HYDROGEOLOGY OF, AND GROUND-WATER QUALITY IN, THE POTOMAC-RARITAN-MAGOTHY AQUIFER SYSTEM IN THE LOGAN TOWNSHIP REGION, GLOUCESTER AND SALEM COUNTIES, NEW JERSEY

By Jean C. Lewis, Joseph J. Hochreiter, Jr., Gary J. Barton, Jane Kozinski, and Frederick J. Spitz

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U.S. DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
Mountain View Office Park
Suite 206
810 Bear Tavern Road
West Trenton, NJ 08628

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square foot (ft^2)	929.0	square centimeter
square foot (ft^2)	0.09294	square meter
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
	Temperature	
degree Fahrenheit (°F)	°C = 5/9 x (°F-32)	degree Celsius
	Specific capacity	
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day
	Transmissivity	
square foot per day (ft^2/d)	0.09290	square meter per day
	Pressure	
pound per square inch (lb/in^2)	6.895	kilopascal

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustmant of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

The hydrogeology of the Potomac-Raritan-Magothy aquifer system in and around Logan Township in a 95-square-mile area adjacent to the Delaware River in Gloucester and Salem Counties, New Jersey, was studied from 1983 through 1987. The aquifer system is the sole source of potable water for the Township, and ground water in parts of the system is known to be contaminated.

The aquifer system is composed of the oldest sediments of the New Jersey Coastal Plain. Confining units divide the aquifer system into upper, middle, and lower aquifers. The aquifers consist of sand and gravel with lenses of clay and silt. The confining units consist of clay and silt with lenses of sand and gravel.

The aquifer system forms a wedge that dips and thickens to the southeast. The upper aquifer crops out in a large part of the study area and is about 0 to 90 feet thick. Its median horizontal hydraulic conductivity, determined by analysis of data from specific-capacity tests, is about 114 feet per day. In the southeastern part of the study area, the upper aquifer is overlain by the Merchantville-Woodbury confining unit, which has a maximum thickness of about 120 feet. The aquifer is underlain by a leaky, discontinuous confining unit with a maximum thickness of about 85 feet. The middle aquifer is 0 to 200 feet thick and has a median horizontal hydraulic conductivity of about 103 feet per day. The confining unit between the middle and lower aquifers is absent in a small area adjacent to the Delaware River; elsewhere in the study area it ranges up to 180 feet thick. The lower aquifer is about 20 to 220 feet thick and has a median horizontal hydraulic conductivity of about 88 feet per day. Nearly impermeable bedrock underlies the lower aquifer.

Water in the aquifers generally flows to the southeast. Locally, water flows toward industrial and municipal pumping sites. Water also flows downward from the upper aquifer toward the lower aquifer through the confining units.

Water samples were collected from 58 wells in nonindustrial parts of the study area to characterize the quality of ambient ground water. Water in the upper and middle aquifers is similar in terms of major dissolved ionic constituents and their concentrations. The dominant cation in water samples from 45 percent of the wells in the upper and middle aquifers is either sodium or calcium; samples from the other 55 percent of these wells have no dominant cation. The dominant anion in the upper and middle aquifers generally is bicarbonate (61 percent of the wells). In samples from all but one of the wells screened in the lower aquifer, sodium is the dominant cation and chloride is the dominant anion. The median concentration of

dissolved solids in the upper, middle, and lower aquifers is 150, 82, and 820 milligrams per liter, respectively.

In nonindustrial parts of the study area, water in the upper and middle aquifers generally is satisfactory for human consumption and most other uses; water in the lower aquifer is slightly saline. U.S. Environmental Protection Agency (USEPA) and New Jersey Department of Environmental Protection primary drinking-water regulations were exceeded in samples from six wells for one or more of the following constituents: cadmium, trichloroethylene, methylene chloride, xylene, total purgeable organic compounds, and nitrate plus nitrite. The concentration of dissolved iron exceeded the USEPA secondary drinking-water regulation in water from 36 of 45 wells screened in the upper and middle aquifers. The USEPA secondary drinking-water regulations for chloride and iron were exceeded in water from seven of the nine wells screened in the lower aquifer.

INTRODUCTION

Because surface water in the Logan Township region in Gloucester and Salem Counties, New Jersey, sometimes contains chloride in concentrations exceeding 250 milligrams per liter (Hochreiter, 1982, p. 16), ground water from the Potomac-Raritan-Magothy aquifer system is the sole source of potable water for the Township. Ground-water contamination reported at four industrial facilities (Miller and others, 1982; Kozinski and others, 1990), and the potential for saltwater intrusion from the Delaware River (Barksdale and others, 1958, p. 46; Toffey, 1982, p. 43) could threaten the Township's water supply. In addition, evidence of saline water in deep parts of the aquifer system underlying the area suggests that saline water could enter the water supply from depth.

To better understand the possible implication of these threats to the potable-water supply, the U.S. Geological Survey (USGS), in cooperation with the Township of Logan, conducted investigations in the township region from June 1983 through September 1987 to determine the hydrogeologic framework of, and ground-water flow and ambient ground-water quality in the underlying aquifer system.

Purpose and Scope

This report describes the hydrogeologic framework of, the ground-water flow system in, and the ambient ground-water quality in the Potomac-Raritan-Magothy aquifer system in the Logan Township region.

The report includes the results of a hydrogeologic analysis of geologic, geophysical, and drillers' logs of 181 wells and test holes. Contour maps illustrate the altitude of the top of the seven hydrogeologic units that comprise the Potomac-Raritan-Magothy aquifer system and the two units directly above and below the aquifer system. Also included are results of permeability measurements and grain-size analyses of confining-unit material taken from geologic cores collected at three sites. Results of analyses of specific-capacity tests of 49 wells and ground-water-pumpage data for 13 industries, public-water-supply companies, and irrigators are presented.

The report also includes potentiometric-surface maps prepared from synoptic water-level data for 50 wells screened in the three major aquifers of the Potomac-Raritan-Magothy aquifer system and water-level hydrographs of nine wells. Ambient ground-water quality of the aquifer system in the study area is described from results of analyses of water samples from 58 wells collected from 1959 through 1987. Also included are maps showing the distribution of dissolved chloride and iron in ground water underlying the study area.

Description of Study Area

Location and Extent

The study area comprises about 95 mi^2 (square miles) in and around Logan Township in Gloucester and Salem Counties, New Jersey (fig. 1). The area encompasses northwestern Gloucester County and northeastern Salem County and is located along the Delaware River.

The study area consists primarily of farmland and undeveloped wetlands with little topographic relief. Land-surface altitude ranges from sea level at the Delaware River to about 150 ft (feet) in the southeast. Residential areas include the long-established towns of Bridgeport, Swedesboro, Gibbstown, and Paulsboro, as well as newer residential developments located along the southeastern border of Logan Township.

Geography

The study area is in the Delaware River drainage basin. Tributaries to the Delaware River within the study area include Oldmans Creek, Birch Creek, Raccoon Creek, Little Timber Creek, and Repaupo Creek (pl. 1a).

The climate is moderate, with average annual temperatures at nearby Marcus Hook, Pennsylvania (plate 1a), of 57.2 °F (degrees Fahrenheit) in 1983 and 56.7 °F in 1984 (A. Graumann, National Oceanic and Atmospheric Administration, oral commun., 1987). Average annual precipitation for 1931-84 at Marcus Hook was 42.82 inches (National Oceanic and Atmospheric Administration, 1984). On average, monthly precipitation ranges from 2.96 in. (inches) in February to 4.51 in. in August. Annual precipitation at Marcus Hook was 48.00 in. in 1983 and was estimated to be 39.24 and 33.50 in. in 1984 and 1985, respectively (A. Gruumann, National Oceanic and Atmospheric Administration, oral commun., 1987). Because precipitation in 1985 was almost 10 in. below normal, the Delaware River Basin Commission declared a drought emergency on May 13, 1985. The emergency continued until September 27, 1985 (Delaware River Basin Commission, 1985, p. 9-13).

Although about 28 percent of the study area is used for agriculture, and about 48 percent is undeveloped (Gloucester County Planning Department, 1978, p. 18) the area has experienced residential and industrial growth since the mid 1960's. The population of Logan Township nearly doubled during 1970-85, increasing from 1,840 to 3,529 (R. Dixon, Gloucester County Planning Commission, oral commun., 1987). Since 1980, industrial development in the Township has occurred primarily west of Raccoon Creek in the southern part of the Township.

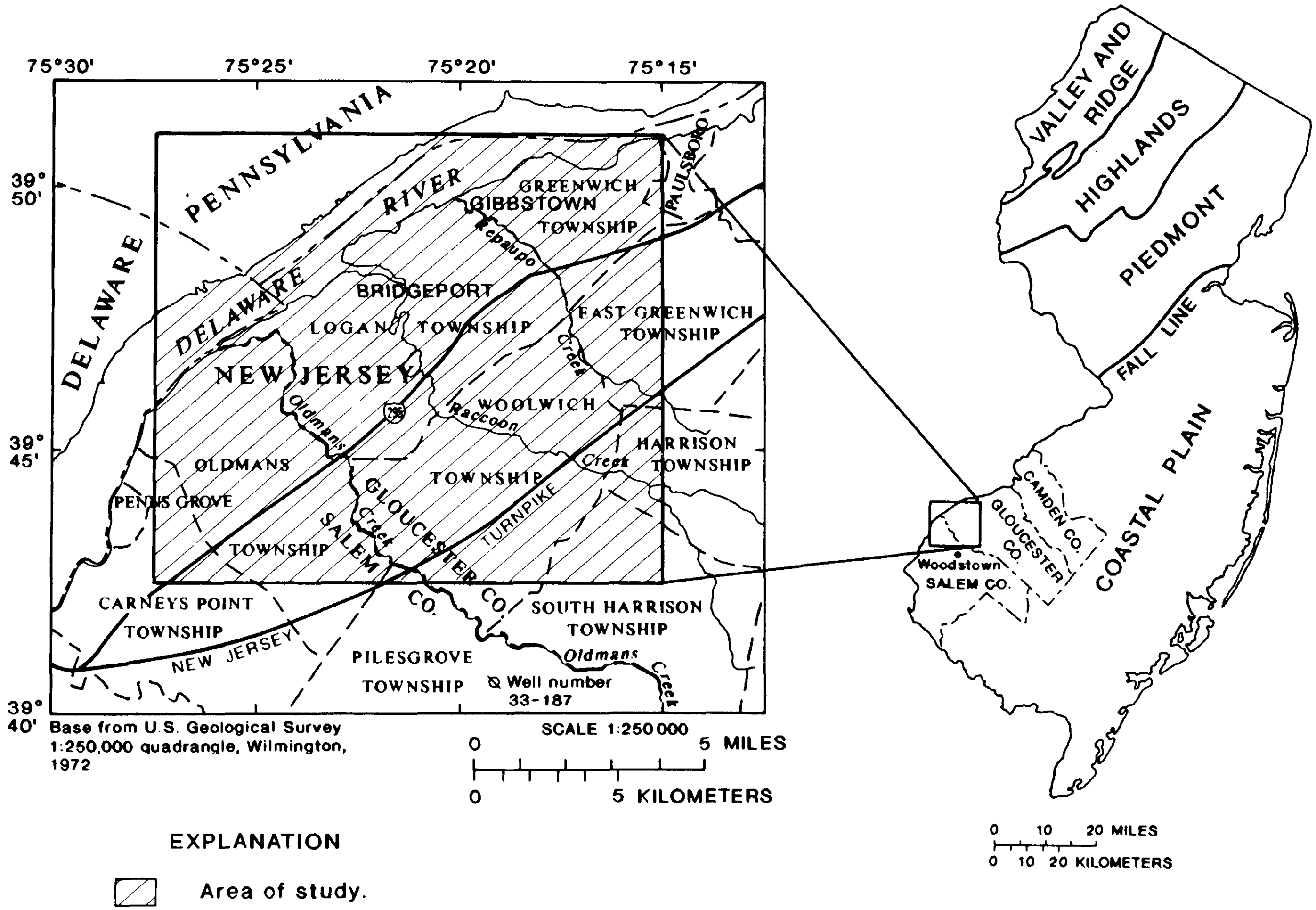

Figure 1.--Location of study area and physiographic provinces of New Jersey.

Geology and Stratigraphy

The study area is in the Atlantic Coastal Plain physiographic province, a terrain characterized by unconsolidated sediments of Early Cretaceous to Holocene age. These sediments include gravel, sand, silt, and clay representing a variety of fluvial and deltaic depositional environments (Owens and Sohl, 1969). The sediments of the Coastal Plain form a wedge that trends approximately northeast-southwest and dips and thickens toward the southeast. Well logs indicate that the thickness of the Coastal Plain sediments in the study area ranges from about 100 ft along the Delaware River to about 1,050 ft in the southeastern corner of the study area. Table 1 lists the geologic and hydrogeologic units found in the study area.

Metamorphic rocks of the Precambrian and Paleozoic Wissahickon Formation underlie the sediments of the Coastal Plain. In Gloucester and Salem Counties, the Wissahickon Formation is composed of schist and gneiss that contain mostly mica and smaller amounts of quartz, feldspar, and chlorite (Hardt and Hilton, 1969, p. 9; Rosenau and others, 1969, p. 23)

The Lower Cretaceous Potomac Group overlies the Wissahickon Formation in the study area. The Potomac Group consists of light-colored sand and gravel interbedded with black, red, white, and yellow clay containing abundant coarse lignitic material. The sand is predominantly quartz, and the clay is mostly kaolinite and illite (U.S. Geological Survey, 1967, sheet 7).

The Upper Cretaceous Raritan Formation overlies and is indistinguishable from the Potomac Group in the study area (Owens and Sohl, 1969, p. 238). The Raritan Formation consists mostly of light-colored sand and gravel interbedded with red, white, and yellow silty clays (Owens and Sohl, 1969, p. 238). The sands are predominantly quartz; the clays are predominantly kaolinite and illite (U.S. Geological Survey, 1967, sheet 7). Lignite and pyrite are common within the clay beds (Rosenau and others, 1969, p. 24).

The Upper Cretaceous Magothy Formation, which overlies the Raritan Formation, consists of white, micaceous, fine- to occasionally coarse-grained quartz sand and fine gravel interbedded with pyritic, lignitic, dark-gray or black clay (Rosenau and others, 1967, p. 24; Hardt and Hilton, 1969, p. 10). The clays are predominantly kaolinite and illite (U.S. Geological Survey, 1967, sheet 7).

In the southeastern half of the study area, the Upper Cretaceous Merchantville Formation overlies the Magothy Formation. In the study area, the Merchantville Formation is a dark-gray, massive, silty, fine to very fine glauconitic quartz sand (Owens and others, 1970, p. 5) that also contains some mica and feldspar (Hardt and Hilton, 1969, p. 15; U.S. Geological Survey, 1967, sheet 6; Minard 1965). Silty clay composed primarily of illite also is found in the study area (U.S. Geological Survey, 1967, sheet 7), and fossiliferous siderite concretions are common in the lower part of the Merchantville Formation (Owens and others, 1970, p. 5).

In much of the Coastal Plain of New Jersey, the Upper Cretaceous Woodbury Clay overlies the Merchantville Formation (Zapecza, 1989, p. B12). It is unclear, however, whether the Woodbury Clay is present in the study area. Early mapping by Lewis and Kummel (1912) shows the Woodbury Clay as a

Table 1.--Geologic and hydrogeologic units in the Logan Township region, New Jersey

<table>
<tr><th>Erathem</th><th>System</th><th>Geologic unit</th><th colspan="2">Hydrogeologic unit</th></tr>
<tr><td rowspan="8">Cenozoic</td><td rowspan="3">Quaternary</td><td>Alluvial deposits (Holocene)</td><td colspan="2" rowspan="5">Undifferentiated upper Cenozoic surficial deposits, commonly hydraulically connected to underlying aquifers or confining units</td></tr>
<tr><td>Van Sciver Lake beds (Pleistocene)</td></tr>
<tr><td>Spring Lake beds (Pleistocene)</td></tr>
<tr><td rowspan="5">Tertiary</td><td>Pensauken Formation (Miocene)</td></tr>
<tr><td>Bridgeton Formation (Miocene)</td></tr>
<tr><td>Kirkwood Formation (lower part) (Miocene)</td><td colspan="2" rowspan="4">Composite confining unit</td></tr>
<tr><td>Vincentown Formation (Paleocene)</td></tr>
<tr><td>Hornerstown Sand (Paleocene)</td></tr>
<tr><td rowspan="11">Mesozoic</td><td rowspan="10">Cretaceous (Upper)</td><td>Navesink Formation</td></tr>
<tr><td>Mount Laurel Sand</td><td colspan="2" rowspan="2">Wenonah-Mount Laurel aquifer</td></tr>
<tr><td>Wenonah Formation</td></tr>
<tr><td>Marshalltown Formation</td><td colspan="2">Marshalltown-Wenonah confining unit</td></tr>
<tr><td>Englishtown Formation</td><td colspan="2">Englishtown aquifer system</td></tr>
<tr><td>Woodbury Clay and Merchantville Formation, undivided</td><td colspan="2">Merchantville-Woodbury confining unit</td></tr>
<tr><td>Magothy Formation</td><td rowspan="5">Potomac-Raritan-Magothy aquifer system</td><td>Upper aquifer</td></tr>
<tr><td rowspan="3">Raritan Formation</td><td>Confining unit</td></tr>
<tr><td>Middle aquifer</td></tr>
<tr><td>Confining unit</td></tr>
<tr><td>Cretaceous (Lower)</td><td>Potomac Group</td><td>Lower aquifer</td></tr>
<tr><td>Paleozoic and Precambrian</td><td></td><td>Wissahickon Formation</td><td colspan="2">Bedrock confining unit</td></tr>
</table>

continuous unit throughout the study area, but mapping since 1960 suggests that the Woodbury Clay pinches out east of Logan Township. Mapping by Minard (1965) showed that the Woodbury Clay is absent in the southeastern part of the Township, and a U.S. Geological Survey map (1967 sheet 2) indicates that the Woodbury Clay pinches out near the southeastern corner of Logan Township. The Woodbury is a dark-blue to black clay, except in its outcrop area, where it is a micaceous silty clay or fine sand (Hardt and Hilton, 1969, p. 18). The clay is composed predominantly of illite. Glauconite and siderite have been reported in the Woodbury Clay in some areas in New Jersey (U.S. Geological Survey, 1967, sheet 7).

Several geologic units overlie the Merchantville Formation or Woodbury Clay southeast of Logan Township, in the southeastern part of the study area. These units include, from oldest to youngest, the Upper Cretaceous Englishtown Formation, Marshalltown Formation, Wenonah Formation, Mount Laurel Sand, and Navesink Formation; the Paleocene Hornerstown Sand and Vincentown Formation; and the Miocene Kirkwood Formation. Except for a thin layer of the Englishtown Formation which crops out in the southeastern corner of the Township, these units are located entirely outside Logan Township. Because of their location, these units do not affect ground-water flow within the Potomac-Raritan-Magothy aquifer system in the Township; therefore, they are not discussed in detail in this report.

Throughout the study area, a discontinuous layer of upper Cenozoic deposits is found at land surface. The upper Cenozoic deposits include, from oldest to youngest, the Miocene Bridgeton and Pensauken Formations, the Pleistocene Spring Lake and Van Sciver beds (Owens and Minard, 1979), and Holocene alluvium (Minard, 1965). Well logs indicate that within the study area the upper Cenozoic deposits generally are less than 20 ft thick except along the Delaware River, where the alluvium is up to 100 ft thick.

The Bridgeton and Pensauken Formations form a discontinuous layer of sand and gravel that crops out in the southeastern part of the study area beginning at a distance of about 2 to 3 mi from the Delaware River. In Gloucester and Salem Counties, the Bridgeton Formation consists of fine- to very coarse-grained quartzose sand and gravel that is stained or cemented with iron oxide in some places (Hardt and Hilton, 1969, p. 30; Rosenau and others, 1969, p. 52). Quartz, microcline, and plagioclase are the principal minerals in the sand. Other minerals found in the Bridgeton Formation include mica, gibbsite, halloysite, kaolinite, and goethite (Owens and Minard, 1979, p. D18).

The lithology and mineralogy of the Pensauken Formation is similar to that of the Bridgeton Formation. In Gloucester and Salem Counties, the Pensauken Formation is primarily medium- to coarse-grained quartzose sand with some gravel and clay. In some areas iron oxides and glauconite are present (Hardt and Hilton, 1969, p. 31; Rosenau and others, 1969, p. 52). The Pensauken Formation contains little or no gibbsite (Owens and Minard, 1979, p. D24).

The Spring Lake and Van Sciver beds crop out adjacent to and beneath the Delaware River (Owens and Minard, 1979, p. D44). These two informal units are similar in lithology and mineralogy (Owens and Minard, 1979, p. D45) and are composed primarily of gray and pale reddish-brown quartz sand interbedded with clayey silt. The clays are predominantly montmorillonite and chlorite (Owens and Minard, 1979, p. D38). Although little information is available concerning these deposits within the study area, Owens and Minard (1979, p. D38 and D42) suggest that both units grade from mostly gravelly sand in central New Jersey to predominantly silt and clay in southern New Jersey. Well logs from the study area suggest that the Spring Lake and Van Sciver beds are composed predominantly of silt and sand in the area north of Raccoon Creek and silt and clay south of Raccoon Creek. Historically, these two units also have been called collectively the "Trenton Gravels" and the "Cape May Formation" (Owens and Minard, 1979, p. D29).

Alluvium in Gloucester and Salem Counties is a mixture of silt, clay, organic material, sand, and gravel deposited in tidal flats and along low-gradient stream channels. Along the Delaware River, most of the alluvium is fine silt or clay mud (Hardt and Hilton, 1969, p. 32; Rosenau and others, 1969, p. 53). Results of geophysical investigations including seismic-reflection and electromagnetic-conductivity surveys, (Duran, 1986) and well logs, indicate that alluvium along the Delaware River in the study area is predominantly silt and sand upstream from its confluence with Raccoon Creek and clay and silt downstream from its confluence with the Creek.

Previous Investigations

Several investigators have reported on the hydrogeologic framework of the Coastal Plain of New Jersey in regional studies. Zapecza (1989) described the hydrogeologic framework of the entire Coastal Plain of New Jersey. The lithology of the Cretaceous System in New Jersey is described in Owens and Sohl (1969). Hardt and Hilton (1969) and Rosenau and others (1969) described the hydrogeology and water resources of Gloucester and Salem counties, respectively. The hydrogeologic framework in the Greenwich Township, Gloucester County, region was described by Barton and Kozinski (in press). Andres (1984) described the geology of parts of Logan Township on the basis of field mapping at selected sites. Owens and Minard (1979) described the upper Cenozoic sediments of the Coastal Plain of New Jersey. Duran (1986) described the distribution of sediments beneath the Delaware River between northeastern Philadelphia, Pennsylvania, and Wilmington, Delaware. The potentiometric surfaces of each aquifer within the Coastal Plain of New Jersey in 1978 and 1983 were described in Walker (1982) and Eckel and Walker (1986), respectively.

A number of investigators have discussed water quality in the Logan Township Region. Fusillo and others (1984) summarized 50 years of ground-water-quality data from the outcrop area of the Potomac-Raritan-Magothy aquifer system in southern New Jersey. Miller and others (1982) reported on ground-water quality throughout the Township.

Three reports concerning water quality in Logan Township were prepared as products of investigations that were part of a cooperative agreement between the U.S. Geological Survey and Logan Township. Hochreiter and Kozinski (1985) reported the results of water-quality investigation of streams and streambed material for three streams in Logan Township. Kozinski and others (1990) reported on a chemical and geophysical investigation at five former or active industrial or waste-disposal sites in Logan Township. Lewis and Hochreiter (1990) summarized the history of contamination and previous investigations at four of those sites.

Well-Numbering and Location System

The U.S. Geological Survey well numbers used in this report are the numbers in the Ground-Water Site Inventory data base of the U.S. Geological Survey. The well number consists of a two-digit county code followed by a three- or four-digit sequence number. County codes used in this report are 15 (Gloucester) and 33 (Salem). For example, well number 15-137 was the 137th well in Gloucester County to be entered into the Ground-Water Site Inventory data base.

In addition, a 15-digit station-identification number is provided for each well listed in table 1. This number can be used to retrieve water-quality data from the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE). The 15-digit number is usually but not always composed of the latitude and longitude of the well followed by a two-digit sequence number. As an example, station-identification number 394851075152601 is located at north latitude 39° 48′ 51", and west longitude 75° 15′ 26" and was the first well recorded at that location.

Numbers also have been assigned to sites from which geophysical data are used in this report. Those numbers consist of a "G" followed by the station number listed in Duran (1986).

Acknowledgments

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HYDROGEOLOGIC FRAMEWORK AND HYDRAULIC PROPERTIES OF THE POTOMAC-RARITAN-MAGOTHY AQUIFER SYSTEM AND ADJACENT UNITS

The hydrogeologic framework of the Potomac-Raritan-Magothy aquifer system and the units immediately adjacent to it was determined by using logs of 181 wells and exploratory test holes in the study area. Depending on availability, geophysical, geologic, and (or) drillers' logs were used to make the interpretations. As part of this investigation, five wells and five test holes were drilled in areas where additional data were needed. Table 2 lists the location, ownership, and construction details for all wells used in this investigation. Table 3 lists the altitude of the top of each hydrogeologic unit at each well site.

The Potomac-Raritan-Magothy aquifer system is composed of the Potomac Group and the Raritan and Magothy Formations. The aquifer system is divided into five hydrogeologic units--the upper, middle, and lower aquifers, and the confining units between those aquifers. The boundaries of the hydrogeologic units generally do not coincide with those of the geologic units (table 1).

The Potomac-Raritan-Magothy aquifer system is overlain by younger hydrogeologic units in most of the study area (table 1). In the southeastern part of the Township, the aquifer system is overlain by the Merchantville-Woodbury confining unit. Southeast of the township, the Merchantville-Woodbury confining unit is overlain by younger hydrogeologic units including the Englishtown aquifer system, the Marshalltown-Wenonah confining unit, the Wenonah-Mount Laurel aquifer, the composite confining unit, and the Kirkwood-Cohansey aquifer system (table 1). Although the Englishtown Formation is present in a small area in the southeastern corner of Logan Township, it is not considered an aquifer there because it is too thin and too fine-grained to yield significant quantities of water to wells. None of the units above the Englishtown Formation is present in Logan Township. Because the units above the Merchantville-Woodbury confining unit are not present in Logan Township and do not affect ground-water flow in the Potomac-Raritan-Magothy aquifer system in the township, they are not discussed in detail in this report.

Throughout the study area, surficial upper Cenozoic deposits form a discontinuous, generally thin veneer of clay, silt, sand, and gravel overlying older hydrogeologic units. The upper Cenozoic deposits directly overlie the Potomac-Raritan-Magothy aquifer system in the northwest part of the study area, where the Potomac-Raritan-Magothy aquifer system is not overlain by the Merchantville-Woodbury confining unit. The bedrock confining unit underlies the Potomac-Raritan-Magothy aquifer system throughout the study area.

Plates 1b through 5b show the configuration of the upper surface of each hydrogeologic unit. The surfaces were determined by analyzing geophysical, geologic, and drillers' logs of wells and test holes, determining the altitude of the top of each unit, and plotting the data on maps. In areas where no data were available, the contours were estimated by using contour maps of Zapecza (1989, pl. 6-10). The approximate outcrop area of each unit is also shown on plates 1b through 5a. As used in this report, the "outcrop area" of a unit is the area in which the unit is exposed at land surface or is overlain only by upper Cenozoic deposits. For all units except the Merchantville-Woodbury confining unit and the lower aquifer, the outcrop areas were delineated by determining the uppermost hydrogeologic unit (except the upper Cenozoic deposits) in logs of wells and test holes. The boundaries of the outcrop area of the Merchantville-Woodbury confining unit were modified from outcrop boundaries of the Merchantville Formation and the Woodbury Clay shown on geologic maps (Minard, 1965; N.J. Department of

Environmental Protection, undated). The northern extent of the outcrop of the lower aquifer was modified from geologic maps compiled by J.P. Owens (U.S. Geological Survey, 1967, pl. 2). Plate 6 shows generalized sections through the hydrogeologic units in the study area.

Except in outcrop areas, water in the aquifers is confined by overlying confining units. Within the outcrop areas shown on plates 1b through 5b, ground water may be confined in localized areas. This condition is found near the Delaware River, where thick clay- and silt-rich upper Cenozoic deposits overlie the aquifers, as shown in the hydrogeologic sections on plates 6a-6e. Water also may be confined elsewhere in the outcrop areas beneath the discontinuous clay layers that are found within each aquifer.

Upper Cenozoic Deposits

Near the Delaware River, the upper Cenozoic deposits are composed mostly of silt and clay with some sand and gravel. The availability of numerous well logs from the Monsanto Company property (pl. 1a) permits a more detailed definition of the upper Cenozoic deposits in this area than was possible for the rest of the study area. In this area, the upper Cenozoic deposits include up to 100 ft of clayey alluvium immediately adjacent to the river. About 2,000 ft from the river, the upper Cenozoic deposits are composed of about 10 to 25 ft of sandy material at the surface overlying 10 to 30 ft of silt and clay (pl. 6b). Well logs and results of geophysical investigations by Duran (1986) suggest that the thick alluvial clay deposits adjacent to the River at the Monsanto Company property are found all along the river in the area downstream from Raccoon Creek. These deposits form a confining unit that separates the river from the aquifers of the Potomac-Raritan-Magothy aquifer system. Upstream from Raccoon Creek, the alluvial deposits also consist mostly of silt, but contain less clay than the deposits downstream. Therefore, a hydraulic connection between the river and the aquifers is more likely upstream from Raccoon Creek than downstream.

