1904) was modified by Berry (1906) and by Barksdale and others (1943, p. 18). These early reports included the Old Bridge Sand Member and the Amboy Stoneware Clay Member as part of the Raritan Formation. Owens and others (1968) redefined the Magothy Formation and, based on unpublished palynological work by Wolfe and Pakiser, included the Amboy Stoneware Clay member as part of the Magothy along with the Morgan beds and the Cliffwood

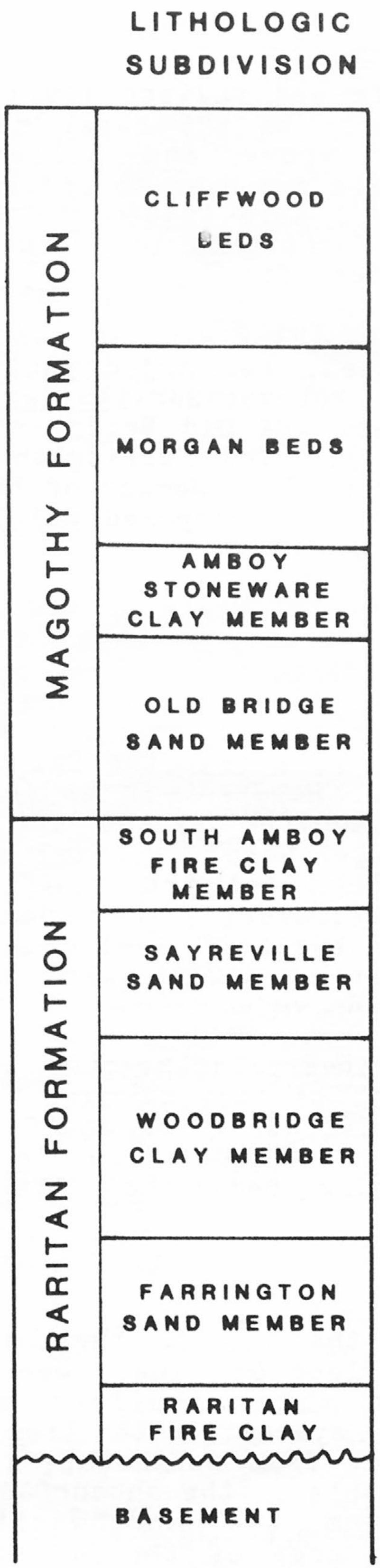

Figure 3.--Lithologic subdivision of the Raritan and Magothy Formations in the Raritan Embayment. (modified from Christopher, 1979, figure 2)

beds. Subsequently Wolfe and Pakiser (1971, p. B41) reassigned the Old Bridge Sand Member as the basal member of the Magothy Formation. Based on spore and pollen analysis and on interpretations of borehole geophysical and lithologic logs, Perry and others (1975, p. 1542) have traced the individual members of the Raritan and Magothy Formations into the deeper subsurface of Monmouth and Ocean Counties (fig. 4).

In the northern Coastal Plain, in parts of Mercer, Middlesex, and Monmouth Counties, two major aquifers have previously been defined within the Potomac-Raritan-Magothy aquifer system: the Farrington aquifer and the Old Bridge aquifer (Barksdale and 1943; and Farlekas, 1979). The Farrington aquifer is composed primarily of the Farrington Sand Member of the Raritan Formation, and the Old Bridge aquifer is composed mainly of the Old Bridge Sand Member of the Magothy Formation.

In the southern Coastal Plain of New Jersey, water-bearing zones within the Potomac Group, Raritan, and Magothy Formations have generally been considered to function together as one hydrologic unit. The lithologic subdivisions of the Raritan and Magothy Formations recognized in the Raritan embayment are not evident in their outcrop area near the Delaware River (Owens and Sohl, 1969, p. 239-242). However, in an intensive study of the Potomac-Raritan-Magothy aquifer system in the Delaware Valley between Trenton and the Delaware Bay, Gill and Farlekas (written communication, 1970) subdivided the aquifer system into three aquifers, designated lower, middle, and upper, and two interjacent confining layers on the basis of geologic and geophysical well logs. Farlekas and others (1976) also show a three-aquifer breakdown of the system in Camden County.

Within the Potomac-Raritan-Magothy aquifer system, five mappable hydrologic units of varying extent are defined in this report. The five units include three aquifers, designated lower, middle, and upper, based on stratigraphic position within the system, and two confining beds that lie interjacent to the aquifers.

Lower aquifer

The altitude of the top of the lower aquifer and its thickness are shown on Plate 6. The lower aquifer has the most limited extent of the three aquifers within the Potomac-Raritan-Magothy aquifer system. It lies on the bedrock or weathered bedrock surface from northwestern Burlington to Salem Counties and is recognizable in the subsurface for approximately 8 to 12 mi downdip from the northwestern extent of the undifferentiated outcrop area of the Potomac Group and Raritan Formation. In the updip direction, the aquifer thins and wedges out as successively younger beds overlap the bedrock surface (section G-G', pl. 4). To the north, the lower aquifer thins and wedges out against a local basement high in the vicinity of Mount Holly in Burlington County (section I-B, pl. 4). In the downdip

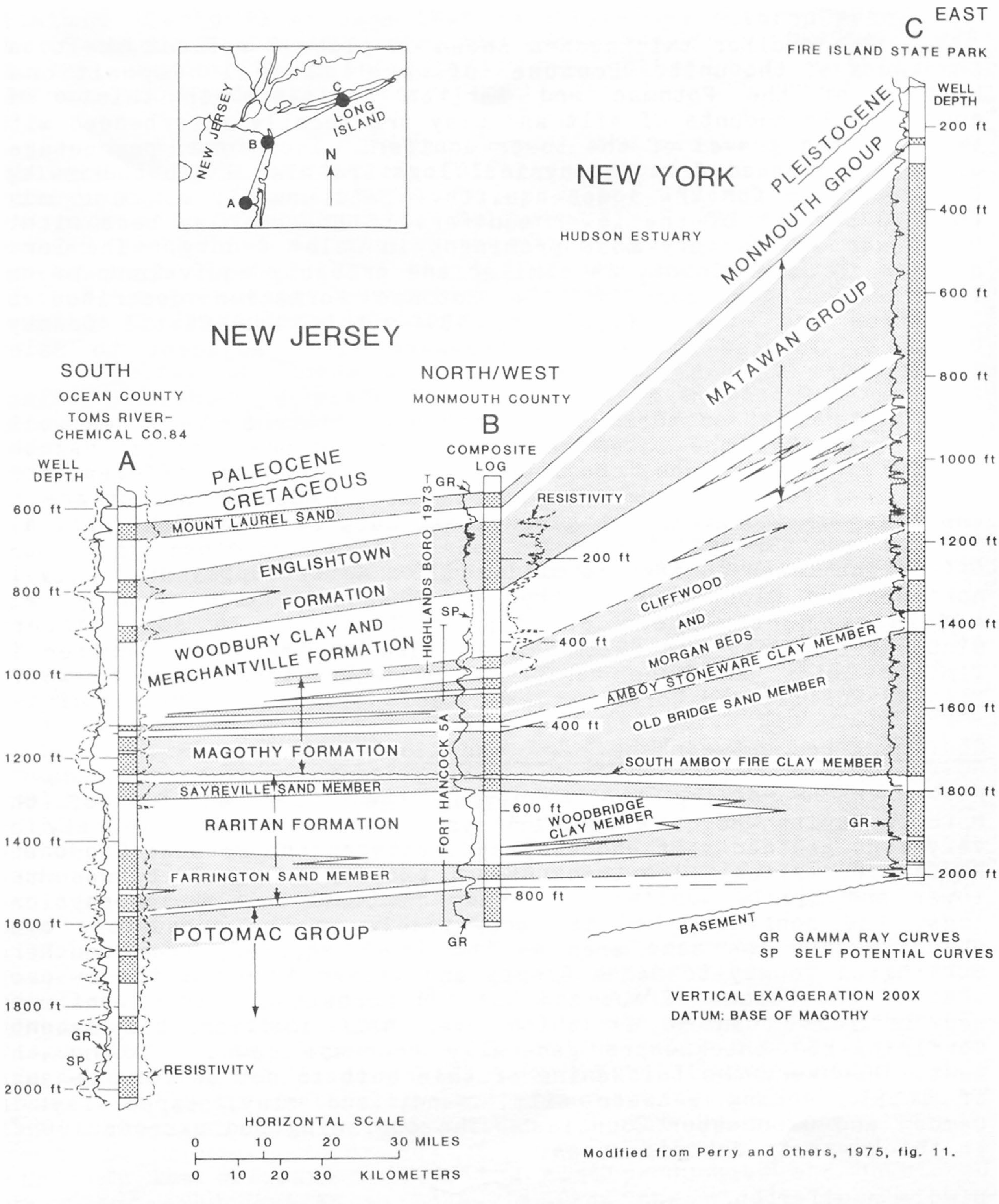

Figure 4.--Stratigraphic section of Cretaceous deposits, Toms River, New Jersey, to Fire Island, New York.

direction, the thickness of the lower aquifer increases uniformly southeastward to greater than 250 ft.

The aquifer thicknesses shown on plate 6 reflect the total thickness of the unit. Because of the fluvial depositional history of the Potomac and Raritan sediments in this area, considerable amounts of silt and clay are locally interbedded with the sand and gravel of the lower aquifer. Therefore, percentages of sand estimated from geophysical logs are also indicated on the thickness map for the lower aquifer. Sand usually makes up more than 70 percent of the lower aquifer. Silt and clay beds within the lower aquifer are most prominent in Salem County. The lower aquifer in Salem County is similar and probably equivalent to the lower hydrologic zone of the Potomac Formation described by Sundstrom and others (1967, p. 18) within New Castle County, Delaware, located across the Delaware River adjacent to Salem County.

Southeast of the area contoured on plate 6, very few wells have penetrated the lower section of the Potomac-Raritan-Magothy aquifer system. Hence, the lower aquifer cannot be differentiated from overlying and underlying units in the deeper subsurface on the basis of the available geophysical data (section H-H', pl. 4).

The lower aquifer is utilized for water supply primarily in northwestern Gloucester County, northwestern Camden County, and adjoining northwestern Burlington County. In southwestern Gloucester county and Salem County, use of the lower aquifer is limited owing to higher chloride concentrations (Luzier, 1980, fig. 2; Fusillo and Voronin, 1981, table 3).

Confining bed between the lower and middle aquifers

The confining bed overlying the lower aquifer of the Potomac-Raritan-Magothy aquifer system is composed primarily of very fine grained silt and clay sediments of the Potomac Group and Raritan Formation. The thickness of the confining bed between the lower and middle aquifers is shown on plate 6. On geophysical logs, the confining bed is recognizable in the subsurface over approximately the same area as the lower aquifer, from southern Burlington County to Salem County and within 12 mi of the outcrop area of the Potomac Group and Raritan Formation. This confining bed is less than 50 ft thick over half its mappable extent. Confining-bed thicknesses generally increase downdip toward the east. However, the thickening of this unit is not uniform because of local lensing between silt, sand, and clay, especially in Camden and Gloucester Counties. The confining bed exceeds 100 ft in thickness in downdip areas.

Middle aquifer

The mappable extent of the top of the middle aquifer is shown on plate 7. The middle aquifer extends from the Delaware River adjacent to Salem County to Raritan Bay in the northeastern

Coastal Plain. Between Salem County and northern Burlington County, the middle aquifer has been traced in the subsurface within a 10- to 12-mi band that parallels the outcrop area. In the uncontoured areas downdip, the middle aquifer, like the lower aquifer, cannot be distinguished from other beds within the Potomac Group and Raritan Formation.

Northeast of Burlington County, the middle aquifer is the equivalent of the Farrington aquifer described by Farlekas (1979). Hydrogeologic section I-B (pl. 4) shows the lateral continuity of the middle aquifer near the Delaware River and the Farrington aquifer recognized in the northeastern Coastal Plain. In the northeastern Coastal Plain the top of the middle aquifer is persistent in the deeper subsurface of Monmouth and northern Ocean Counties (hydrogeologic sections, pl. 3).

Aquifer thickness and percentages of sand of the middle aquifer are shown on plate 8. In the northern Coastal Plain, the thickness of the middle aquifer ranges from less than 50 ft in and near the outcrop to more than 150 ft near the junction of Mercer, Middlesex, and Monmouth Counties. Although the top of the middle aquifer can be traced into northern Ocean County, it is not possible, relying solely on geophysical data, to separate it from underlying sediments within the Potomac-Raritan-Magothy aquifer system. Therefore, thickness contours have not been extended farther downdip into Monmouth and Ocean Counties.

The predominantly sandy nature of the undifferentiated sediments between the bedrock surface and the top of the middle aquifer in northern Ocean County is evident from the geophysical logs on sections D-D' (pl. 3) and K-C' (pl. 5). This undifferentiated zone within the Potomac-Raritan-Magothy aquifer system has become important in recent years. A number of large production public-supply wells in northern Ocean County are equipped with multiple screens so as to tap sandy beds in this zone. More detailed studies are needed to show what effect heavy ground-water withdrawals from this zone may have on updip differentiated aquifers within the Potomac-Raritan-Magothy aquifer system.

Between Salem and Burlington Counties near the Delaware River, percentages of sand and aquifer thicknesses of the middle aquifer are more variable over shorter distances than in the northeastern Coastal Plain of New Jersey where sand generally ranges from 75 to 85 percent. In and near the outcrop area near the Delaware River, sand ranges from 60 to 100 percent. In this area, lithologic variability and abrupt changes in thickness of individual sand and clay beds within the unit are common.

In the Delaware Valley, the most productive and developed areas for ground-water withdrawals from the middle aquifer are located between northwestern Burlington and northwestern Gloucester Counties. As in the lower aquifer, discontinuous silt and clay beds are common within the middle aquifer in Salem County.

Confining bed between the middle and upper aquifers

The confining bed thickness between the middle and upper aquifers of the aquifer system is shown on plate 9. In the northeastern Coastal Plain of New Jersey this confining bed is equivalent primarily to the Woodbridge Clay Member of the Raritan Formation. The Woodbridge Clay is a thin- to thick-bedded sequence of micaceous silts and clays (Owens and Sohl, 1969, p. 239). Locally, the confining bed may also include the clayey lithofacies of the Sayreville Sand Member and the South Amboy Fire Clay Member, both of the Raritan Formation (Farlekas, 1979, p. 16). In the downdip areas of Burlington, Ocean, and Monmouth Counties, this confining bed may be the equivalent of the Bass River Formation proposed by Petters (1976).

Thickness of the confining bed generally increases from around 50 ft in and near the outcrop to more than 150 ft toward the southeast, with some local thicknesses in excess of 200 ft. However, locally in northern Gloucester and Camden Counties near the Delaware River, the confining bed between the middle and upper aquifers is less than 20 ft thick.

Upper aquifer

The upper aquifer is the most extensive unit of the Potomac-Raritan-Magothy aquifer system, and it coincides most closely with a single geologic unit, the Magothy Formation. It is recognizable on geophysical logs that penetrate the section throughout the Coastal Plain of New Jersey (pls. 3, 4, and 5).

The altitude of the top and the thickness of the upper aquifer are shown on plates 10 and 11, respectively. In the northeastern Coastal Plain the upper aquifer is the equivalent primarily of the Old Bridge Sand Member of the Magothy Formation. Locally the aquifer also includes the Sayreville Sand Member of the Raritan Formation, where the South Amboy Fire Clay Member is thin or missing (Farlekas, 1979, p. 22). The upper aquifer decreases in thickness from greater than 200 ft in the northeastern Coastal Plain to approximately 50 ft in Cape May County. It is composed predominately of permeable coarse-grained sediments. Clay beds are generally thin and localized. Therefore, percentages of sand are not included on the thickness map for the upper aquifer.