At distances of more than about two to three miles from the Delaware River, the upper Cenozoic deposits consist mostly of sand and gravel and generally are less than 20 ft thick. The maximum thickness determined from well logs was 45 ft for well 15-1007, near the southeastern corner of the study area. Where these thin, sandy deposits overlie aquifers, they generally are undifferentiable from the aquifers and are considered part of the aquifers in this report. Where they overlie confining units, they are too thin to be used for water supply except for domestic purposes.

Merchantville-Woodbury Confining Unit

The Merchantville-Woodbury confining unit overlies the Potomac-Raritan-Magothy aquifer system in the southeastern half of the study area (pl. 1b). It is composed of the Upper Cretaceous Merchantville Formation and Woodbury Clay (table 1), and contains glauconite beds and thin- to thick-bedded sequences of micaceous clays and clayey silts (Zapecza, 1989, p. B12). In Camden 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 some domestic needs. Although this sandy unit may extend into the study area, no evidence of it has been found in well logs.

A particle-size analysis performed on a geologic core taken from the Merchantville-Woodbury confining unit at the site of well 15-615 indicated that the core contained about 5 percent sand, 35 percent silt, and 15 percent clay, by weight, according to the Wentworth (1922) scale (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985). A core taken at the site of well 15-712 contained 40 percent sand, 45 percent silt, and 15 percent clay (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1986).

Laboratory tests on the core from the site of well 15-615 indicated a vertical hydraulic conductivity of 6.80 X 10^{-4} ft/d (feet per day) (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985). This value was obtained by performing the test three times with a constant effective stress of 40 lb/in^2. The reported value is the average for the three tests. The vertical hydraulic conductivity of a core collected at the site of well 15 712 was measured at 7.06 X 10^{-3} ft/d (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985). That core was tested using incremental effective stresses of 5 and 13.9 lb/in^2. The reported hydraulic conductivity value is for a measurement made after the sample had remained under the higher effective stress for at least 24 hours.

The top of the Merchantville-Woodbury confining unit is found at altitudes ranging from approximately 40 ft above sea level in the western part of the outcrop area to approximately 80 ft below sea level in the southeastern part of the study area (pl. 1b), and at depths ranging from 0 ft in the outcrop area to about 230 ft in the southeastern part of the study area. Within the study area, the thickness of the Merchantville-Woodbury confining unit ranges from a featheredge along the northwestern boundary of its outcrop area to about 120 ft in the southeastern part of the study area.

In parts of the study area, the Merchantville-Woodbury confining unit is overlain directly by another confining unit because the Englishtown aquifer system, which overlies the Merchantville-Woodbury confining unit, is only 20 to 40 ft thick (Zapecza, 1989, pl. 12) and silty in the study area. In fact, according to Owens and Sohl (1969, p. 244), the Englishtown Formation resembles the Merchantville Formation in this area. Consequently, the Englishtown aquifer system cannot be differentiated from the underlying Merchantville-Woodbury confining unit or the overlying Marshalltown-Wenonah confining unit. Where the units cannot be differentiated, the combined thickness of the Merchantville-Woodbury confining unit, the Englishtown aquifer system, and the Marshalltown-Wenonah confining unit ranges from approximately 148 to 181 ft.

Potomac-Raritan-Magothy Aquifer System

Upper aquifer

The upper aquifer consists primarily of quartzose sand and silt with clayey layers and lenses. It crops out throughout a large part of the study area (pl. 2a). In the outcrop area, it probably is overlain by discontinuous, sandy upper Cenozoic deposits that are undifferentiable from the aquifer in most places. The aquifer thickens from a featheredge at the northwestern edge of the outcrop area to about 65 to 90 ft to the southeast, then thins to about 40 ft in the southeastern corner of the study area. Its greatest thickness is found at the eastern edge of the study area in East Greenwich Township. The top of the upper aquifer is found at depths ranging from 0 ft to about 350 ft below land surface and at altitudes ranging from about 20 ft in the northwestern part of the outcrop area to about -200 ft in the southeastern part of the study area (pl. 2a).

Several methods have been used to investigate the hydraulic properties of the upper aquifer. Martin (1990, fig. 57) determined that the transmissivity of the aquifer ranges from about 3,000 to 11,000 ft^2/d (square feet per day) in the study area. Martin's value was determined by using a three-dimensional digital model of regional ground-water flow in the Coastal Plain of New Jersey. The specific capacity for eight wells in the aquifer ranges from 9 to 48 (gal/min)/ft (gallons per minute per foot of drawdown), and the median specific capacity is 15 (gal/min)/ft (table 4). The horizontal hydraulic conductivity of the aquifer at the site of each of the eight wells was estimated by using the method described by Bennett (1976, p. 8) for determining horizontal hydraulic conductivity on the basis of specific capacity. Bennett's method assumes that flow around the well has reached steady state. For this reason, only wells that had been pumped for 8 hours or longer were used. The horizontal hydraulic conductivities determined by using this method range from 79 to 212 ft/d, with a median of 114 ft/d (table 4). The transmissivity of the aquifer at each of the eight sites was estimated by multiplying the horizontal hydraulic conductivity by the thickness of the aquifer at the site. Aquifer thickness was estimated from difference of the altitude of the upper surface of the upper aquifer and the underlying confining unit (table 3 and plates 2a and 2b). Transmissivity determined by using this method ranged from 2,660 to 13,780 ft^2/d (table 4).

Confining Unit Between the Upper and Middle Aquifers

The confining unit between the upper and middle aquifers consists of alternating layers and lenses of clay, silt, and sand. Where several well logs are available within small areas, including the Bridgeport Rental and Oil Services, Inc., site, the Chemical Leaman Tank Lines, Inc., site, and the Rollins Environmental Services, Inc., site (pl. 1a), it is evident that individual sand, silt, and clay beds are discontinuous. Consequently, the confining unit between the upper and middle aquifers probably is leaky and discontinuous in much of the study area, and the existence of a direct hydraulic connection between the upper and middle aquifers is likely in many areas. At isolated well sites (wells 15-549 and 15-582), the confining unit is absent.

Particle-size analyses were performed on three geologic samples collected from the most visibly clay-rich zones within the confining unit. One sample from the site of well 15-615 had clay, silt, and sand contents of 60, 30, and 10 percent, respectively, by weight according to the Wentworth (1922) scale. Another sample from that site had clay, silt, and sand contents of 60, 35, and 5 percent, respectively. A sample from the site of well 15-622 had clay, silt, and sand contents of 55, 35, and 10 percent, respectively (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985).

Table 4.--Summary of specific-capacity-test data and estimates of hydraulic conductivity and transmissivity for the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey

[Hydraulic conductivity was calculated using the approximation method of Bennett (1976, p. 8), according to the equation,

$$K = 212 \frac{Q}{sd},$$

where Q is discharge in gallons per minute (gal/min), s is drawdown in the well in feet, and d is the length of the screen, in feet. (gal/min)/ft, gallons per minute per foot; ft/d, foot per day; ft^2/d, feet squared per day. Well records are listed in table 2; well locations are shown on pl. 1. USGS, U.S. Geological Survey.]

USGS well number	Specific-capacity-test data: Date	Duration (hours)	Discharge (gal/min)	Drawdown (feet)	Specific capacity ((gal/min)/ft)	Estimated hydraulic conductivity (ft/d)	Aquifer thickness[1] (ft)	Estimated transmissivity (ft^2/d)
Upper aquifer								
15- 65	5/15/50	8	700	50	14	103	40	4,240
15-237	2/28/33	8	592	16	37	196	60	11,760
15-240	5/01/63	8	650	40	16	84	45	3,780
15-339	4/01/69	8	100	5	20	212	65	13,780
15-342	8/04/67	16	1,529	32	48	117	91	10,650
15-392	8/13/64	8	37	10	4	79	50	3,950
33- 74	4/30/68	8	219	20	11	111	24	2,660
33-345	10/02/44	8	306	33	9	151	65	9,820
Median					15	114		7,030
Middle aquifer								
15- 69	7/08/59	8	1,007	29	35	123	79	9,720
15- 70	2/03/44	8	524	22	24	252	65	16,380
15- 71	10/03/49	24	180	13	14	293	67	19,630
15- 72	4/15/50	24	700	45	16	330	67	22,110
15- 73	9/10/51	16	800	60	13	141	67	9,450
15- 77	10/27/49	24	183	15	12	287	83	23,820
15- 79	10/24/67	24	754	41	18	156	85	13,260
15- 80	6/01/46	24	650	54	12	159	85	13,520
15- 93	12/15/50	8	602	53	11	96	112	10,750
15-134	5/22/70	8	402	18	22	90	52	4,680
15-135	9/21/72	24	548	38	14	61	45	2,740
15-136	10/03/72	6	805	46	18	74	34	2,520
15-140	5/26/72	24	402	22	18	74	75	5,500
15-165	6/02/30	36	150	15	10	212	60	12,720
15-167	5/07/69	8	406	28	14	103	55	5,660
15-170	5/16/70	7	125	7	18	189	100	18,900
15-171	4/19/72	24	175	34	5	55	61	3,360
15-174	3/16/72	24	175	29	6	43	42	1,810
15-178	2/01/72	36	69	32	2	23	53	1,220
15-236	12/22/69	10	1,016	17	60	177	130	23,010
15-391	12/15/50	8	126	59	2	18	71	1,280
15-569	12/09/81	72	1,002	63	16	85	82	6,970
15-609	8/23/72	24	800	50	16	85	45	3,820
33- 79	12/12/67	6	80	8	10	141	59	8,320
33- 80	6/03/63	8	600	55	11	116	65	7,540
33 -85	6/26/67	48	304	47	6	69	67	4,620
33- 89	6/03/67	8	151	44	3	73	71	5,180
Median					14	103		7,540
Lower aquifer								
15- 91	6/05/49	24	140	65	2	24	30	720
15-103	12/28/45	24	860	13	66	701	40	28,040
15-104	6/30/40	24	1,000	18	56	406	40	16,240
15-107	12/10/45	24	840	9	93	659	60	39,540
15-133	5/19/70	9	412	21	20	83	96	7,970
15-139	5/20/70	10	412	15	27	132	78	10,300
15-142	6/02/70	12	410	26	16	80	72	5,760
15-173	3/14/72	25	406	19	21	96	45	4,320
15-175	2/01/72	21	300	54	6	59	7	410
15-176	1/17/72	24	205	12	17	90	30	2,700
15-177	1/25/72	36	250	18	14	74	49	3,630
15-181	3/01/72	72	510	46	11	117	19	2,220
33- 86	7/01/67	48	304	38	8	85	39	3,320
33- 88	5/26/67	8	151	57	3	22	35	770
Median					16	88		3,980

[1] Thickness of the middle aquifer does not include the thickness of the confining unit between the upper and lower parts of the middle aquifer.

Hydraulic-conductivity analyses also were performed on these geologic samples. The vertical hydraulic conductivities of the two samples from the site of well 15-615 were 3.20×10^{-5} and 9.38×10^{-5} ft/d, and the vertical hydraulic conductivity of a sample from the site of well 15-622 was 3.34×10^{-5} ft/d (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985). For each core, three hydraulic-conductivity tests were done at the same effective stress, and the three results were averaged. For cores from the site of well 15-615, the effective stress applied was 40 lb/in^2; for the core from the site of well 15-622, the effective stress was 30 lb/in^2 (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985).

The confining unit crops out in a narrow (about 0.5-mi wide) band extending across the study area approximately 1 mi from the Delaware River. In most of the outcrop area, the unit is overlain by less than 20 ft of sandy upper Cenozoic deposits. The altitude of the top of the unit ranges from about 20 ft above sea level in parts of the outcrop area to about 240 ft below sea level in the southeastern corner of the study area (pl. 2b). The depth of the top of the unit ranges from about land surface in parts of the outcrop area to about 390 ft below land surface in the southeastern corner of the study area. Except at scattered, localized sites where the confining unit is absent, its thickness ranges from about 5 ft in the northeastern part of the study area to about 85 ft in an area east of Oldmans Creek just north of Interstate 295. In most of the study area, the unit is 20 to 45 ft thick.

Middle Aquifer

The middle aquifer consists primarily of medium to coarse quartzose sand and gravel with a few interbedded layers and lenses of silty clay. Its thickness ranges from about 0 ft in the northwestern part of the study area to about 200 ft in the southeastern part. The unit crops out in a band generally about 0.5 to 1.3 mi wide parallel to the Delaware River. In most of the outcrop area, the aquifer is overlain by upper Cenozoic deposits that are generally clay- and silt-rich (pl. 6a-6e).

Transmissivity of the middle aquifer was estimated by Martin (1990, fig. 56) to range from 2,000 to 5,000 ft^2/d in the study area. Martin's estimates were determined by using a three-dimensional digital model of regional ground-water flow in the New Jersey Coastal Plain. The specific capacity of 27 wells screened in the aquifer ranges from 2 to 60 (gal/min)/ft, within median specific capacity of 14 (gal/min)/ft (table 4). The horizontal hydraulic conductivity of the aquifer at the 27 well sites ranges from 18 to 330 ft/d with a median of 103 ft/d. These hydraulic conductivities were determined by the method described by Bennett (1976, p. 8) for estimating horizontal hydraulic conductivity from specific capacity. Transmissivities determined by multiplying these hydraulic conductivities by the thickness of the aquifer at each site range from 1,220 to 23,000 ft^2/d and the median is 7,540 ft^2/d.

The range of transmissivities determined from specific-capacity tests is much greater than the range of values estimated by Martin. Martin's model simulated ground-water flow on a regional scale and was not designed to provide site-specific transmissivities. For the Logan Township study area, the model was divided into cells, each having an area of 6.25 mi^2. Consequently, small-scale variations in both thickness and hydraulic conductivity of the aquifers could not be simulated, and the transmissivity for each cell represented an average value for the entire cell. For example, if a transmissivity of 5,000 ft^2/d was determined for a particular model cell, the actual transmissivity within the cell probably was a range of values averaging about 5,000.

In addition, the median transmissivity determined from the 27 specific-capacity tests is higher than the maximum transmissivity estimated by Martin, probably because most of the 27 wells are located in clusters at a few industrial sites rather than being evenly distributed throughout the study area. Consequently, no specific-capacity data are available for large parts of the study area.

Transmissivity also would tend to be high because most of the tested wells were in industrial areas. In calculating transmissivity on the basis of hydraulic conductivity, the horizontal hydraulic conductivity at the screened interval is assumed to be representative of the horizontal hydraulic conductivity of the entire thickness of the aquifer. Industrial and public-supply wells commonly are screened in the most productive depth interval of the aquifer in order to obtain the maximum possible yield, whereas test wells and observation wells may or may not be screened in the most productive part of the aquifer, depending on the purpose for which the well was installed. Of the 27 wells tested in the middle aquifer, 16 were industrial or public-supply wells and 11 were test wells. Also, the screened interval of industrial and public-supply wells is sometimes underreamed during well installation (reaming is a process that widens the diameter of the borehole at the screened interval and increases the specific capacity of the well).

In addition, there are potential sources of error associated with the process of specific-capacity testing. These errors include errors in measuring the discharge of the well, particularly if the discharge rate changed during the test, and errors in measuring the water levels from which drawdown is calculated.

The middle aquifer is divided into an upper and lower part by a confining unit composed of clay and silt in parts of the Greenwich Township area (Barton and Kozinski, in press). This confining unit extends into parts of the Logan Township study area.

Upper part

The upper part of the middle aquifer crops out in a narrow (about 500- to 6,000-ft wide) band parallel to the Delaware River (pl. 3a). The top of the aquifer is found at altitudes ranging from about 20 ft above sea level in parts of the outcrop area to about 300 ft below sea level in the southeastern corner of the study area (pl. 3a), and at depths below land surface ranging from 0 to about 450 ft. The upper part of the middle aquifer generally is about 20 to 40 ft thick in the western part of the study area. The unit thickens from west to east, reaching a maximum thickness of about 85 ft in East Greenwich Township.

Confining unit between the upper and lower parts

The confining unit is present generally in the northwestern part of the study area. It is absent in the southeastern part and along much of Raccoon Creek. It is also absent in a small area in Greenwich Township near the Delaware River (pl. 3b). It consists primarily of clay and silt with some interbedded sand. The confining unit crops out in a narrow (less than 2,000-ft wide) band parallel to the Delaware River (pl. 3b).

The top of the confining unit is found at altitudes ranging from about sea level in parts of the outcrop area to about 260 ft below sea level at its southeastern edge (pl. 3b), and at depths below land surface ranging from 0 to about 310 ft. The unit is less than 40 ft thick except in a small part of Greenwich Township, where it has a maximum thickness of 60 ft.

A particle-size analysis performed on a geologic core collected from a clay-rich zone of the confining unit at the site of well 15-622 indicated that it contained about 45 percent clay, 45 percent silt, and 10 percent sand, by weight, according to the Wentworth (1922) scale (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985). A core from the site of Well 15-712 contained 70 percent clay, 25 percent silt, and 5 percent sand (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1986).

Laboratory tests on the core from the site of well 15-622 indicated a vertical hydraulic conductivity of 1.54×10^{-4} ft/d (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985). That value was obtained by performing the test three times with a constant effective stress of 30 lb/in^2. The reported value is the average for the three tests. For the core from the site of well 15-712, the vertical hydraulic conductivity was found to be 3.91×10^{-5} ft/d. This core was tested with incremental effective stresses of 20, 40, 60, 80, and 100 lb/in^2. The reported hydraulic-conductivity value is for a measurement taken after the core had remained under the highest effective stress for at least 24 hours.

Lower part

The lower part of the middle aquifer crops out in a narrow (less than 4,000-ft wide) band parallel to the Delaware River (pl. 4a). Its top surface is found at altitudes ranging from about sea level in parts of the outcrop area to about 260 ft below sea level at its most southeastern point (pl. 4a), and at depths ranging from land surface to about 430 ft below land surface.

The lower part of the middle aquifer is generally less than 20 ft thick in the northwestern part of the study area. It is thicker downdip, reaching a maximum thickness of about 60 ft at its southernmost point west of Swedesboro. The aquifer also is relatively thick, about 120 ft, in the extreme northeastern part of the study area.

Confining Unit Between the Middle and Lower Aquifers

The confining unit between the middle and lower aquifers consists primarily of red, white, and gray silty clay with some interbedded clayey silt and sand. It crops out in a discontinuous band parallel to the Delaware River (pl. 4b). The outcrop area generally is less than 2,000 ft wide except in the western part of the study area, where it is more than 7,000 ft wide. In its outcrop area, it is overlain primarily by upper Cenozoic silt and clay (pl. 6b-6e). The unit is less than 20 ft thick in the northwestern corner of the study area and in an area bordered aproximately by Route 295, Still Run, the Greenwich-East Greenwich Township boundary, the Logan-Woolwich Township boundary line, and Route 322. It is thickest in the southeastern corner of the study area, where it is 180 ft thick. The top of the unit ranges from about land surface in parts of the outcrop area to 650 ft below land surface in the southeastern corner of the study area. The altitude of the top surface of the confining unit ranges from about 5 ft above to 500 ft below sea level (pl. 4b).

The confining unit is absent in an area comprising about 1.3 mi^2 along the Delaware River in the vicinity of Monsanto Company (pl. 1a and 4b). Consequently, the middle and lower aquifers are in direct hydraulic connection in that area, as shown in hydrogeologic section B-B' (pl. 6b).

Particle-size analyses were performed on two geologic cores from clay-rich zones at the site of well 15-615 and four cores from clay-rich zones at the site of well 15-622. The two cores from the site of well 15-615 contained clay (25 and 30 percent), silt (65 and 30 percent), and sand (10 and 40 percent). The four cores from the site of well 15-622 contained 30 to 55 percent clay, 10 to 55 percent silt, and 5 to 40 percent sand, based on the Wentworth (1922) scale (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985).

Laboratory tests on the cores from the site of well 15-615 indicated vertical hydraulic conductivities of 2.51×10^{-5} and 1.07×10^{-4} ft/d. These values were obtained by testing each core three times using a constant effective stress of 40 lb/in^2 and averaging the results of the three tests. Tests on the four cores from the site of well 15-622 indicated vertical hydraulic conductivities of 3.29×10^{-5} to 1.26×10^{-4} ft/d. These values were obtained by testing each core three times using a constant effective stress of 30 lb/in^2 and averaging the results of the three tests (E.N. Manuel, Woodward-Clyde Consultants, written commun., 1985).

Lower Aquifer

The lower aquifer consists primarily of medium to coarse quartzose sand and gravel with a few interbedded layers and lenses of silty clay. It crops out along a narrow (generally less that 2,000-ft wide) band adjacent to and beneath the Delaware River (pl. 5a). In its outcrop area, it is overlain by upper Cenozoic deposits that generally are composed of silt and clay.

The lower aquifer thickens from less than 20 ft in parts of its outcrop area to about 220 ft in the southeastern corner of the study area. The altitude of the top of the aquifer ranges from about 7 ft above sea level in the northeastern part of the outcrop area to about 680 ft below sea level in the southeastern corner of the study area (pl. 5a). The top surface is at depths ranging from about 4 ft below land surface in the eastern part of the outcrop area to about 830 ft below land surface in the southeastern corner of the study area. Where the aquifer underlies the Delaware River, the top of the aquifer is separated from the river by 15 to 25 ft of alluvial silt and clay.

Martin (1990, fig. 55) estimated that the transmissivity of the lower aquifer ranges from 4,000 to 11,000 ft/d in the study area. Martin's value was determined by using a three-dimensional digital model of regional ground-water flow in the Coastal Plain of New Jersey. The specific capacity of 14 wells in the study area ranges from 2 to 93 (gal/min)/ft, with a median of 16 (gal/min)/ft (table 4). Horizontal hydraulic conductivity determined from specific capacity by the method described by Bennett (1976, p. 8) ranges from 22 to 701 ft/d, with a median of 88 ft/d (table 4). Transmissivity of the aquifer at the sites of the 14 specific-capacity tests ranges from 720 to 39,540 ft^2/d, with a median of 3,980 ft^2/d.

As was the case for the middle aquifer, the range of transmissivity values determined from specific-capacity data is greater than that determined by a regional ground-water-flow model, probably because of the effect of averaging wide ranges of transmissivity values within each model cell. The median transmissivity value determined from specific-capacity tests in the lower aquifer was less than the low end of the range reported by Martin. As was the case for the middle aquifer, possible explanations include the uneven areal distribution of tested wells and errors inherent in specific-capacity tests and in estimating horizontal hydraulic conductivity from specific capacity. The uneven areal distribution probably is the most significant factor. All of the specific-capacity tests were done in the northwestern part of the study area, where the aquifer is thinnest. The thickness of the aquifer at the test sites ranges from 7 to 96 ft, but the maximum thickness of the aquifer is 220 ft. Consequently, all of the transmissivities (determined by multiplying hydraulic conductivity by thickness) are for the relatively thin part of the aquifer.

Bedrock Confining Unit

A bedrock confining unit (table 1) underlies the Potomac-Raritan-Magothy aquifer system throughout the study area. The bedrock is composed of the Wissahickon Formation, which consists primarily of metamorphic gneiss and schist (Hardt and Hilton, 1969, p. 9). Fractures in the rocks permit some movement of ground water; however, the fractures have only a small capacity for storing or yielding water (Hardt and Hilton, 1969, p. 9). Although a few wells in Gloucester County penetrate the Wissahickon Formation, sand and gravel overlying the rock is the major source of water to those wells (Hardt and Hilton, 1969, p. 9). No wells in Salem County are known to obtain water from the bedrock (Rosenau and others, 1969, p. 24). Because the Wissahickon Formation supplies much less water than does the overlying Potomac-Raritan-Magothy aquifer system, it acts as a confining unit to the aquifer system.

In most of the study area, the bedrock confining unit is overlain by the lower aquifer of the Potomac-Raritan-Magothy aquifer system. Along the

Delaware River, it is overlain by upper Cenozoic deposits (pl. 6a-6e). The altitude of the top of the unit ranges from about 50 ft above sea level to about 900 ft below sea level. The bedrock surface is at depths of about 50 to 1,050 ft below land surface.

GROUND WATER

Withdrawals

The Potomac-Raritan-Magothy aquifer system is the major source of water for public, industrial, and agricultural uses in the Logan Township area. Ground-water withdrawals from the Potomac-Raritan-Magothy system in the Logan Township area increased from 6.7 Mgal/d (million gallons per day) in 1956 to a record high of 11.9 Mgal/d in 1969 (fig. 2). These figures are based on pumpage reported to the New Jersey Department of Environmental Protection (NJDEP). After 1969, withdrawals decreased to 6.2 Mgal/d in 1979, then increased to the 1985 pumpage level of 7.1 Mgal/d. The large pumpage during the late 1960's possibly is attributable to a regional drought during the mid-1960's. Until 1981 when pumpage from the lower aquifer increased to more than 3 Mgal/d, the middle aquifer was the most heavily used aquifer in the Potomac-Raritan-Magothy aquifer system, with withdrawals of 2.9 to 4.9 Mgal/d.

Based on pumpage reported to the NJDEP, industrial water use during 1985 accounted for 64 percent of the ground-water withdrawals in the Logan Township area (fig. 3). Industries that use ground water in the area include Hercules, Inc., E.I. Dupont de Nemours and Company, Inc., and Mobil Oil Corporation in Greenwich Township; Monsanto Company in Logan Township; B.F. Goodrich Chemical Group in Oldmans Township; and PMC Canning in Swedesboro Borough (table 5). Thirty-nine percent of the pumpage in 1985 in the study area was from the industries located in Greenwich Township (table 5). Mobil Oil Corporation, the largest water user in the study area, pumped 2.3 Mgal/d from the lower aquifer in Greenwich Township.

Little seasonal change in pumpage occurred during 1985 (fig. 3). Based on figures reported to the NJDEP, pumpage in January and December of 1985 was greater than 0.6 Mgal/d as a result of increased industrial water use. Because most of the study area is agriculturally developed, an increase in water use for irrigation is expected during summer months. The apparent absence of this trend probably results from one or more of the following factors: (1) a significant amount of irrigation water may be obtained from ponds; (2) the amount of ground water pumped for irrigation by some individual users probably is less than the minimum amount reportable to the NJDEP; or (3) in the area southeast of Logan Township, some irrigation water may be pumped from the Englishtown or Wenonah-Mount Laurel aquifer system.

Historical Water-Level Trends

Long-term water-level hydrographs (fig. 4) for wells screened in the Potomac-Raritan-Magothy aquifer system generally reflect the increased pumpage during the 1960's shown in figure 2. The minimum annual water level measured in well 33-342, screened in the upper aquifer, declined about 4.8 ft from 1952-69. The minimum annual water level measured in well 15-97,

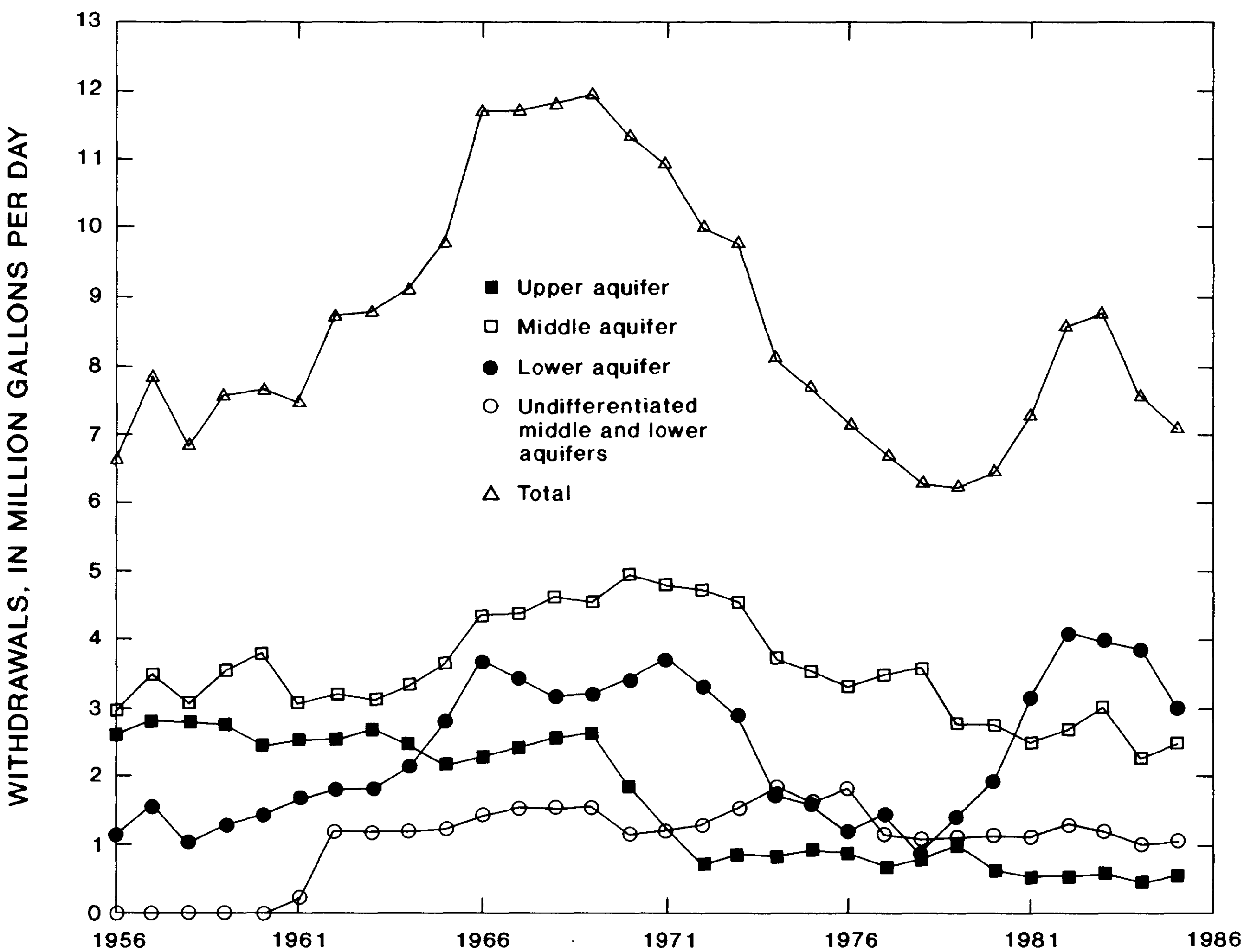

Figure 2.--Ground-water withdrawals from the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey, 1956-85.

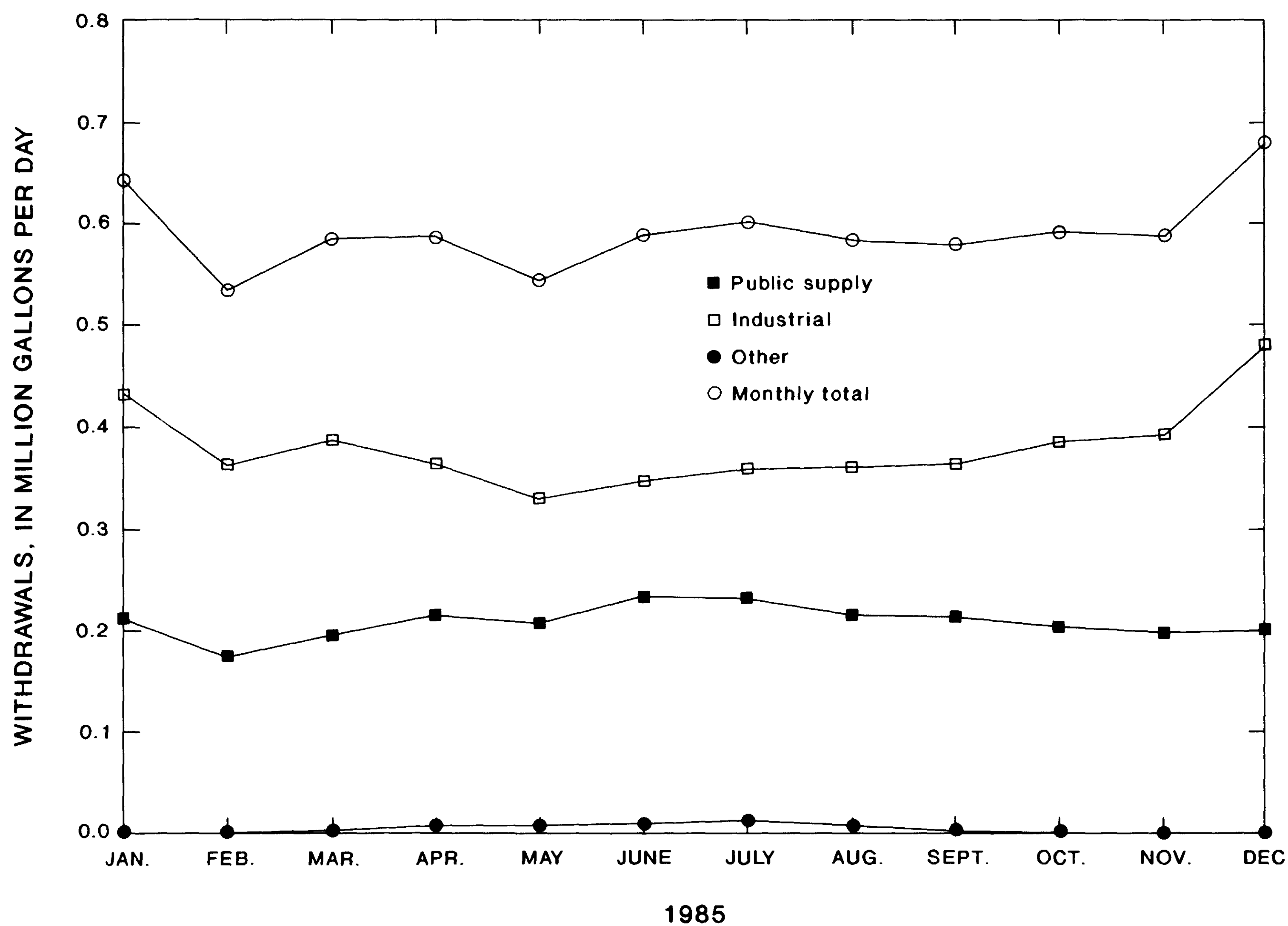

Figure 3.--Ground-water withdrawals from the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey, 1985.

Table 5.--Summary of reported pumpage from the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey, 1985

[USGS, U.S. Geological Survey; Aquifer codes: MRPA, undifferentiated aquifer of the Potomac-Raritan-Magothy aquifer system (see table 2); MRPAU, upper aquifer of the Potomac-Raritan-Magothy aquifer system; MRPAM, middle aquifer of the Potomac-Raritan-Magothy aquifer system; MRPAL, lower aquifer of the Potomac-Raritan-Magothy aquifer system; data from N.J. Department of Environmental Protection]

USGS well number	Well owner	Aquifer code	Total pumpage (million gallons per day)
	Carneys Point Township		
33-347	Penns Grove Water Supply Company	MRPAU	0.532402
33-346	Penns Grove Water Supply Company	MRPAL	.539685
	Total pumpage within study area for this Township		1.072087
	Greenwich Township		
15- 69	Greenwich Township Water Department	MRPAM	0.219055
15- 72	E. I. Dupont de Nemours and Company	MRPAM	.391431
15- 76	Hercules, Inc.	MRPAM	.132430
15-347	Greenwich Township Water Department	MRPAM	.124572
15-348	Greenwich Township Water Department	MRPAM	.397810
	Total pumpage from middle aquifer		1.265298
15-109	Mobil Oil Corporation	MRPAL	2.271545
	Total pumpage within study area for this Township		3.536843
	Logan Township		
15-137	Pureland Water Company	MRPAM	0.315400
15-144	Pureland Water Company	MRPAM	.046735
15-166	Penns Grove Water Supply Company	MPRAM	.040438
	Total pumpage from middle aquifer		.402573
15-158	Monsanto Company	MRPA	.590828
15-159	Monsanto Company	MRPA	.421656
	Total pumpage from undifferentiated aquifer		1.012484
	Total pumpage within study area for this Township		1.415057
	Oldmans Township		
33- 74	Oldmans Township Water Department	MRPAU	0.014593
33- 83	B. F. Goodrich Chemical Group	MRPAM	.256756
33- 85	B. F. Goodrich Chemical Group	MRPAM	.309459
	Total pumpage from middle aquifer		.566215
33- 86	B. F. Goodrich Chemical Group	MRPAL	.175113
33- 82	Bridge, Bruce H.	MRPA	.008378
	Total pumpage within study area for this Township		0.764299

Table 5.--Summary of reported pumpage from the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey, 1985--Continued

USGS well number	Well owner	Aquifer code	Total pumpage (million gallons per day)
	Swedesboro Borough		
15-236	Swedesboro Borough Water Department	MRPAM	0.251280
	Total pumpage within study area for this Borough		0.251280
	Woolwich Township		
15-338	Maugeri, Joseph	MRPA	0.043806
15-394	PMC Canning Company	MRPAU	.012950
	Total pumpage within study area for this Township		0.056756
Total pumpage in study area			7.096322

screened in the middle aquifer, declined about 5.3 ft from 1954-66. Water levels in these wells generally increased after the late 1960's, but quantification of the increases is difficult because monthly water-level measurements in these wells were discontinued in 1975; thereafter, measurements were made only twice annually. The water level in well 33-187, which is south of the study area (fig. 1) and screened in the lower aquifer, has declined steadily from 1959-88, but the rate of decline was lower after 1966 (fig. 4). The rate of decline from 1959-66 was approximately 1.4 ft/yr (feet per year). More recently, from 1967-88, the rate of decline was approximately 0.4 ft/yr. The water levels in this well are affected by pumpage both outside and inside the study area. Although pumpage in the study area from the lower aquifer more than doubled from 1980-82, the rate at which the water level in well 33-187 declined did not increase during that period.

Potentiometric Surfaces and Lateral Flow

Potentiometric surfaces in the confined parts of the upper, middle, and lower aquifers of the Potomac-Raritan-Magothy aquifer system (pls. 7a through 8a, respectively) were determined on the basis of ground-water-level measurements in 51 wells in the study area, 13 wells screened in the upper aquifer, 28 wells screened in the middle aquifer, 8 wells screened in the lower aquifer, and 1 well screened in the area where the middle and lower aquifers are in direct hydraulic connection (table 6). In order to reduce the effect of seasonal changes on water levels, all but one of the water levels were measured within a 2-day period in June 1985. One well was measured 13 days earlier. Water levels were measured in both water-supply wells and observation wells. At water-supply wells, the pumps were turned off for approximately 1 hour before measurement of the water level to allow recovery. Where possible, wells were measured by using the wetted-steel-tape method. A few wells were measured with an electric tape. Contours on potentiometric-surface maps (pl. 7a-8a) in areas where data for 1985 were sparse were based on regional trends from 1983 (Eckel and Walker, 1986) and 1986 (Barton and Kozinski, in press). Generalized ground-water-flow directions, indicated by arrows on the potentiometric-surface maps, were determined from the potentiometric contours.

The potentiometric-surface contour lines and ground-water-flow lines shown on plates 7a-8a do not extend into the outcrop areas because in many parts of the outcrop areas the aquifers are unconfined. In unconfined aquifers, ground-water-flow patterns usually are more complex than in confined areas and many more data points are required to determine ground-water-flow directions. Ground-water-flow directions in unconfined aquifers are controlled by the configuration of the water table, which in turn is controlled primarily by topography. Consequently, ground-water flow in unconfined aquifers generally is from topographically high areas to topographically low areas, except where altered by pumpage. Because there is no industrial or municipal pumpage from the unconfined parts of the aquifers in the study area, ground water in those areas probably flows from hilltops to valleys and streams.

Ground-water levels in some wells in the study area fluctuate daily in response to tides in the Delaware River. However, the tidal fluctuations

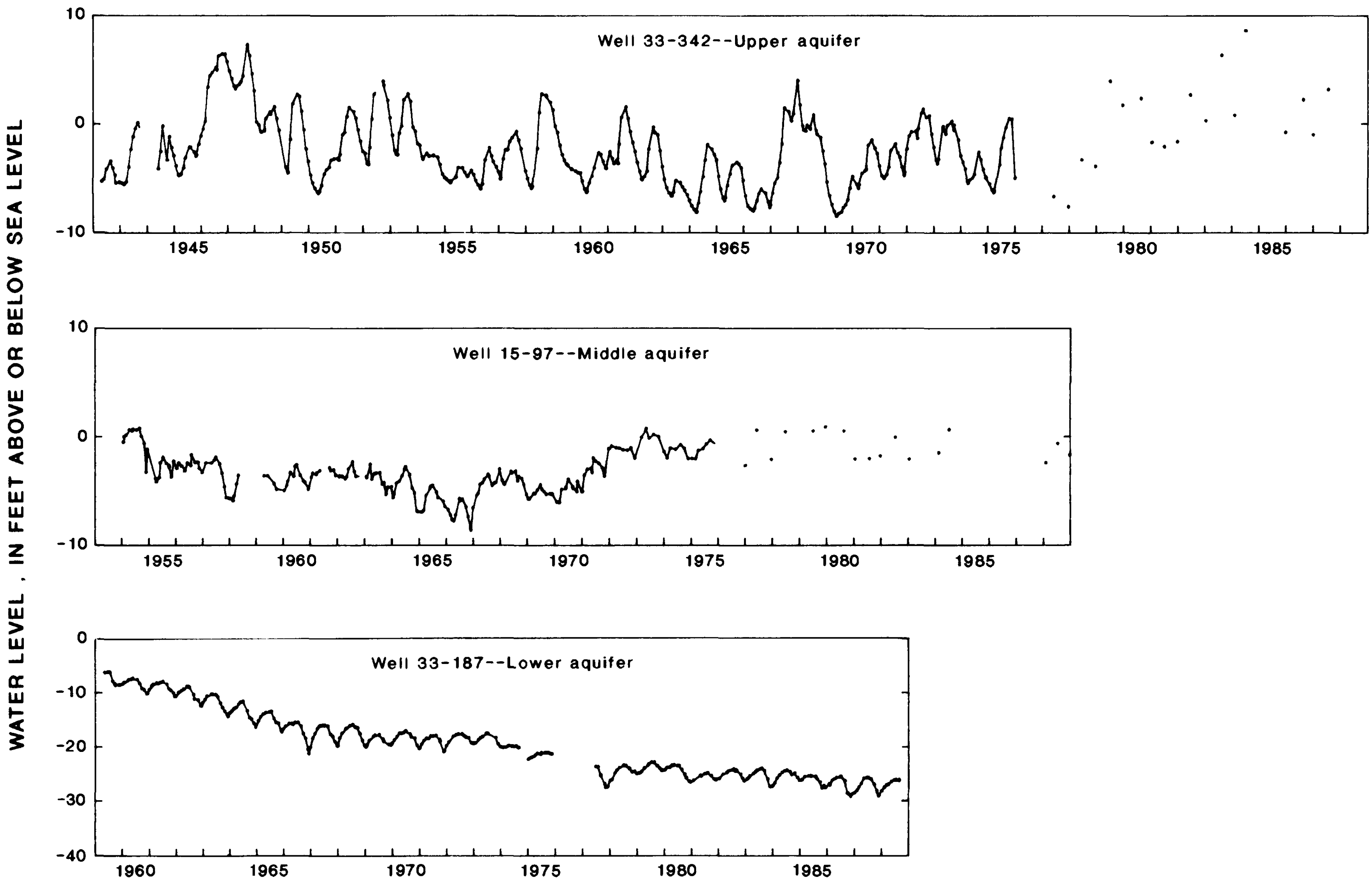

Figure 4.--Hydrographs of water levels in three wells screened in the Potomac-Raritan-Magothy aquifer system, Logan Township region, New Jersey.

Table 6.--Ground-water levels in the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey, June 1985

[Well locations are shown on plates 1a and 7a-8a; USGS, U.S. Geological Survey]

USGS well number	Date of measurement	Altitude of water level (feet above or below sea level)
	Upper aquifer	
15-147	6/26	4
15-240	6/25	-20
15-339	6/25	-20
15-345	6/25	-12
15-353	6/26	3
15-546	6/26	2
15-564	6/26	3
15-573	6/26	3
15-613	6/26	1
15-614	6/26	2
15-617	6/26	-7
15-707	6/26	2
33- 75	6/26	-12
	Middle aquifer	
15- 76	6/25	-8
15- 96	6/25	-2
15- 97	6/25	-2
15-134	6/26	-8
15-135	6/26	-2
15-140	6/26	-1
15-143	6/26	1
15-144	6/26	-4
15-146	6/26	-3
15-161	6/25	-6
15-170	6/25	4
15-178	6/25	1
15-395	6/25	-2
15-540	6/26	2
15-549	6/26	4

Table 6.--Ground-water levels in the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey, June 1985--Continued

USGS well number	Date of measurement	Altitude of water level (feet above or below sea level)
	Middle aquifer--Continued	
15-550	6/26	2
15-569	6/26	-15
15-585	6/26	1
15-586	6/26	2
[1]15-611	6/26	-2
15-616	6/25	-8
15-620	6/26	2
15-657	6/25	-6
15-660	6/25	2
15-665	6/25	-5
15-668	6/25	-3
15-697	6/26	1
33- 89	6/25	-6
33-442	6/25	-3
	Lower aquifer	
15-118	6/25	-9
15-139	6/26	-10
15-349	6/26	-6
15-350	6/26	-9
[1]15-611	6/26	-2
15-615	6/26	-14
15-618	6/12	-7
15-658	6/25	-4
33- 86	6/25	-14

[1] This well is located in the area where the confining unit between the middle and lower aquifers is absent; therefore, the measured water level is assumed to represent water levels in both aquifers.

are not great enough to significantly affect the potentiometric surfaces in the aquifers (pl. 7a-8a). Hourly water-level data for wells 15-564, 15-618, and 15-620, all in east-central Logan Township (pl. 1a), and for wells 15-615, 15-616, and 15-617, all in southeastern Logan Township (pl. 1a), indicate that the amplitude of tidal fluctuations is less than 0.6 ft in each of the wells. The greatest tidal fluctuation (about 0.5 ft) was observed in well 15-620, which is screened in the lower part of the middle aquifer.

Water levels in the upper aquifer indicate that confined ground water in the Logan Township study area flows southeast and east (pl. 7a). Regional water levels (Eckel and Walker, 1986, pl. 3) indicate that, after leaving the study area, water flows east, then northeast, toward regional cones of depression centered in Camden County (fig. 1). Water levels range from 4 ft above sea level in the outcrop area (well 15-147) to more than 30 ft below sea level in Harrison and South Harrison Townships. The 1985 potentiometric surface is similar to that determined from 1983 water-level data (Eckel and Walker, 1986, pl. 3).

Water levels in the middle aquifer also indicate southeasterly ground-water flow in the Logan Township region (pl. 7b). Regional water levels (Eckel and Walker, 1986, pl. 2) indicate that, after leaving the study area, ground water flows toward a regional cone of depression in northern Camden County. A cone of depression in the Woodstown area, which is south of the study area (fig. 1), probably also influences the direction of ground-water flow in the study area (Eckel and Walker, 1986, pl. 2). Water levels in this aquifer range from 4 ft above sea level in well 15-549, located near the Bridgeport Rental and Oil Services, Inc., site (pl. 1a) and well 15-170, located east of Cedar Swamp, to more than 30 ft below sea level in Harrison and South Harrison Townships. Industrial and public-supply ground-water withdrawals (table 5) have lowered the potentiometric surface to below sea level in the northern part of Greenwich, Logan, and Oldmans Townships. Industrial pumpage causes the northward ground-water flow shown south of the outcrop area on plate 7b.

Water levels in the lower aquifer (pl. 8a) indicate that confined ground water in the western part of the Logan Township region flows southward, and in the eastern part, confined ground water flows southeast. Regional water levels (Eckel and Walker, 1986, pl. 1) indicate that the southward flow is toward cones of depression at Woodstown and Penns Grove (fig. 1), and the southeastward flow is toward a regional cone of depression centered in Camden County (Eckel and Walker, 1986, pl. 1). Heads in the lower aquifer range from 2 ft below sea level in the northwestern part of Logan Township to more than 30 ft below sea level in Harrison and South Harrison Townships. Industrial pumpage from the lower aquifer creates a slight depression in the potentiometric surface in Oldmans Township.

Vertical Flow

In addition to the lateral ground-water flow within aquifers described in the preceding section, ground water in the Logan Township region also flows vertically from the upper to the middle aquifer and from the middle to the lower aquifer. The rate of vertical ground-water flow is determined by the difference in water levels among the aquifers and on the vertical hydraulic conductivity of the confining units.

Hourly water-level recorders were installed in several wells in the study area to assess the vertical distribution of water levels among the aquifers of the Potomac-Raritan-Magothy aquifer system. Hydrographs of three wells located within 100 ft of each other in the east-central part of Logan Township are shown in figure 5--well 15-564, screened in the upper aquifer; well 15-620, screened in the lower part of the middle aquifer; and well 15-618, screened in the lower aquifer. The hydrographs indicate that the water level in the upper aquifer at this location is consistently about 0.4 ft above the level in the lower part of the middle aquifer, and the level in the lower part of the middle aquifer is consistently about 9 ft above the level in the lower aquifer. Hourly water levels also were recorded in well 15-540, which is in the same area but is screened in the upper part of the middle aquifer. The hydrograph for this well indicates that the water level in the upper part of the middle aquifer is consistently about 0.25 ft below that of the upper aquifer and 0.15 ft above that of the lower part of the middle aquifer.

Hydrographs of three wells located within 50 feet of each other in the southeastern part of Logan Township indicate similar relations among aquifers (fig. 6). These wells include well 15-617, screened in the upper aquifer; well 15-616, screened in the middle aquifer, and well 15-615, screened in the lower aquifer. The hydrographs indicate that at this location the water level in the upper aquifer is consistently about 1 ft above the level in the middle aquifer and that the level in the middle aquifer is consistently about 7 ft above the level in the lower aquifer.

The vertical distribution of water levels among the aquifers of the Potomac-Raritan-Magothy aquifer system described above also was noted at all other locations in the study area where well clusters were equipped with continuous water-level recorders. These clusters include wells 15-140 and 15-139 in Logan Township west of Raccoon Creek; wells 15-143 and 15-350 also in Logan Township west of Raccoon Creek, and wells 15-712, 15-713, and 15-728 in Greenwich Township just east of Repaupo Creek (pl. 1a).

The vertical distribution of water levels indicates that water flows vertically from the upper to the middle aquifer. The relatively small head difference between the upper and middle aquifers indicates that the confining unit between these aquifers probably is leaky. In addition, water from the upper aquifer can enter the middle aquifer directly in areas where the confining unit between the aquifers is absent.

The relatively large head difference between the middle and lower aquifers reflects the presence of the thick, continuous confining unit between them and indicates that water flows vertically downward from the middle to the lower aquifer. If ground-water pumpage from the middle aquifer was increased, however, the water level in the middle aquifer could decline to a point below the water level in the lower aquifer. Under these circumstances, water in the lower aquifer, which generally is not potable because of high chloride concentrations (see section on ground-water quality), could leak into the middle aquifer.

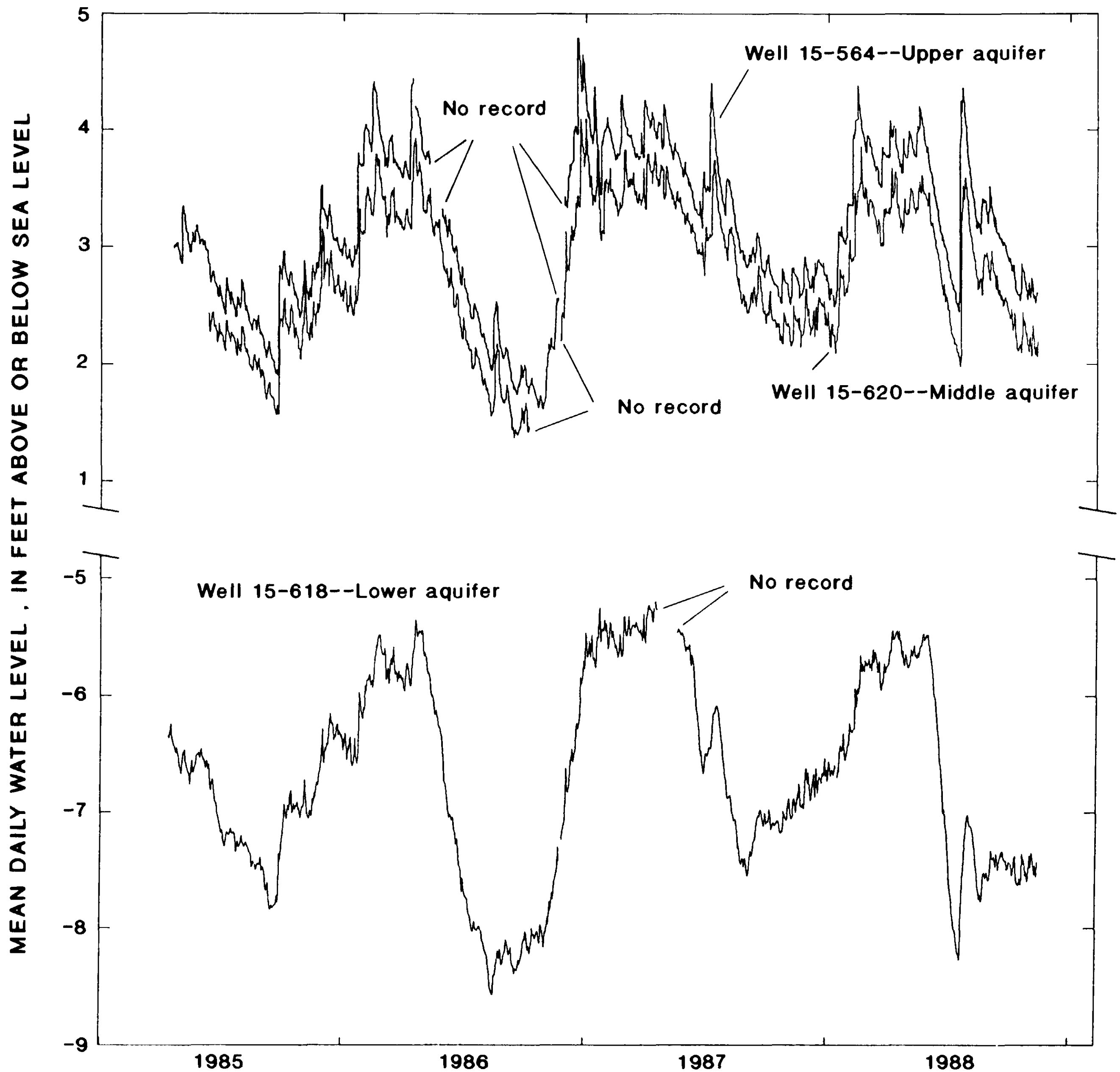

Figure 5.--Hydrographs of water levels in three wells screened in the Potomac-Raritan-Magothy aquifer system, east-central Logan Township, New Jersey, 1985-88.

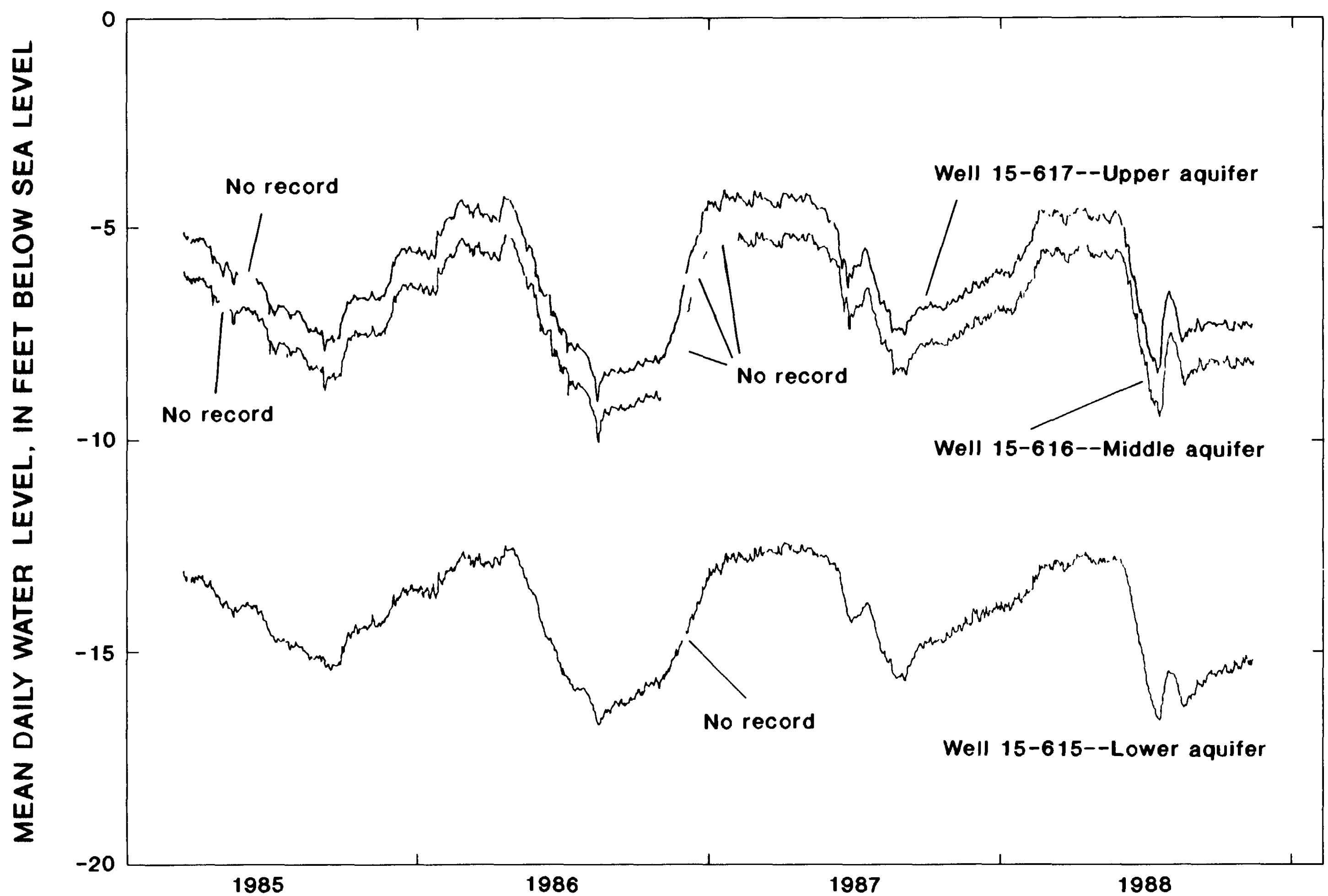

Figure 6.--Hydrographs of water levels in three wells screened in the Potomac-Raritan-Magothy aquifer system, southeastern Logan Township, New Jersey, 1985-88.