In the Raritan embayment the Magothy Formation thickens rapidly and includes the interbedded sand, silt, and clay sequences of the Cliffwood and Morgan beds (Perry and others 1975, p. 1543). These beds are recognized only locally in outcrop and in the subsurface of the Sandy Hook Bay area. Perry and others (1975, fig. 11) show that downdip the Cliffwood and Morgan beds interfinger and pinch out within the Merchantville Formation and Woodbury Clay (fig. 4). The top of the upper aquifer in the Sandy Hook area, as mapped in this report (pl. 10), is the top of the Old Bridge Sand Member of the Magothy Formation. Therefore, the thickness of the upper aquifer (pl. 11) in the Sandy Hook area does not include the overlying Cliffwood and Morgan beds of the Magothy Formation.

Merchantville-Woodbury Confining Bed

The confining bed overlying the upper aquifer of the Potomac-Raritan-Magothy aquifer system is composed primarily of sediments of the Merchantville Formation and the Woodbury Clay of Late Cretaceous age. The Merchantville Formation is the oldest outcropping glauconitic unit in the New Jersey Coastal Plain. In addition to glauconite beds, the unit also contains thin- to thick-bedded sequences of micaceous clays and clayey silts. Locally within Camden County and parts of Gloucester County, Farlekas and others (1976, p. 53) mapped a sand unit within the Merchantville Formation as much as 30-ft thick that supplies water for small domestic needs. The overlying Woodbury Clay is essentially a thick, massive clayey silt (Owens and Sohl, 1969, p. 242). The contact between the underlying upper aquifer of the Potomac-Raritan-Magothy aquifer system and the Merchantville-Woodbury confining bed is distinct and easily detected on geophysical logs (pls. 3, 4, and 5).

The Merchantville-Woodbury confining bed is the most extensive confining bed within the New Jersey Coastal Plain. It functions as an effective confining layer between the upper aquifer of the Potomac-Raritan-Magothy aquifer system and the Englishtown aquifer system. It is also the major confining bed between the upper aquifer and the Wenonah-Mount Laurel aquifer in downdip areas to the southeast where the Englishtown aquifer system is absent. The thickness of the Merchantville-Woodbury confining bed is shown on plate 12. The Merchantville Formation crops out in an irregular band between Raritan Bay and the Delaware River adjacent to Salem County. The outcrop area of the younger Woodbury Clay parallels the Merchantville outcrop, but pinches out southwest of Woodbury in Gloucester County (Owens and Sohl, 1969, p. 242).

On plate 12, the line showing the approximate downdip extent of the Englishtown aquifer system divides the map into two areas. Between this line and the outcrop area the Merchantville-Woodbury confining bed lies between the upper aquifer of the Potomac-Raritan-Magothy aquifer system and the Englishtown aquifer system. In this area, confining-bed thicknesses range from about 100 ft near the outcrop area in Salem County to greater than 350 ft in the northeastern Coastal Plain of New Jersey. In the northeastern Coastal Plain, low-permeability units of the Magothy Formation overlying the Old Bridge Sand Member are included within the Merchantville-Woodbury confining bed. These units are the Amboy Stoneware Clay Member and the thin intercalated beds of sand, silt, and clay of the Morgan and Cliffwood Beds.

Downdip from the line indicating the limit of the Englishtown aquifer system, the Merchantville-Woodbury confining bed lies interjacent to the upper aquifer of the Potomac-Raritan-Magothy aquifer system and the Wenonah-Mount Laurel aquifer. Here, the confining bed also includes silty and clayey sediments of the Englishtown Formation, the Marshalltown Formation, and the fine-grained lower part of the Wenonah Formation. Confining bed thicknesses beyond the downdip limit of the Englishtown aquifer system range from less than 150 ft in Cumberland County to more than 450 ft in Ocean County.

An abrupt increase in confining bed thickness occurs along the limit of the Englishtown aquifer system in southern Ocean County. This is attributed mainly to the greater thickness of silty and clayey sediments of the Englishtown Formation in this area, and the absence of the lower sand unit of the Englishtown aquifer system (Section E-E', pl. 3 and section L'-A', pl. 5). The change in confining bed thickness along the edge of the downdip extent of the Englishtown aquifer system becomes less apparent toward the southwestern Coastal Plain of New Jersey. This is due to the thinning of the Englishtown, Marshalltown, and Wenonah Formations in this direction.

Englishtown Aquifer System

The Englishtown Formation, of Late Cretaceous age, crops out in the western part of the New Jersey Coastal Plain in an irregular band that extends from Raritan Bay to the Delaware River adjacent to Salem County (pl. 13). Owens and Sohl (1969, p. 244) reported that several distinct lithofacies of the formation can be recognized along strike. However, in areas where the Englishtown Formation is exposed, the primary components are fine- to medium-grained sands.

Nichols (1977b) described the geohydrology of the Englishtown Formation in the northern Coastal Plain of New Jersey and recognized that the lithology of the Englishtown Formation in the shallow subsurface of Middlesex, Monmouth, and northwestern Ocean Counties was similar to the lithology in outcrop areas toward the west. In these updip areas of the northern Coastal Plain of New Jersey, the entire Englishtown Formation functions as one aquifer (sections A-A', B-B', and C-C', pl. 3).

In the deeper subsurface of southeastern Monmouth County and northeastern Ocean County, Nichols (1977b, p. 12-15) identified three distinct lithofacies within the Englishtown Formation. These included an upper and lower sand facies separated by a clayey silt lithofacies. Nichols (1977b, p. 22) considered the upper sand lithofacies of primary importance in the areas where the two distinct sands occur. Only four production wells are known to tap the lower sand lithofacies. Two wells produce water from the lower sand near Lavallette, Ocean County (plate 13), where the upper sand is absent. The other two wells tap both the lower and upper sand units in the Lakewood area of Ocean County (Walker, 1982, p. 32). All other major production wells that tap the Englishtown aquifer system are screened in the upper sand. Nichols (1977a, p. 20) recognized the lower sand lithofacies as being lithologically and hydrologically continuous with the upper sand in updip areas; but because of the lack of data, he included only the upper sand as part of the Englishtown aquifer in his simulation model of the aquifer.

The subdivisions of the Englishtown aquifer system from updip areas in Ocean and Monmouth Counties, where the entire system functions as a single water-bearing unit, to downdip areas in northeastern Ocean County and southeastern Monmouth County, where three distinct lithofacies are present, are shown on sections D-D' and E-E' plate 3, and K-C' and L'-A', plate 5.

Structure contours of the top of the Englishtown aquifer system are shown on plate 13. Where two sands are present within the Englishtown Formation in southeastern Monmouth and northeastern Ocean counties, the contours represent the top of the upper sand. For wells in which the lower sand has been recognized, the altitude of the top of the lower sand also is given.

The approximate downdip limit of the Englishtown aquifer system is shown on plates 13 and 14. South and east of a line paralleling Forked River in Ocean County, Hammonton in Atlantic County, and Bridgeton in Cumberland County, the Englishtown aquifer cannot be recognized on geophysical logs that penetrate the section (well 29-19, section E-E', pl. 3).

The thickness map of the Englishtown aquifer system is shown on Plate 14. In northern Monmouth County, the Englishtown aquifer system thickens from about 40 ft near the outcrop area of the Englishtown Formation to greater than 140 ft near Red Bank. In this area, as in most of Monmouth County, the entire Englishtown aquifer system functions as a single water-bearing unit (sections A-A', B-B', and C-C', pl. 3).

The thickness of the aquifer system shown in southeastern Monmouth and northeastern Ocean Counties, includes the clayey silt lithofacies that lies between the lower and upper sand units. For wells that penetrate the entire Englishtown section in this area, thicknesses of the upper and lower sand units are given in addition to the thickness of the entire aquifer system (pl. 14). The aquifer system is thickest where the upper and lower sand units are present in the subsurface. Thicknesses of the clayey silt lithofacies can be calculated from plate 14 by adding the thicknesses of the upper and lower sand units and subtracting this total from the thickness of the entire aquifer system at that point.

The thickness of the upper sand varies between 40 and 110 ft in southeastern Monmouth and northeastern Ocean Counties. The upper sand thins toward the southeast and cannot be identified in the subsurface east of Toms River, Ocean County. Only the lower sand is recognizable in wells near Lavallette on the barrier beach in Ocean County (section L'-A', pl. 5).

As the upper sand unit thins toward the southeast, the thickness of the underlying clayey silt lithofacies increases (sections D-D', E-E', pl. 3, and K-C', L'-A', pl. 5). The lower sand has a rather uniform thickness generally between 30 and 50 ft in Ocean County.

The Englishtown aquifer system thins in outcrop and in the subsurface in a southwestern direction (section J-J', pl. 4). In parts of Burlington, Camden, Gloucester, and Salem Counties, the aquifer is commonly less than 40 ft thick. The sands within the Englishtown aquifer system in this area are finer grained, and local silt and clay beds within the unit are common. The aquifer is not a major source of water supply between Burlington County and southern Salem County, owing to the decrease in aquifer thickness, greater proportion of fine-grained sediments, resulting lower yields, and the presence of other more productive aquifers (Nichols, 1977b, p. 20).

The Marshalltown-Wenonah Confining Bed

The confining bed overlying the Englishtown aquifer system is composed of the Marshalltown Formation and the fine-grained lower part of the Wenonah Formation. The Marshalltown Formation and the overlying Wenonah Formation, both Late Cretaceous in age, crop out in a northeast-southwest trending belt in the western part of the New Jersey Coastal Plain (pl. 15). The Marshalltown Formation is a thin, uniform, sheet-like deposit of glauconitic silt and sand, usually ranging between 10- to 20-ft thick throughout much of the subsurface of the Coastal Plain. The Wenonah Formation is generally a dark-gray, poorly sorted, micaceous, silty, fine quartz sand. The Wenonah Formation also contains abundant glauconite in its lower part. However, glauconite content diminishes toward the top of the unit as the formation becomes coarser grained (Owens and Sohl, 1969, p. 245). The thickness of the confining bed between the Englishtown aquifer system and the Wenonah-Mount Laurel aquifer is shown on plate 15. Most of the variation in confining bed thickness is attributed to the variable thickness of the fine-grained lower part of the Wenonah Formation. The Marshalltown-Wenonah confining bed ranges in thickness from about 20 ft in northern Monmouth County to more than 80 ft in Ocean County. The confining bed generally thins toward the southwest. This is consistent with the thinning and pinching out of the outcrop area of the Wenonah Formation in this direction.

The thickness of the Marshalltown-Wenonah confining bed is shown only over the mappable extent of the underlying Englishtown aquifer system. Beyond this limit, the sediments of the Marshalltown and Wenonah Formations become part of the extensive Merchantville-Woodbury confining bed, effectively confining the upper aquifer of the Potomac-Raritan-Magothy aquifer system from the Wenonah-Mount Laurel aquifer. In northeastern Ocean County at Lavallette, where only the lower sand of the Englishtown Formation is present, the Marshalltown-Wenonah confining bed is more than

180 ft thick (sections D-D', E-E', pl. 3, and L'-A', pl. 5). In this area the Marshalltown-Wenonah confining bed includes the fine-grained low-permeability sediments of the Englishtown Formation that overlie the lower sand of the Englishtown Formation.

The leaky nature of the Marshalltown-Wenonah confining bed has been discussed by many investigators. Nemickas (1976, p. 37) has discussed the effect of ground-water withdrawals from the Englishtown aquifer on the Mount Laurel aquifer. Walker (1982) finds similar cones of depression for both aquifers in the Lakewood area of Ocean County, where no significant pumpage from the Wenonah-Mount Laurel aquifer has been reported.

Wenonah-Mount Laurel Aquifer

The Wenonah-Mount Laurel aquifer is composed of the coarse-grained fraction of the Wenonah Formation and the Mount Laurel Sand, both Late Cretaceous in age. The sediments generally increase in grain size toward the top of the aquifer. The major component of the aquifer is the Mount Laurel Sand.

Structure contours for the top of the Wenonah-Mount Laurel aquifer are shown on plate 16. The Wenonah-Mount Laurel aquifer can be traced in the subsurface throughout the Coastal Plain of New Jersey southeast of its outcrop area. The aquifer is easily identified on gamma-ray logs below the high radiation kick of the Navesink Formation (section J-J', pl. 4).

The thickness of the Wenonah-Mount Laurel aquifer is shown on plate 17. In the northeastern Coastal Plain of New Jersey aquifer thicknesses generally range from 40 ft to greater than 100 ft. Thicknesses between 60 and 80 ft are common throughout wide areas of Monmouth and Ocean Counties. In the northeastern Coastal Plain of New Jersey the aquifer is used mainly in southeastern Monmouth and northern Ocean Counties. The thickest parts of the aquifer are within 10 to 15 mi of the outcrop area of the Mount Laurel Sand in Burlington, Camden, Gloucester, and Salem Counties, where thicknesses of 100 to 120 ft are common. After reaching maximum thicknesses greater than 120 ft in the southwestern Coastal Plain of New Jersey, the aquifer thins gradually toward the southeast to less than 25 ft in Cape May County.

Water in the aquifer contains more than 250 milligrams per liter (mg/L) chloride in most of Cumberland County, the southern half of Atlantic County, and all of Cape May County, based on the altitude of the 250 mg/L isochlor shown by Meisler (1981, fig. 2). All production wells that tap the Wenonah-Mount Laurel aquifer between northern Burlington County and southern Salem County are within 10 mi of the outcrop area of the Mount Laurel Sand.

Composite Confining Bed

Overlying the Wenonah-Mount Laurel aquifer and subjacent to the major aquifers within the Kirkwood Formation and Cohansey Sand lies a complex series of geologic units ranging in age from Late Cretaceous to Miocene. The predominant lithology of most of these units consists of silty and clayey glauconitic quartz sands. The units have low to moderate permeabilities and are generally grouped together and described hydrologically as a composite confining bed (Rush, 1968; Anderson and Appel, 1969; and Nemickas, 1976). This confining bed consists of the Navesink Formation and, depending on location within the Coastal Plain, can include most or only a few of the following geologic units: the Red Bank Sand, Tinton Sand, Hornerstown Sand, Vincentown Formation, Manasquan Formation, Shark River Formation, Piney Point Formation, and the basal clay of the Kirkwood Formation. Parts of the Red Bank Sand, Vincentown Formation, and Piney Point Formation contain fairly permeable sands that are locally used as sources of water supply. Although the aquifers within the Vincentown and Piney Point Formations are considered to be minor aquifers, they are regionally extensive in the New Jersey Coastal Plain. Framework information for the Vincentown aquifer and Piney Point aquifer is presented following the discussion of the composite confining bed.

The outcrop area and combined total thickness of the geologic units incorporated within the composite confining bed are shown on plate 18. The northwestern edge of the outcrop is the downdip limit of the outcrop of the Mount Laurel Sand. The southeastern edge of the outcrop is bounded by the updip limit of the outcrop of the Kirkwood Formation. The clay bed at the base of the Kirkwood Formation has been excluded as part of the outcrop of the composite confining bed because its outcrop has not been mapped separately from the sand of the Kirkwood Formation. However, it is included as part of the total thickness shown on the hydrogeologic sections and on plate 18. In the downdip direction, the composite confining bed increases rapidly in thickness from less than 50 ft in outcrop, to 796 ft in well No. 29-19 at Island Beach State Park, and to more than 1,190 ft in Cape May County.

The Upper Cretaceous Navesink Formation is the basal unit of the composite confining bed throughout its extent in the New Jersey Coastal Plain. It is unconformably overlain by the Paleocene Hornerstown Sand. These two formations that span the Cretaceous-Tertiary boundary in New Jersey are excellent marker beds for stratigraphic correlation. Gamma-ray logs that penetrate the Navesink Formation and Hornerstown Sand show the same high radiation signature throughout the New Jersey Coastal Plain (section J-J', pl. 4). These high radiation kicks coincide with high concentrations of glauconitic sand and shell beds at the base of the Navesink Formation and near the top of the Hornerstown Sand (Rosenau and others, 1969, p. 45). The combined thickness of the Navesink Formation and Hornerstown Sand is fairly uniform ranging from 60 to 90 ft throughout much of the subsurface.