Recharge and Discharge

Recharge to the aquifers in the study area is primarily from precipitation falling on the outcrop areas of the aquifers and by downward leakage through the confining units. In addition, the general southeasterly direction of flow suggests that, within each aquifer, water flows into the study area from the northwest across the western border of the study area. Significant induced recharge from the Delaware River is unlikely because vertical head gradients near the river are small and because of the clay- and silt-rich upper Cenozoic deposits that separate the river from the aquifers. Induced recharge from the river may occur, however, in parts of Greenwich Township bordering the river, where ground-water-pumpage rates are high and the upper Cenozoic sediments generally are less clay-rich than in Logan Township.

Ground-water discharge in the confined parts of the aquifers is primarily by lateral flow out of the study area to the south, southeast, and east, and by pumpage. In the outcrop areas, water also leaves the aquifers by evapotranspiration and by discharge to streams.

GROUND-WATER QUALITY

The quality of ambient water in the Logan Township region is influenced primarily by the chemical composition of precipitation recharging the unconfined system, the quality of water leaking through the confining units, and the intrusion of slightly to moderately saline water from deeper parts of the aquifer system (Barksdale and others, 1958, fig. 16).

Ambient ground-water quality in the Potomac-Raritan-Magothy aquifer system in the Logan Township region was characterized from results of chemical analyses of water from 58 wells. The wells sampled and the types of water-quality data available for each well are listed by aquifer in table 7. Construction and altitude data for these 58 wells are included in table 2, and their locations are shown on plate 1a. Twenty-one of these wells are screened in the upper aquifer, 25 are screened in the middle aquifer, and 9 are screened in the lower aquifer. Three additional wells are screened where the middle and lower aquifers are undifferentiated in northwestern Logan Township. The depth to the bottom of the well screen in the sampled wells ranges from 18 to 279 ft, from 61 to 312 ft, and from 60 to 345 ft below land surface for wells in the upper, middle, and lower aquifers, respectively. Samples were considered to represent ambient conditions because all wells are either beyond the probable extent of contaminant plumes emanating from industrial or hazardous-waste-disposal sites (pl. 1a), or screened in an aquifer isolated from known or potential ground-water contamination.

Sample Collection

The water samples were collected during 1980-87 except for some samples collected from well 15-166 as early as 1958. Standardized field techniques were used (Brown and others, 1970; Wood, 1976) to ensure collection of representative water samples. Samples were collected as near as possible to the wellhead to minimize contact with plumbing systems. Sampling procedures varied with the type of well sampled. Samples from domestic wells were

Table 7.--Types of water-quality data available for wells in the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey, 1980-87

[I, analyses for physical properties, common ions, and nutrients; M, analyses for trace elements; P, analyses for purgeable organic compounds; H, analyses for pesticides and herbicides; USGS, U.S. Geological Survey]

Upper Aquifer		Middle Aquifer		Area in which the middle and lower aquifers cannot be differentiated	
USGS well number	Available data	USGS well number	Available data	USGS well number	Available data
15-240	I, M, P	15-137	I, M, P	15-159	I, M, P
15-337	I, M, P	15-140	I, M	15-163	I, M, P, H
15-340	I, M, P	15-143	I, M, P	15-597	I, M, P
15-341	I, M	15-144	I, M, H		
15-342	I, M, P	15-146	I, M, P		
15-345	I, M, P, H	15-161	I, M, P	Lower Aquifer	
15-353	I, M	15-166	I, M, P, H	15-139	I, M, P
15-363	I, M	15-167	I, M, P	15-349	I, M, P
15-366	I, M, P	15-236	I, M, P	15-350	I, M, P
15-392	I, M, P	15-347	I, M, P	15-398	I, M
15-417	I, M, P	15-348	I, M, P, H	15-615	I, M, P
15-501	I, M	15-395	I, M, P	15-618	I, M, P
15-519	I, M	15-399	I, M, P	15-634	I, M, P
15-564	I, M, H	15-409	I, M, P	15-712	I, M, P
15-617	I, M	15-453	I, M, P, H	33- 86	I, M, P
15-626	I, M	15-539	I, M, P		
15-728	I, M, H	15-540	I, M		
33- 74	I, M, P	15-569	I, M		
33- 76	I, M, P	15-616	I, M		
33-370	I, M, H	15-620	I, M		
33-439	I, M, H	15-713	I, M, H		
		33- 83	I, M, P		
		33- 85	I, M, P		
		33-419	I, M		
		33-420	I, M		

collected at spigots prior to discharging into holding tanks and prior to passing through water-treatment systems or filters. Observation wells were sampled with portable submersible pumps. Temperature, pH, specific conductance, and dissolved-oxygen concentrations (field-measured properties) of the well discharge were monitored from the start of evacuation until after sampling was completed. When field-measured properties were stable and a minimum of three casing volumes of water had been evacuated from the well, samples were collected. The well discharge was assumed to be chemically stable and representative of water within the aquifer near the well. Water samples were preserved according to standardized techniques currently used by the U.S. Geological Survey (Feltz and Anthony, 1984; Feltz and others, 1985).

Laboratory Analysis, Quality Assurance, and Quality Control

Chemical analyses were performed at the U.S. Geological Survey National Water Quality Laboratories (NWQL) in Lakewood, Colorado, and Doraville, Georgia. Analytical methods used by the NWQL are documented in Fishman and Friedman (1985) and Wershaw and others (1987). The constituents that were analyzed for and the detection limits of the analytical methods used are listed in table 8.

Ground-water samples were analyzed for physical properties, common ions, and nutrients (table 9); selected trace elements (table 10); purgeable organic compounds (POCs) (table 11); and selected herbicides and pesticides (table 12).

The quality-assurance (QA) program for chemical data listed in tables 9 through 12 consisted of submitting two sequential samples for four of the wells to the NWQL for analysis. Analytical results for samples from the four wells--15-728, 15-615, 15-712, and 15-564--are listed in tables 9 and 10, table 10, table 10, and table 12, respectively. The analytical results reported by the NWQL for these samples indicate that laboratory precision and accuracy for each constituent were within the limits suggested by Skougstad and others (1979) and Feltz and others (1985).

The quality-control program used by the NWQL is described by Jones (1987) and Friedman and Erdmann (1982). Quality-control procedures used at the laboratory include daily analyses of blind samples and standards. A blind sample consists of an unlabeled duplicate of a sample. The purpose of blind samples is to eliminate prejudice on the part of the analyst because of knowledge regarding the origin of the sample. Standards are samples having known concentrations. In addition, spiked samples are analyzed at the NWQL whenever requested for a particular USGS project. A spiked sample consists of reagent-grade deionized water spiked with ampuled concentrates of purgeable organic compounds or trace metals. The ampules are prepared by the USEPA.

In order to verify the accuracy of individual analyses used in this report, each analysis was checked to determine whether the concentration of cations in the sample equaled the concentration of anions. Because water is electrically neutral, the number of milliequivalents of cations in solution must equal the number of the milliequivalents of anions. No analysis was

Table 8.--Constituents measured in water from wells in the Logan Township region, New Jersey, 1980-87, and their detection limits

[Detection limits from the U.S. Geological Survey National Water-Quality Laboratories; all units are mg/L (milligrams per liter) except where noted; µg/L, micrograms per liter]

Chemical and physical properties	Detection limit	Chemical and physical properties	Detection limit
Alkalinity (field)	1	specific conductance (field)	see footnote [1]
Dissolved oxygen (field)	.1	temperature (field)	0.5° C
pH (field)	.1 unit		

Major ions (dissolved)	Detection limit	Major ions (dissolved)	Detection limit
Calcium	0.02	manganese	0.1
Chloride	.1	potassium	.1
Fluoride	.1	silica	.006
Iron	3.0	sodium	.2
Magnesium	.1	sulfate	.2

Trace elements (dissolved)	Detection limits[2]	Trace elements (dissolved)	Detection limits[2]
Aluminum	10, 100 µg/L	lead	10, 30 µg/L
Arsenic	1 ,2 µg/L	lithium	4 µg/L
Barium	10 µg/L	molybdenum	10 µg/L
Beryllium	.5, 1 µg/L	strontium	1 µg/L
Cadmium	1, 3 µg/L	vanadium	6, 18 µg/L
Chromium	10 µg/L	zinc	3 to 19 µg/L
Copper	10, 30 µg/L		

Nutrients (dissolved)	Detection limit	Nutrients (dissolved)	Detection limit
Nitrogen (NO2)	0.01	nitrogen (NH4)	[2]0.01, 0.07
Nitrogen (NO2 + NO3)	.10	orthophosphorous (P)	.01

Volatile organic compounds (total)	Detection limits[1]	Purgeable organic compounds (total)	Detection limits[1]
Benzene	0.2, 1.0, 3.0, 10 µg/L	trichloroethylene	0.2, 1.0, 3.0, 10 µg/L
Bromoform	.2, 1.0, 3.0, 10 µg/L	trichlorofluoromethane	.2, 1.0, 3.0, 10 µg/L
Chlorobenzene	.2, 1.0, 3.0, 10 µg/L	vinyl chloride	.2, 1.0, 3.0, 10 µg/L
Chloroethane	.2, 1.0, 3.0, 10 µg/L	1,1-dichloroethylene	.2, 1.0, 3.0, 10 µg/L
Chloroform	.2, 1.0, 3.0, 10 µg/L	1,1-dichloroethane	.2, 1.0, 3.0, 10 µg/L
Dichlorobromomethane	.2, 1.0, 3.0, 10 µg/L	1,1,1-trichloroethane	.2, 1.0, 3.0, 10 µg/L
Dichlorodifluoromethane	.2, 1.0, 3.0, 10 µg/L	1,1,2-trichloroethane	.2, 1.0, 3.0, 10 µg/L
Ethylbenzene	.2, 1.0, 3.0, 10 µg/L	1,1,2,2-tetrachloroethane	.2, 1.0, 3.0, 10 µg/L
Methylbromide	.2, 1.0, 3.0, 10 µg/L	1,2-dichloroethane	.2, 1.0, 3.0, 10 µg/L
Tetrachloroethylene	.2, 1.0, 3.0, 10 µg/L	1,3-dichloropropylene	.2, 1.0, 3.0, 10 µg/L
Toluene	.2, 1.0, 3.0, 10 µg/L	2-chloroethylvinyl-ether	.2, 1.0, 3.0, 10 µg/L

[1] Detection limit is a function of dissolved-solids concentration.

[2] Detection limit varies with analytical method used.

Table 8.--Constituents measured in water from wells in the Logan Township region, New Jersey, 1980-87, and their detection limits--Continued

Pesticides (total)	Detection limit	Pesticides (total)	Detection limit
	Organochlorine insecticides		
Aldrin	0.01 µg/L	PCBs (total)	0.1 µg/L
Chlordane	.1 µg/L	heptachlor	.01 µg/L
DDD	.01 µg/L	heptachlor epoxide	.01 µg/L
DDE	.01 µg/L	lindane	.01 µg/L
DDT	.01 µg/L	methoxychlor	.01 µg/L
Dieldrin	.01 µg/L	mirex	.01 µg/L
Endosulfan	.01 µg/L	perthane	.1 µg/L
Endrin	.01 µg/L	toxaphene	1.0 µg/L
	Organophosphorus insecticides		
Diazinon	0.01 µg/L	methyl trithion	0.01 µg/L
Ethion	.01 µg/L	parathion	.01 µg/L
Malathion	.01 µg/L	trithion	.01 µg/L
	Triazine herbicides (total)		
Ametryne	0.1 µg/L	prometryne	0.1 µg/L
Atrazine	.1 µg/L	propazine	.1 µg/L
Cyanazine	.1 µg/L	sinazine	.1 µg/L
Promethone	.1 µg/L	sinetryne	.1 µg/L

used in this study if the discrepancy between the milliequivalents of cations and anions exceeded 10 percent.

Distribution of Selected Physical Properties and Chemical Constituents

Methods used to characterize the quality of water in the Potomac-Raritan-Magothy aquifer system within the study area include descriptive statistics, trilinear water-quality diagrams, and isoconcentration maps, all of which are based on the most recent water analysis for each well; and diagrams showing changes in water quality through time. Statistical summaries include the minimum, median, and maximum concentrations of ions and compounds as measures of the central tendency and variability of the data (table 13). More rigorous statistical analysis is not applicable to these data because the majority of the data are not normally or log-normally distributed. These statistics exclude analyses of samples from wells screened in the area where the middle and lower aquifers are undifferentiated.

pH and Dissolved Oxygen

The pH and concentration of dissolved oxygen are useful in characterizing chemical and biochemical reactions in ground water. The magnitude of each of these variables reflects the solubility of inorganic elements and compounds, and organic compounds. Both variables were monitored in most of the sampled wells (table 9). The median pH of water in the upper, middle, and lower aquifers of the Potomac-Raritan-Magothy aquifer system in the Logan Township region was 6.5, 5.8, and 6.7, respectively (table 13). In general, ground water is more acidic in the unconfined part of the system. The median concentration of dissolved oxygen in the upper, middle, and lower aquifers was 0.2 mg/L (milligrams per liter), 0.4 mg/L, and 0.1 mg/L, respectively (table 8). Concentrations were greatest--generally more than 1.0 mg/L (maximum 9.6 mg/L)--in water from wells screened in unconfined parts of the upper and middle aquifers.

Dissolved Solids

The Potomac-Raritan-Magothy aquifer system in the Logan Township region contains both fresh water (concentrations of dissolved solids less than 1,000 mg/L) and slightly to moderately saline water (dissolved solids 1,000-3,000 mg/L), as classified by Heath (1983, p. 64). The median concentration of dissolved solids in water from the upper, middle, and lower aquifers was 150, 82, and 820 mg/L, respectively (table 13). The maximum concentrations of dissolved solids in water from the upper and middle aquifers was 410 mg/L; concentrations in water from wells screened in the area where the middle and lower aquifers are undifferentiated ranged from 580 mg/L to 720 mg/L (table 9).

Major Ions

Percentages of major dissolved ions in water samples can be plotted on trilinear diagrams in milliequivalents per liter. The triangles at the lower left and lower right of a trilinear diagram graphically represent the composition of water with respect to cations and anions (fig. 7). The apexes of each of the two triangles represents 100 percent of each of three

Table 10.--Selected trace elements in water from wells in the Logan Township region, New Jersey, 1980-87

[Dissolved constituents; units are micrograms per liter; --, data not available; <, less than the indicated detection limit; for example, <1 means that the concentration in the sample is less than the detection limit of 1 µg/L; well locations shown on pl. 1; USGS, U.S. Geological Survey]

USGS well number	Date	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Chromium	Hexavalent chromium	Cobalt	Copper	Lead	Lithium	Mercury	Molybdenum	Strontium	Vanadium	Zinc
Upper aquifer of the Potomac-Raritan-Magothy aquifer system																	
15-240	09-10-80	--	--	80	<1	<1	--	--	<3	<10	<10	10	--	<10	620	<6	<4
15-240	11-18-86	10	<1	86	<0.5	<1	20	--	<3	<10	<10	12	--	<10	420	<6	11
15-337	10-14-80	--	--	70	<1	4	--	--	<3	<10	<10	7	--	<10	430	<6	<4
15-340	10-20-80	--	--	80	<1	<1	--	--	10	<10	<10	7	--	<10	440	<6	6
15-341	10-27-80	--	--	110	<1	3	--	--	<3	<10	13	5	--	<10	550	<6	14
15-342	09-26-85	10	<1	120	<.5	<1	<10	<1	<3	<10	<10	11	--	<10	580	<6	22
15-345	10-27-80	--	--	60	<1	6	--	--	10	<10	17	45	--	<10	280	<6	120
15-345	12-04-86	<10	<1	86	<.5	2	<10	--	<3	<10	<10	50	--	<10	400	<6	5
15-353	04-18-85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	26
15-363	11-20-86	<10	<1	89	<.5	<1	<10	--	<3	<10	<10	12	--	<10	440	<6	6
15-366	11-17-80	--	--	140	<1	1	--	--	<3	<10	<10	12	--	<10	760	<6	<4
15-392	09-08-80	--	--	120	<1	6	--	--	<3	<10	13	10	--	<10	730	<6	72
15-417	09-25-80	--	--	50	1	<1	--	--	6	16	<10	<4	--	<10	95	<6	230
15-417	10-03-85	90	<1	79	<.5	1	<10	<1	10	10	<10	<4	--	<10	130	<6	67
15-501	11-19-86	<10	<1	86	<.5	1	20	--	<3	<10	<10	13	--	<10	410	<6	12
15-519	11-18-86	<10	<1	83	<.5	1	30	--	<3	<10	<10	37	--	<10	650	<6	12
15-564	05-18-85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
15-564	11-25-86	<10	<1	73	<.5	2	<10	--	<3	<10	<10	5	--	<10	130	<6	8
15-617	02-27-85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13
15-617	11-21-85	--	--	--	--	--	--	--	--	--		--	--	--	270	--	--
15-617	12-03-86	<10	2	100	<.5	3	<10	--	<3	<10	<10	41	--	<10	470	<6	11
15-626	12-05-86	40	<1	49	<.5	<1	<10	--	<3	<10	<10	5	--	<10	48	<6	9
15-728	04-22-87	<10	4	89	<.5	<1	<10	--	<3	<10	20	29	--	<10	400	<6	6
15-728	04-22-87	<10	3	94	<.5	2	<10	--	<3	<10	10	33	--	<10	410	<6	6
33- 74	10-03-80	--	--	40	6	2	--	--	<3	<10	<10	7	--	15	290	<6	10
33- 76	10-20-80	--	--	40	<1	4	--	--	90	<10	<10	12	--	15	120	11	7
33-370	07-17-86	90	<1	39	2	<1	<10	--	<3	50	<10	7	<0.1	<10	90	<6	14
33-439	07-25-86	470	<1	88	2	<1	<10	--	20	50	<10	<4	<.1	<10	96	<6	76
Middle aquifer of the Potomac-Raritan-Magothy aquifer system																	
15-137	09-26-80	--	--	90	<1	2	--	--	9	<10	<10	12	--	<10	320	<6	15
15-140	03-14-85	--	--	--	--	--	--	--	--	-	--	--	--	--	70	--	69
15-140	11-20-85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	46
15-143	09-30-80	--	--	60	2	<1	--	--	3	<10	<10	16	--	<10	76	<6	26
15-144	09-26-80	--	--	40	3	<1	--	--	5	<10	<10	18	<.1	<10	60	<6	19
15-144	07-14-86	<10	<1	27	<.5	<1	<10	--	<3	10	<10	21	--	<10	65	<6	190
15-146	10-01-80	--	--	70	<1	<1	--	--	20	<10	<10	14	--	<10	160	<6	61
15-161	10-20-82	<100	2	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
15-166	09-16-80	--	--	80	<1	3	--	--	3	<10	<10	7	<.1	<10	71	<6	34
15-166	12-22-82	200	<1	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
15-166	06-16-86	30	<1	82	1	<1	<10	--	4	20	<10	8	--	<10	67	<6	30
15-167	10-19-82	100	<1	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
15-236	09-10-80	--	--	140	<1	2	--	--	<3	<10	<10	9	--	<10	730	<6	6
15-347	12-10-80	--	--	80	<1	<1	--	--	5	<10	<10	6	--	<10	94	<6	62
15-347	09-22-82	100	1	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
15-347	07-25-85	40	<1	63	<.5	<1	<10	<1	4	<10	10	6	--	<10	91	<6	97
15-347	11-05-86	40	<1	68	<.5	<1	<10	--	<3	10	<10	6	--	<10	90	<6	67
15-348	09-18-80	--	--	40	<1	<1	--	--	20	17	<10	11	<.1	<10	62	<6	87
15-348	12-22-82	100	<1	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
15-348	07-14-86	1100	<1	77	2	19	<10	--	40	10	<10	16	--	<10	96	<6	150

Table 10.--Selected trace elements in water from wells in the Logan Township region, New Jersey, 1980-87--Continued

USGS well number	Date	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Chromium	Hexavalent chromium	Cobalt	Copper	Lead	Lithium	Mercury	Molybdenum	Strontium	Vanadium	Zinc
Middle aquifer of the Potomac-Raritan-Mgothy aquifer system--Continued																	
15-348	11-17-6	1100	<1	80	2	--	<10	--	30	10	<10	16	--	<10	93	<6	140
15-395	10-30-6	20	7	70	2	<3	<10	--	<9	<30	<30	18	--	<30	72	<18	37
15-399	09-15-0	--	--	90	<1	3	--	--	20	<10	<10	45	--	<10	230	<6	43
15-409	10-09-0	--	--	40	1	3	--	--	<3	<10	<10	<4	--	10	61	<6	46
15-453	06-06-6	460	<1	42	3	<1	<10	--	20	20	<10	13	<0.1	<10	96	<6	41
15-539	05-17-4	--	1	--	--	<1	<10	<1	--	--	10	--	< .1	--	--	--	3,700
15-540	12-10-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	40
15-569	11-10-6	20	<1	100	0.8	2	<10	--	<3	<10	<10	16	--	<10	390	<6	16
15-616	02-28-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10
15-616	11-20-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11
15-616	11-26-6	<10	<1	68	1	<1	<10	--	<3	<10	<10	21	--	<10	110	<6	<3
15-620	06-07-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	43
15-620	11-25-6	10	<1	60	<.5	<1	<10	--	<3	<10	<10	21	--	<10	85	<6	32
15-713	12-03-6	10	1	64	<.5	1	<10	--	<3	<10	<10	23	--	<10	300	<6	<3
33- 83	10-09-0	--	--	50	2	5	--	--	<3	11	<10	10	--	19	94	8	11
33- 83	10-21-2	100	1	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
33- 85	10-09-0	--	--	60	3	4	--	--	<3	<10	<10	11	--	22	170	<6	6
33- 85	10-21-2	<100	1	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
33-419	11-21-0	--	--	40	<1	<1	--	--	<3	<10	<10	7	--	<10	110	<6	17
33-420	11-21-0	--	--	30	<1	1	--	--	5	<10	<10	8	--	<10	27	<6	39
Area in which the Middle aquifer and the Lower aquifer of the Potomac-Raritan-Magothy aquifer system cannot be differentiated																	
15-159	09-23-0	--	--	90	<1	7	--	--	<3	<10	<10	12	--	<10	570	<6	<4
15-159	10-19-2	100	4	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
15-163	10-28-2	100	1	--	--	--	10	<1	--	--	--	--	--	--	--	--	--
15-163	06-04-4	--	1	--	--	3	10	1	--	--	10	--	0.2	--	--	--	13
15-597	05-31-4	--	1	--	--	2	10	1	--	--	<10	--	0.2	--	--	--	98
Lower aquifer of the Potomac-Raritan-Magothy aquifer system																	
15-139	09-26-0	--	--	200	<1	2	--	--	6	<10	<10	21	--	<10	2200	<6	11
15-139	03-13-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<10
15-139	11-10-6	<10	<1	230	27	<3	<10	--	<9	<30	30	46	--	40	2100	24	<9
15-349	10-01-0	--	--	170	<1	<1	--	--	30	<10	<10	33	--	<10	310	<6	87
15-350	09-30-0	--	--	<2	2	<1	--	--	<3	<10	<10	<4	--	60	<1	<6	<4
15-398	11-17-6	10	36	130	1	6	<10	--	<4	<10	20	4	--	<10	140	12	<3
15-615	02-28-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20
15-615	12-02-6	<10	<1	250	<1	<3	<10	--	<9	<30	<30	35	--	<30	2000	<18	26
15-615	12-02-6	<10	<1	240	<1	<3	<10	--	<9	<30	<30	32	--	<30	1900	<18	31
15-618	03-01-5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7
15-618	11-24-6	<10	1	150	<.5	2	<10	--	<3	<10	<10	28	--	<10	1100	<6	13
15-634	10-08-6	<10	<1	91	<.5	<1	<10	--	10	<10	<10	44	--	<10	4400	<6	24
15-712	12-16-6	<10	<1	360	<1	<1	<10	--	<9	<30	<30	39	--	<30	3700	<18	<19
15-712	12-16-6	<10	<1	350	<.5	2	<10	--	<3	<10	<10	42	--	<10	3500	<6	15
15-712	03-19-7	<10	<1	360	<1	<3	<10	--	<3	<10	<30	39	--	<30	3700	<18	<9
15-712	03-19-7	<10	<1	370	<1	<3	<10	--	<3	<10	<30	45	--	<30	3700	<18	18
33- 86	10-21-2	100	1	--	--	--	10	--	--	--	--	--	--	--	--	--	--

Table 13.-- Statistical summary of physical properties and the concentrations of common ions, nutrients, and trace elements in water from wells in the Logan Township region, New Jersey, 1980-87

[All constituents dissolved; concentrations in milligrams per liter, except as noted; minimum, median, and maximum values are for the most recent analysis of each consitutent for each well; µg/L, micrograms per liter; <, less than; --, no data available]

	Upper aquifer				Middle aquifer				Lower aquifer			
Constituents	Number of wells	Minimum	Median	Maximum	Number of wells	Minimum	Median	Maximum	Number of wells	Minimum	Median	Maximum
Specific conductance (microsiemens/ centimeter at 25 degrees Celsius)	21	119	241	648	25	49	170	750	9	461	1,420	2,870
pH (units)	21	4.14	6.50	7.80	25	4.36	5.80	7.20	9	5.30	6.70	7.49
Alkalinity (as $CaCO_3$)	21	0	78	164	24	<1	20	106	9	6	130	192
Solids (sum of constituents)	20	91	150	410	22	29	82	370	9	260	820	1,900
Oxygen	13	<.1	.2	9.6	15	<.1	.4	7.6	7	<.1	.1	.2
Calcium	21	5.0	16	27	25	1.5	5.6	28	9	10	21	94
Sodium	21	2.1	14	130	25	2.0	7.1	110	9	52	280	530
Potassium	21	1.2	5.2	21	25	1.0	2.1	11	9	2.5	6.8	13
Magnesium	21	1.7	5.1	17	25	.58	2.8	12	9	4.1	9.5	27
Iron (µg/l)	21	5	750	25,000	24	18	2,600	21,000	9	180	6,700	73,000
Manganese (µg/l)	21	11	37	1,000	25	29	99	500	9	36	150	1,100
Silica	21	3.4	10	23	25	4.5	11	25	9	8.5	9.7	31
Chloride	21	1.7	14	130	25	4.3	14	210	9	110	400	820
Sulfate	21	2.3	23	75	25	<5.0	12	62	9	4.6	12	660
Floride	7	<.1	<.1	.3	15	<.1	<.1	.2	5	.1	.5	.9
Nitrite (as Nitrogen)	14	<.01	<.01	.15	17	<.01	<.01	.02	7	<.01	<.01	<.01
Nitrate + nitrite (as Nitrogen)	21	<.10	.02	22	17	<.01	.02	18	9	<.10	<.10	2.60
Ammonia (as Nitrogen)	14	.02	.10	.30	18	<.01	.06	.43	7	.34	.80	15
Phosporous (ortho) Orthophosphate	21	<.01	.04	.49	25	<.01	.01	.22	8	<.01	<.01	.20
Aluminum (µg/L)	13	<10	<10	470	14	<10	20	1,100	7	<10	<10	100
Arsenic (µg/L)	13	<1	<1	3	14	<1	<1	7	7	<1	<1	36
Barium (µg/L)	20	39	86	140	20	27	66	140	8	<2	160	370
Beryllium (µg/L)	20	<.5	<.5	6	20	<.5	.5	3	8	<.5	<1	27
Cadmium (µg/L)	20	<1	1	4	21	<1	<1	19	8	<1	<3	6
Chromium (µg/L)	13	<10	<10	30	15	<10	<10	10	7	<10	<10	10
Chromium (hexavalent) (µg/L)	2	<1	<1	<1	8	<1	<1	<1	0	--	--	--
Cobalt (µg/L)	20	<3	<3	90	20	<3	<3	30	8	<3	<6	30
Copper (µg/L)	20	<10	<10	50	20	<10	<10	20	8	<10	<10	<30
Lead (µg/L)	20	<10	<10	13	21	<10	<10	10	8	<10	<20	30
Lithium (µg/L)	20	<4	10	50	20	<4	14	45	8	<4	32	46
Mercury (µg/L)	2	<.1	<.1	<.1	5	<.1	<.1	<.1	0	--	--	--
Molybdenum (µg/L)	20	<10	<10	15	20	<10	<10	22	8	<10	<20	60
Strontium (µg/L)	20	48	420	760	21	27	94	730	8	<1	1,500	4,400
Vanadium (µg/L)	20	<6	<6	11	20	<6	<6	8	8	<6	<6	24
Zinc (µg/L)	21	<4	11	76	23	<3	37	3,700	8	<3	16	87

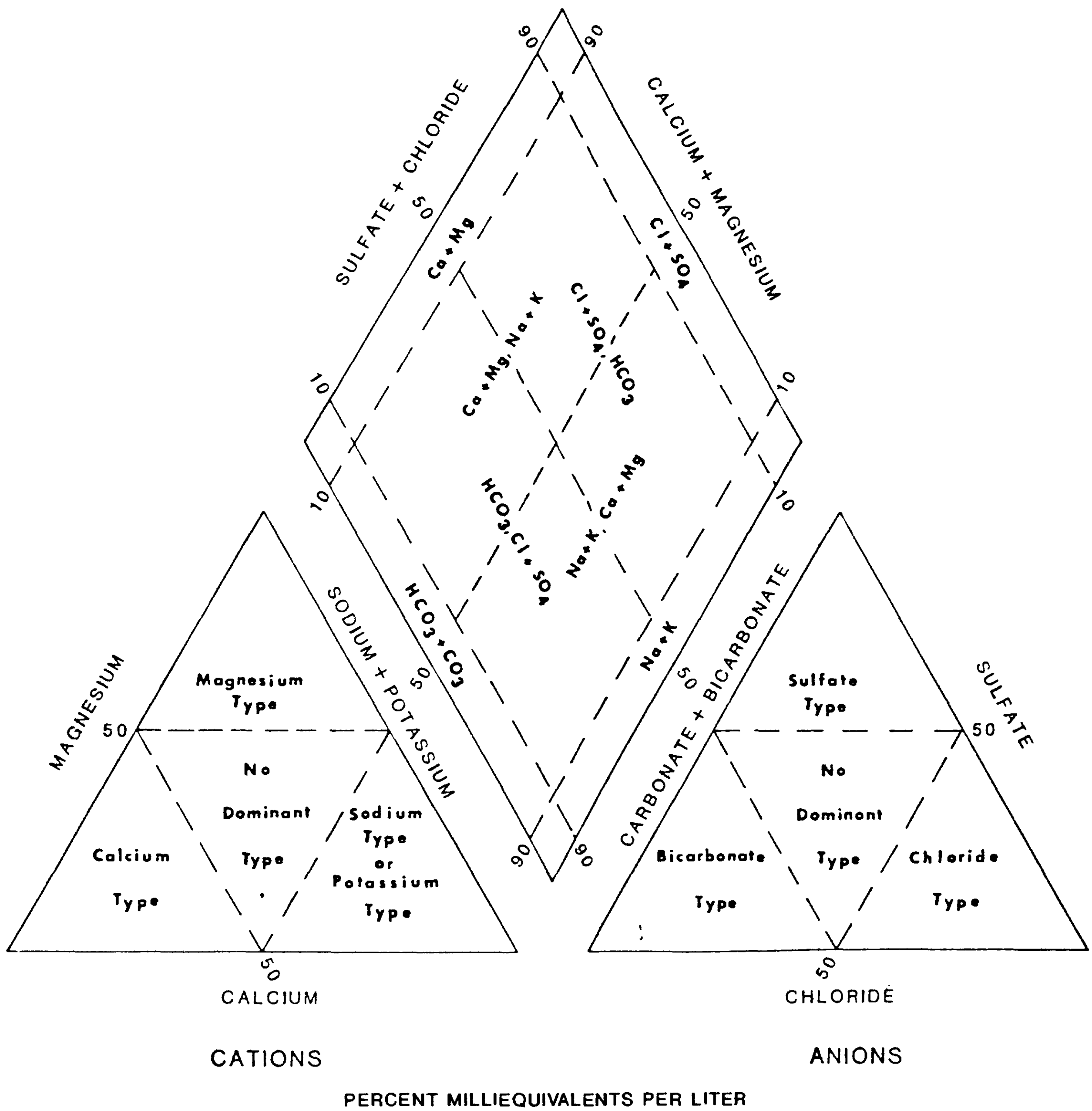

Figure 7.--Trilinear diagram illustrating hydrochemical facies in ground water. (From Back, 1966, fig. 5.)

constituents. The large diamond-shaped field in the center of the diagram represents the composition of water with respect to both cations and anions.

The distribution of major cations and anions in water from the upper, middle, and lower aquifers is shown in trilinear diagrams in figures 8a, 8b, and 8c, respectively. The data plotted on these diagrams are based on the most recent sample from each well. Because the concentration of nitrate is not shown on the diagrams, water samples having greater than 5 percent nitrate in milliequivalents per liter are not plotted. These wells include wells 15-417, 15-564, 15-626, 33-370, and 33-439 (upper aquifer) and wells 15-140, 15-146, 15-166, 15-347, 15-409, 15-453, 15-540, and 15-620 (middle aquifer).

The inorganic water chemistry is similar in the upper and middle aquifers (figs. 8a and 8b). In the upper aquifer, the dominant cations were sodium plus potassium (31 percent of the wells) and calcium (19 percent). No dominant cation was found in 50 percent of the wells. The dominant anions in the upper aquifer were bicarbonate plus carbonate (69 percent of the wells, chloride (12 percent of the wells), and sulfate (6 percent). Because the pH of all these water samples is below 10, little, if any, carbonate was expected, and bicarbonate was the major dissolved inorganic carbon species (Hem, 1985, pg. 107, fig. 19). No dominant anion was found in samples from 12 percent of the wells screened in the upper aquifer.

In the middle aquifer, the dominant cations were sodium plus potassium (35 percent of the wells) and calcium (6 percent). No dominant cation was found in 59 percent of the wells. The dominant anions in the middle aquifer were bicarbonate plus carbonate (53 percent of the wells), chloride (23 percent), and sulfate (12 percent). No dominant anion was found in 12 percent of the wells.

In the lower aquifer, the dominant cations were sodium plus potassium (100 percent of the wells) and the dominant anion was chloride (89 percent). No dominant anion was found in 11 percent of the wells.

Chloride

The median concentration of chloride in water samples from wells screened in the upper, middle, and lower aquifers was 14, 14, and 400 mg/L, respectively. In the upper aquifer, chloride concentrations ranged from 1.7 to 130 mg/L. The lowest values (less than 10 mg/L) were found in the southern part of the study area; a slight increase in concentrations was seen toward the northern part of the Logan Township region. Elevated chloride concentrations (greater than 50 mg/L) were found in East Greenwich Township and near Birch Creek in the northwestern part of Logan Township, (pl. 8b).

Chloride-concentration values for samples collected from both the middle aquifer and the area where the middle and lower aquifers are undifferentiated are plotted on plate 9a. In the middle aquifer, chloride concentrations ranged from 4.3 to 210 mg/L. Because no significant difference was found among the chloride-concentration values for samples taken from the upper and lower parts of the middle aquifer, the chloride concentration shown on plate 9a represent samples from both parts.

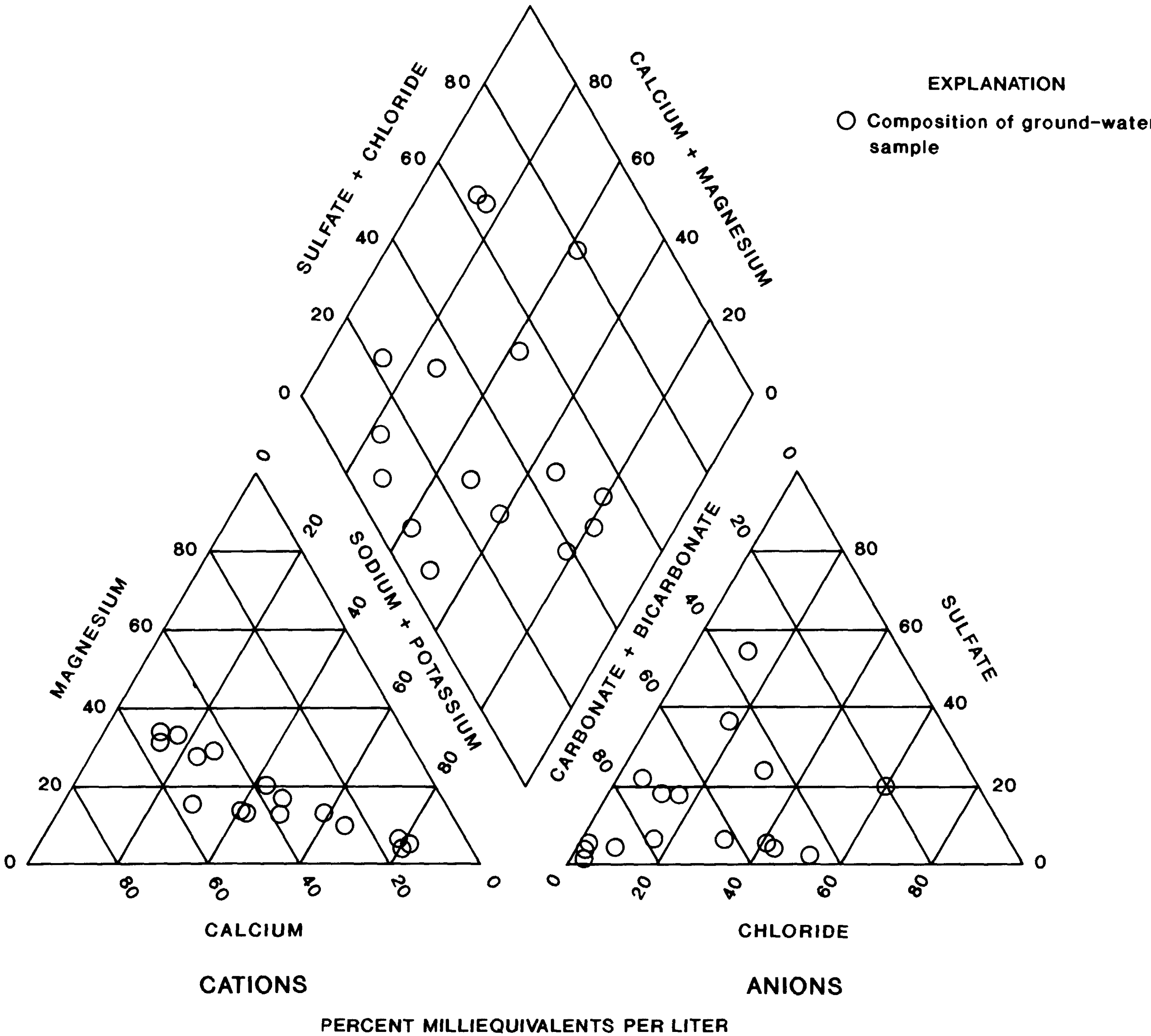

Figure 8a.--Major-ion chemistry of water in the upper aquifer of the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey.

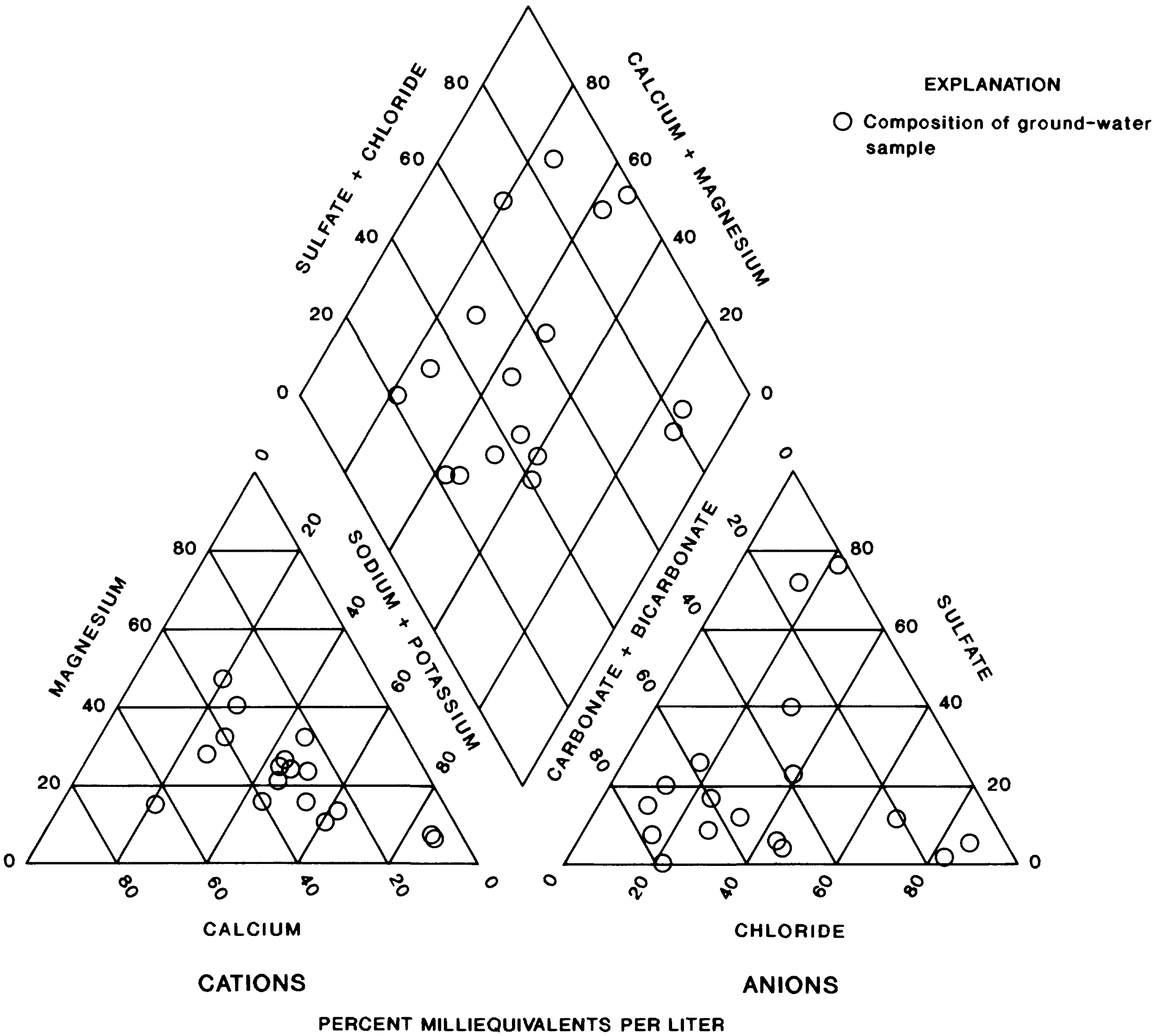

Figure 8b.--Major-ion chemistry of water in the middle aquifer of the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey.

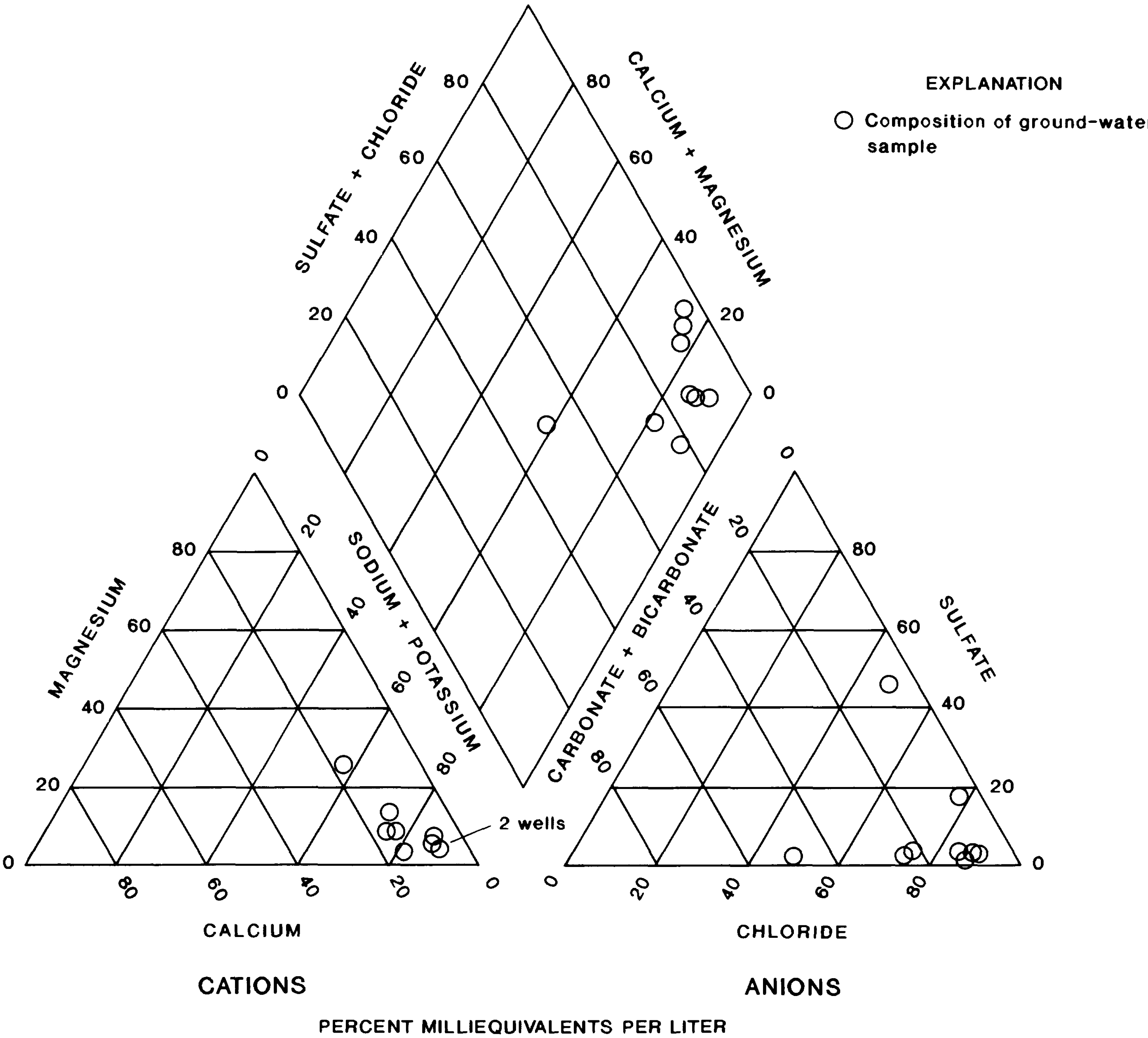

Figure 8c.--Major-ion chemistry of water in the lower aquifer of the Potomac-Raritan-Magothy aquifer system in the Logan Township region, New Jersey.

Throughout most of the study area, chloride concentrations in samples from the middle aquifer were less than 50 mg/L. In the northwestern part of the study area, samples from two wells screened in the middle aquifer contained 81 and 210 mg/L chloride.

In water from the area where the middle and lower aquifers are undifferentiated, the chloride concentration ranged from 160 to 350 mg/L (pl. 9a). These chloride-concentration values are generally higher than those for the middle aquifer, probably because of mixing of water from the lower aquifer with water from the middle aquifer. Mixing probably is facilitated by industrial pumpage in the area. The chloride concentration in samples from well 15-158 (in the undifferentiated area) increased from 77 mg/L shortly after pumpage began in 1961 to 240 mg/L 3 1/2 years later. A similar increase was noted in well 15-159, also in the undifferentiated area (Geraghty and Miller, 1965, p. 4). The increase in chloride concentration through time in these wells probably was caused by upconing of chloride-rich water from the lower part of the undifferentiated aquifer.

Concentrations of chloride in samples from the lower aquifer (pl. 9b) are one to two orders of magnitude higher than those in samples from the upper and middle aquifers. Concentrations of chloride exceeded the secondary drinking-water regulation of 250 mg/L (U.S. Environmental Protection Agency, 1988c) in water from seven of the nine wells sampled in the lower aquifer. Chloride concentrations in the lower aquifer increase downdip, from 110 mg/L in the northwestern part of the region to 820 mg/L in the southeastern part.

Historical chloride-concentration data for water samples from wells in the region is sparse. Based on data for 1958-88 for wells 15-144 and 15-166 (fig. 9), chloride concentrations have remained nearly constant in the middle aquifer in southeastern Logan Township and Bridgeport. However, chloride concentrations in samples from well 33-83, in Oldmans Township, increased from 4.8 mg/L in 1980 to 24 mg/L in 1987 (fig. 9). The reason for the increased chloride concentration at this well site is unknown. Based on limited historical chloride-concentration data for samples collected from 1979-86 at well 33-86 (fig. 9), chloride concentrations appear to have been relatively stable in the lower aquifer in the Pedricktown area since 1979.

Iron

Concentrations of iron in water from the Potomac-Raritan-Magothy aquifer system in the Logan Township region commonly exceeded the secondary drinking-water regulation of 300 μg/L (micrograms per liter): iron exceeded the regulation in water from 36 of 45 wells sampled in the upper and middle aquifers, and 8 of 9 wells sampled in the lower aquifer (pl. 10a-11). The median concentration of iron in water samples from wells screened in the upper, middle, and lower aquifers was 750, 2,600, and 6,700 μg/L, respectively.

Iron is an essential element for metabolism in animals and plants. If present in excessive amounts, however, it forms red oxyhydroxide precipitates that stain laundry and plumbing fixtures (Hem, 1985, p. 77). Previous work shows that iron in concentrations exceeding the USEPA secondary drinking-water regulation in ground water is prevalent in this

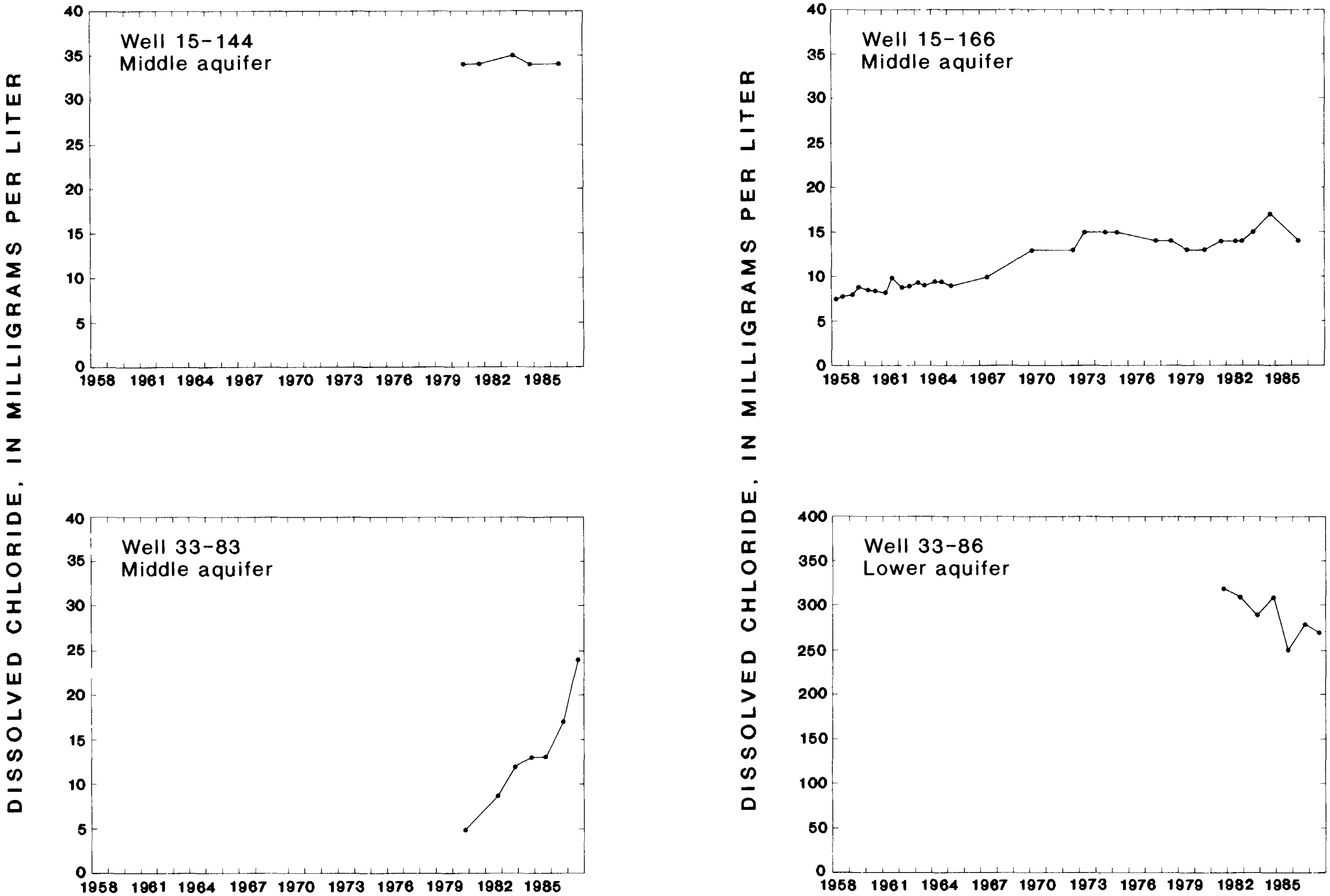

Figure 9.--Changes in concentration of dissolved chloride through time in water samples from selected wells in the Logan Township region, New Jersey.

aquifer system throughout Logan Township (C. Barton, U.S. Geological Survey, written commun., 1989) and New Jersey (Barksdale and others, 1958, p. 98; Langmuir, 1969a, 1969b; Fusillo and others, 1984, p. 13; Harriman and Sargent, 1985, p. 27). High concentrations of iron in ground water in the aquifer system in the study area, as well as throughout New Jersey, are associated with pH values less than 7 and concentrations of dissolved oxygen less than 1 mg/L (Langmuir, 1969a, p. 20). These conditions generally are present where the aquifer is confined within a few miles from the outcrop.

Relation of Water Quality to Drinking-Water Regulations

Ambient water in the upper and middle aquifers of the Potomac-Raritan-Magothy aquifer system generally is of satisfactory quality for human consumption and most other uses. High chloride concentrations in the lower aquifer generally render the water unpotable. Table 14 lists primary and secondary drinking-water regulations established by the USEPA and the NJDEP. Concentrations of metals exceeded USEPA and NJDEP primary regulations in water from well 15-348, screened in the middle aquifer, which contained 19 μg/L cadmium. Concentrations of POCs exceeded USEPA and NJDEP primary regulations in water from well 15-453, screened in the middle aquifer, which contained 43 μg/L methylene chloride, 850 μg/L xylene, and 1,163 μg/L total POCs; and well 15-347, also screened in the middle aquifer, which contained 2.6 μg/L of trichloroethylene. Water from all nine wells sampled in the lower aquifer were within USEPA and NJDEP drinking-water regulations with respect to metals and POCs. Samples collected from five wells in the upper aquifer and five wells in the middle aquifer were analyzed for selected herbicides and pesticides. All of those samples were within primary drinking-water regulations set by the USEPA and NJDEP for pesticides and herbicides (tables 12 and 14).

The concentration of nitrate plus nitrite exceeded the USEPA and NJDEP primary drinking-water regulations in water from four wells. Three of those wells are screened in the upper aquifer (wells 15-564, 15-626, and 33-439) and one is screened in the middle aquifer (well 15-453). The maximum concentration of nitrate plus nitrite detected was 22 mg/L in well 33-439. The median concentration of nitrate plus nitrite in water samples from wells screened in the upper, middle, and lower aquifers of the Potomac-Raritan-Magothy aquifer system was 0.02, 0.02, and less than 0.1 mg/L (detection limit), respectively. The primary sources of nitrate and nitrite are anthropogenic: sewage, fertilizers, and farm manure. The four wells in which the concentration of nitrate plus nitrite in ground water exceeded the USEPA and NJDEP drinking-water regulations are in agricultural areas.