Hydrogeologic section J-J' on plate 4 shows a progressively greater separation between high radiation kicks of the Navesink Formation and Hornerstown Sand in northwestern Ocean and Monmouth Counties. This is caused by the northeastward thickening wedge of the Upper Cretaceous Red Bank and Tinton Sands that overlie the Navesink Formation in this area. Northeast of Freehold in Monmouth County, low radiation on logs 25-37 and 25-360 (section J-J', pl. 4) indicates that the Red Bank Sand section is fairly permeable in and near the outcrop. The significant widening of the composite confining bed toward the northeast end of its outcrop area in Monmouth County (pl. 18) is caused by the presence of the Red Bank Sand. Many domestic wells tap the Red Bank Sand within its Monmouth County outcrop area. However, total withdrawals are minimal (Jablonski, 1968, p. 65). Southeast of its outcrop, the Red Bank Sand thins rapidly and is absent throughout most of the New Jersey Coastal Plain.

The primary factors causing the dramatic increase in thickness of the composite confining bed in the downdip direction (sections D-D', E-E', pl. 3) are the rapid thickening of beds within the Vincentown and Manasquan Formations, and the addition of beds of the Shark River Formation and Piney Point Formation.

Vincentown aquifer

Throughout most of its subsurface extent, the Vincentown Formation functions primarily as a confining bed. However, within its outcrop area and for approximately 8 to 10 mi downdip, the formation is tapped by many domestic wells and locally by industrial and public-supply wells.

The outcrop area of the Vincentown Formation and the approximate extent, structure contours of the top, and thickness of the Vincentown aquifer are shown on plate 19. The outcrop area extends in an irregular and discontinuous band from northeastern Monmouth County to the Delaware River adjacent to Salem County. In areas where its outcrop is discontinuous, the Vincentown Formation subcrops below the overlapping Kirkwood Formation. In and near its outcrop, the Vincentown Formation of Paleocene age contains two lithofacies: a massive sparsely glauconitic quartz sand and a very fossiliferous calcareous quartz sand (Parker and others, 1964, p. 58). The massive quartz sand occurs mainly in outcrop from Ocean County to eastern Monmouth County. The fossiliferous lime-sand facies crops out from Burlington to Salem Counties (Owens and Sohl, 1969, p. 249). These two lithofacies make up the moderately permeable section of the Vincentown Formation, herein referred to as the Vincentown aquifer.

The extent of the Vincentown aquifer can be traced in the subsurface from Monmouth to Salem Counties, but only in a narrow band 3- to 10-mi wide adjacent to and paralleling the outcrop area. The moderately permeable quartz and limesand facies in and near the outcrop grades rapidly into finer grained silts and clays downdip. This sharp facies change to less permeable beds downdip has been noted by Enright (1969, p. 15), Parker and others (1964, p. 58), and Rush (1968, p. 53) and is supported by borehole geophysics data (sections D-D', pl. 3, and L-A', pl. 5). The Vincentown aquifer is easily recognizable above the characteristic signature of the underlying Hornerstown Sand on gamma-ray logs that penetrate the section (section J-J', pl. 4). On geophysical logs from areas southeast of the limit of the aquifer, the Vincentown Formation mainly shows beds of higher radioactivity and low resistivity, indicating poor permeabilities.

The Vincentown aquifer thickens from about 20 ft in outcrop and along the southeastern limit to approximately 80 ft in Salem County and northern Burlington County. The aquifer's maximum thickness exceeds 140 ft in Monmouth County, near the outcrop area. The most productive areas of the Vincentown aquifer are in areas of greatest thickness, primarily in Monmouth and Salem Counties.

The thickness of the confining bed underlying the Vincentown aquifer, which can include sediments of the Navesink Formation, Red Bank, Tinton, and Hornerstown Sands, can be obtained by calculating the base of the Vincentown aquifer from the top and thickness maps (pl. 19) and subtracting the base from the top of the Wenonah-Mount Laurel aquifer (pl. 16). The thickness of the confining bed overlying the Vincentown aquifer, which can include sediments of the Manasquan and basal Kirkwood Formations, can be calculated by comparing the map of the top of the Vincentown aquifer (pl. 19) with the base of the Kirkwood-Cohansey aquifer system (pl. 23). Confining bed thicknesses can also be calculated from table 4 in the back of the report.

Piney Point aquifer

The Piney Point Formation of middle and late Eocene age is composed of fine- to coarse-grained glauconitic quartz sand and shell beds. Sandy silt and clay are common within the formation and can dominate locally. The Piney Point Formation does not crop out and rests mainly on the beveled surface of the Manasquan Formation (Parker and others, 1964, p. 60) of early Eocene age (Enright, 1969, p. 17). It also overlies and may be equivalent to part of the middle Eocene Shark River Formation in the northeastern Coastal Plain of New Jersey (Enright, 1969, p. 19). The Piney Point Formation is unconformably overlain by a silty clay in the basal part of the Miocene Kirkwood Formation, locally referred to as the Alloway Clay Member in the southern Coastal Plain of New Jersey (Isphording, 1970; Nemickas and Carswell, 1976).

The name Piney Point Formation was first given by Otten (1955, p. 85) to glauconitic sand and shell beds considered to be late Eocene (Jackson) in age, from a well at Piney Point, St. Marys County, Maryland. The Piney Point Formation was later traced northeastward to the eastern shore of Maryland by Rasmussen and others (1957, p. 61-67) and subsequently into Delaware by Rasmussen and others (1958). Rasmussen identified the formation in sediments of Jackson age penetrated by a deep well at Atlantic City, New Jersey (Richards and others, 1962, p. 31). Richards and others (1962) and Parker and others (1964) have traced the Piney Point Formation into Cumberland, Cape May, and Atlantic Counties and as far east as Atlantic City.

The supposed late Eocene (Jackson) age of the Piney Point Formation has recently been in question. Brown and others (1972, p. 49) examined original material from the type section of the Piney Point. They assigned a middle Eocene (Claiborne) age to the formation based on the discovery of a characteristic middle Eocene foraminifera and several species of ostracodes. Olsson and others (1980) have recently proposed a late Oligocene age for the Piney Point Formation in Maryland and New Jersey based on a study of planktonic foraminifera.

The glauconitic quartz sand and shell beds of the Piney Point Formation yield moderate supplies of water locally to Coastal Plain wells. However, the Piney Point is extensive in the New Jersey subsurface and is believed to be capable of supplying additional water needs. Therefore, information is provided herein for aquifer extent, top, and thickness.

Nemickas and Carswell (1976) recognized the water-bearing potential of the Piney Point Formation in southern New Jersey. They presented stratigraphic and hydrologic data for the Piney Point aquifer and the overlying Alloway Clay Member of the Kirkwood Formation. On the basis of geophysical logs, Nemickas and Carswell (1976, p. 4) mapped the aquifer in Salem, Gloucester, Cumberland, Atlantic, and Camden Counties.

The altitude of the top of the Piney Point aquifer and the approximate subsurface limit are shown on plate 20. This report redefines the extent of the Piney Point aquifer and shows that it is laterally persistent from the southern Coastal Plain of New Jersey into parts of Burlington and Ocean counties. In Camden, Burlington, and Ocean Counties this water-bearing unit, here shown as the Piney Point aquifer, has previously been interpreted as being part of the Manasquan Formation. Herrick (1962, p. B-57) showed a glauconitic shelly sand at the base of the Kirkwood Formation between an interval of approximately 219-260 ft below land surface, in a well at the U.S. Geological Survey New Brooklyn Park test well site, in Camden County (adjacent to well number 07-476 of this report). He assigned a middle Eocene (Claiborne) age and the name Manasquan Formation to these sediments, based on foraminifers found within this zone. The Manasquan Formation is older, being early Eocene in age, according to a more recent study by Enright (1969, p. 17). The middle Eocene age given by Herrick (1962) is consistent with the age of the Piney Point Formation determined by Brown and others (1972, p. 49) at Piney Point, Maryland.

Nemickas and Carswell (1976, p. 4, fig. 5) have updated Herrick's interpretation by tracing the Piney Point aquifer from

Cumberland and Salem Counties northward into the same unit within the New Brooklyn Park test well (7-476) described by Herrick (1962) as the Manasquan Formation.

Hydrogeologic section L-L', plate 5, shows the continuation of the Piney Point aquifer from Atlantic City northward into the central Coastal Plain of New Jersey. The unit shown as the Piney Point aquifer in U.S. Geological Survey wells 29-425 (Webbs Mills), 5-676 (Coyle Airport), and 5-30 (Oswego Lake), has previously been reported as Manasquan Formation by Rush (1968, p. 54) and Anderson and Appel (1969, p. 43). Herrick (written commun., 1962) analyzed the sediments in the three Geological Survey wells listed above. He assigned a middle Eocene (Claiborne) age and the name Manasquan Formation to the sediments within the unit shown as Piney Point on section L-L', plate 5. This unit is directly correlative with the unit described by Herrick (1962, B-57) in the New Brooklyn Park well in Camden County, that was later shown as the Piney Point aquifer by Nemickas and Carswell (1976, p. 4, fig. 5).

Hydrogeologic section L'-A', plate 5, shows the lateral persistence of the Piney Point aquifer along the coast from Atlantic City northward including wells at Barnegat Light and Seaside Park in Ocean County. Production wells for local water supply tapping this zone in Ocean County have been previously described as tapping the Manasquan Formation (Anderson and Appel, 1969, p. 44).

Nemickas and Carswell (1976, p. 1) defined the Piney Point aquifer as "the upper sandy part of the Eocene sediments that is laterally continuous with the Piney Point aquifer in Delaware." This report follows the same convention. Regardless of previous formation names or disputes in time-stratigraphic correlations, moderately permeable glauconitic sand and shell beds that lie below the basal clay of the Kirkwood Formation, and that are laterally continuous with the Piney Point aquifer of the Delaware and Maryland Coastal Plain are herein described as the Piney Point aquifer.

The thickness of the Piney Point aquifer is shown on plate 21. Downdip, two major areas of sand accumulation are evident. In the southwestern Coastal Plain of New Jersey, aquifer thickness increases toward the south and downdip from the northwestern limit of the aquifer. Thicknesses of more than 200 ft occur in southwestern Cumberland County. The other area of thick sand accumulation lies within the east-central Coastal Plain in Burlington and Ocean Counties. Here maximum thicknesses exceed 130 ft. The Piney Point aquifer thins updip (section F-F', pl. 4) where it wedges out between sediments of the underlying Manasquan Formation and the overlying Kirkwood Formation.

Thickness of the confining-bed material underlying and overlying the Piney Point aquifer can be calculated from table 3, from the hydrogeologic sections, and from comparisons of the maps of the Piney Point aquifer with those of vertically adjacent aquifers.

Atlantic City 800-Foot Sand

The Atlantic City 800-foot sand is a major water-bearing unit that lies within the lower part of the Kirkwood Formation of middle Miocene age. It is the principal artesian aquifer supplying water along the barrier beaches from Stone Harbor in Cape May County to Harvey Cedars in Ocean County. The Atlantic City 800-foot sand is composed of gray, medium- to coarse-grained quartz sands and gravel with a considerable amount of interspersed fragmented shell material.

Structure contours on the top of the Atlantic City 800-foot sand, its thickness, and approximate extent are shown on plate 22. The approximate updip limit of the 800-foot sand is based on the approximate updip limit of the overlying confining bed. The Atlantic City 800-foot sand is recognizable in the subsurface only where it is overlain by the thick massive clay bed southeast of the double-dashed line (pl. 22). This confining bed is described in detail in the following section. In areas northwest of the limit of the confining bed, the Kirkwood Formation is composed primarily of fine- to medium-grained sand that is hydraulically connected to the overlying Cohansey Sand and younger deposits, forming a relatively thick water-table aquifer.

It is not explicitly known whether the 800-foot sand continues beyond the western edge of the overlying confining bed and forms part of the larger water-table system to the west. This is significant because if a lateral connection exists, most of the recharge to the 800-foot sand would be from unconfined areas to the west. The presumed relationship of the Atlantic City 800-foot sand to the underlying and overlying confining beds and the unconfined Kirkwood-Cohansey aquifer system is illustrated in figure 5.

The Atlantic City 800-foot sand overlies a clay bed at the base of the Kirkwood Formation that is the uppermost unit of the composite confining bed described previously. This basal clay appears to be the equivalent of the Alloway Clay Member of the Kirkwood Formation described by Nemickas and Carswell (1976). This underlying clay bed can be traced laterally updip beyond the limit of the thick clay bed that overlies the Atlantic City 800-foot sand (sections F-F', pl. 4, and L-L', L'-A', pl. 5).

The Atlantic City 800-foot sand generally thickens downdip. The aquifer also thickens toward the south from approximately 40 ft at Barnegat Light, Ocean County, to greater than 200 ft at Cape May City, Cape May County. The aquifer thickness at Atlantic City is more than 150 ft.

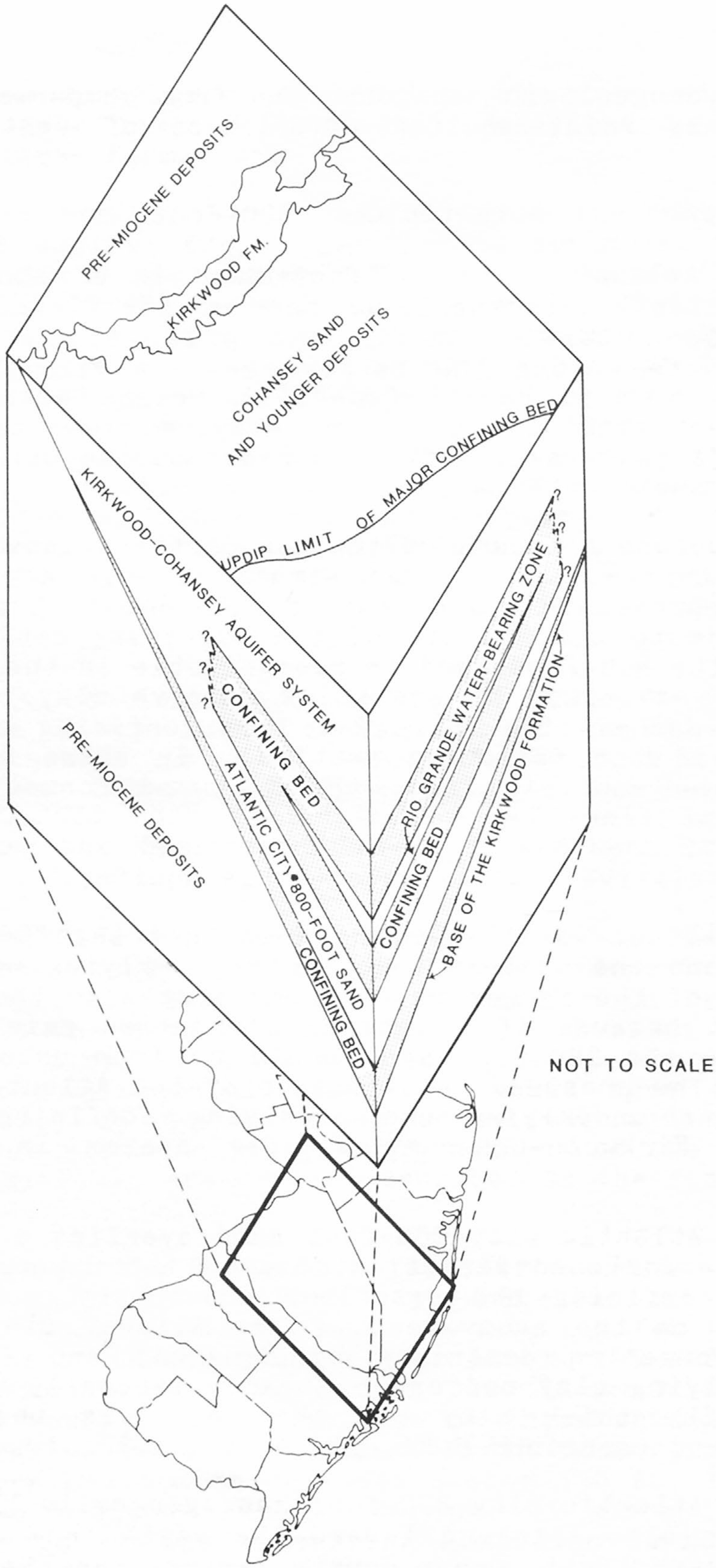

Figure 5.--Block diagram showing the presumed stratigraphic relationship between the Kirkwood-Cohansey aquifer system and the Atlantic City 800-foot sand.