SUMMARY AND CONCLUSIONS

The Potomac-Raritan-Magothy aquifer system is the sole source of potable water and the predominant source of water used for industry and agriculture in the 95-mi^2 study area in and near Logan Township, Gloucester County, New Jersey. The study area is in the Atlantic Coastal Plain, which is characterized by Lower Cretaceous to Holocene unconsolidated sediments. The Potomac-Raritan-Magothy aquifer system consists of the oldest sediments of the New Jersey Coastal Plain. The aquifer system is underlain by metamorphic gneiss and schist of the Wissahickon Formation and overlain

Table 14.--Maximum concentrations of inorganic elements or compounds and organic compounds with drinking-water regulations in water from wells in the Logan Township region, New Jersey, 1980-87

[Drinking-water regulations and maximum concentrations in micrograms per liter, except where noted; maximum concentrations were determined using the most recent analysis for each consitutent; BD, concentration of the constituent is less than the detection limit; NR, recommended drinking-water standards have not been established; mg/L, milligrams per liter; USEPA, U.S. Environmental Protection Agency; NJDEP, New Jersey Department of Environmental Protection]

Element or compound	Drinking-water regulations: USEPA primary regulations[3]	NJDEP primary regulations[4]	USEPA secondary regulations[5]	Maximum concentrations[6]: Upper aquifer	Middle aquifer	Lower aquifer
Arsenic	50	50	NR	4	7	36
Barium	1,000	1,000	NR	140	140	370
Cadmium	10	10	NR	6	19(1)	6
Chromium (including hexavalent)	50	50	NR	30	10	10
Fluoride (mg/L)	4	2	2	0.3	0.2	0.9
Lead	50	50	NR	20	20	30
Mercury	2	2	NR	BD	BD	BD
Nitrate-nitrogen (mg/L)	10	10	NR	22(3)	18(1)	2.6
Selenium	10	10	NR	--	--	--
Silver	50	50	NR	--	--	--
Benzene	5	1	NR	BD	BD	0.3
Carbon tetrachloride	5	2	NR	BD	BD	BD
Chlorobenzene	NR	4	NR	BD	BD	1.4
Methylene Chloride	NR	2	NR	BD	43(1)	BD
Tetrachloroethylene	NR	1	NR	BD	BD	.2
Trichloroethylene	5	1	NR	BD	2.6(1)	BD
Trihalomethanes[1]	100	100	NR	BD	.2	.2
Vinyl chloride	2	2	NR	BD	BD	BD
Xylene(s)	NR	44	10	BD	850(1)	BD
1,1-Dichloroethylene	7	2	NR	BD	BD	BD
1,1,1-Trichloroethane	200	26	NR	4.2	.4	BD
1,2-Dichloroethane	5	2	NR	BD	BD	.8
1-2-Cis and trans dichloroethene	NR	10	NR	BD	BD	BD
1,2-Dichlorobenzene	NR	600	NR	BD	BD	BD
1,3-Dichlorobenzene	NR	600	NR	BD	BD	BD
1,4-Dichlorobenzene	75	75	NR	BD	BD	BD
1,2,4-Trichlorobenzene	NR	8	NR	--	--	--
Total purgeable organic compound--maximum concentration for a single well[2]	NR	50	NR	4.2	1,163(1)	.4
Chlordane	NR	0.5	NR	BD	BD	--
Endrin	0.2	.2	NR	BD	BD	--
Lindane	4	4	NR	BD	BD	--
Methoxychlor	100	100	NR	BD	BD	--
PCB's (polychlorinated biphenyls) (total)	NR	.5	NR	BD	BD	--
Silvex	10	10	NR	BD	BD	--
Toxaphene	5	5	NR	BD	BD	--
2,4-D	100	100	NR	BD	BD	--
Chloride (mg/L)	NR	NR	250	130	210	820(7)
Copper	NR	NR	1,000	50	20	BD
Iron	NR	NR	300	25,000(16)	21,000(20)	73,000(8)
Manganese	NR	NR	50	1,000(8)	500(21)	1,100(7)
Sulfate (mg/L)	NR	NR	250	75	62	660(1)
Solids (dissolved) (mg/L)	NR	NR	500	410	370	1,900(7)
Zinc	NR	NR	5,000	76	3,700	87

1 Trihalomethanes include bromoform, chloroform, dibromochloromethane, and dichlorobromomethane. The 100 µg/L regulation applies to the total concentration of these constituents in a sample.

2 The number of purgeable organic compounds analyzed for in water samples is variable.

3 USEPA Primary Drinking-Water Regulations. Constituents covered by these regulations have been determined to be harmful to public health (U.S. Environmental Protection Agency, 1988a, 1988b).

4 NJDEP Primary Drinking-Water Regulations. Constituents covered by these regulations have been determined to be harmful to public health (New Jersey Register, 1989)

5 USEPA Secondary Drinking-Water Regulations. These regulations are for esthetic qualitites of water such as taste and odor (U.S. Environmental Protection Agency, 1988c.)

6 Numbers in parentheses indicate the number of samples in which applicable drinking-water regulations were exceeded.

either by the Merchantville Formation or by a generally thin layer of upper Cenozoic sand, gravel, silt, or clay.

In the southeastern part of the Logan Township region, the Potomac-Raritan-Magothy aquifer system is overlain by the Merchantville-Woodbury confining unit. In the northwestern part of the study area, the Potomac-Raritan-Magothy aquifer system is overlain by a heterogeneous, discontinuous layer of upper Cenozoic clay, silt, sand, gravel, and boulders. Near the Delaware River, these deposits are composed primarily of clay and silt and are up to 100 ft thick. Farther southeast, the upper Cenozoic deposits are composed primarily of sand, gravel, and boulders, and are in direct hydraulic connection with the aquifers of the Potomac-Raritan-Magothy aquifer system.

Laboratory tests to determine the vertical hydraulic conductivity of two samples of the Merchantville-Woodbury confining unit indicated values of 6.80×10^{-4} and 7.06×10^{-3} ft/d. The unit crops out in a belt about 2 mi wide and dips to the southeast. The unit's upper surface reaches a maximum depth of about 230 ft in the southeastern corner of the study area. The thickness of the unit ranges from 0 to 120 ft. In parts of the study area, the Merchantville-Woodbury confining unit is undifferentiable from the overlying Englishtown aquifer system and the Marshalltown-Wenonah confining unit.

Throughout the Coastal Plain, the Potomac-Raritan-Magothy aquifer system has been divided into five hydrogeologic units--the upper aquifer, the middle aquifer, the lower aquifer, and the confining units between these aquifers. In parts of the Logan Township region, the middle aquifer has been divided into upper and lower parts with an intervening confining unit.

The upper aquifer of the Potomac-Raritan-Magothy aquifer system consists of sand and silt with clayey layers and lenses. It crops out over a large part of the study area and dips to the southeast. The aquifer's upper surface reaches a maximum depth below land surface of about 350 ft in the southeast corner of the study area. The thickness of the aquifer ranges from about 0 to 90 ft. The median hydraulic conductivity of the aquifer is about 114 ft/d, based on specific-capacity data from eight wells.

The confining unit between the upper and middle aquifers consists of interbedded, discontinuous beds of clay, silt, and sand. Consequently, this unit is leaky in many parts of the study area and is absent in other parts. In the study area, the unit crops out in a narrow (about 0.5-mi wide) band and dips to the southeast. The unit's upper surface reaches a maximum depth below land surface of about 390 ft in the southeast corner of the study area. Its thickness generally ranges from about 5 to 85 ft. In many parts of the study area, however, the clay beds are less than 5 ft thick, and, in isolated locations, the unit is not present at all.

The middle aquifer consists primarily of medium to coarse quartzose sand and gravel with a few interbedded layers of silty clay. It crops out in a narrow band parallel to the Delaware River, and dips to the southeast. The aquifer's upper surface reaches a maximum depth below land surface of about 450 ft in the southeastern corner of the study area. The median hydraulic conductivity of the aquifer is about 103 ft/d, based on specific-capacity data from 27 wells. In much of the study area, the middle aquifer is divided into two parts by a confining unit that generally is less than 40 ft thick.

The confining unit between the middle and lower aquifers consists primarily of silty clay with some interbedded clayey silt and sand. Its thickness ranges from less than 20 to 180 ft. The unit crops out in a band generally less than 7,000 ft wide and dips to the southeast. Its upper surface reaches a maximum depth below land surface of about 650 ft in the southeastern corner of the study area. The unit is absent in an area adjacent to the Delaware River at the Monsanto Company property.

The lower aquifer consists primarily of sand, gravel, and interbedded silty clay. It crops out along a narrow band adjacent to and beneath the Delaware River and dips to the southeast. The upper surface of the aquifer reaches a maximum depth below land surface of about 830 ft in the southeastern corner of the study area. The thickness of the aquifer ranges from less than 20 to about 220 ft. The median hydraulic conductivity of the lower aquifer is about 88 ft/d, based on specific-capacity data from 14 wells.

The bedrock confining unit consists of nearly impermeable metamorphic gniess and schist. Along the Delaware River, it directly underlies the clay, silt, and sand of the upper Cenozoic deposits; throughout the rest of the study area, it underlies the lower aquifer of the Potomac-Raritan-Magothy aquifer system. The top of the unit is about 50 ft below the surface of the Delaware River and attains a maximum depth of about 1,050 ft below land surface in the southeastern corner of the study area.

In 1985, approximately 7.1 Mgal/d of water was pumped from the Potomac-Raritan-Magothy aquifer system in the study area. That year, most of the pumpage (about 64 percent) was for industrial use and seasonal variation in pumpage rates was small. The highest reported average yearly pumpage was 11.9 Mgal/d in 1969. After 1969, pumpage rates in the region declined.

Long-term records of water levels in wells screened in the upper and middle aquifers of the Potomac-Raritan-Magothy aquifer system generally declined until the late 1960's and rose thereafter. The water level in a well screened in the lower aquifer has declined since 1959, but the decline has been less rapid since 1966.

The potentiometric surfaces of all three aquifers of the Potomac-Raritan-Magothy aquifer system in the Logan Township region suggest that ground water flows to the southeast toward a regional cone of depression centered in northern Camden County. Pumpage by Woodstown and by industries in Greenwich, Logan, and Oldmans Townships have created small, localized cones of depression in the middle and lower aquifers.

The vertical distribution of water levels in the Potomac-Raritan-Magothy aquifer system in the study area indicates that water moves downward from the upper aquifer toward the lower aquifer. A relatively small head difference (generally about 0.25 to 1.0 ft) between the upper and middle aquifers probably reflects the leaky nature of the confining unit between these aquifers. The relatively large head difference between the middle and lower aquifers (generally 7 to 9 ft) reflects the thick and continuous nature of the confining unit between these aquifers.

Recharge to the aquifers in the study area is primarily by precipitation in the outcrop areas and by downward leakage from the upper to the middle aquifer. Ground water also flows laterally into the study area from the west. Little potential exists for significant induced recharge from the Delaware River because thick alluvial deposits of silt and clay separate the aquifers from the river. Discharge from the aquifers is primarily by lateral flow out of the study area to the south, southeast, and east; by pumpage; and, in outcrop areas, by evapotranspiration and discharge to streams.

Ambient ground-water quality in the Potomac-Raritan-Magothy aquifer system was characterized from the results of recent analyses (1980-87) of water samples from 58 wells. Samples were considered to be representative of ambient conditions because all wells are either beyond the probable extent of contaminant plumes emanating from industrial or hazardous-waste-disposal sites, or are screened in an aquifer isolated from known or potential ground-water contamination. Water samples were analyzed for physical properties, common ions, trace elements, purgeable organic compounds, and pesticides and herbicides. Analysis of results of quality-control samples indicates that laboratory precision and accuracy are within limits suggested by Skougstad and others (1979) and Feltz and others (1985).

Water is similar in the upper and middle aquifers in terms of major dissolved ionic constituents. The dominant cation in samples from 45 percent of the wells in the upper and middle aquifers was either sodium or calcium; samples from the other 55 percent of these wells contained no dominant cation. The dominant anion in the upper and middle aquifers generally was bicarbonate (61 percent of the wells). In samples from all but one of the wells screened in the lower aquifer, sodium was the dominant cation and chloride was the dominant anion. The median concentration of dissolved solids in the upper, middle, and lower aquifers was 150, 82, and 820 mg/L, respectively.

The median concentration of chloride in water samples from wells screened in the upper, middle, and lower aquifers was 14, 14, and 400 mg/L, respectively. Chloride concentrations were elevated (81 to 210 mg/L) in wells screened in the middle aquifer in northwestern Logan Township, in wells screened in the lower aquifer (110 to 820 mg/L), and in wells screened in the area where the middle and lower aquifers are undifferentiated. In the undifferentiated aquifer, the elevated chloride concentrations probably are caused by mixing of water from the middle and lower aquifers facilitated by industrial pumpage.

Ambient water in the upper and middle aquifers generally is of satisfactory quality for human consumption and most other uses; the lower aquifer is slightly saline. Primary drinking-water regulations set by the U.S. Environmental Protection Agency were exceeded in samples from six wells for one or more of the following constituents: cadmium, trichloroethylene, methylene chloride, xylene, total purgeable organic compounds, and nitrate plus nitrite. The concentration of dissolved iron exceeded the USEPA secondary drinking-water regulation in water from 36 of the 45 wells sampled in the upper and middle aquifers. In water from seven of the nine wells sampled in the lower aquifer, concentrations of chloride and iron exceeded USEPA secondary drinking-water regulations.

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GLOSSARY

Altitude. As used in this report, "altitude" refers to the distance above or below sea level.

Aquifer. A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Cone of depression. A depression in the water table or other potentiometric surface produced by the withdrawal of water from an aquifer; it is shaped like an inverted cone with its apex at the area of greatest pumpage.

Confining unit. A body of less permeable material stratigraphically adjacent to one or more aquifers. The hydraulic conductivity of a confining unit may range from nearly zero to some value significantly lower than that of the aquifer.

Dip. The angle at which a stratum or any planar feature is inclined from the horizontal. The dip is at a right angle to the strike.

Discharge. The process by which water is removed from an aquifer.

Dissolved. Chemical constituents in a water sample that pass through a 0.45-micrometer membrane filter. This is a convenient operational definition used by Federal agencies that collect water data. Determinations of "dissolved" constituents are made on subsamples of the filtrate.

Evaporation. The process by which water passes from the liquid to the vapor state.

Evapotranspiration. The sum of evaporation and transpiration.

Ground water. Water saturating soil, unconsolidated deposits, or bedrock beneath the land surface.

Ground water, confined. Water under pressure significantly greater than atmospheric. Its upper limit is the bottom of a unit with distinctly lower hydraulic conductivity than that of the material in which the confined water occurs. "Artesian" is synonymous with confined.

Head, static. The height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point. Head, when used alone, is understood to mean static head.

Hydraulic conductivity. The capacity of soil, unconsolidated deposits, and rock to transmit water. For an isotropic medium, it is expressed as the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

Isotropy. That condition in which all significant properties are independent of direction.

Lithology. The physical character of a rock, generally as determined macroscopically or with the aid of a low-power magnifier.

Micrograms per liter (µg/L). A unit expressing the concentration of chemical constituents in solution as the mass (microgram = 1 x 10^{-6} gram) of solute per unit volume (liter) of water. One µg/L is approximately equal to 1 part per billion (ppb) in aqueous solutions of low dissolved-solids concentration.

Milliequivalent. A number computed by multiplying the reported concentration of an individual ion, in milligrams per liter, by the valence charge of the ion and then dividing the result by the formula weight of the ion in grams.

Milligrams per liter (mg/L). A unit expressing the concentration of chemical constituents in solution as the mass (milligram) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter. For water containing less than 7,000 mg/L dissolved solids, the numerical value for milligrams per liter of a constituent is the same as for concentrations in parts per million (ppm).

Minimum detection limit. For a given type of sample and analytical procedure, the concentration value below which the presence of the constituent being analyzed can be neither verified nor denied. Minimum detection limits can be identified in the tables of this report by a "less-than" (<) symbol preceding a numerical value. The reported minimum detection limit can vary from analysis to analysis for any single constituent.

Organic compounds, purgeable (USEPA priority pollutants). A group of 31 organic compounds which, because of their purgeable nature, can be stripped as a vapor from a water sample by the injection of an inert gas prior to analysis by gas chromatography (GC). Two compounds (acrolein and acrylonitrile) of this group remain in the water sample after vapor stripping. These two compounds are determined by direct aqueous injection GC-mass spectroscopy (MS). As a group, these 31 compounds are of lower molecular weight than acid- or base/neutral-extractable compounds, and commonly have higher vapor pressures. Their boiling points are below 150 degrees Celsius.

Outcrop. As used in this report, outcrop areas are defined as areas where a geologic or hydrogeologic unit is exposed at land surface or is covered by only upper Cenozoic deposits.

Potentiometric surface. A surface that represents the static head in an aquifer. The potentiometric surface is defined by the levels to which water will rise in tightly cased wells. See head, static.

Recharge. The process by which water is added to an aquifer.

Sea level. In this report, "sea level" refers to the the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Specific conductance. A measure of the capacity of a water to conduct an electrical current, expressed in microsiemens per centimeter at 25 degrees Celsius.

Strike. The course or bearing of the outcrop of an inclined bed or structure on a level surface; the direction or bearing of a horizontal line in the plane of an inclined stratum, joint, fault, cleavage plane, or other structural plane. It is perpendicular to the direction of the dip. A horizontal bed or structure has zero strike.

Transmissivity. The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It equals the hydraulic conductivity multiplied by the aquifer thickness.

Transpiration. The process by which plants give off water vapor through their leaves.

Water table. The level in the saturated zone at which the pressure is equal to the atmospheric pressure. An unconfined aquifer and a water-table aquifer are one in the same.

(p. 64 follows)

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey

[Location of wells shown on plate 1a; altitudes in feet above sea level, rounded to the nearest foot; --, no data available; depths of screened intervals rounded to nearest foot; USGS, U.S. Geological Survey;

Aquifer codes:
HPPM--undifferentiated Holocene, Pleistocene, Pliocene and Miocene deposits
WBMV--Merchantville-Woodbury confining unit
MRPA--Potomac-Raritan-Magothy aquifer system
MRPAU--upper aquifer the of Potomac-Raritan-Magothy aquifer system
MRPAM--middle aquifer of the Potomac-Raritan-Magothy aquifer system
MRPAL--lower aquifer of the Potomac-Raritan-Magothy aquifer system
WSCK--Wissahickon gneiss;

Codes for available data:
H--Water-level hydrographs
L--Logs; used to determine the hydrogeologic framework (plates 1b-6 and table 3)
P--Pumpage data (table 5)
Q--Water-quality data (plates 8b-11 and tables 9-14)
S--Water-level data from June 1985 (plates 7a-8a and table 6)
W--Data from specific-capacity tests (table 4)]

USGS well number	Site identification number	New Jersey permit number	Owner	Local well number or name	Municipality
Gloucester County					
15- 64	394838075153801	30-00739	Greenwich T W D	Test Well 2-59	Greenwich Township
15- 65	394851075152601	30-00036	Greenwich T W D	GTWD 2(New 3)	Greenwich Township
15- 66	394857075153701	30-01002	Greenwich T W D	Test Well 1-63	Greenwich Township
15- 67	394900075165801	30-00738	Greenwich T W D	Test Well 1-58	Greenwich Township
15- 69	394919075160201	30-00757	Greenwich T W D	GTWD 3(New 4)	Greenwich Township
15- 70	394932075172201	--	Greenwich T W D	5/GTWD1 (New2)	Greenwich Township
15- 71	394933075174801	30-00031	E I Dupont	RR Turnabout	Greenwich Township
15- 72	394936075174701	30-00037	E I Dupont	Repauno 3	Greenwich Township
15- 73	394936075174702	30-00078	E I Dupont	Repauno Nitr 3	Greenwich Township
15- 75	394940075162901	30-00190	Hercules Chemical	Gibbstown Ob 4	Greenwich Township
15- 76	394940075170901	30-01224	Hercules Chemical	4 1970	Greenwich Township
15- 77	394944075171101	30-00033	E I Dupont	Gage Well 3	Greenwich Township
15- 79	394944075173401	30-01145	E I Dupont	Repauno 6	Greenwich Township
15- 80	394944075173501	--	E I Dupont	Repauno 2	Greenwich Township
15- 81	394945075171701	30-00907	E I Dupont	Repauno 5	Greenwich Township
15- 83	394948075163001	30-00189	Hercules Chemical	Gibbstown OB 3	Greenwich Township
15- 85	394948075163902	30-00186	Hercules Chemical	Gibbstown TH 2	Greenwich Township
15- 86	394948075163903	30-00318	Hercules Chemical	Gibbstown TH 5	Greenwich Township
15- 88	394952075163601	30-00316	Hercules Chemical	Gibbstown TH 7	Greenwich Township
15- 89	394952075165301	30-00230	Hercules Chemical	Gibbstown 1	Greenwich Township
15- 91	394952075173001	30-00024	E I Dupont	Repauno W	Greenwich Township
15- 92	394954075164201	30-00317	Hercules Chemical	Gibbstown TH 6	Greenwich Township
15- 93	394956075152101	30-00049	Mobil Oil Company	Mobil 46	Greenwich Township
15- 94	394958075151201	--	Mobil Oil Company	Mobil 44	Greenwich Township
15- 95	394958075154501	--	Mobil Oil Company	Mobil 43	Greenwich Township
15- 96	394959075165001	30-00188	Hercules Chemical	Gibbstown OB 2	Greenwich Township
15- 97	395000075163601	30-00315	Hercules Chemical	Gibbstown TH 8	Greenwich Township
15- 98	395005075152301	--	Mobil Oil Company	Mobil 45	Greenwich Township
15- 100	395009075170601	--	E I Dupont	Repauno OB 6	Greenwich Township
15- 101	395012075152001	--	Mobil Oil Company	Mobil 40	Greenwich Township
15- 103	395021075173001	--	E I Dupont	Repauno H	Greenwich Township
15- 104	395021075174001	--	E I Dupont	Repauno J	Greenwich Township
15- 107	395025075175701	--	E I Dupont	Repauno C	Greenwich Township
15- 109	395027075150301	--	Mobil Oil Company	Mobil 41	Greenwich Township
15- 117	395033075181401	--	E I Dupont	Cavern 9 Test	Greenwich Township
15- 118	395036075150101	30-00198	Mobil Oil Company	Mobil 47	Greenwich Township
15- 133	394510075224401	30-01222	Pureland Water Co.	Test Well 1	Logan Township
15- 134	394510075224402	--	Pureland Water Co.	Test Well 2	Logan Township
15- 135	394516075224101	30-01314	Shell Oil Co.	Obs Well 8A	Logan Township
15- 136	394524075224601	30-01308	Shell Oil Co.	Test Well 10 B	Logan Township

USGS well number	Year of construction	Latitude (degrees)	Longitude (degrees)	Altitude of land surface (feet)	Screened interval (feet below land surface) Top	Bottom	Diameter of screen (inches)	Aquifer code	Available data
Gloucester County									
15- 64	1959	394857	751537	10	238	248	6.0	MRPAL	L
15- 65	1950	394851	751526	20	69	98	15.0	MRPAU	W
15- 66	1963	394844	751629	0	200	210	6.0	MRPA [1]	L
15- 67	1958	394900	751658	5	157	172	6.0	MRPAM	L
15- 69	1959	394920	751619	10	108	168	12.0	MRPAM	L,P,W
15- 70	1944	394932	751722	10	76	96	16.0	MRPAM	L,W
15- 71	1949	394933	751748	1	89	99	6.0	MRPAM	L,W
15- 72	1950	394936	751747	6	91	101	12.0	MRPAM	L,P,W
15- 73	1951	394936	751747	0	67	87	10.0	MRPAM	L,W
15- 75	1953	394940	751629	14	98	106	3.0	MRPAM	L
15- 76	1970	394939	751704	15	90	120	10.0	MRPAM	L,P,S
15- 77	1949	394944	751711	9	88	97	6.0	MRPAM	L,W
15- 79	1967	394944	751734	10	84	109	12.0	MRPAM	L,W
15- 80	1945	394944	751735	11	89	105	13.6	MRPAM	W
15- 81	1965	394945	751717	10	81	99	8.0	MRPAM	L
15- 83	1953	394948	751630	15	117	125	3.0	MRPAM	L
15- 85	1953	394948	751639	12	(Test hole)			MRPAL	L
15- 86	1954	394948	751639	11	107	112	3.0	MRPAM	L
15- 88	1954	394952	751636	13	96	102	3.0	MRPAM	L
15- 89	1954	394952	751653	10	78	98	10.0	MRPAM	L
15- 91	1949	394952	751730	10	84	103	8.0	MRPAL	L,W
15- 92	1954	394954	751642	4	107	113	3.0	MRPAM	L
15- 93	1950	394956	751521	6	111	136	12.0	MRPAM	L,W
15- 94	1947	394958	751512	7	116	136	16.0	MRPAM	L
15- 95	1947	394954	751531	5	129	139	16.0	MRPAM	L
15- 96	1953	394959	751650	14	129	134	3.0	MRPAM	L,S
15- 97	1954	395000	751636	6	102	107	3.0	MRPAM	H,L,S
15- 98	1947	395006	751532	3	95	115	16.0	MRPAM	L
15- 100	1957	395009	751706	3	79	84	4.0	MRPAM	L
15- 101	1944	395012	751520	20	195	225	16.0	MRPAL	L
15- 103	1945	395021	751730	2	83	103	10.0	MRPAL	W
15- 104	1940	395021	751740	2	74	103	10.0	MRPAL	W
15- 107	1945	395025	751757	2	75	105	10.0	MRPAL	W
15- 109	1946	395027	751503	20	230	260	8.0	MRPAL	L, P
15- 117	1965	395033	751814	7	(Test hole)			WSCK	L
15- 118	1953	395036	751501	18	220	240	12.0	MRPAL	L,S
15- 133	1970	394510	752244	20	317	367	6.0	MRPAL	L,W
15- 134	1970	394510	752244	18	136	189	6.0	MRPAM	S,W
15- 135	1972	394516	752241	7	130	180	6.0	MRPAM	L,S,W
15- 136	1972	394524	752246	17	136	186	6.0	MRPAM	L,W

Footnotes at end of table.

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Site identification number	New Jersey permit number	Owner	Local well number or name	Municipality
Gloucester County--Continued					
15- 137	394535075205401	30-01371	Pureland Water Co.	Pure 2(3-1973)	Logan Township
15- 138	394553075214801	--	Musumeci, Frank	1	Logan Township
15- 139	394606075213301	30-01223	Pureland Water Co.	Test Well 3	Logan Township
15- 140	394606075213302	30-01248	Pureland Water Co.	Test Well 4	Logan Township
15- 141	394606075213303	30-01243	Pureland Water Co.	Obs 1 (1970)	Logan Township
15- 142	394607075223801	30-01312	Pureland Water Co.	Test Well 5	Logan Township
15- 143	394607075223802	--	Pureland Water Co.	Landtect TW-6C	Logan Township
15- 144	394611075212001	30-01370	Pureland Water Co.	1-1973	Logan Township
15- 146	394648075231801	--	Pureland Water Co.	Landtect TW-9	Logan Township
15- 147	394706075195101	--	Shoemaker, R A	1	Logan Township
15- 148	394708075234101	--	Pureland Water Co.	Test Well 8	Logan Township
15- 154	394715075204801	30-01181	Rollins Env Services	1	Logan Township
15- 156	394716075235801	30-00800	Monsanto Chem	Test 4	Logan Township
15- 157	394728075221901	--	Pureland Water Co.	Test Well 7	Logan Township
15- 158	394733075235101	30-00873	Monsanto Chem	Bridgeport W2	Logan Township
15- 159	394736075234401	30-00872	Monsanto Chem	Bridgeport E1	Logan Township
15- 160	394742075220801	30-00796	Monsanto Chem	Test 2	Logan Township
15- 161	394737075272201	30-00801	Monsanto Chem	Ob1(TW5-ObC)	Logan Township
15- 162	394743075232501	30-00799	Monsanto Chem	Test 3	Logan Township
15- 163	394747075241001	30-00795	Monsanto Chem	Ob3(TW1-Oba)	Logan Township
15- 165	394755075210801	--	Penns Grove WSC	Bridgeport 1	Logan Township
15- 166	394755075210802	30-00410	Penns Grove WSC	Bridgeport 2	Logan Township
15- 167	394757075233001	30-01170	Monsanto Chem	Monsanto 1	Logan Township
15- 170	394848075191301	30-01220	Camden Lime Company	Repaup 1	Logan Township
15- 171	394900075214500	30-01295	American Dredging Co	Raccoon Is T11	Logan Township
15- 172	394900075214501	30-01284	American Dredging Co	Raccoon Is T 3	Logan Township
15- 173	394900075214502	30-01290	American Dredging Co	Raccoon Is T 8	Logan Township
15- 174	394900075214503	30-01291	American Dredging Co	Raccoon Is T 9	Logan Township
15- 175	394900075214504	30-01277	American Dredging Co	Raccoon Is T 1	Logan Township
15- 176	394900075214505	30-01278	American Dredging Co	Raccoon Is T 2	Logan Township
15- 177	394900075214506	30-01285	American Dredging Co	Raccoon Is T 4	Logan Township
15- 178	394900075214507	30-01286	American Dredging Co	Raccoon Is T 5	Logan Township
15- 179	394900075214508	30-01289	American Dredging Co	Raccoon Is T 7	Logan Township
15- 180	394900075214509	30-01294	American Dredging Co	Raccoon Is T10	Logan Township
15- 181	394913075215301	30-01288	American Dredging Co	Raccoon Is T 6	Logan Township
15- 236	394434075184301	30-01177	Swedesboro B WD	SBWD 3	Swedesboro Borough
15- 237	394437075183501	--	Swedesboro B WD	SBWD 1	Swedesboro Borough
15- 240	394510075183802	--	Del Monte Corp	9	Swedesboro Borough
15- 337	394346075211001	30-00431	Maugeri, Sal	Maugeri S1	Woolwich Township
15- 338	394348075211001	--	Maugeri, Joseph	Maugeri J1	Woolwich Township
15- 339	394350075191001	30-01161	Grasso, J S	1	Woolwich Township
15- 340	394356075214301	--	Catalano, Frank	1	Woolwich Township
15- 341	394420075164701	--	Butler, Walter H	1	Woolwich Township
15- 342	394438075191401	30-01104	Del Monte Corp	10	Woolwich Township
15- 345	394642075182301	--	Musumeci, Peter	1	Woolwich Township
15- 347	394932075172202	30-01545	Greenwich T W D	GTWD 5 (2-A)	Greenwich Township
15- 348	394920075154101	30-01776	Greenwich T W D	GTWD 6	Greenwich Township
15- 349	394650075231601	--	Pureland Water Co	Landtect 2	Logan Township
15- 350	394550075231301	--	Pureland Water Co	Obs 1 (1973)	Logan Township
15- 353	394649075231601	--	Pureland Water Co	Landtect 3	Logan Township
15- 363	394618075154201	30-00817	Sherman, A	1	East Greenwich Township
15- 366	394620075150701	30-01736	Cianciulli, Tim	1	East Greenwich Township
15- 391	395020075154001	--	Sacony Van Oil	No-12 1950	Greenwich Township
15- 392	394527075160701	30-01015	NJ Turnpike Auth.	1964-S-1	Woolwich Township
15- 394	394513075191301	30-01094	PMC Canning Company	Can-1-1966	Woolwich Township