A relatively thin clay bed within the Atlantic City 800-foot sand, with thicknesses generally ranging from 10 to 30 ft is recognized on geophysical logs from Ocean City, Cape May County, to Beach Haven, Ocean County (section M-M', pl. 5). Most of the production wells along the coast are screened in the lower part of the double sand separated by this thin clay bed. According to unpublished results from an aquifer test in 1980 at Atlantic City, Atlantic County, significant leakage can occur from the upper sandy zone of the aquifer (Tilley and Straus, written commun., 1978).

Confining Bed Overlying the Atlantic City 800-Foot Sand

The thickness and extent of the confining bed that overlies the Atlantic City 800-foot sand is shown on plate 22. This massive clay bed within the Kirkwood Formation is commonly described as being rich in diatoms. Woolman (1895) often referred to this unit as the "Great Diatom Bed."

The confining bed thickness increases in the downdip direction from less than 100 ft in the vicinity of Mays Landing, Atlantic County to more than 300 ft beneath the Atlantic City area. The confining bed is thickest along the barrier beaches of Cape May County, where thicknesses of 400 to 450 ft are common. However, sandy zones within the confining bed are common in the Cape May area. The confining bed thins toward the line approximating its westernmost limit in the subsurface. It cannot be identified in wells located less than 5 mi updip from the limit shown on the map (pl. 22). This indicates that the clay bed is either truncated or that an abrupt lithologic change from silt and clay to sand occurs over a relatively short distance. No evidence for a gradual pinchout of the unit has been observed.

The updip extent of this confining bed could only be approximated because of limited geophysical data. However, water-level data indicate that water-bearing sands of the Kirkwood Formation are largely unconfined west of the limit of the confining bed shown on plate 22 (Walker, 1983), supporting the given interpretation.

Rio Grande water-bearing zone

Positioned midway within the confining bed that overlies the Atlantic City 800-foot sand lies a relatively thin artesian aquifer (sections L-L', L'-A, M-M', pl. 5). Gill (1962) described this unit in Cape May County and referred to it as the Rio Grande water-bearing zone, after the town in Cape May County that uses it for public supply. The same unit was recognized as early as 1890 in the Atlantic City region and on the southern barrier beaches of Ocean County, where it was generally referred to as the 550-foot horizon (Woolman, 1891, p. 269 and 1892, p. 224). The lateral persistence of the Rio Grande water-bearing zone from Cape May County to Ocean County is shown on section M-M' (pl. 5). Thickness and structure contour maps of this unit are not given in this report. Tops and thicknesses of the Rio Grande water-bearing zone can be calculated from the hydrogeologic sections.

The Rio Grande water-bearing zone is utilized mainly in southern Cape May County, where aquifer thicknesses can exceed 100 ft. It is generally less than 40 ft thick throughout much of the coastal areas in southern Ocean and Atlantic Counties. The aquifer is seldom used outside of southern Cape May County and is of minor importance. Therefore, in this report, the Rio Grande water-bearing zone has been included as part of the confining bed overlying the 800-foot sand shown on plate 22.

Kirkwood-Cohansey Aquifer System

The Kirkwood-Cohansey aquifer system is predominantly a water-table aquifer that underlies an area of approximately 3,000 mi^2 southeast of the updip limit of the outcrop of the Kirkwood Formation. This aquifer system is composed of the Kirkwood Formation, Cohansey Sand, and, depending on location, can include overlying deposits of the Beacon Hill Gravel, Bridgeton Formation, and Cape May Formation (Rhodehamel, 1973). The Kirkwood-Cohansey aquifer system is confined by overlying Pleistocene deposits on the peninsular part of Cape May County.

The lithology of the Kirkwood Formation, as indicated previously, is variable. Along coastal areas thick clay beds are dominant with interbedded zones of sand and gravel. In the subsurface, updip from the coast, fine to medium sand and silty sand are common, and regionally extensive clay beds occur only in the basal part of the formation.

The Cohansey Sand, also of Miocene age, is coarser grained than the underlying Kirkwood Formation. It is predominantly a light-colored quartz sand containing minor amounts of pebbly sand, fine- to coarse-grained sand, silty and clayey sand, and interbedded clay (Rhodehamel, 1973, p. 24). Some local clay beds within the Cohansey Sand are relatively thick. Locally, perched water tables and semiconfined conditions can exist in the Kirkwood-Cohansey aquifer system.

Overlying the Cohansey Sand are the Beacon Hill Gravel and the Bridgeton Formation, both considered to be Miocene fluvial deposits (Owens and Minard, 1979). The Beacon Hill Gravel overlies the Cohansey Sand only in remnant patches on the highest hills between Clarksburg, Monmouth County, and Warren Grove, Ocean County, where it can be as much as 40 ft thick (Owens and Minard, 1979, p. D6). The coarse-grained sand and gravel of the Bridgeton Formation are more widespread and can generally add 30 to 50 ft of thickness to the aquifer system in parts of Camden, Gloucester, Salem, Cumberland, Atlantic, and Cape May Counties (Owens and Minard, 1979, p. D14).

Throughout most of Cape May County, the Pleistocene Cape May Formation directly overlies the Cohansey Sand. Gill (1962, p. 21) divided the Cape May Formation into four distinct environmental facies. In order of deposition they are: estuarine sand, estuarine clay, marine sand, and deltaic sand. Gill (1962, fig. 2) has shown that in the northern half of Cape May County and along the coast as far south as Stone Harbor, the Cohansey Sand is in hydraulic connection with the overlying marine and deltaic sand facies. The marine sand facies of the Cape May Formation adds as much as 100 ft to the thickness of the Kirkwood-Cohansey aquifer system in the northern half of Cape May County. On the peninsular part of Cape May County, the Cohansey Sand is generally in hydraulic connection with the estuarine sand facies but is confined by the overlying estuarine clay facies (Gill, 1962, fig. 2). The estuarine clay facies generally ranges from 25 to 125 ft in thickness (Gill, 1962, p. 27).

The base of the Kirkwood-Cohansey aquifer system is shown on plate 23. The map illustrates two major regional basal surfaces for the water-table aquifer. The two surfaces are differentiated by the double-dashed line representing the approximate westward limit of the major confining bed overlying the Atlantic City 800-foot sand. The basal surface for the Kirkwood-Cohansey aquifer system west of this line is the top of the clay bed lying within the lower part of the Kirkwood Formation. This clay bed, as shown on hydrogeologic sections F-F' (pl. 4) and L-L' (pl. 5), is the updip extension of the confining bed underlying the 800-foot sand, and is probably the equivalent of the Alloway Clay Member of the Kirkwood Formation described by Nemickas and Carswell (1976).

The basal surface east of the double-dashed line is the top of the thick diatomaceous clay bed that overlies the Atlantic City 800-foot sand. The discontinuity in the structure contours on the base of the unconfined system at the double-dashed line is caused by the presence of this clay bed. The base of the aquifer system directly updip from the northwestern limit of the confining bed generally lies more than 350 ft below sea level. At Egg Harbor City, Atlantic County, several miles downdip from the western limit of the confining bed, the base of the water-table aquifer is only 160 ft below sea level. The difference in altitudes of the two basal surfaces of the Kirkwood-Cohansey aquifer system is shown diagrammatically in figure 5.

The thickness of the confining bed underlying the Kirkwood-Cohansey aquifer system west of the double-dashed line is shown on plate 18 as the composite confining bed. If, in more detailed studies, the Vincentown and Piney Point aquifers are considered to be important, the thickness of the confining bed between the base of the unconfined aquifer and these minor aquifers can be calculated by comparing the maps of the tops of the Vincentown (pl. 19) and Piney Point (pl. 20) aquifers with the base of the Kirkwood-Cohansey aquifer system west of the double-dashed line (pl. 23).

It is important to note that the Cohansey Sand is a confined aquifer beneath the peninsular portion of Cape May County. However, on plate 23, structure contours have been extended throughout Cape May County to illustrate the base of the confined Cohansey Sand. Information regarding the water-table system in Cape May County can be found in Gill (1962).

The extent of the confining bed overlying the Atlantic City 800-foot sand partly determines the thickness of the Kirkwood-Cohansey aquifer system. An abrupt change in the thickness of the Kirkwood-Cohansey aquifer system at the double-dashed line is shown on plate 24. The water-table aquifer thickens downdip from less than 50 ft at the Kirkwood outcrop to more than 400 ft near the edge of the upper confining bed of the Atlantic City 800-foot sand. In areas where this clay bed occurs in the subsurface, the aquifer thickness ranges from about 140 ft along the northwestern extent of the clay bed to approximately 400 ft in the Atlantic City area.

The aquifer-thickness map for the Kirkwood-Cohansey aquifer system represents not only the saturated thickness of the water-table aquifer but also the unsaturated section. The thickness of the aquifer at each control point represents the total thickness of the unit calculated by subtracting the depth of the basal confining bed from the altitude of land surface.

SUMMARY AND CONCLUSIONS

The Coastal Plain of New Jersey is a seaward-dipping wedge of unconsolidated sediments that range in age from Cretaceous to Quaternary. These sediments are composed of clay, silt, sand, and gravel and include continental, coastal, and marine-type deposits.

Hydrogeologic units described in this report can differ from formal stratigraphic units because a geologic formation can contain more than one aquifer, a formation may function as an aquifer in one area and as a confining bed in another, or an aquifer or confining bed may be composed of several geologic formations.

The occurrence and configuration of 15 regional hydrogeologic units have been defined within the Coastal Plain of New Jersey based on the interpretation of borehole geophysics data. Structure-contour maps and aquifer thickness maps are provided for nine aquifers listed in ascending order:

1. Lower aquifer of the Potomac-Raritan-Magothy aquifer system
2. Middle aquifer of the Potomac-Raritan-Magothy aquifer system
3. Upper aquifer of the Potomac-Raritan-Magothy aquifer system
4. Englishtown aquifer system
5. Wenonah-Mount Laurel aquifer
6. Vincentown aquifer
7. Piney Point aquifer

8. Atlantic City 800-foot sand
9. Kirkwood-Cohansey aquifer system

Thickness maps are provided for six confining beds listed in ascending order:

1. Confining bed between the lower and middle aquifers of the Potomac-Raritan-Magothy aquifer system
2. Confining bed between the middle and upper aquifers of the Potomac-Raritan-Magothy aquifer system
3. Merchantville-Woodbury confining bed
4. Marshalltown-Wenonah confining bed
5. Composite confining bed
6. Confining bed overlying the Atlantic City 800-foot sand

The structure-contour and thickness maps are supplemented by 14 hydrogeologic sections that show vertical and horizontal relationships among the 15 hydrogeologic units.

The major points presented by this hydrogeologic framework are:

1. The Potomac-Raritan-Magothy aquifer system is divided into five mappable units of varying extent. The five units include three aquifers, designated as lower, middle, and upper, and two confining beds that lie interjacent to the aquifers.

2. The lower aquifer of the Potomac-Raritan-Magothy aquifer system is defined in the subsurface near the outcrop area between Burlington and Salem Counties.

3. The middle aquifer of the Potomac-Raritan-Magothy aquifer system occurs over the same area as the lower aquifer, but is also laterally continuous in the subsurface of the northern Coastal Plain of New Jersey where it is equivalent to the Farrington aquifer.

4. The upper aquifer of the Potomac-Raritan-Magothy aquifer system is mapped in the subsurface throughout the Coastal Plain southeast of the outcrop area of the Magothy Formation. The upper aquifer is equivalent to the Old Bridge aquifer in the northeastern Coastal Plain of New Jersey.

5. The Merchantville-Woodbury confining bed is the most extensive confining bed within the Coastal Plain. This unit functions as an effective confining bed between the upper aquifer of the Potomac-Raritan-Magothy aquifer system and the Englishtown aquifer system. In areas where the Englishtown aquifer system is absent, the Merchantville-Woodbury confining bed effectively

confines the upper aquifer of the Potomac-Raritan-Magothy aquifer system from the Wenonah-Mount Laurel aquifer.

6. The Englishtown aquifer system primarily functions as a single aquifer but contains two water-bearing sands in parts of Monmouth and Ocean Counties. South of a line paralleling Forked River (Ocean County), Hammonton (Atlantic County), and Bridgeton (Cumberland County), the Englishtown aquifer system is not recognized on geophysical logs that penetrate the section.

7. The Marshalltown-Wenonah confining bed is a thin leaky unit that ranges in thickness from 20 to 80 ft. This confining bed lies between the Englishtown aquifer system and the Wenonah-Mount Laurel aquifer.

8. The Wenonah-Mount Laurel aquifer is identified in the subsurface throughout the New Jersey Coastal Plain southeast of the outcrop of the Mount Laurel Sand.

9. Sediments that overlie the Wenonah-Mount Laurel aquifer and that are subjacent to the major aquifers within the Kirkwood Formation and Cohansey Sand function primarily as a composite confining bed, but include minor aquifers, namely the Vincentown and Piney Point.

10. The Vincentown Formation functions as an aquifer within 3 to 10 mi downdip of its outcrop area. In areas further downdip the Vincentown Formation functions as a confining bed.

11. The Piney Point aquifer is laterally persistent from the southern Coastal Plain northward into Burlington and Ocean Counties. The name Piney Point aquifer replaces the name Manasquan Formation for this water-bearing unit in Burlington and Ocean Counties.

12. The Atlantic City 800-foot sand of the Kirkwood Formation can be recognized in the subsurface along coastal areas of Cape May, Atlantic, and southern Ocean Counties, but only as far west as the limit of the overlying confining bed. In areas west of the limit of the overlying confining bed, the Kirkwood Formation is in hydraulic connection with the overlying Cohansey Sand and younger surficial deposits and is an unconfined aquifer.

13. The Kirkwood-Cohansey aquifer system is predominantly a water-table aquifer that underlies an area of approximately 3,000 mi^2 southeast of the updip limit of the outcrop of the Kirkwood Formation. The aquifer

system is composed of the Kirkwood Formation, Cohansey Sand, and overlying deposits of the Beacon Hill Gravel, Bridgeton Formation, and Cape May Formation.

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Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain.

Well number	Location		Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
	Latitude	Longitude				
1- 22	392124	742548	TRAYMORE HOTEL 1	ATLANTIC CITY	820	
1- 37	392151	742459	ATLANTIC CITY WD GALEN HALL	ATLANTIC CITY	811	
1- 39	392336	742330	BRIGANTINE WD NEW 4	BRIGANTINE CITY	840	M-M'
1-116	393211	743829	EGG HAR WTR WKS 3	EGG HARBOR CITY	429	
1-117	393206	743836	EGG HAR WTR WKS 5	EGG HARBOR CITY	457	
1-180	392754	742701	USGS OCEANVILLE 1	GALLOWAY TWP	958	L-L'
1-219	392625	744156	HAMILTON TWP WD TH 2-73	HAMILTON TWP	378	
1-227	392709	744439	HAMILTON TWP WD 5	HAMILTON TWP	367	
1-349	394041	744604	STATE OF NJ MULLICA 2D	HAMMONTON TOWN	214	
1-366	391821	743207	LONGPORT WD OBS	LONGPORT BORO	720	
1-369	391905	743127	LONGPORT WD 3	LONGPORT BORO	832	M-M'
1-566	392434	743032	ATLANTIC CITY WD 600	PLEASANTVILLE CITY	558	
1-578	391826	743709	USGS JOBS POINT	SOMERS POINT CITY	1000	
1-605	393825	744929	HAMMONTON WD 5	HAMMONTON TOWN	294	
1-648	392125	742604	BALLY PARK PLACE 1	ATLANTIC CITY	851	M-M'
1-649	392246	742714	US DEPT OF ENERGY TH 4-78	ATLANTIC CITY	1002	L-L',L'-A'
1-650	392653	744254	HAMILTON TWP WD TH 1-73	HAMILTON TWP	381	
1-700	392933	744604	USGS ACGS 4	HAMILTON TWP	925	
1-701	393148	745617	BUENA BORO MUA T-1	BUENA BORO	550	
5- 5	393847	743036	TRANSCONTINENTAL GAS TH 16	BASS RIVER TWP	1612	
5- 11	393925	743104	TRANSCONTINENTAL GAS TH 15	BASS RIVER TWP	1630	
5- 30	394208	742645	USGS OSWEGO LAKE 2	BASS RIVER TWP	345	L-L'
5-105	400612	744853	HOOKER CHEM COMPANY TH 1-66	BURLINGTON TWP	227	F-F'
5-117	400749	743630	GRAY, FRANCIS 1	CHESTERFIELD TWP	314	
5-127	395938	745810	NJ WATER COMPANY RIVERTON 14	CINNAMINSON TWP	342	
5-164	395233	745418	EVESHAM MUA TH 11	EVESHAM TWP	809	
5-198	395720	744822	MOUNT HOLLY WC LLWS 2	LUMBERTON TWP	355	
5-209	400412	744323	COLUMBUS WC 3-1969	MANSFIELD TWP	318	
5-212	400515	744109	N BURL CO HIGH SCHOOL 1	MANSFIELD TWP	344	
5-221	400750	744549	PUBLIC SERV E-G NEWBOLD ISLAND	MANSFIELD TWP	232	
5-228	395630	745855	MAPLE SHADE WD 10	MAPLE SHADE TWP	508	
5-249	395209	745043	MEDFORD TWP WD 3-1968	MEDFORD TWP	546	
5-262	395524	745025	USGS MEDFORD 4	MEDFORD TWP	1132	G-G'
5-274	395838	745905	CAMPBELL SOUP 1	MOORESTOWN TWP	249	
5-290	395936	744655	MOUNT HOLLY WC 6	MOUNT HOLLY TWP	628	I-B

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well number	Location Latitude	Location Longitude	Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
5-293	400021	744737	ACME FOOD STORE 1	MOUNT HOLLY TWP	424	
5-303	395607	745648	MOUNT LAUREL MUA 1	MOUNT LAUREL TWP	593	
5-332	400106	743720	US ARMY FORT DIX 5	NEW HANOVER TWP	1133	
5-334	400138	743753	US ARMY FORT DIX 3	NEW HANOVER TWP	852	
5-340	400300	743514	US AIR FORCE MCGUIRE B	NORTH HANOVER TWP	1008	
5-344	400546	743446	HOFFMAN-LAROCHE 1974 WELL	NORTH HANOVER TWP	891	
5-368	395755	743239	PEMBERTON TWP WD 7	PEMBERTON TWP	368	
5-378	395815	743840	BURLINGTON CO INST 5	PEMBERTON TWP	420	
5-385	395839	744249	IONAC CHEM CORP 5	PEMBERTON TWP	840	
5-388	395939	743742	US ARMY FORT DIX 6	PEMBERTON TWP	1140	F-F',J-J'
5-417	394608	744054	STATE OF NJ MULICA 10D	SHAMONG TWP	244	
5-436	400118	744010	HELIS, WM G STOCK FARM 1	SPRINGFIELD TWP	657	
5-440	400242	744223	RHODIA CORP 1	SPRINGFIELD TWP	634	F-F',I-B
5-448	400355	744809	STATE OF NJ 1-REST AREA	SPRINGFIELD TWP	211	
5-451	394536	743542	STATE OF NJ MULLICA 5D	TABERNACLE TWP	216	
5-454	394812	744031	STATE OF NJ MULLICA 3D	TABERNACLE TWP	224	
5-464	395114	744542	AMOS ALLEN PARK 1	TABERNACLE TWP	382	
5-465	395123	743835	TRANSCONTINENTAL GAS TH 9	TABERNACLE TWP	852	
5-485	393832	743608	STATE OF NJ MULLICA 12D	WASHINGTON TWP	370	
5-488	393844	743855	STATE OF NJ BATSTO 2	WASHINGTON TWP	546	
5-598	394223	744153	STATE OF NJ MULLICA 11D	WASHINGTON TWP	209	
5-608	394300	743830	STATE OF NJ MULLICA 4D	WASHINGTON TWP	314	
5-612	394305	743357	STATE OF NJ MULLICA 13D	WASHINGTON TWP	303	
5-635	400041	745049	INDUCTOTHERM 1	WESTAMPTON TWP	436	
5-644	400005	745237	WILLINGBORO MUA DCB 12	WILLINGBORO TWP	524	G-G'
5-648	400103	745409	WILLINGBORO MUA 3-OBS	WILLINGBORO TWP	315	
5-658	400158	745307	WILLINGBORO MUA 7	WILLINGBORO TWP	304	G-G'
5-668	400308	745325	WILLINGBORO MUA DCB 28	WILLINGBORO TWP	240	
5-672	394558	742950	TRANSCONTINENTAL GAS TH 13	WOODLAND TWP	1513	
5-676	394914	742544	USGS COYLE AIRPORT	WOODLAND TWP	590	F-F',L-L'
5-678	394940	743143	STATE OF NJ MULLICA 8S	WOODLAND TWP	225	
5-681	395019	743106	TRANSCONTINENTAL GAS TH 1	WOODLAND TWP	1147	
5-683	395122	743017	USGS BUTLER PLACE 1	WOODLAND TWP	2275	F-F'
5-691	395210	743726	TRANSCONTINENTAL GAS TH 11	WOODLAND TWP	949	
5-695	395328	743720	SUNNY PINES CONSTRUCTION TH 1-74	WOODLAND TWP	546	

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well number	Location		Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
	Latitude	Longitude				
5-696	395330	742946	TRANSCONTINENTAL GAS TH 5	WOODLAND TWP	897	
5-697	395351	743048	TRANSCONTINENTAL GAS TH 6	WOODLAND TWP	900	
5-699	395442	742950	TRANSCONTINENTAL GAS TH 7	WOODLAND TWP	908	
5-724	395413	744231	HAMPTON LAKE WC 3	SOUTHAMPTON TWP	366	
5-737	395749	743448	JENKINS & SONS 1961 WELL	PEMBERTON TWP	284	
5-739	400150	744820	BURL CO COUNTRY CLUB 2-1966	WESTAMPTON TWP	314	
5-741	400218	744604	LAUREL OAKS ENT 1-1973	SPRINGFIELD TWP	285	
5-752	395247	745157	EVESHAM MUA TH 13	EVESHAM TWP	510	J-J'
5-767	400420	745245	TENNECO CHEM TH 4	BURLINGTON TWP	162	G-G'
7- 8	395148	750542	BELLMAWR BORO WD 4	BELLMAWR BORO	588	
7- 19	395146	745614	BERLIN WD 10	BERLIN BORO	785	
7- 78	395616	750632	CAMDEN CITY WD CITY 5N	CAMDEN CITY	183	
7-117	395229	745712	NJ WATER COMPANY HUTTON HILL 1	CHERRY HILL TWP	602	
7-121	395252	745943	NJ WATER COMPANY BROWNING TH 1	CHERRY HILL TWP	819	
7-130	395353	745708	NJ WATER COMPANY OLD ORCHARD A	CHERRY HILL TWP	801	I-B
7-146	395455	745924	NJ WATER COMPANY KINGSTON 27	CHERRY HILL TWP	540	
7-163	395609	750028	NJ WATER COMPANY COLUMBIA 22	CHERRY HILL TWP	463	
7-170	394832	745915	CLEMENTON WD ABANDON WELL	CLEMENTON BORO	172	
7-172	395426	750514	COLLINGSWOOD WD 6	COLLINGSWOOD BORO	334	
7-184	394950	745855	NJ WATER COMPANY GIBBSBORO OBS 1	GIBBSBORO BORO	1160	
7-221	395356	750738	USGS COAST GUARD 1	GLOUCESTER CITY	254	
7-228	394556	745835	CAMDEN CO BD ED VOC&TECH HS 1	GLOUCESTER TWP	471	
7-251	394759	750158	GARDEN STATE WC TH 1	GLOUCESTER TWP	518	
7-257	394829	750347	SUN TEMP INDUST	GLOUCESTER TWP	388	
7-278	395238	750316	NJ WATER COMPANY HADDON 15	HADDON HEIGHTS BORO	596	
7-283	395246	750433	NJ WATER COMPANY EGBERT OBS	HADDON HEIGHTS BORO	462	
7-299	395322	750154	HADDONFIELD WD LAYNE 2	HADDONFIELD BORO	620	
7-303	395404	750202	HADDONFIELD WD TH 1965	HADDONFIELD BORO	551	H-H'
7-317	395134	750251	OWENS CORNING TH 2	MAGNOLIA BORO	675	H-H',I-B
7-320	395652	750307	MCHVIL PNSK WCM WOODBINE 1	MERCHANTVILLE BORO	283	H-H'
7-363	395842	750312	CAMDEN CITY WD PUCHACK 2	PENNSAUKEN TWP	158	
7-392	394641	745909	PINE HILL MUA 1	PINE HILL BORO	715	
7-412	394922	745630	NJ WATER COMPANY ELM TREE 2	VOORHEES TWP	1356	H-H'
7-430	394204	744921	STATE OF NJ MULLICA 7D	WATERFORD TWP	270	
7-451	394628	744923	STATE OF NJ MULLICA 1D	WATERFORD TWP	225	

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well number	Location Latitude	Location Longitude	Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
7-469	394104	745134	ANCORA STATE HOSPITAL 3	WINSLOW TWP	352	
7-476	394215	745617	USGS NEW BROOKLYN PARK 1	WINSLOW TWP	2081	H-H'
7-512	394522	745625	JOHNS-MANVILLE TH 1	WINSLOW TWP	892	
7-516	395345	750653	GLOUCESTER CITY WD 43	GLOUCESTER TWP	281	
9- 2	390420	744435	AVALON WD 7-71	AVALON BORO	898	
9- 13	385613	745457	CAPE MAY CITY WD TH 10	CAPE MAY CITY	1002	
9- 19	385557	745738	CAPE MAY PT WD LIGHTHOUSE 1	CAPE MAY POINT BORO	568	
9- 24	385404	745742	USGS HIGBEE 2	LOWER TWP	389	
9- 33	385650	745535	CAPE MAY C WD COLD SPRINGS PUMP STA	LOWER TWP	DL*	
9- 66	390135	745349	WILDWOOD WD RIO GRANDE 22	MIDDLE TWP	500	
9- 89	390425	745446	USGS OYSTER LAB 4	MIDDLE TWP	192	
9- 93	390525	744851	NJ WATER COMPANY NEPTUNUS TH 1	MIDDLE TWP	807	M-M'
9-110	391604	743539	NJ WATER COMPANY OCEAN CITY 12	OCEAN CITY	878	M-M'
9-125	391726	743352	NJ WATER COMPANY OCEAN CITY 11	OCEAN CITY	910	
9-126	390747	744241	SEA ISLE CITY WD 5	SEA ISLE CITY	860	
9-132	390301	744545	STONE HARBOR WD 4	STONE HARBOR BORO	966	
9-148	391707	743756	ATLANTIC CITY ELECTRIC LAYNE 4	UPPER TWP	716	
9-149	391816	744953	MORRIS APRIL BROS	UPPER TWP	DL*	
9-159	385830	745021	WILDWOOD WD 35	WILDWOOD CREST BORO	979	
9-166	390351	744504	STONE HARBOR WD 5	STONE HARBOR BORO	899	
9-177	390642	744248	WONDER ICE COMPANY ABANDONED	AVALON BORO	896	
9-181	385718	745700	ANCHOR GAS DICKINSON 1	LOWER TWP	6402	
11- 44	392733	750924	CUMBERLAND CO VOC SCH 3	DEERFIELD TWP	625	
11- 72	392442	751916	CUMBERLAND CO SHEPPARDS 1	GREENWICH TWP	624	
11- 96	391829	751208	CUMBERLAND CO JONES IS 2	LAWRENCE TWP	570	
11-116	391118	745705	MOORES BEACH FIRE DEPT	LAWRENCE TWP	DL*	
11-132	392512	745212	USGS RAGOVIN 1	MAURICE RIVER TWP	3738	
11-163	392528	750641	CUMBERLAND CO FAIR GROUNDS 3	MILLVILLE CITY	550	
15- 1	393912	750522	CLAYTON WD 3	CLAYTON BORO	1000	
15- 3	394015	750559	CLAYTON WD 4-1973	CLAYTON BORO	938	
15- 6	394627	750813	WOODBURY WD SEWELL 1A	DEPTFORD TWP	345	
15- 27	394751	751248	E GREENWICH WD TEST 3	EAST GREENWICH TWP	238	
15-131	394501	751229	CLEARVIEW BD ED HS 1	HARRISON TWP	440	
15-137	394535	752054	PURELAND WC 2(3-1973)	LOGAN TWP	236	
15-139	394608	752135	PURELAND WC TH 3	LOGAN TWP	345	I-B

*DL - Drillers log

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well number	Location Latitude	Location Longitude	Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
15-154	394715	752048	ROLLINS ENVIRONMENTAL 1	LOGAN TWP	279	
15-157	394728	752219	LANDTECT CORP TH 7	LOGAN TWP	202	
15-183	394431	750911	PITMAN COUNTRY CLUB 1	MANTUA TWP	445	
15-192	394641	751109	MANTUA TWP MUA 5	MANTUA TWP	470	
15-194	394732	751037	MANTUA TWP MUA 4	MANTUA TWP	336	
15-227	394426	750747	PITMAN WD P3	PITMAN BORO	516	
15-253	394437	750249	WASHINGTON TWP MUA 6(FRIES MILLS 1)	WASHINGTON TWP	730	
15-267	394546	750400	WASHINGTON TWP MUA 3	WASHINGTON TWP	642	
15-282	394913	751105	W DEPTFORD TWP WD 5 KINGS HYWAY	WEST DEPTFORD TWP	482	
15-287	394920	751226	SHELL CHEM COMPANY TH 1	WEST DEPTFORD TWP	442	
15-296	394942	751317	SHELL CHEM COMPANY OBS 5	WEST DEPTFORD TWP	329	
15-308	395044	751242	PENNWALT CORP TH 8	WEST DEPTFORD TWP	270	
15-312	395107	750946	W DEPTFORD TWP WD 6 RED BANK AVE	WEST DEPTFORD TWP	384	
15-323	395232	750942	TEXACO EAGLE POINT OBS 3	WEST DEPTFORD TWP	271	
15-330	394858	750845	WOODBURY HGTS BORO 1 HELEN AVE	WOODBURY HEIGHTS BORO	247	
15-331	394955	750908	WOODBURY WD RAILROAD 5	WOODBURY CITY	481	I-B
15-379	394601	751005	MANTUA TWP MUA 6	MANTUA TWP	410	
15-383	394750	751249	E GREENWICH WD TH 3	EAST GREENWICH TWP	308	
15-414	395127	750853	W DEPTFORD TWP WD TH 7-79	WEST DEPTFORD TWP	361	
15-422	394259	750853	ZEE ORCHARDS 1-1980	HARRISON TWP	606	J-J'
15-430	395153	750949	TEXACO EAGLE POINT 6A	WEST DEPTFORD TWP	342	
21- 13	401536	742920	E WINDSOR MUA TH 5	EAST WINDSOR TWP	674	D-D'
21- 30	400954	743853	GARDEN STATE WC CROSSWICKS WC1	HAMILTON TWP	292	
21- 75	401500	744002	GARDEN STATE WC PAXSON AVE 12	HAMILTON TWP	150	
21- 85	401625	743131	HIGHTSTOWN WD TH 3	HIGHTSTOWN BORO	392	D-D',I-B
21- 99	401159	743403	ENGLAND, ROBERT 2	WASHINGTON TWP	428	
21-101	401238	743448	PRINCETON MEMORIAL PARK 1	WASHINGTON TWP	500	E-E',I-B
21-134	401535	743703	W WINDSOR WC TH C	WEST WINDSOR TWP	176	
23- 25	401902	742912	CARTER WALLACE 6	CRANBURY TWP	397	
23- 50	402432	742212	ANHEUSER BUSCH 5	EAST BRUNSWICK TWP	290	
23- 59	402456	742442	E BRUNSWICK TWP WD 2	EAST BRUNSWICK TWP	234	
23-114	402319	742246	DUHERNAL WC OBS 52F	OLD BRIDGE TWP	224	
23-146	402350	741834	OLD BRIDGE MUA BROWNTOWN 3	OLD BRIDGE TWP	510	
23-179	402436	742041	OLD BRIDGE MUA OBS 2-1972	OLD BRIDGE TWP	329	
23-236	402038	742345	NJ HOME FOR BOYS 4	MONROE TWP	496	C-C',I-B