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Year of construction	Latitude (degrees)	Longitude (degrees)	Altitude of land surface (feet)	Screened interval (feet below land surface) Top	Bottom	Diameter of screen (inches)	Aquifer code	Available data
Gloucester County--Continued									
15- 137	1973	394535	752054	29	158	208	12.0	MRPAM	L,P,Q
15- 138	1951	394553	752148	15	28	34	4.0	HPPM	L
15- 139	1970	394608	752135	7	301	345	6.0	MRPAL	H,L,Q,S,W
15- 140	1970	394608	752135	6	132	184	6.0	MRPAM	H,Q,S,W
15- 141	1970	394606	752133	0	128	185	4.0	MRPAM	L
15- 142	1970	394607	752238	20	223	265	6.0	MRPAL	L,W
15- 143	1970	394551	752313	19	102	152	6.0	MRPAM	H,Q,S
15- 144	1973	394613	752129	8	81	[2]136	6.0	MRPAM	L,P,Q,S
15- 146	1970	394648	752318	5	82	101	6.0	MRPAM	Q,S
15- 147	1954	394706	751951	18	33	39	4.0	MRPAU	S
15- 148	1970	394708	752341	5	(Test hole)			WSCK	L
15- 154	1970	394716	752113	10	66	96	6.0	MRPAM	L
15- 156	1960	394720	752350	10	(Test hole)			WSCK	L
15- 157	1970	394728	752219	5	103	123	6.0	MRPAM.	L
15- 158	1961	394733	752351	12	57	82	12.0	MRPA [4]	L,P
15- 159	1961	394736	752344	11	56	81	12.0	MRPA [4]	L,P,Q
15- 160	1960	394806	752250	10	(Test hole)			WSCK	L
15- 161	1960	394739	752232	8	70	90	6.0	MRPAM	L,Q,S
15- 162	1960	394743	752325	1	(Test hole)			WSCK	L
15- 163	1961	394747	752410	10	95	100	6.0	MRPA [4]	L,Q
15- 165	1930	394755	752108	5	30	40	8.0	MRPAM	W
15- 166	1955	394755	752108	5	65	85	6.0	MRPAM	L,P,Q
15- 167	1969	394726	752319	10	64	94	10.0	MRPAM	L,Q,W
15- 170	1970	394854	751906	10	86	106	8.0	MRPAM	L,S,W
15- 171	1972	394817	752107	5	61	81	6.0	MRPAM	L,W
15- 172	1972	394851	752242	5	(Test hole)			WSCK	L
15- 173	1972	394836	752124	5	113	160	6.0	MRPAL	L,W
15- 174	1972	394836	752124	5	42	72	6.0	MRPAM	W
15- 175	1972	394858	752225	8	100	120	6.0	MRPAL	L,W
15- 176	1972	394840	752145	5	97	137	6.0	MRPAL	L,W
15- 177	1972	394833	752207	5	90	130	6.0	MRPAL	L,W
15- 178	1972	394840	752145	9	50	70	6.0	MRPAM	S,W
15- 179	1973	394839	752135	5	52	72	6.0	MRPAM	L
15- 180	1972	394822	752125	5	48	58	6.0	MRPAM	L
15- 181	1972	394839	752135	5	106	126	6.0	MRPAL	L,W
15- 236	1969	394434	751843	75	241	312	12.0	MRPAM	L,P,Q,W
15- 237	1933	394437	751835	35	174	[2]220	12.0	MRPAU	W
15- 240	1963	394510	751838	32	190	231	10.0	MRPAU	Q,S,W
15- 337	1955	394346	752110	48	128	148	6.0	MRPAU	L,Q
15- 338	----	394348	752110	60	159	--[3]	--	MRPAU	P
15- 339	1969	394350	751910	90	247	267	7.5	MRPAU	L,S,W
15- 340	1954	394356	752143	50	108	114	4.0	MRPAU	Q
15- 341	1955	394420	751647	60	222	228	3.0	MRPAU	Q
15- 342	1967	394438	751914	60	192	279	12.0	MRPAU	L,Q,W
15- 345	1954	394642	751823	62	94	100	4.0	MRPAU	Q,S
15- 347	1977	394932	751722	20	82	117	12.0	MRPAM	P,Q
15- 348	1978	394910	751541	20	105	135	12.0	MRPAM	L,P,Q
15- 349	1973	394650	752316	6	170	220	6.0	MRPAL	L,Q,S
15- 350	1970	394550	752313	20	234	284	6.0	MRPAL	H,L,Q,S
15- 353	1973	394649	752316	6	8	18	6.0	MRPAU	Q,S
15- 363	1960	394618	751542	40	145	151	3.8	MRPAU	L,Q
15- 366	1978	394620	751507	80	209	219	3.0	MRPAU	L,Q
15- 391	1950	395020	751540	20	109	134	12.0	MRPAM	W
15- 392	1964	394527	751607	105	241	251	6.0	MRPAU	L,Q,W
15- 394	1966	394513	751913	30	124	149	10.0	MRPAU	L,P

Footnotes at end of table.

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Site identification number	New Jersey permit number	Owner	Local well number or name	Municipality
Gloucester County--Continued					
15- 395	394807075172701	30-01972	Repaupo Fire Co	30-1972	Logan Township
15- 398	394928075194101	30-02016	Pettit, Louis	419	Logan Township
15- 399	394900075191301	30-01616	Allied Energy	No-1 1977	Logan Township
15- 400	394620075234001	30-01311	Pureland Water Co.	Obs-6-B-72	Logan Township
15- 404	395033075175301	30-01026	E I Dupont	Testhole 1	Greenwich Township
15- 408	394913075162001	30-01106	Greenwich T W D	Test 1966	Greenwich Township
15- 409	394713075223301	30-01448	Logan Twp MUA	No-1-1975	Logan Township
15- 412	395033075174001	30-01031	E I Dupont	Test 4 1965	Greenwich Township
15- 417	394820075183301	31-14415	S & S Auctions	1-1978	Logan Township
15- 419	394713075231301	30-01310	Shell Oil Co.	Obs 6-A	Logan Township
15- 444	394737075224301	30-02032	Monsanto Chem	7D	Logan Township
15- 452	394803075180201	30-01778	Yarborough, Kenneth	8-61B	Logan Township
15- 453	394832075184601	30-01946	Gaventa, Al & Son	30-1946	Logan Township
15- 454	394630075200001	30-01830	Mulvenna, Joseph	30-1830	Logan Township
15- 455	394710075203401	30-02021	Briggs, Robert W	30-2021	Logan Township
15- 459	394800075201801	31-10640	True, H L	1	Logan Township
15- 462	394824075183401	30-02575	Meyers, Lou	611	Logan Township
15- 463	394752075175601	30-01586	Myers, Vernon	1	Logan Township
15- 466	394707075182801	31-14545	Lumpkin, John	1	Logan Township
15- 468	394838075185301	30-02293	Penn Jersey Concrete	1	Logan Township
15- 471	394636075162001	30-01652	Ricker, Charles	3-105	East Greenwich Township
15- 496	394651075163201	30-01774	Nelson, Robert	1	East Greenwich Township
15- 497	394715075153701	30-01872	Hughes, William	1	East Greenwich Township
15- 498	394702075155401	30-00342	Dehner, Lawrence A	1	East Greenwich Township
15- 499	394651075152101	30-01603	Ross, R H	1	East Greenwich Township
15- 501	394632075161401	30-01566	Henderson, Virginia	1	East Greenwich Township
15- 502	394730075163001	30-01517	Dehner, Lawrence A	2	East Greenwich Township
15- 503	394819075170201	30-01834	Morris, Edward A	1	Greenwich Township
15- 504	394814075171201	30-02066	Fehlauer, Albert	1	Greenwich Township
15- 507	395030075173002	30-01027	E I Dupont	TW 5	Greenwich Township
15- 511	394828075165601	30-01519	Fehlauer, Albert	2	Greenwich Township
15- 513	394843075160001	30-00990	Mills, Wilmer	1	Greenwich Township
15- 514	394925075174301	30-00970	Greenwich T W D	TW Station Rd	Greenwich Township
15- 516	394650075175201	30-01562	Zane, Larry	1	Woolwich Township
15- 518	394622075183601	30-01781	Emery, Walter	1	Woolwich Township
15- 519	394649075173801	30-01788	Miskofsky, Nicholas	1	Woolwich Township
15- 520	394625075171201	30-01766	DeVault, Stephen	1	East Greenwich Township
15- 523	394443075220601	30-01580	Marino, Russell	1	Woolwich Township
15- 524	394606075181001	30-01078	Musumeci, Frank	2	Woolwich Township
15- 525	394431075201401	30-00594	Casella Bros Inc	2	Woolwich Township
15- 526	394449075194001	30-01482	New Gloucester Comm	1	Woolwich Township
15- 527	394547075184101	30-01516	Musumeci, Anne	1	Woolwich Township
15- 528	394512075190401	30-02711	PMC Cannery Company	1	Woolwich Township
15- 530	394700075163001	30-01523	Davis, Joseph W	1	East Greenwich Township
15- 539	394752075190701	30-03067	US EPA-Swindell	S-6	Logan Township
15- 540	394800075193601	30-02621	US EPA	EPA 108	Logan Township
15- 546	394800075195001	30-02387	Chemical Leaman	CL2	Logan Township
15- 549	394757075194202	30-02423	Chemical Leaman	DW1	Logan Township
15- 550	394800075195002	30-02425	Chemical Leaman	DW2	Logan Township
15- 553	394815075192701	30-03070	US EPA-NJDOT	S-12	Logan Township
15- 564	394802075193301	30-03081	US EPA-Gaventa	S-9	Logan Township
15- 569	394529075204501	30-02405	Pureland Water Co.	PWC 3	Logan Township
15- 573	394715075205001	--	Rollins Env Services	U	Logan Township
15- 575	394719075210802	30-02511	Rollins Env Services	MA 11D	Logan Township
15- 582	394715075210603	30-02482	Rollins Env Services	MA 1D	Logan Township

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Year of construction	Latitude (degrees)	Longitude (degrees)	Altitude of land surface (feet)	Screened interval (feet below land surface) Top	Bottom	Diameter of screen (inches)	Aquifer code	Available data
Gloucester County--Continued									
15- 395	1979	394801	751759	20	93	113	6.0	MRPAM	L,Q,S
15- 398	1979	394935	751938	1	50	60	4.0	MRPAL	L,Q
15- 399	1977	394900	751913	10	71	91	10.0	MRPAM	L,Q
15- 400	1972	394534	752303	5	97	147	6.0	MRPAM	L
15- 404	1965	395033	751753	5	(Test hole)			MRPAL	L
15- 408	1966	394913	751620	5	130	140	6.0	MRPAM	L
15- 409	1975	394710	752240	20	50	[2]94	6.0	MRPAM	L,Q
15- 412	1965	395033	751740	5	(Test hole)			MRPAL	L
15- 417	1978	394814	751819	10	61	71	4.0	MRPAU	Q
15- 419	1972	394525	752257	7	134	164	4.0	MRPAM	L
15- 444	1979	394756	752344	16	65	70	4.0	MRPA [4]	L
15- 452	1978	394803	751802	20	70	80	3.0	MRPAU	L
15- 453	1979	394832	751846	10	51	61	4.0	MRPAM	L,Q
15- 454	1978	394630	752000	20	65	75	4.0	MRPAU	L
15- 455	1979	394710	752034	20	69	79	4.0	MRPAU	L
15- 459	1977	394800	752018	10	62	69	4.0	MRPAM	L
15- 462	1981	394824	751834	10	59	69	4.0	MRPAM	L
15- 463	1977	394752	751756	20	56	67	3.0	MRPAU	L
15- 466	1979	394707	751828	30	64	74	4.0	MRPAU	L
15- 468	1980	394838	751853	10	85	95	6.0	MRPAM	L
15- 471	1978	394636	751620	45	120	131	3.0	MRPAU	L
15- 496	1978	394651	751632	45	150	160	4.0	MRPAU	L
15- 497	1979	394715	751537	45	109	119	4.0	MRPAU	L
15- 498	1954	394702	751554	62	60	70	3.0	MRPAU	L
15- 499	1977	394651	751521	60	195	200	3.0	MRPAU	L
15- 501	1977	394632	751614	50	162	167	4.0	MRPAU	L,Q
15- 502	1977	394730	751630	30	63	70	4.0	MRPAU	L
15- 503	1978	394819	751702	5	48	58	4.0	MRPAU	L
15- 504	1979	394814	751712	5	51	61	4.0	MRPAU	L
15- 507	1965	395030	751730	5	(Test hole)			WSCK	L
15- 511	1977	394828	751656	10	40	47	4.0	MRPAU	L
15- 513	1963	394843	751600	15	38	43	3.7	MRPAU	L
15- 514	1963	394925	751743	10	162	173	6.0	MRPAL	L
15- 516	1978	394650	751752	40	112	122	4.0	MRPAU	L
15- 518	1978	394622	751836	65	110	115	4.0	MRPAU	L
15- 519	1978	394649	751738	35	75	87	3.0	MRPAU	L,Q
15- 520	1978	394625	751712	62	135	150	3.0	MRPAU	L
15- 523	1977	394443	752206	45	80	91	3.0	MRPAU	L
15- 524	1966	394606	751810	52	125	155	4.0	MRPAU	L
15- 525	1956	394431	752014	90	180	186	3.7	MRPAU	L
15- 526	1976	394449	751940	60	147	151	3.0	MRPAU	L
15- 527	1977	394547	751841	58	115	125	3.0	MRPAU	L
15- 528	1982	394512	751904	15	120	190	10.0	MRPAU	L
15- 530	1977	394700	751630	35	66	73	4.0	MRPAU	L
15- 539	1983	394751	751907	6	60	70	4.0	MRPAM	Q
15- 540	1982	394800	751936	7	87	97	4.0	MRPAM	H,Q,S
15- 546	1981	394758	751951	10	20	30	2.0	MRPAU	S
15- 549	1981	394757	751945	7	94	97	4.0	MRPA [5]	L,S
15- 550	1981	394758	751951	10	100	102	4.0	MRPAM	L,S
15- 553	1983	394815	751927	10	(Test hole)			MRPAM	L
15- 564	1983	394802	751933	7	42	52	4.0	MRPAU	H,Q,S
15- 569	1981	394529	752045	32	161	201	12.0	MRPAM	L,Q,S,W
15- 573	1976	394715	752050	22	20	22	--	MRPAU	S
15- 575	1981	394719	752108	1	45	55	1.2	MRPAM	L
15- 582	1981	394715	752106	2	57	67	1.2	MRPA [5]	L

Footnotes at end of table.

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Site identification number	New Jersey permit number	Owner	Local well number or name	Municipality
Gloucester County--Continued					
15- 585	394704075205801	30-02522	Rollins Env Services	DP5	Logan Township
15- 586	394720075205201	30-02539	Rollins Env Services	DP4	Logan Township
15- 597	394730075240601	30-02136	Monsanto Chem	28D	Logan Township
15- 609	394521075224501	--	Shell Oil Co	10A	Logan Township
15- 611	394719075235702	30-02125	Monsanto Chem	32D	Logan Township
15- 613	394705075205701	--	Rollins Env Services	T	Logan Township
15- 614	394718075205201	--	Rollins Env Services	W19	Logan Township
15- 615	394637075191601	--	US Geological Survey	Shiveler Lower	Logan Township
15- 616	394637075191602	--	US Geological Survey	Shiveler Middl	Logan Township
15- 617	394637075191603	--	US Geological Survey	Shiveler Upper	Logan Township
15- 618	394804075193301	--	US Geological Survey	Gaventa Deep	Logan Township
15- 620	394804075193302	30-03677	US Geological Survey	Gaventa Middle	Logan Township
15- 621	394722075173101	30-03685	US Geological Survey	Lopes Tst hole	Logan Township
15- 622	394752075200201	30-35325	US Geological Survey	CLTL Test hole	Logan Township
15- 626	394729075210101	30-33900	Logan Twp-A Pierce	MW 102 S	Logan Township
15- 629	394937075165501	30-03369	Hercules Chemical	MW 8C	Greenwich Township
15- 630	394937075164501	30-03371	Hercules Chemical	MW 19C	Greenwich Township
15- 634	394944075175001	--	Dupont, E I	Obs 40	Greenwich Township
15- 657	394941075173702	30-03461	Dupont, E I	Obs 38	Greenwich Township
15- 658	394941075173701	30-03460	Dupont, E I	Repauno M-37	Greenwich Township
15- 660	394953075173303	30-03428	Dupont, E I	Obs 33	Greenwich Township
15- 661	394953075173301	30-03426	Dupont, E I	Obs 31	Greenwich Township
15- 665	394936075171103	--	Hercules Chemical	MW 20C	Greenwich Township
15- 668	394944075164803	30-03370	Hercules Chemical	MW 10C	Greenwich Township
15- 678	394946075161201	30-03625	Mobil Oil Company	W-5C	Greenwich Township
15- 680	395038075160501	30-03602	Mobil Oil Company	W-7C	Greenwich Township
15- 692	394952075173401	30-03594	EI Dupont	Interceptor 46	Greenwich Township
15- 694	395021075153302	30-03614	Mobil Oil Company	W-9C	Greenwich Township
15- 695	394952075150201	30-03609	Mobil Oil Company	W-3C	Greenwich Township
15- 697	394755075210803	30-03332	Penns Grove Water Co	Brdgprt Backup	Logan Township
15- 707	394800075193602	50-00077	US Geological Survey	Gaventa W Tab	Logan Township
15- 711	395048075151802	30-03608	Mobil Oil Company	W-8C	Greenwich Township
15- 712	394808075172401	30-04347	US Geological Survey	Stefka-1	Greenwich Township
15- 713	394808075172402	30-04348	US Geological Survey	Stefka-2	Greenwich Township
15- 728	394808075172404	30-04549	US Geological Survey	Stefka-4	Greenwich Township
15- 736	395009075150501	30-03606	Mobil Oil Company	W-1C	Greenwich Township
15- 738	394948075152401	30-03612	Mobil Oil Company	W-4C	Greenwich Township
15- 739	394936075172801	30-03529	E.I. Dupont	43	Greenwich Township
15- 740	395033075151301	30-02748	Mobil Oil Company	Harco-1	Greenwich Township
15- 767	394813075182002	30-03684	US Geological Survey	S & S Auct TH	Logan Township
15- 768	394705075194301	30-03695	US Geological Survey	Shoemaker TH	Logan Township
15- 769	394728075183901	30-03686	US Geological Survey	Giammarino TH	Logan Township
15-1007	394335075155701	30-03122	Maccherone, Saranne K.	Maccherone Dom	South Harrison Township
15-1014	394247075202001	30-02247	B S T Development Co	BST Dev. Dmstc	Woolwich Township
15-1023	394401075195101	30-01762	Scaffo, Angela	Scaffo 30-1762	Woolwich Township
15-1047	394730075231901		Monsanto Chem	Test Well 7	Logan Township
Salem County					
33- 74	394241075220501	30-01151	Oldmans Twp W D	1 (Auburn W C)	Oldmans Township
33- 75	394258075220001	--	MacKannan, C	CM1 (Auburn Hi	Oldmans Township
33- 76	394328075244601	30-00661	Dawson, H W	Dawson 1	Oldmans Township
33- 79	394540075251901	30-01149	Nostrip Chemicals	Nostrip 1	Oldmans Township
33- 80	394542075251001	30-00974	Air Reduction	Airco 1	Oldmans Township

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Year of construction	Latitude (degrees)	Longitude (degrees)	Altitude of land surface (feet)	Screened interval (feet below land surface) Top	Bottom	Diameter of screen (inches)	Aquifer code	Available data
Gloucester County--Continued									
15- 585	1981	394704	752058	8	79	89	6.0	MRPAM	L,S
15- 586	1981	394720	752052	12	95	125	6.0	MRPAM	S
15- 597	1980	394730	752406	8	63	68	--	MRPA [4]	Q
15- 609	1972	394521	752257	13	133	173	6.0	MRPAM	L,W
15- 611	1980	394719	752357	9	37	42		MRPA [4]	S
15- 613	----	394705	752057	7	14	17	--	MRPAU	S
15- 614	----	394718	752052	17	10	20	--	MRPAU	S
15- 615	1985	394637	751916	29	378	388	4.0	MRPAL	H,L,Q,S
15- 616	1985	394637	751916	31	230	240	4.0	MRPAM	H,Q,S
15- 617	1985	394637	751916	31	60	70	4.0	MRPAU	H,Q,S
15- 618	1985	394804	751933	7	230	240	4.0	MRPAL	H,L,S,Q
15- 620	1985	394804	751933	7	131	141	4.0	MRPAM	H,Q,S
15- 621	1985	394722	751731	25	(Test hole)			WSCK	L
15- 622	1985	394752	752002	10	(Test hole)			WSCK	L
15- 626	1984	394729	752101	12	9	19	4.0	MRPAU	Q
15- 629	1984	394939	751654	11	90	120	2.0	MRPAM	L
15- 630	1984	394937	751645	12	98	118	2.0	MPPAM	L
15- 634	1984	394944	751750	5	136	141	6.0	MRPAL	L,Q
15- 657	1984	394941	751737	9	89	94	6.0	MRPAM	L,S
15- 658	1984	394941	751737	9	144	149	6.0	MRPAL	S
15- 660	1984	394953	751733	8	20	25	6.0	MRPAM	S
15- 661	1984	394953	751733	8	109	119	6.0	MRPAM	L
15- 665	1984	394936	751709	15	102	122	2.0	MRPAM	L,S
15- 668	1984	394944	751648	8	92	112	2.0	MRPAM	L,S
15- 678	1985	394946	751612	9	194	204	4.0	MRPAL	L
15- 680	1985	395038	751605	9	186	196	4.0	MRPAL	L
15- 692	1985	394952	751734	5	96	136	12.0	MRPAM	L
15- 694	1985	395021	751533	11	215	225	4.0	MRPAL	L
15- 695	1985	394952	751502	8	230	240	4.0	MRPAL	L
15- 697	1984	394755	752108	8	69	84	8.0	MRPAM	S
15- 707	1985	394800	751936	7	6	7	2.0	MRPAU	S
15- 711	1985	395048	751518	12	153	163	4.0	MRPAL	L
15- 712	1986	394808	751724	6	275	290	4.0	MRPAL	H,L,Q
15- 713	1986	394808	751724	6	125	155	8.0	MRPAM	H,Q
15- 728	1987	394808	751724	4	46	56	4.0	MRPAU	H,Q
15- 736	1985	395009	751505	16	222	232	4.0	MRPAL	L
15- 738	1985	394948	751524	4	188	198	4.0	MRPAL	L
15- 739	1984	394936	751728	5	98	103	4.0	MRPAM	L
15- 740	1982	395033	751513	20	(Not a well)			WSCK	L
15- 767	1985	394813	751820	9	(Test hole)			WSCK	L
15- 768	1985	394705	751943	5	(Test hole)			WSCK	L
15- 769	1985	394728	751839	15	(Test hole)			WSCK	L
15-1007	1984	394335	751557	95	300	305	4.0	MRPAU	L
15-1014	1980	394247	752020	80	244	254	3.0	MRPAU	L
15-1023	1978	394354	752006	78	205	215	4.0	MRPAU	L
15-1047	1968	394730	752319	10	60	100	--	MRPAM	L
Salem County									
33- 74	1968	394241	752201	80	185	206	6.0	MRPAU	L,P,Q,W
33- 75	1941	394258	752200	16	129	134	--	MRPAU	S
33- 76	1957	394328	752446	27	118	123	4.0	MRPAU	L,Q
33- 79	1967	394540	752519	10	107	122	6.0	MRPAM	L,W
33- 80	1963	394542	752510	15	112	132	12.0	MRPAM	L,W

Footnotes at end of table.

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Site identification number	New Jersey permit number	Owner	Local well number or name	Municipality
Salem County--Continued					
33- 82	394542075260301	30-00660	Bridge, Bruce H	Bridge	Oldmans Township
33- 83	394547075253501	30-01139	B F Goodrich Co	#9 (PW-1)	Oldmans Township
33- 85	394556075253001	30-01141	B F Goodrich Co	#6 (PW-2)	Oldmans Township
33- 86	394557075252301	30-01139	B F Goodrich Co	#4 (PW-3)	Oldmans Township
33- 88	394559075253001	30-01136	B F Goodrich Co	Test 1	Oldmans Township
33- 89	394559075253002	30-01138	B F Goodrich Co	Test 3	Oldmans Township
33- 101	394702075242701	30-00223	Pan Am Refining	Formation TW 3	Oldmans Township
[6]33- 187	394037075191501	--	US Geological Survey	Point Airy Obs	Pilesgrove Township
33- 342	394236075272101	--	NJ Water Policy	Penns Grove 24	Carneys Point Township
33- 345	394247075271401	--	Penns Grove WSC	PGWSC 2B	Carneys Point Township
33- 346	394256075271801	30-00563	Penns Grove WSC	Layne 1	Carneys Point Township
33- 347	394256075272301	--	Penns Grove WSC	Ranney	Carneys Point Township
33- 358	394520075250301	30-00080	Huber, HS	1	Oldmans Township
33- 370	394507075243001	30-01800	Grim, Eugene	1	Oldmans Township
33- 402	394657075254602	--	US Army Corps of Eng	EHW-1 Test	Oldmans Township
33- 403	394515075271701	--	US Army Corps of Eng	EHW-13	Oldmans Township
33- 405	394300075272701	30-00542	Penns Grove WSC	Test 1 1956	Carneys Point Township
33- 419	394540075254003	--	NL Industries	Monitor 8R	Oldmans Township
33- 420	394540075254004	--	NL Industries	Monitor 9R2	Oldmans Township
33- 432	394553075251301	30-01141	B F Goodrich Co	3	Oldmans Township
33- 435	394548075253001	30-01140	B F Goodrich Co	2	Oldmans Township
33- 438	394523075241101	30-02662	Lindle, T Earl	1	Oldmans Township
33- 439	394453075235101	30-02665	Bond, Willard K	1	Oldmans Township
33- 440	394400075240901	30-02656	Old Man's Airport	1	Oldmans Township
33- 442	394617075252201	--	US Army	EAB 8	Oldmans Township
33- 444	394459075270201	--	US Army	DGB 100	Oldmans Township
33- 446	394449075272501	--	US Army	DGB 102	Oldmans Township
33- 447	394441075272501	--	US Army	DGB 104	Oldmans Township
33- 448	394648075253801	30-02234	US Army Corps of Eng	EHW-4	Oldmans Township
33- 657	394353075235301	30-02862	Musumeci, Anthony	Musumeci Irrig	Oldmans Township
33- 660	394451075263201	30-03381	Dietrich, Jim	Dietrich 1	Oldmans Township
33- 669	394317075224001	30-02968	Tant Builders Inc	Tant 697	Oldmans Township

[1] The well screen is located in the confining unit between the middle and lower aquifers.

[2] Well has multiple screens. Values listed are the depths of the top of the uppermost screen and the bottom of the lowermost screen.

[3] The depth of the bottom of the screen is unknown. The depth of the well is 176 feet below land surface; therefore, the bottom of the screen is at or above 176 feet below land surface.

[4] This well is located in the area where the confining unit between the middle and lower aquifers is absent; the screen is located in the undifferentiated middle and lower aquifers.

[5] The confining unit between the upper and middle aquifers is absent at the site of this well; the screen is located in the undifferentiated upper and middle aquifers.

[6] This well is outside the study area. Its location is shown in figure 1.

[7] This well is screened in the Potomac-Raritan-Magothy aquifer system, but the exact depth of the screened interval is unknown.