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well number	Location		Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
	Latitude	Longitude				
23-291	402109	743013	MONROE TWP MUA OBS 1	SOUTH BRUNSWICK TWP	207	
23-348	402605	741957	SAYREVILLE WD OBS 101	SAYREVILLE BORO	290	B-B',I-B
23-404	402745	741645	SAYREVILLE WD MORGAN OBS 1	SAYREVILLE BORO	315	A-A'
23-430	402923	741651	JERSEY CENTRAL P&L 7-1972	SOUTH AMBOY CITY	206	
23-553	401950	742750	MONROE TWP MUA TH 16	MONROE TWP	463	
25- 13	401137	740121	AVON WD 4	AVON BY THE SEA BORO	1298	C-C',K-C',L'-A'
25- 34	401558	740908	US NAVY EARLE 2(B)	COLTS NECK TWP	837	
25- 37	401610	741205	HOMINY HILLS GOLF CLUB 2-1963	COLTS NECK TWP	671	C-C',J-J'
25- 52	401720	740315	R H MACY & CO TH	EATONTOWN BORO	892	
25- 55	401744	742135	ENGLISHTOWN WD 1	ENGLISHTOWN BORO	598	
25- 82	401412	741606	FREEHOLD TWP WD KOENIG LANE 1	FREEHOLD TWP	666	
25- 97	401625	741501	FREEHOLD TWP WD 6-OLD SO. GULF2	FREEHOLD TWP	654	
25-103	401646	741737	FREEHOLD TWP WD 7-74	FREEHOLD TWP	882	C-C'
25-119	402403	735923	HIGHLANDS BORO WD 3	HIGHLANDS BORO	895	
25-153	402444	741015	W KEANSBURG WC 4	HOLMDEL TWP	665	
25-156	402449	740910	LILY TULIP TH-DEEP	HOLMDEL TWP	793	
25-162	400815	741043	NJ NATURAL GAS 1-1973	HOWELL TWP	676	
25-168	400957	741305	ALDRICH WC 2	HOWELL TWP	609	
25-174	401245	741520	ADELPHIA WC 2-1974	HOWELL TWP	843	
25-207	402626	741142	KEYPORT BORO WD 6	KEYPORT BORO	300	
25-210	401639	735936	MONMOUTH CON WC WEST END 1	LONG BRANCH CITY	995	B-B',L'-A'
25-214	401429	742146	MANALAPAN T WD LAMBS RD 1	MANALAPAN TWP	753	
25-218	401557	742318	BOY SCOUTS AMERICA QUAIL HILL 2	MANALAPAN TWP	482	
25-220	401537	742012	BATTLEGROUND COUNTRY CLUB IRR	MANALAPAN TWP	492	
25-228	401733	741818	GORDONS CORNER WC OBS	MANALAPAN TWP	815	
25-231	402004	741855	GORDONS CORNER WC 6	MANALAPAN TWP	714	
25-249	401902	741811	GORDONS CORNER WC 4	MARLBORO TWP	828	
25-251	401908	741510	GORDONS CORNER WC 9	MARLBORO TWP	620	
25-262	402102	741353	MARLBORO STATE HOSPITAL 15	MARLBORO TWP	870	B-B'
25-272	402208	741452	MARLBORO TWP MUA OBS 1	MARLBORO TWP	698	
25-303	402106	740810	BAMM HOLLOW COUNTRY CLUB 1	MIDDLETOWN TWP	729	
25-320	402705	735959	NATIONAL PK SER FORT HANCOCK 5A	MIDDLETOWN TWP	878	
25-332	401930	735841	MON BCH CLD STR 1971 DEEP	MONMOUTH BCH BORO	845	A-A',L'-A'
25-351	401323	740156	MONMOUTH CON WC WHITESVILLE	NEPTUNE TWP	777	L'-A'
25-360	402054	740320	RED BANK WD 4	RED BANK BORO	805	A-A',J-J'

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well number	Location Latitude	Location Longitude	Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
25-374	400804	740227	SEA GIRT WD 5	SEA GIRT BORO	755	
25-391	400928	740211	SPRING LAKE HIGHTS WD 4	SPRNG LK HGTS BORO	719	L'-A'
25-407	401005	742939	PUNK BROS DEEP WELL	UPPER FREEHOLD TWP	950	
25-428	400823	740455	WALL TWP WD ALLENWOOD 1	WALL TWP	755	
25-429	400834	740834	USGS ALLAIRE STATE PARK C	WALL TWP	575	
25-436	400952	740725	BRISBANE CHILD TREAT CENTER 3-71	WALL TWP	1040	
25-453	402632	741051	UNION BEACH WD 3-77	UNION BEACH BORO	579	A-A'
25-456	402640	740904	INT FLAVOR FRAG 3R	UNION BEACH BORO	582	
25-486	400711	740202	US DEPT OF ENERGY TH 2-78	MANASQUAN BORO	974	L'-A'
25-487	400908	741330	ALDRICH WC TH 4	HOWELL TWP	622	
25-492	401134	741014	ROKEACH & SONS TH	FARMINGDALE BORO	495	
25-493	401231	741127	HOWELL TWP 1-75	HOWELL TWP	843	
25-495	401850	740301	US DEPT OF ENERGY TC-40	EATONTOWN BORO	1003	B-B'
29- 9	393346	741430	BEACH HAVEN WD 8	BEACH HAVEN BORO	656	
29- 19	394829	740535	USGS IS BEACH OBS 3 TW1	BERKELEY TWP	3878	E-E',L'-A'
29- 25	395448	741444	TRANSCONTL GAS TH 20	BERKELEY TWP	1426	
29- 45	400431	740832	BRICK TWP MUA FP 9	BRICK TWP	1807	D-D',K-C'
29- 70	395905	740359	NJ WATER COMPANY NORMANDY 4	DOVER TWP	1500	D-D',L'-A'
29- 85	395929	741421	TOMS RIVER CHEM 84	DOVER TWP	2242	E-E',K-C'
29-118	400200	742110	US NAVY LAKEHURST 32	JACKSON TWP	1732	
29-134	400320	741954	JACKSON TWP MUA SCM 1	JACKSON TWP	1109	E-E'
29-138	400414	742702	USGS COLLIERS MILLS 1	JACKSON TWP	403	
29-233	400742	741639	JACKSON TWP MUA 4	JACKSON TWP	565	
29-238	400819	742625	JACKSON TWP MUA 7	JACKSON TWP	800	D-D',E-E',J-J'
29-240	400847	741531	JACKSON TWP MUA 5	JACKSON TWP	224	
29-425	395323	742255	USGS WEBBS MILLS 2	LACEY TWP	388	L-L'
29-429	400046	741838	LAKEHURST WD 1	LAKEHURST BORO	1017	
29-433	400312	741123	LAKEWOOD TWP MUA SO LKWD 3	LAKEWOOD TWP	720	
29-440	400504	741324	NJ WATER COMPANY LAKEWOOD 10	LAKEWOOD TWP	1614	D-D'
29-441	400505	741114	NJ WATER COMPANY LAKEWOOD OBS	LAKEWOOD TWP	759	
29-449	400614	741157	NJ WATER COMPANY LAKEWOOD 9	LAKEWOOD TWP	740	
29-453	395808	740416	LAVALLETTE WD 4	LAVALLETTE BORO	1467	
29-457	393510	741327	LONG BEACH WC TERRACE 3	LONG BEACH TWP	698	M-M'
29-462	393253	742308	LITTLE EGG HARBOR MUA MYSTIC 3	LITTLE EGG HARBOR TWP	587	
29-464	393428	742202	LITTLE EGG HARBOR MUA MYSTIC 2	LITTLE EGG HARBOR TWP	664	

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well Number	Location		Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
	Latitude	Longitude				
29-488	395729	742343	CEDAR GLEN LAKES WC 1	MANCHESTER TWP	208	
29-491	395900	742102	AM SMELTNG & REFINING 1	MANCHESTER TWP	1700	
29-492	395906	742138	AM SMELTNG & REFINING OBS 1	MANCHESTER TWP	1599	
29-504	400210	740310	NJ WATER COMPANY MANTOLOKING 7	MANTOLOKING BORO	1375	
29-514	394742	741420	USGS GARDEN ST PKY OBS 2	OCEAN TWP	462	
29-515	395558	741013	PINE BEACH WATER UTILITY 1	PINE BEACH BORO	392	
29-534	395609	741240	USGS TOMS RIVER TH 2	SOUTH TOMS RIVER BORO	1230	
29-542	395547	740434	SEASIDE PARK WD 4	SEASIDE PARK BORO	446	L'-A'
29-547	393845	741053	SHIP BOTTOM WD TH 1973	SHIP BOTTOM BORO	993	F-F',L'-A'
29-560	393938	741006	SURF CITY WD 4	SURF CITY BORO	546	
29-561	393948	740954	SURF CITY WD 5	SURF CITY BORO	610	
29-565	393610	742031	TUCKERTON MUA 4	TUCKERTON BORO	492	
29-572	394617	741933	TRANSCONTINENTAL GAS TH 18	UNION TWP	1737	F-F'
29-573	394647	742025	TRANSCONTINENTAL GAS TH 17	UNION TWP	1619	
29-575	400652	741717	JACKSON TWP MUA 9	JACKSON TWP	1655	D-D'
29-583	394454	740655	BARNEGAT LIGHT WD TH-78	BARNEGAT LIGHT BORO	639	L'-A'
29-585	395028	741044	US DEPT OF ENGERY TH C-39	LACEY TWP	967	
29-598	394201	741212	AMER TELE & TEL TH 1960	STAFFORD TWP	440	
29-601	400206	741253	MAR VAC BLDG COMPANY HOUSE 1-74	LAKEWOOD TWP	231	
29-604	400348	742119	POWERS, ED DOMESTIC T-79	JACKSON TWP	140	
29-771	394330	735836	AMCOR 6011	OFF SHORE	958	
29-774	394042	741411	STAFFORD TWP MUA 4	STAFFORD TWP	520	
29-809	395527	740826	OCEAN GATE BORO 4	OCEAN GATE BORO	398	
33- 2	393202	751630	CUMBERLAND CO BOSTWICK 3	ALLOWAY TWP	562	
33- 9	393330	751826	ALGER, PAUL 1	ALLOWAY TWP	375	
33- 15	393406	752056	SELIGMAN, J R 1	ALLOWAY TWP	91	
33- 20	393534	751752	HORNER, EPHRAIM	ALLOWAY TWP	280	J-J'
33- 22	393534	751018	ELMER WC TH 3	ELMER BORO	523	
33- 33	392751	752441	L ALLOWAY CK SC LACTES 1	LOWER ALLOWAYS CK TWP	378	
33- 64	393912	752436	E I DUPONT TH 3	MANNINGTON TWP	830	
33- 69	394139	752349	NJ TURNPIKE AUTHORITY IN-1	OLDMANS TWP	331	
33-106	393514	752911	LINSKI, ALEX	PENNSVILLE TWP	366	
33-107	393620	753310	STATE OF NJ FORT MOTT SP 1	PENNSVILLE TWP	118	
33-108	393641	753322	US ARMY FINNS POINT	PENNSVILLE TWP	319	
33-111	393746	752955	PENNSVILLE TWP WD HOOK RD OBS	PENNSVILLE TWP	196	

Table 3.--Record of wells used to construct the hydrogeologic framework of the New Jersey Coastal Plain--Continued.

Well number	Location		Local well identifier	Municipality	Total depth logged (feet)	Hydrogeologic section (see plate 2)
	Latitude	Longitude				
33-115	393938	753036	PENNSVILLE TWP WD TH 2	PENNSVILLE TWP	244	
33-117	393954	753013	PENNSVILLE TWP WD 3	PENNSVILLE TWP	325	
33-139	394131	753009	E I DUPONT CHAMBERS OBS 1	PENNSVILLE TWP	488	
33-148	393751	751848	MCBRIDE, GORDON	PILESGROVE TWP	69	
33-158	393848	752010	ACME MARKETS COMPANY 1	PILESGROVE TWP	578	
33-187	394037	751915	USGS POINT AIRY OBS	PILESGROVE TWP	672	
33-194	394102	751943	KELLY, W F	PILESGROVE TWP	475	
33-198	394117	752207	DUBOIS BROTHERS IRRIGATION 74	PILESGROVE TWP	417	
33-209	393013	750816	PARVIN STATE PARK B	PITTSGROVE TWP	220	
33-236	393004	752026	CALLS TRAILER CAMP	QUINTON TWP	330	
33-241	393253	752422	SALEM CITY WD QUINTON ST	QUINTON TWP	294	
33-251	393348	752755	USGS SALEM 1	SALEM CITY	800	
33-280	393625	751513	DARETOWN PUBLIC SCHOOL 1	UPPER PITTSGROVE TWP	441	
33-302	394000	752439	E I DUPONT COURSES LANDING 2A	UPPER PENNS NECK	804	I-B
33-346	394256	752718	PENNS GROVE WSC LAYNE 1	UPPER PENNS NECK	368	
33-384	393137	752458	WILD OAK COUNTRY CLUB 1-IRR-73	QUINTON TWP	268	J-J'
33-389	393223	750442	E I DUPONT TH 2-66	PITTSGROVE TWP	1042	
33-391	393338	752701	BOSCOS DINER	QUINTON TWP	326	
33-393	393750	753149	PENNSVILLE TWP WD TH 1-64	PENNSVILLE TWP	809	I-B
33-394	393835	751655	LAUTENBACH, WM HOUSE WELL	PILESGROVE TWP	134	I-B
33-401	392751	753207	PUBLIC SERV E-G TH 1-80	LOWER ALLOWAYS CK TWP	1800	
PH- 19	395314	751010	US NAVAL BASE	PHILADELPHIA PA	248	

BORO - Borough
CO - County
MUA - Municipal Utilities Authority
OBS - Observation well
PW - Production well
TH - Test hole

TWP - Township
USGS - U.S. Geological Survey
WC - Water Company
WD - Water Department
WTR WKS - Water Works

Table 4.--Altitudes of top and base of hydrogeologic units.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system	Atlantic City 800-foot sand		Piney Point aquifer		Vincentown aquifer		Wenonah-Mount Laurel aquifer		Englishtown aquifer system		Potomac-Raritan-Magothy aquifer system: Upper aquifer		Middle aquifer		Lower aquifer	
		Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base
1- 22	10	-398	-698	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1- 37	10	-399	-692	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1- 39	10	-326	-651	-785	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-116	45	-160	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-117	45	-157	-304	-393	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-180	27	-200	-491	-627	-717	-767	--	--	--	--	--	--	--	--	--	--	--	--
1-219	60	-248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-227	10	-200	-278	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-349	59	-143	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-366	5	-280	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-369	5	-303	-645	-800	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-566	12	-258	-512	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-578	10	-266	-560	-692	-808	-862	--	--	--	--	--	--	--	--	--	--	--	--
1-605	110	-173	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-648	7	-393	-681	-835	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-649	5	-312	-647	-780	-902	-964	--	--	--	--	--	--	--	--	--	--	--	--
1-650	20	-221	-300	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-700	40	-136	-200	-298	-446	-531	--	--	--	--	--	--	--	--	--	--	--	--
1-701	118	-154	--	--	-272	--	--	--	--	--	--	--	--	--	--	--	--	--
5- 5	18	--	--	--	--	--	--	--	-980	-1076	--	--	-1401	--	--	--	--	--
5- 11	19	-307	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5- 30	92	-268	--	--	-367	-504	--	--	--	--	--	--	--	--	--	--	--	--
5-105	33	--	--	--	--	--	--	--	--	--	--	--	--	--	-75	-165	--	--
5-117	95	--	--	--	--	--	--	--	--	--	41	-3	-171	--	--	--	--	--
5-127	35	--	--	--	--	--	--	--	--	--	--	--	--	-22	-65	-167	-239	-287
5-164	110	--	--	--	--	--	80	30	-34	-98	-146	-162	-350	-450	-560	-635	--	--
5-198	10	--	--	--	--	--	--	--	-24	-72	-92	-140	-322	--	--	--	--	--
5-209	73	--	--	--	--	--	--	--	--	--	--	39	-123	-207	--	--	--	--
5-212	82	--	--	--	--	--	--	--	--	--	60	17	-142	-231	--	--	--	--
5-221	10	--	--	--	--	--	--	--	--	--	--	--	--	--	-157	-203	--	--
5-228	40	--	--	--	--	--	--	--	--	--	--	--	-93	-176	-232	-282	-390	-471
5-249	55	--	--	--	--	--	--	--	-95	-165	-223	-241	-453	--	--	--	--	--
5-262	74	--	--	--	--	--	--	--	6	-79	-108	-192	-322	-414	-544	-703	-764	-1022
5-274	40	--	--	--	--	--	--	--	--	--	--	--	-10	-90	--	--	--	--
5-290	15	--	--	--	--	--	--	--	--	--	--	-73	-240	-360	-511	-613	--	--

Table 4.--Altitudes of top and base of hydrogeologic units--Continued.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system	Atlantic City 800-foot sand		Piney Point aquifer		Vincentown aquifer		Wenonah-Mount Laurel aquifer		Englishtown aquifer system		Potomac-Raritan-Magothy aquifer system: Upper aquifer		Middle aquifer		Lower aquifer	
		Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base
5-293	60	--	--	--	--	--	--	--	--	34	-3	-73	-224	-306	--	--	--	--
5-303	20	--	--	--	--	--	--	--	--	--	--	-30	-142	-207	-250	-376	-460	--
5-332	150	--	--	--	--	--	--	40	-26	-90	-153	-178	-384	-516	--	--	--	--
5-334	165	--	--	--	--	--	135	50	-29	-98	-137	-191	-363	--	-670	--	--	--
5-340	126	--	--	--	--	--	--	--	6	-68	-124	-174	-354	-507	-654	-710	--	--
5-344	136	--	--	--	--	--	--	--	74	6	-34	-113	-288	-344	-454	-528	--	--
5-368	90	10	--	--	--	--	--	--	-200	--	--	--	--	--	--	--	--	--
5-378	65	--	--	--	--	--	--	--	-123	-227	-263	-298	--	--	--	--	--	--
5-385	30	--	--	--	--	--	--	--	-30	-130	-170	-212	-450	-500	-710	-818	--	--
5-388	160	44	--	--	--	--	1	-28	-98	-180	-233	-259	-476	-592	-740	--	--	--
5-417	48	-137	--	--	-164	--	--	--	--	--	--	--	--	--	--	--	--	--
5-436	96	--	--	--	--	--	--	--	32	-60	-95	-141	-315	-422	--	--	--	--
5-440	75	--	--	--	--	--	--	--	--	33	8	-36	-206	-325	-434	-566	--	--
5-448	40	--	--	--	--	--	--	--	--	--	--	--	-22	-104	-153	--	--	--
5-451	67	-116	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-454	67	-100	--	--	-135	--	--	--	--	--	--	--	--	--	--	--	--	--
5-464	130	--	--	--	--	--	--	--	-230	--	--	--	--	--	--	--	--	--
5-465	98	-53	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-485	51	-305	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-488	35	-269	--	--	-340	-429	--	--	--	--	--	--	--	--	--	--	--	--
5-598	34	-150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-608	63	-165	--	--	-234	--	--	--	--	--	--	--	--	--	--	--	--	--
5-612	41	-183	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-635	65	--	--	--	--	--	--	--	--	--	--	5	-130	-177	-223	--	--	--
5-644	18	--	--	--	--	--	--	--	--	--	--	-2	-132	-175	-222	-370	-401	-498
5-648	34	--	--	--	--	--	--	--	--	--	--	--	-81	-120	-168	--	--	--
5-658	19	--	--	--	--	--	--	--	--	--	--	--	-12	-29	-62	-238	--	--
5-668	48	--	--	--	--	--	--	--	--	--	--	--	--	-17	-44	-200	--	--
5-672	90	-135	--	--	-266	-361	--	--	-750	-840	-860	--	-1182	-1291	--	--	--	--
5-676	197	-111	--	--	-231	-350	--	--	--	--	--	--	--	--	--	--	--	--
5-678	112	-88	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-681	108	-102	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-683	132	-90	--	--	-175	-240	--	--	-558	-662	-681	-750	-948	-1074	--	--	--	--
5-691	109	-56	--	--	--	--	--	--	-347	-461	-501	-543	-751	--	--	--	--	--
5-695	111	-47	--	--	--	--	--	--	-297	-401	--	--	--	--	--	--	--	--

Table 4.--Altitudes of top and base of hydrogeologic units--Continued.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system	Atlantic City 800-foot sand		Piney Point aquifer		Vincentown aquifer		Wenonah-Mount Laurel aquifer		Englishtown aquifer system		Potomac-Raritan-Magothy aquifer system: Upper aquifer		Middle aquifer		Lower aquifer	
		Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base	Top	Base
5-696	124	-56	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-697	144	-56	--	--	--	--	--	--	-436	-530	-592	-638	--	--	--	--	--	--
5-699	117	-56	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5-724	43	--	--	--	--	--	--	--	-147	-257	-294	--	--	--	--	--	--	--
5-737	75	25	--	--	--	--	--	--	-195	--	--	--	--	--	--	--	--	--
5-739	80	--	--	--	--	--	--	--	--	--	50	-10	-146	-230	--	--	--	--
5-741	35	--	--	--	--	--	--	--	--	--	--	-28	-165	--	--	--	--	--
5-752	45	--	--	--	--	--	35	-11	-61	-151	-182	-194	-393	--	--	--	--	--
5-767	10	--	--	--	--	--	--	--	--	--	--	--	--	--	-13	-129	--	--
7- 8	80	--	--	--	--	--	--	--	--	--	--	--	-101	-189	-242	-320	-370	-480
7- 19	145	-10	--	--	--	--	--	--	-151	-225	-285	-315	-485	-568	--	--	--	--
7- 78	22	--	--	--	--	--	--	--	--	--	--	--	--	-1	-19	-57	-80	-149
7-117	156	--	--	--	--	--	112	78	24	-8	-80	-94	-271	-417	--	--	--	--
7-121	80	--	--	--	--	--	--	--	--	4	-32	-47	-210	-282	-377	-548	-568	-682
7-130	71	--	--	--	--	--	--	--	--	17	-36	-79	-216	-292	-380	-521	-577	-676
7-146	40	--	--	--	--	--	--	--	--	--	--	10	-126	-198	-226	-390	-425	-483
7-163	32	--	--	--	--	--	--	--	--	--	--	--	-71	-142	-183	-278	-338	-438
7-170	55	--	--	--	--	--	25	-21	-69	--	--	--	--	--	--	--	--	--
7-172	10	--	--	--	--	--	--	--	--	--	--	--	-56	-91	-105	-141	-178	-298
7-184	70	--	--	--	--	--	40	17	-38	-93	-147	-176	-348	-420	-452	-630	-800	-1027
7-221	10	--	--	--	--	--	--	--	--	--	--	--	--	-82	-106	-162	-192	-237
7-228	145	-15	--	--	--	--	--	--	-165	-271	-309	--	--	--	--	--	--	--
7-251	75	--	--	--	--	--	45	29	-17	-97	-131	-155	-316	--	--	--	--	--
7-257	75	--	--	--	--	--	--	49	10	-77	-109	-143	-284	--	--	--	--	--
7-278	65	--	--	--	--	--	--	--	--	34	8	-23	-127	-215	-231	-301	-388	-535
7-283	24	--	--	--	--	--	--	--	--	--	--	--	-83	-164	-176	-233	-343	-468
7-299	75	--	--	--	--	--	--	--	--	--	--	--	-119	-214	-254	-388	-472	-535
7-303	55	--	--	--	--	--	--	--	--	--	--	--	-98	-188	-229	-325	-387	-461
7-317	68	--	--	--	--	--	--	--	--	38	-1	-57	-184	-302	-336	-426	-501	--
7-320	65	--	--	--	--	--	--	--	--	--	--	--	--	-21	-59	-123	-153	--
7-363	14	--	--	--	--	--	--	--	--	--	--	--	--	-4	-19	-48	-66	-144
7-392	150	--	--	--	--	--	--	--	-112	-204	-246	-282	-443	-535	--	--	--	--
7-412	150	60	--	--	--	--	20	-24	-71	-161	-184	-246	-398	-504	-532	-660	-802	-1076
7-430	94	-86	--	--	-162	--	--	--	--	--	--	--	--	--	--	--	--	--
7-451	122	-56	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 4.--Altitudes of top and base of hydrogeologic units--Continued.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system Base	Atlantic City 800-foot sand Top	Atlantic City 800-foot sand Base	Piney Point aquifer Top	Piney Point aquifer Base	Vincentown aquifer Top	Vincentown aquifer Base	Wenonah-Mount Laurel aquifer Top	Wenonah-Mount Laurel aquifer Base	Englishtown aquifer system Top	Englishtown aquifer system Base	Potomac-Raritan-Magothy aquifer system Upper aquifer Top	Upper aquifer Base	Middle aquifer Top	Middle aquifer Base	Lower aquifer Top	Lower aquifer Base
7-469	105	-101	--	--	-167	--	--	--	--	--	--	--	--	--	--	--	--	--
7-476	111	-38	--	--	-100	-135	--	--	-378	-477	-502	-561	-687	-789	--	--	--	--
7-512	160	-25	--	--	--	--	--	--	-238	-360	-386	-410	-578	-660	--	--	--	--
7-516	10	--	--	--	--	--	--	--	--	--	--	--	--	-112	-124	-167	-203	-262
9- 2	5	-367	-795	-918	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9- 13	10	-315	-666	-886	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9- 19	6	-280	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9- 24	9	-241	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9- 33	15	-295	-645	-810	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9- 66	5	-247	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9- 89	7	-202	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9- 93	6	-264	-635	-790	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-110	6	-280	-643	-809	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-125	10	-300	-643	-803	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-126	7	-324	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-132	7	-377	-820	-954	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-148	9	-281	-569	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-149	12	-145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-159	5	-337	-784	-927	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-166	5	-340	-789	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-177	5	-346	-750	-905	--	--	--	--	--	--	--	--	--	--	--	--	--	--
9-181	22	--	-588	-768	-923	-1013	--	--	-1964	-1988	--	--	-2179	-2230	--	--	--	--
11- 44	80	-88	--	--	-196	-330	--	--	--	--	--	--	--	--	--	--	--	--
11- 72	12	-38	--	--	-146	-281	--	--	--	--	--	--	--	--	--	--	--	--
11- 96	10	-264	--	--	-343	-555	--	--	--	--	--	--	--	--	--	--	--	--
11-116	5	-165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11-132	91	-400	--	--	-479	-505	--	--	-1205	-1271	--	--	-1385	-1477	--	--	--	--
11-163	80	-149	--	--	-258	-424	--	--	--	--	--	--	--	--	--	--	--	--
15- 1	133	28	--	--	-68	-157	--	--	-287	-415	-445	-465	-609	--	--	--	--	--
15- 3	140	56	--	--	--	--	--	--	-226	-340	-368	-391	-529	--	--	--	--	--
15- 6	20	--	--	--	--	--	--	--	--	--	-54	-98	-200	--	--	--	--	--
15- 27	47	--	--	--	--	--	--	--	--	--	--	--	-89	--	--	--	--	--
15-131	130	--	--	--	--	--	--	80	20	-60	-86	-108	-230	--	--	--	--	--
15-137	29	--	--	--	--	--	--	--	--	--	--	--	-16	-89	-132	--	--	--
15-139	8	--	--	--	--	--	--	--	--	--	--	--	--	-50	-113	-188	-262	-340

Table 4.--Altitudes of top and base of hydrogeologic units--Continued.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system Base	Atlantic City 800-foot sand Top	Atlantic City 800-foot sand Base	Piney Point aquifer Top	Piney Point aquifer Base	Vincentown aquifer Top	Vincentown aquifer Base	Wenonah-Mount Laurel aquifer Top	Wenonah-Mount Laurel aquifer Base	Englishtown aquifer system Top	Englishtown aquifer system Base	Potomac-Raritan-Magothy aquifer system: Upper aquifer Top	Upper aquifer Base	Middle aquifer Top	Middle aquifer Base	Lower aquifer Top	Lower aquifer Base
15-154	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-138	-177	-249
15-157	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-105	-145	-202
15-183	85	--	--	--	--	--	--	52	3	-79	-103	-120	-259	--	--	--	--	--
15-192	88	--	--	--	--	--	--	--	--	--	--	--	-202	-302	--	--	--	--
15-194	10	--	--	--	--	--	--	--	--	--	--	--	-166	-285	--	--	--	--
15-227	100	--	--	--	--	--	--	36	-20	-106	-126	-146	-293	-388	--	--	--	--
15-253	152	66	--	--	--	--	--	--	-112	-206	-232	-264	-430	-566	--	--	--	--
15-267	150	70	--	--	--	--	-10	-34	-80	-170	-205	-236	-395	--	--	--	--	--
15-282	55	--	--	--	--	--	--	--	--	--	--	--	-54	-181	-234	-305	-329	--
15-287	30	--	--	--	--	--	--	--	--	--	--	--	-35	-123	-199	-242	-276	-360
15-296	17	--	--	--	--	--	--	--	--	--	--	--	-23	-117	-183	-233	-269	--
15-308	10	--	--	--	--	--	--	--	--	--	--	--	--	-91	-156	-186	-225	--
15-312	20	--	--	--	--	--	--	--	--	--	--	--	-61	-135	-160	-190	-291	-356
15-323	21	--	--	--	--	--	--	--	--	--	--	--	--	-91	-111	-164	-224	--
15-330	40	--	--	--	--	--	--	--	--	--	--	--	-104	-194	--	--	--	--
15-331	30	--	--	--	--	--	--	--	--	--	--	--	-96	-182	-230	-308	-337	-450
15-379	125	--	--	--	--	--	--	71	29	-51	-75	-99	-234	--	--	--	--	--
15-383	51	--	--	--	--	--	--	--	--	--	--	--	-83	--	--	--	--	--
15-414	30	--	--	--	--	--	--	--	--	--	--	--	-32	-119	-130	-199	-252	--
15-422	140	90	--	--	--	--	19	-3	-53	-154	-175	-205	-338	-438	--	--	--	--
15-430	15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	-240	-315
21- 13	120	--	--	--	--	--	--	--	--	--	--	88	-82	-212	-278	-446	--	--
21- 30	25	--	--	--	--	--	--	--	--	--	--	--	-65	-121	-215	--	--	--
21- 75	76	--	--	--	--	--	--	--	--	--	--	--	--	--	-38	--	--	--
21- 85	100	--	--	--	--	--	--	--	--	--	--	--	2	-96	-170	-286	--	--
21- 99	118	--	--	--	--	--	--	--	--	--	--	62	-92	-199	-268	--	--	--
21-101	135	--	--	--	--	--	--	--	--	--	--	--	-39	-125	-225	-310	--	--
21-134	65	--	--	--	--	--	--	--	--	--	--	--	--	--	-61	-100	--	--
23- 25	120	--	--	--	--	--	--	--	--	--	--	--	24	-81	-107	-250	--	--
23- 50	76	--	--	--	--	--	--	--	--	--	--	--	--	--	-153	-233	--	--
23- 59	122	--	--	--	--	--	--	--	--	--	--	--	--	--	-42	--	--	--
23-114	25	--	--	--	--	--	--	--	--	--	--	--	--	-75	-183	--	--	--
23-146	80	--	--	--	--	--	--	--	--	--	--	--	--	--	-251	--	--	--
23-179	10	--	--	--	--	--	--	--	--	--	--	--	--	-80	-204	-291	--	--
23-236	90	--	--	--	--	--	--	--	--	--	--	--	-80	-158	-280	--	--	--

Table 4.--Altitudes of top and base of hydrogeologic units--Continued.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system Base	Atlantic City 800-foot sand Top	Atlantic City 800-foot sand Base	Piney Point aquifer Top	Piney Point aquifer Base	Vincentown aquifer Top	Vincentown aquifer Base	Wenonah-Mount Laurel aquifer Top	Wenonah-Mount Laurel aquifer Base	Englishtown aquifer system Top	Englishtown aquifer system Base	Potomac-Raritan-Magothy aquifer system: Upper aquifer Top	Upper aquifer Base	Middle aquifer Top	Middle aquifer Base	Lower aquifer Top	Lower aquifer Base
23-291	107	--	--	--	--	--	--	--	--	--	--	--	--	--	-32	--	--	--
23-348	34	--	--	--	--	--	--	--	--	--	--	--	--	-56	-159	-251	--	--
23-404	23	--	--	--	--	--	--	--	--	--	--	--	--	-90	-178	-267	--	--
23-430	12	--	--	--	--	--	--	--	--	--	--	--	--	--	-116	-155	--	--
23-553	130	--	--	--	--	--	--	--	--	--	--	--	17	-92	-131	-295	--	--
25- 13	29	--	--	--	--	-172	--	--	-395	-443	-510	-627	-956	-1167	--	--	--	--
25- 34	135	--	--	--	--	--	67	29	-101	-174	-205	-295	-505	--	--	--	--	--
25- 37	135	--	--	--	--	--	--	108	-44	-124	-137	-235	-425	--	--	--	--	--
25- 52	70	--	--	--	--	--	70	-48	-174	-232	-282	-386	-671	--	--	--	--	--
25- 55	70	--	--	--	--	--	--	--	--	--	--	12	-204	-311	-461	--	--	--
25- 82	130	--	--	--	--	--	--	--	-4	-56	-107	-184	-392	--	--	--	--	--
25- 97	200	--	--	--	--	--	--	--	20	-30	-66	-156	-350	--	--	--	--	--
25-103	107	--	--	--	--	--	--	--	81	17	-9	-97	-315	-483	-593	-690	--	--
25-119	20	--	--	--	--	--	--	--	--	--	--	-235	-604	-756	--	--	--	--
25-153	65	--	--	--	--	--	--	--	--	--	--	--	-321	-391	-567	-625	--	--
25-156	60	--	--	--	--	--	--	--	--	--	--	-52	-334	-412	--	--	--	--
25-162	69	-11	--	--	--	--	--	--	-275	-384	-435	-583	--	--	--	--	--	--
25-168	150	42	--	--	--	--	-64	-113	-207	-292	-330	--	--	--	--	--	--	--
25-174	102	--	--	--	--	--	--	44	-74	-146	-186	-262	-506	-658	--	--	--	--
25-207	11	--	--	--	--	--	--	--	--	--	--	--	-182	-269	--	--	--	--
25-210	10	--	--	--	--	--	10	-136	-238	-346	-385	-510	-756	-980	--	--	--	--
25-214	190	--	--	--	--	--	--	--	94	4	-40	-90	-318	-456	--	--	--	--
25-218	258	--	--	--	--	--	--	--	184	106	55	-10	-186	--	--	--	--	--
25-220	140	--	--	--	--	--	--	--	100	10	-8	-99	-280	--	--	--	--	--
25-228	148	--	--	--	--	--	--	--	131	73	38	-72	-294	-420	--	--	--	--
25-231	121	--	--	--	--	--	--	--	--	--	--	9	-197	-302	-441	-594	--	--
25-249	140	--	--	--	--	--	--	--	--	86	60	-34	-248	-328	-524	-670	--	--
25-251	125	--	--	--	--	--	--	--	73	2	-27	-83	-343	-443	--	--	--	--
25-262	135	--	--	--	--	--	--	--	66	29	17	-53	-289	-419	-575	-695	--	--
25-272	118	--	--	--	--	--	--	--	--	102	66	28	-212	-354	-471	--	--	--
25-303	70	--	--	--	--	--	--	--	--	--	-52	-170	-426	-602	--	--	--	--
25-320	14	--	--	--	--	--	--	--	--	--	--	-102	-394	-535	-715	-851	--	--
25-332	10	--	--	--	--	--	--	--	-182	-236	-286	-414	-720	--	--	--	--	--
25-351	18	--	--	--	--	--	-112	-206	-318	-390	-442	-562	--	--	--	--	--	--
25-360	146	--	--	--	--	--	--	--	-34	-94	-110	-258	-458	-624	--	--	--	--

Table 4.--Altitudes of top and base of hydrogeologic units--Continued.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system Base	Atlantic City 800-foot sand Top	Atlantic City 800-foot sand Base	Piney Point aquifer Top	Piney Point aquifer Base	Vincentown aquifer Top	Vincentown aquifer Base	Wenonah-Mount Laurel aquifer Top	Wenonah-Mount Laurel aquifer Base	Englishtown aquifer system Top	Englishtown aquifer system Base	Potomac-Raritan-Magothy aquifer system: Upper aquifer Top	Upper aquifer Base	Middle aquifer Top	Middle aquifer Base	Lower aquifer Top	Lower aquifer Base
25-374	20	--	--	--	--	--	--	--	--	--	-626	--	--	--	--	--	--	--
25-391	20	-16	--	--	--	--	--	--	-469	-541	-584	--	--	--	--	--	--	--
25-407	129	--	--	--	--	--	--	--	88	68	-17	-99	-281	-375	-457	-501	--	--
25-428	112	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
25-429	95	--	--	--	--	--	--	--	-351	-410	-471	--	--	--	--	--	--	--
25-436	60	--	--	--	--	--	--	--	-328	-398	-446	-632	-824	--	--	--	--	--
25-453	10	--	--	--	--	--	--	--	--	--	--	--	-218	-294	-452	-528	--	--
25-456	10	--	--	--	--	--	--	--	--	--	--	--	-204	-316	--	--	--	--
25-486	10	-110	--	--	--	--	--	--	-541	-602	-657	-857	--	--	--	--	--	--
25-487	130	20	--	--	--	--	-100	-140	-228	-298	-345	--	--	--	--	--	--	--
25-492	80	--	--	--	--	--	-52	-99	--	--	--	--	--	--	--	--	--	--
25-493	130	--	--	--	--	--	98	-40	-146	-257	-314	-422	-620	--	--	--	--	--
25-495	15	--	--	--	--	--	--	--	-117	-157	-235	-327	-543	-765	-867	-967	--	--
29- 9	5	-268	-554	-675	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29- 19	10	-394	--	--	-518	-565	--	--	-1190	-1250	--	--	-1742	-1910	--	--	--	--
29- 25	41	--	--	--	--	--	--	--	-808	-863	-943	-1040	-1260	-1379	--	--	--	--
29- 45	8	-136	--	--	--	--	--	--	-496	-562	-614	-794	-1004	-1188	-1322	--	--	--
29- 70	5	--	--	-235	--	--	--	--	-798	-865	--	-1086	-1307	-1473	--	--	--	--
29- 85	65	-140	--	--	--	--	--	--	-589	-635	-717	-851	-1052	-1235	-1357	--	--	--
29-118	100	--	--	--	--	--	--	--	-296	-360	-420	-565	-742	-862	-950	--	--	--
29-134	95	20	--	--	--	--	--	--	-275	-361	-417	-560	-743	-871	-990	--	--	--
29-138	137	79	--	--	--	--	7	-43	-119	-209	-249	--	--	--	--	--	--	--
29-233	80	--	--	--	--	--	-82	-124	-210	-296	-350	--	--	--	--	--	--	--
29-238	133	--	--	--	--	--	--	87	-17	-74	-124	-223	-433	-511	-610	--	--	--
29-240	75	41	--	--	--	--	-45	-135	--	--	--	--	--	--	--	--	--	--
29-425	126	-106	--	--	-190	-261	--	--	--	--	--	--	--	--	--	--	--	--
29-429	65	-35	--	--	--	--	--	--	-433	-499	-559	-709	-905	--	--	--	--	--
29-433	50	-68	--	--	--	--	--	--	-497	-573	-618	--	--	--	--	--	--	--
29-440	72	-24	--	--	--	--	--	--	-358	-453	-505	-668	-904	-1052	-1166	--	--	--
29-441	30	--	--	--	--	--	--	--	-427	-506	-554	-722	--	--	--	--	--	--
29-449	55	--	--	--	--	--	--	--	-345	-435	-493	-655	--	--	--	--	--	--
29-453	10	--	--	--	--	--	--	--	-810	-880	--	-1115	-1334	-1500	--	--	--	--
29-457	8	-247	-530	-651	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-462	8	--	-453	-562	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-464	25	-150	-447	-523	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 4.--Altitudes of top and base of hydrogeologic units--Continued
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system Base	Atlantic City 800-foot sand Top	Atlantic City 800-foot sand Base	Piney Point aquifer Top	Piney Point aquifer Base	Vincentown aquifer Top	Vincentown aquifer Base	Wenonah-Mount Laurel aquifer Top	Wenonah-Mount Laurel aquifer Base	Englishtown aquifer system Top	Englishtown aquifer system Base	Potomac-Raritan-Magothy aquifer system: Upper aquifer Top	Upper aquifer Base	Middle aquifer Top	Middle aquifer Base	Lower aquifer Top	Lower aquifer Base
29-488	170	-20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-491	89	-50	--	--	--	--	--	--	-449	-531	-585	-729	-900	-1055	--	--	--	--
29-492	97	-40	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-504	5	-180	--	--	--	--	--	--	-695	-765	-841	--	-1278	--	--	--	--	--
29-514	44	-290	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-515	30	-196	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-534	18	--	--	--	--	--	--	--	-748	-845	-891	-1012	--	--	--	--	--	--
29-542	12	-248	--	--	-428	--	--	--	--	--	--	--	--	--	--	--	--	--
29-547	7	-221	-453	-579	-675	-803	--	--	--	--	--	--	--	--	--	--	--	--
29-560	10	-200	-430	-536	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-561	10	-200	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-565	10	-180	-445	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-572	148	-299	--	--	--	--	--	--	-978	-1042	-1092	-1187	-1468	--	--	--	--	--
29-573	156	-253	--	--	-394	-504	--	--	-942	-1010	--	--	-1428	--	--	--	--	--
29-575	135	55	--	--	--	--	-99	-141	-233	-277	-357	-507	-695	-812	-945	--	--	--
29-583	5	-157	-379	-419	-590	--	--	--	--	--	--	--	--	--	--	--	--	--
29-585	15	-267	--	--	-361	-433	--	--	--	--	--	--	--	--	--	--	--	--
29-598	5	-193	-405	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-601	95	-33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-604	115	58	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-771	0	-258	-523	-599	-706	--	--	--	--	--	--	--	--	--	--	--	--	--
29-774	8	-202	-374	-481	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29-809	8	-204	--	--	-314	--	--	--	--	--	--	--	--	--	--	--	--	--
33- 2	85	25	--	--	-85	-175	--	--	-307	-443	--	--	--	--	--	--	--	--
33- 9	77	--	--	--	--	--	-167	-206	-246	--	--	--	--	--	--	--	--	--
33- 15	30	--	--	--	--	--	-52	--	--	--	--	--	--	--	--	--	--	--
33- 20	77	--	--	--	--	--	-107	-129	-178	--	--	--	--	--	--	--	--	--
33- 22	105	--	--	--	--	--	--	--	-309	-415	--	--	--	--	--	--	--	--
33- 33	12	--	--	--	-79	-119	-208	-240	-302	--	--	--	--	--	--	--	--	--
33- 64	20	--	--	--	--	--	--	--	--	--	--	--	-154	-220	--	-563	-640	--
33- 69	40	--	--	--	--	--	--	--	--	--	--	--	-116	--	-250	--	--	--
33-106	10	--	--	--	--	--	--	--	--	-80	-94	-106	-215	-265	--	--	--	--
33-107	8	--	--	--	--	--	--	--	--	--	--	--	-102	--	--	--	--	--
33-108	7	--	--	--	--	--	--	--	--	--	--	--	-99	-139	-189	--	--	--
33-111	10	--	--	--	--	--	--	--	--	--	--	--	-128	-170	--	--	--	--

Table 4.--Altitudes of top and base of hydrogeologic units--Continued.
[In feet above or below sea level]

Well number	Altitude of land surface	Kirkwood-Cohansey aquifer system Base	Atlantic City 800-foot sand Top	Atlantic City 800-foot sand Base	Piney Point aquifer Top	Piney Point aquifer Base	Vincentown aquifer Top	Vincentown aquifer Base	Wenonah-Mount Laurel aquifer Top	Wenonah-Mount Laurel aquifer Base	Englishtown aquifer system Top	Englishtown aquifer system Base	Potomac-Raritan-Magothy aquifer system: Upper aquifer Top	Upper aquifer Base	Middle aquifer Top	Middle aquifer Base	Lower aquifer Top	Lower aquifer Base
33-115	7	--	--	--	--	--	--	--	--	--	--	--	--	-99	-139	--	--	--
33-117	7	--	--	--	--	--	--	--	--	--	--	--	--	-98	-140	-277	--	--
33-139	5	--	--	--	--	--	--	--	--	--	--	--	--	--	-35	-185	-255	-440
33-148	69	--	--	--	--	--	16	--	--	--	--	--	--	--	--	--	--	--
33-158	57	--	--	--	--	--	37	12	-26	-103	-133	-180	-284	-300	-482	--	--	--
33-187	71	--	--	--	--	--	--	--	19	-64	-82	-119	-223	-269	-365	--	--	--
33-194	90	--	--	--	--	--	--	--	36	-42	-62	-94	-199	-225	-326	--	--	--
33-198	51	--	--	--	--	--	--	--	--	1	-39	-70	-159	-185	-272	--	--	--
33-209	75	-79	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
33-236	60	--	--	--	-88	-165	--	--	--	--	--	--	--	--	--	--	--	--
33-241	10	--	--	--	--	--	-15	-94	-165	--	--	--	--	--	--	--	--	--
33-251	6	--	--	--	--	--	--	--	-54	-142	-174	-194	-309	-354	-534	-775	--	--
33-280	133	87	--	--	--	--	-134	-150	-188	-301	--	--	--	--	--	--	--	--
33-302	30	--	--	--	--	--	--	--	--	-18	-25	-62	-149	-200	-270	-493	-615	--
33-346	12	--	--	--	--	--	--	--	--	--	--	--	--	--	-79	-188	-218	--
33-384	22	--	--	--	--	--	-64	-131	-188	--	--	--	--	--	--	--	--	--
33-389	80	-72	--	--	-193	-336	--	--	--	--	-630	-670	-860	-923	--	--	--	--
33-391	14	--	--	--	--	--	--	--	-77	-186	--	--	--	--	--	--	--	--
33-393	9	--	--	--	--	--	--	--	--	--	--	--	-102	-149	-187	-365	-476	-766
33-394	130	--	--	--	--	--	21	--	--	--	--	--	--	--	--	--	--	--
33-401	20	--	--	--	--	--	-48	-118	-146	-252	--	--	-410	-470	--	--	--	--
PH- 19	10	--	--	--	--	--	--	--	--	--	--	--	--	-51	-90	-118	-179	--