Table 2.--Records of selected wells and borings in the Logan Township region, New Jersey--Continued

USGS well number	Year of construction	Latitude (degrees)	Longitude (degrees)	Altitude of land surface (feet)	Screened interval (feet below land surface) Top	Bottom	Diameter of screen (inches)	Aquifer code	Available data
Salem County--Continued									
33- 82	1957	394542	752603	6	--	--	--	MRPA [7]	P
33- 83	1968	394547	752535	10	93	133	12.0	MRPAM	L,P,Q
33- 85	1967	394556	752530	10	109	129	6.0	MRPAM	L,P,Q,W
33- 86	1967	394557	752523	13	169	189	6.0	MRPAL	L,P,Q,S,W
33- 88	1967	394559	752530	12	157	182	6.0	MRPAL	W
33- 89	1967	394559	752530	12	68	78	6.0	MRPAM	S,W
33- 101	1953	394702	752427	2	(Test hole)			WSCK	L
33- 187	1958	394037	751914	73	664	672	6.0	MRPAL	H
33- 342	1941	394236	752724	18	46	51	6.0	MRPAU	H
33- 345	1944	394241	752711	10	45	58	12.0	MRPAU	L,W
33- 346	1956	394256	752718	19	317	357	12.0	MRPAL	L,P
33- 347	1939	394256	752723	17	--	--	--	MRPAU	P
33- 358	1951	394520	752503	18	75	81	4.0	MRPAM	L
33- 370	1979	394449	752554	25	42	52	4.0	MRPAU	L,Q
33- 402	1980	394657	752546	6	109	114	7.0	MRPAL	L
33- 403	1980	394515	752717	9	38	43	7.0	HPPM	L
33- 405	1956	394300	752727	20	319	339	--	MRPAL	L
33- 419	1980	394540	752540	10	101	108	4.0	MRPAM	L,Q
33- 420	1980	394540	752540	10	53	61	4.0	MRPAM	Q
33- 432	1968	394553	752513	10	180	195	12.0	MRPAL	L
33- 435	1968	394548	752530	10	104	124	12.0	MRPAM	L
33- 438	1982	394512	752358	10	45	55	3.0	MRPAU	L
33- 439	1982	394449	752351	25	49	59	4.0	MRPAU	Q
33- 440	1982	394400	752409	40	58	68	3.0	MRPAU	L
33- 442	1982	394617	752522	9	95	100	2.0	MRPAM	L,S
33- 444	1982	394459	752702	23	83	88	2.0	MRPAM	L
33- 446	1982	394449	752725	9	63	68	2.0	MRPA [1]	L
33- 447	1982	394441	752725	15	69	72	2.0	MRPAM	L
33- 448	1980	394648	752538	13	37	42	4.0	MRPAM	L
33- 657	1983	394358	752344	45	160	260	8.0	MRPAM	L
33- 660	1984	394451	752632	30	206	[2]244	8.0	MRPAL	L
33- 669	1983	394317	752240	60	90	100	4.0	WBMV	L

Table 3.--Altitudes of the tops of aquifers and confining units in the Logan Township region, New Jersey

[Altitudes are in feet above or below sea level. Well locations are shown on plate 1a. -- indicates that the unit is not present in the logged interval; "?" indicates that the unit probably is present, but the log lacks sufficient detail to determine its depth]

USGS well number	Altitude of land surface (feet)	Wenonah-Mt. Laurel aquifer	Marshall-Wenonah confining unit	Englishtown aquifer system	Merchant-Woodbury confining unit	Potomac-Raritan-Magothy aquifer system: Upper aquifer	Potomac-Raritan-Magothy aquifer system: Confining unit	Middle aquifer: Upper part	Middle aquifer: Confining unit	Middle aquifer: Lower part	Confining unit	Lower aquifer	Bedrock confining unit
[1]15- 64	10	--	--	--	-3	-35	-113	-119	--	--	-160	-189	-277
[1]15- 66	0	--	--	--	-6	-25	-108	-119	--	--	-198	-255	-295
[1, 2]15- 67	5	--	--	--	--	5	-17	-41	-120	-130	-168	-194	-257
[1]15- 69	10	--	--	--	--	6	-10	-50	-90	-120	-159	--	--
[1]15- 70	10	--	--	--	--	--	-7	-17	--	--	--	--	--
[1]15- 71	1	--	--	--	--	--	--	1	-42	?	-102	--	--
[1]15- 72	6	--	--	--	--	--	--	?	-26	-49	-97	--	--
[1]15- 73	0	--	--	--	--	--	--	-7	--	--	--	--	--
[1, 2]15- 75	14	--	--	--	--	13	-14	-38	-93	--	--	--	--
[1]15- 76	15	--	--	--	--	--	-5	-11	-66	-72	-106	--	--
[1]15- 77	9	--	--	--	--	--	--	8	?	?	-90	--	--
[1]15- 79	10	--	--	--	--	--	--	4	-52	-70	-99	--	--
[1]15- 81	10	--	--	--	--	--	--	10	-53	-67	-89	--	--
[1]15- 83	15	--	--	--	--	--	-2	-7	-87	?	-112	--	--
[1]15- 85	12	--	--	--	--	--	?	?	-63	-98	-132	-163	-194
[1]15- 86	11	--	--	--	--	--	0	-15	?	?	?	--	--
[1]15- 88	13	--	--	--	--	--	?	?	-89	-101	-112	--	--
[1]15- 89	10	--	--	--	--	--	--	-11	-45	-64	-103	--	--
[1]15- 91	10	--	--	--	--	--	--	10	-12	-54	-95	?	--
[1]15- 92	4	--	--	--	--	--	--	-4	?	?	-127	--	--
[1]15- 93	6	--	--	--	--	--	--	6	-99	-123	-133	--	--
[1]15- 94	7	--	--	--	--	--	--	7	-82	-118	-140	--	--
[1]15- 95	5	--	--	--	--	--	--	5	-72	-123	-137	--	--
[1, 2]15- 96	14	--	--	--	--	--	--	6	-37	-104	-122	--	--
[1, 2]15- 97	5	--	--	--	--	--	--	1	-72	-84	-112	--	--
[1]15- 98	3	--	--	--	--	--	--	3	-77	-80	-112	--	--
[1, 2, 3]15- 100	3	--	--	--	--	--	--	1	-15	-62	-87	--	--
[1]15- 101	20	--	--	--	--	--	--	20	-78	-91	?	-160	--
[1]15- 109	20	--	--	--	--	--	--	20	-40	-65	-139	-204	-251
[1, 2, 3]15- 117	7	--	--	--	--	--	--	--	--	--	--	7	-52
[1]15- 118	18	--	--	--	--	--	--	18	-56	-73	-123	-195	--
[2]15- 133	20	--	--	--	--	20	-47	-114	-138	-146	-174	-262	-358
15- 135	7	--	--	--	--	7	-32	-125	?	?	-173	--	--
15- 136	17	--	--	--	--	17	-16	-89	?	?	-150	--	--
[1, 2]15- 137	29	--	--	--	13	-15	-89	-131	--	--	--	--	--

Footnotes at end of table.

Table 3.--Altitudes of the tops of aquifers and confining units in the Logan Township region, New Jersey--Continued

USGS well number	Altitude of land surface (feet)	Wenonah-Mt. Laurel aquifer	Marshall-Wenonah confining unit	Englishtown aquifer system	Merchantville-Woodbury confining unit	Potomac-Raritan-Magothy aquifer system: Upper aquifer	Confining unit	Middle aquifer: Jpper part	Middle aquifer: Confining unit	Middle aquifer: Lower part	Confining unit	Lower aquifer	Bedrock confining unit
[1]15- 138	15	--	--	--	11	--	--	--	--	--	--	--	--
[1]15- 139	6	--	--	--	--	-22	-48	-111	--	--	-186	-260	-338
[1]15- 141	0	--	--	--	--	-3	?	-120	--	--	--	--	--
[2]15- 142	20	--	--	--	--	20	-1	-88	-110	-120	-134	-214	-286
[1, 2]15- 144	7	--	--	--	--	7	-40	-112	--	--	--	--	--
[2]15- 148	5	--	--	--	--	--	--	--	--	-43	-63	-122	-182
[1, 2]15- 154	10	--	--	--	--	-18	-33	-62	--	--	-151	-187	-259
[2]15- 156	10	--	--	--	--	--	--	--	--	-46	--	--	-143
[2, 3]15- 157	5	--	--	--	--	--	-7	-30	--	--	-105	-145	-202
15- 158	12	--	--	--	--	--	--	--	--	-33	--	--	--
15- 159	11	--	--	--	--	--	--	--	--	-31	--	--	--
15- 160	10	--	--	--	--	--	--	--	--	-42	-65	-71	-143
[2]15- 161	8	--	--	--	--	--	--	--	--	-44	-70	-119	-192
[2]15- 162	1	--	--	--	--	--	--	--	--	-47	-81	-103	-164
[2]15- 163	10	--	--	--	--	--	--	--	--	-74	--	--	-108
[1, 2]15- 166	5	--	--	--	--	5	-2	-23	-38	-55	-100	--	--
15- 167	10	--	--	--	--	--	--	--	-37	-47	--	--	--
[1]15- 170	10	--	--	--	--	--	--	7	-65	-83	-112	--	--
[2]15- 171	5	--	--	--	--	--	--	-4	-24	-36	-77	-130	-159
[2]15- 172	5	--	--	--	--	--	--	--	--	--	--	-102	-115
[1, 2]15- 173	5	--	--	--	--	--	--	4	-20	-33	-56	-95	--
[1, 2]15- 175	8	--	--	--	--	--	--	--	--	--	--	-98	--
[1, 2]15- 176	5	--	--	--	--	--	--	--	2	-14	-67	-99	--
[1, 2]15- 177	5	--	--	--	--	--	--	--	--	-53	-58	-77	-126
[1, 2]15- 179	5	--	--	--	--	--	--	5	-10	-38	-58	?	?
[1, 2]15- 180	5	--	--	--	--	--	--	3	-27	-46	-68	-113	-149
[1, 2]15- 181	5	--	--	--	--	--	--	?	?	?	?	-102	-121
15- 236	75	--	40	--	--	-112	-169	-196	--	--	--	--	--
15- 337	48	--	--	--	48	-72	--	--	--	--	--	--	--
15- 339	90	90	34	--	--	-122	--	--	--	--	--	--	--
15- 342	60	--	53	--	--	-95	-186	-199	--	--	--	--	--
[1]15- 348	20	--	--	--	--	11	-73	-80	--	--	-138	--	--
[2, 3]15- 349	6	--	--	--	--	6	-31	-42	-64	-74	-122	-168	-213
[2]15- 350	20	--	--	--	--	20	-6	-66	-97	-104	-129	-212	-264
[1]15- 363	40	--	--	40	25	-95	--	--	--	--	--	--	--
[1]15- 366	80	--	35	15	0	-120	--	--	--	--	--	--	--
[1]15- 392	90	90	17	-7	-21	-142	--	--	--	--	--	--	--
[1]15- 394	30	--	--	--	10	-84	--	--	--	--	--	--	--
[1]15- 395	20	--	--	--	3	-14	-72	?	--	--	--	--	--
[1]15- 398	1	--	--	--	--	--	--	--	--	--	1	-31	--

Footnotes at end of table.

Table 3.--Altitudes of the tops of aquifers and confining units in the Logan Township region, New Jersey--Continued

USGS well number	Altitude of land surface (feet)	Wenonah-Mt. Laurel aquifer	Marshalltown-Wenonah confining unit	Englishtown aquifer system	Merchantville-Woodbury confining unit	Potomac-Raritan-Magothy aquifer system							Bedrock confining unit
						Upper aquifer	Confining unit	Middle aquifer			Confining unit	Lower aquifer	
								Upper part	Confining unit	Lower part			
[1,2]15- 399	10	--	--	--	--	--	--	10	-42	-60	-72	--	--
15- 400	5	--	--	--	--	5	-9	-89	-117	-123	-141	--	--
[1]15- 404	5	--	--	--	--	--	--	--	--	--	--	-7	-72
[1]15- 408	5	--	--	--	--	-24	-35	-54	-112	-130	-140	--	--
15- 409	20	--	--	--	--	--	11	-24	-56	-91	--	--	--
[1]15- 412	5	--	--	--	--	--	--	--	--	--	5	-27	--
15- 419	7	--	--	--	--	7	-9	-99	-116	-128	-156	--	--
15- 444	16	--	--	--	--	--	--	--	--	-45	--	--	--
[1]15- 452	20	--	--	--	20	-12	--	--	--	--	--	--	--
[1]15- 453	10	--	--	--	--	9	4	?	--	--	--	--	--
[1]15- 454	20	--	--	--	20	-32	--	--	--	--	--	--	--
[1]15- 455	20	--	--	--	--	19	--	--	--	--	--	--	--
[1]15- 459	10	--	--	--	--	10	-34	-49	--	--	--	--	--
[1]15- 462	10	--	--	--	--	8	-19	-35	--	--	--	--	--
[1]15- 463	20	--	--	--	20	-15	--	--	--	--	--	--	--
[1]15- 466	30	--	--	--	25	-21	--	--	--	--	--	--	--
[1]15- 468	10	--	--	--	--	?	?	-22	-70	?	--	--	--
[1]15- 471	45	--	--	45	0	-73	--	--	--	--	--	--	--
[1]15- 496	45	--	--	45	7	-78	--	--	--	--	--	--	--
[1]15- 497	45	--	--	--	35	-61	--	--	--	--	--	--	--
[1]15- 498	62	--	--	62	56	-72	--	--	--	--	--	--	--
[1]15- 499	60	--	60	48	6	?	--	--	--	--	--	--	--
[1]15- 501	50	--	--	--	24	-81	--	--	--	--	--	--	--
[1]15- 502	30	--	--	--	25	-29	--	--	--	--	--	--	--
[1]15- 503	5	--	--	--	-15	-20	--	--	--	--	--	--	--
[1]15- 504	5	--	--	--	--	-24	--	--	--	--	--	--	--
[1]15- 507	5	--	--	--	--	--	--	--	--	?	?	?	-76
[1]15- 511	10	--	--	--	--	-2	--	--	--	--	--	--	--
[1]15- 513	15	--	--	--	5	-6	--	--	--	--	--	--	--
[1]15- 514	10	--	--	--	--	--	--	9	-56	-115	-119	-141	--
[1]15- 516	40	--	--	--	40	-34	--	--	--	--	--	--	--
[1]15- 518	65	--	--	--	35	-37	--	--	--	--	--	--	--
[1]15- 519	35	--	--	--	35	-40	--	--	--	--	--	--	--
[1]15- 520	62	--	--	62	7	-76	--	--	--	--	--	--	--
15- 523	45	--	--	--	20	-35	--	--	--	--	--	--	--
[1]15- 524	52	--	--	--	6	-53	--	--	--	--	--	--	--
15- 525	90	--	82	--	--	-70	--	--	--	--	--	--	--
[2]15- 526	60	--	--	60	9	-76	--	--	--	--	--	--	--
[1]15- 527	58	--	--	--	16	-53	--	--	--	--	--	--	--
[1]15- 528	15	--	--	--	-10	-101	--	--	--	--	--	--	--

Footnotes at end of table.

Table 3.--Altitudes of the tops of aquifers and confining units in the Logan Township region, New Jersey--Continued

USGS well number	Altitude of land surface (feet)	Wenonah-Mt. Laurel aquifer	Marshalltown-Wenonah confining unit	Englishtown aquifer system	Merchantville-Woodbury confining unit	Potomac-Raritan-Magothy aquifer system: Upper aquifer	Potomac-Raritan-Magothy aquifer system: Confining unit	Middle aquifer: Upper part	Middle aquifer: Confining unit	Middle aquifer: Lower part	Potomac-Raritan-Magothy aquifer system: Confining unit	Potomac-Raritan-Magothy aquifer system: Lower aquifer	Bedrock-confining unit
[1] 15- 530	35	--	--	--	25	-29	--	--	--	--	--	--	--
[2] 15- 549	7	--	--	--	--	7	--	?	-85	--	--	--	--
[1,2] 15- 550	10	--	--	--	--	10	-30	-68	-85	?	--	--	--
[1,2,3] 15- 553	10	--	--	--	--	10	-14	-32	-92	-104	-147	--	--
[1,2] 15- 569	32	--	--	--	20	-18	-96	-133	-175	-200	--	--	--
[1] 15- 575	1	--	--	--	--	-18	-28	?	--	--	--	--	--
[1] 15- 582	1	--	--	--	--	-13	--	?	--	--	--	--	--
[1] 15- 585	7	--	--	--	--	7	-25	-72	--	--	--	--	--
[2,3] 15- 609	13	--	--	--	--	13	-8	-98	-114	-122	-151	--	--
[1,2] 15- 615	29	--	--	--	29	-19	-88	-129	--	--	-235	-261	-399
[1,2] 15- 618	7	--	--	--	--	7	-54	-78	-103	-117	-159	-216	-243
[1,2] 15- 621	25	--	--	--	21	-30	-99	-115	-181	-210	-285	-318	-400
[1,2] 15- 622	10	--	--	--	--	3	-20	-40	-75	-98	-141	-200	-250
[1] 15- 629	11	--	--	--	--	--	1	-8	--	--	-117	--	--
[1] 15- 630	12	--	--	--	--	--	-10	?	?	?	-122	--	--
[1,2] 15- 634	5	--	--	--	--	--	--	4	-22	-47	?	-115	-145
[1,2] 15- 658	9	--	--	--	--	--	--	9	-56	-66	-88	-129	-152
[1,2] 15- 661	8	--	--	--	--	--	--	7	-16	-53	--	--	--
[1] 15- 665	14	--	--	--	--	--	-11	-23	--	--	--	--	--
[1] 15- 668	7	--	--	--	--	--	-10	-17	-58	-64	-113	--	--
[1,2] 15- 678	9	--	--	--	--	3	-13	-20	-86	-104	-130	-164	--
[1,2] 15- 680	8	--	--	--	--	--	--	--	--	8	-76	-136	--
[1,2] 15- 692	5	--	--	--	--	--	--	5	-19	-59	--	--	--
[1,2] 15- 694	10	--	--	--	--	--	--	10	-71	-81	-117	-201	--
[1,2] 15- 695	8	--	--	--	--	8	-30	-40	-82	-112	-164	-214	--
[1,2] 15- 711	11	--	--	--	--	--	--	--	--	11	-109	--	--
[1,2] 15- 712	6	--	--	--	0	-15	-61	-67	-156	-178	-217	-237	-329
[1,2] 15- 736	16	--	--	--	--	--	--	16	-77	-92	-166	-201	--
[1,2] 15- 738	4	--	--	--	--	--	--	4	-73	-86	-150	-171	--
[1,2] 15- 739	5	--	--	--	--	--	--	5	-35	-75	-105	--	--
[1] 15- 740	20	--	--	--	--	--	--	16	-49	-58	-129	-201	-249
[1,2] 15- 767	9	--	--	--	3	-19	-59	-68	-116	-128	-186	-206	-311
[1,2] 15- 768	5	--	--	--	5	0	-85	-135	-155	-167	-219	-248	-337
[1,2] 15- 769	15	--	--	--	10	-10	-60	-80	-100	-120	-175	-219	-328
15-1007	95	50	-7	--	--	-188	--	--	--	--	--	--	--
15-1014	80	80	35	-10	-35	-130	--	--	--	--	--	--	--
15-1023	78	--	50	--	--	-110	--	--	--	--	--	--	--
[2] 15-1047	10	--	--	--	--	--	--	--	--	-47	-101	-111	-200
[2] 33- 74	80	80	36	16	0	-104	-128	-180	--	--	--	--	--

Footnotes at end of table.

Table 3.--Altitudes of the tops of aquifers and confining units in the Logan Township region, New Jersey--Continued

USGS well number	Altitude of land surface (feet)	Wenonah-Mt. Laurel aquifer	Marshall-Wenonah confining unit	Englishtown aquifer system	Merchant-Woodbury confining unit	Potomac-Raritan-Magothy aquifer system: Upper aquifer	Confining unit	Middle aquifer: Upper part	Middle aquifer: Confining unit	Middle aquifer: Lower part	Confining unit	Lower aquifer	Bedrock confining unit
33- 76	27	--	--	--	27	-18	--	--	--	--	--	--	--
[2]33- 79	10	--	--	--	--	10	-5	-35	-68	-90	-116	--	--
33- 80	15	--	--	--	--	15	-6	-27	-65	-90	--	--	--
33- 83	10	--	--	--	--	--	-2	-31	-54	-77	-125	--	--
33- 85	10	--	--	--	--	--	5	-28	-54	-79	-120	-155	-190
33- 86	13	--	--	--	--	--	8	-24	-50	-77	-96	-148	-187
33- 101	2	--	--	--	--	--	--	--	-42	-65	-86	-115	-133
33- 345	10	--	--	--	--	10	--	--	--	--	--	--	--
[2]33- 346	19	--	--	--	--	19	-26	-72	-100	-126	-181	-211	--
33- 358	18	--	--	--	--	?	?	-47	--	--	--	--	--
33- 370	25	--	--	--	--	25	--	--	--	--	--	--	--
33- 402	6	--	--	--	--	--	--	--	--	--	-26	-94	-110
33- 403	8	--	--	--	--	--	--	--	--	--	-83	--	--
33- 405	20	--	--	--	--	20	-25	-75	-101	-120	-187	-216	--
33- 419	10	--	--	--	--	10	-24	-32	-48	-84	--	--	--
33- 432	10	--	--	--	--	--	5	-21	-68	-80	-100	-150	--
33- 435	10	--	--	--	--	--	6	-37	-50	-77	-114	--	--
33- 438	10	--	--	--	--	10	-45	--	--	--	--	--	--
33- 440	40	--	--	--	40	-5	--	--	--	--	--	--	--
[2,3]33- 442	9	--	--	--	--	--	9	-1	-31	-59	-93	--	--
[2,3]33- 444	23	--	--	--	--	--	--	--	--	-44	-66	--	--
[3]33- 446	9	--	--	--	--	--	--	--	-37	-45	-53	--	--
[3]33- 447	15	--	--	--	--	--	--	15	-27	-54	-60	--	--
33- 448	13	--	--	--	--	--	--	--	--	-12	-29	--	--
33- 657	45	--	--	--	30	-30	-90	-115	-155	-185	--	--	--
33- 660	30	--	--	--	--	--	24	-4	-9	-69	-73	-163	--
33- 669	60	--	--	--	43	-60	-114	-151	--	--	--	--	--

[1] Interpretations listed are by Barton and Kozinski (in press).

[2] Geophysical logs are available and were used in these interpretations.

[3] Drillers' logs are available for all wells except these.

(p.80 follows)

Table 9.--Physical properties of, and common ions and nutrients in, water from wells in the Logan Township region, New Jersey, 1980-87[1]

[Dissolved constituents, milligrams per liter except as noted; --, data not available; <, less than the detection limit; for example, "<0.01" means that the concentration in the sample is less than the detection limit of 0.01 mg/L; USGS, U.S. Geological Survey; µS/cm, microsiemens per centimeter; µg/L, micrograms per liter; °C, degrees Celsius]

USGS well number	Date	Specific conductance (µS/cm)	Ph (standard units)	Alkalinity total field as $CaCO_3$	Oxygen	Nitrogen, ammonia	Sodium	Potassium	Calcium
Upper aquifer of the Potomac-Raritan-Magothy aquifer system									
15-240	09-10-80	365	7.60	114	--	--	50	5.7	17
15-240	11-18-86	179	6.43	46	.3	0.17	14	4.0	12
15-337	10-14-80	178	7.10	93	--	--	15	4.2	16
15-340	10-20-80	180	7.00	94	--	--	9.5	4.0	20
15-341	10-27-80	224	7.50	87	--	--	22	5.2	16
15-342	09-26-85	293	7.20	104	.2	.22	39	5.4	17
15-345	10-27-80	148	6.50	45	--	--	1.8	3.0	11
15-345	12-04-86	204	6.39	41	<.1	.05	2.1	3.6	15
15-345	12-04-86	204	6.40	41	<.1	.08	--	--	--
15-353	04-18-85	325	6.10	31	--	.15	26	3.5	27
15-363	11-20-86	506	7.79	126	<.1	.30	87	5.6	12
15-366	11-17-80	648	7.70	164	--	--	130	8.1	20
15-392	09-08-80	442	7.80	114	--	--	56	7.2	19
15-417	09-25-80	198	5.00	3	--	--	3.4	7.7	16
15-417	10-03-85	251	5.10	5	1.3	.04	4.6	7.2	24
15-501	11-19-86	400	7.29	135	.1	.25	69	5.7	11
15-519	11-18-86	209	6.16	98	<.1	.08	4.1	4.2	22
15-564	05-18-85	390	6.40	39	--	.48	5.7	24	27
15-564	11-25-86	370	6.36	37	3.0	.03	--	--	--
15-564	11-25-86	374	6.50	37	2.8	.03	5.8	21	27
15-617	02-27-85	248	6.40	35	--	.01	3.8	3.8	13
15-617	11-21-85	238	6.20	32	.5	<.07	3.2	3.7	12
15-617	12-03-86	241	6.39	38	.1	.06	3.4	4.1	15
15-626	12-05-86	269	5.28	3	9.6	.02	3.2	16	23
15-728	04-22-87	210	6.19	74	.3	.16	7.7	3.3	14
15-728	04-22-87	211	6.23	78	.2	.17	7.8	3.3	14
33- 74	10-03-80	173	7.20	89	--	--	19	3.9	14
33- 76	10-20-80	119	6.50	60	--	--	2.1	1.2	5.0
33-370	07-17-86	187	4.86	1	8.9	.02	2.5	6.4	14
33-439	07-25-86	368	4.40	0	5.9	.11	15	7.5	25
33-439	08-13-87	410	4.14	--	7.0	.12	--	--	--
Middle aquifer of the Potomac-Raritan-Magothy aquifer system									
15-137	09-26-80	206	6.20	62	--	--	22	3.5	8.1
15-137	10-11-83	217	6.50	--	--	--	--	--	--
15-137	09-26-84	250	6.80	--	--	--	23	--	--
15-137	09-09-86	223	6.70	--	--	--	--	--	--
15-140	03-14-85	181	6.00	18	--	.15	21	.9	1.4
15-140	11-20-85	133	5.10	9	1.2	.05	22	1.4	1.5
15-143	09-30-80	83	5.40	4	--	--	3.4	1.7	4.6
15-143	10-31-84	83	5.60	12	--	--	3.2	1.7	5.0
15-144	09-26-80	158	5.80	14	--	--	25	1.1	1.6
15-144	09-16-81	162	5.80	--	--	--	--	--	--
15-144	10-11-83	162	5.70	--	--	--	--	--	--
15-144	09-26-84	165	6.00	--	--	--	23	--	--
15-144	07-14-86	152	5.73	15	.4	.06	22	1.3	1.9
15-144	09-09-86	170	5.80	--	--	--	--	--	--
15-146	10-01-80	428	5.50	9	--	--	45	5.1	15
15-161	10-20-82	127	6.50	57	.3	.34	4.8	1.0	3.3
15-166	04-10-58	126	--	--	--	--	--	--	--
15-166	08-25-58	135	--	--	--	--	--	--	--
15-166	04-07-59	157	--	--	--	--	--	--	--
15-166	09-01-59	140	--	--	--	--	--	--	--
15-166	04-05-60	136	--	--	--	--	--	--	--
15-166	08-22-60	135	--	--	--	--	--	--	--
15-166	04-07-61	143	--	--	--	--	--	--	--
15-166	08-28-61	154	--	--	--	--	--	--	--
15-166	04-19-62	147	--	--	--	--	--	--	--

[1] Results of analyses of ground-water samples from well 15-166 for 1958-79 also included.

Table 9.--Physical properties of, and common ions and nutrients in, water from wells in the Logan Township region, New Jersey, 1980-87[1]--Continued

USGS well number	Date	Magnesium	Iron (μg/L)	Manganese (μg/L)	Silica	Nitrogen, nitrite	Nitrogen, NO_2+NO_3	Phosphorus, ortho	Chloride	Sulfate	Fluoride	Solids residue at 180° C	Solids, sum of constituents
Upper aquifer of the Potomac-Raritan-Magothy aquifer system													
15-240	09-10-80	4.7	650	33	9.8	--	0.07	0.12	42	20	--	211	220
15-240	11-18-86	3.9	2700	44	12	<0.01	<.10	.04	22	23	--	102	120
15-337	10-14-80	3.2	2600	22	12	--	.00	.41	2.4	4.6	--	112	120
15-340	10-20-80	3.4	2700	24	11	--	.08	.27	1.9	5.8	--	112	120
15-341	10-27-80	4.3	530	11	9.7	--	.02	.12	6.1	24	--	150	140
15-342	09-26-85	4.6	100	15	10	<.01	<.10	.02	13	24	0.3	167	180
15-345	10-27-80	4.6	11000	170	24	--	.00	.06	6.7	18	--	117	110
15-345	12-04-86	5.9	17000	230	23	<.01	<.10	<.01	16	51	--	125	160
15-345	12-04-86	--	--	--	--	<.01	<.10	<.01	--	--	--	--	--
15-353	04-18-85	4.7	690	78	3.4	.01	2.60	<.01	67	31	<.1	227	180
15-363	11-20-86	3.6	750	11	9.9	<.01	<.10	.09	76	11	--	293	280
15-366	11-17-80	5.3	570	15	9.4	--	.01	.08	130	6.4	--	395	410
15-392	09-08-80	5.1	440	14	9.4	--	.03	.05	64	9.4	--	242	240
15-417	09-25-80	5.5	500	290	7.2	--	4.30	.00	11	45	--	120	120
15-417	10-03-85	8.0	340	380	6.3	.03	8.10	<.01	28	41	<.1	162	120
15-501	11-19-86	3.6	750	13	10	<.01	<.10	.17	50	15	--	242	250
15-519	11-18-86	7.7	8000	98	21	<.01	<.10	.13	15	5.5	--	117	150
15-564	05-18-85	18	12	62	5.1	1.00	14.0	.01	16	79	<.1	282	210
15-564	11-25-86	--	--	--	--	.15	13.0	<.01	--	--	--	--	--
15-564	11-25-86	17	65	37	5.5	.15	13.0	<.01	12	75	--	249	190
15-617	02-27-85	6.2	27000	330	18	<.01	<.10	.08	16	61	.3	220	170
15-617	11-21-85	6.1	20000	340	18	<.01	<.10	--	14	61	.3	136	160
15-617	12-03-86	5.9	25000	310	18	<.01	<.10	.03	11	61	--	125	170
15-626	12-05-86	8.0	10	19	4.5	<.01	16.0	<.01	14	42	--	171	110
15-728	04-22-87	6.4	17000	180	21	<.01	<.10	<.01	12	19	--	125	150
15-728	04-22-87	6.4	17000	190	21	<.01	<.10	<.01	13	19	--	124	150
33- 74	10-03-80	2.6	1500	12	11	--	.02	.49	1.7	2.9	--	113	110
33- 76	10-20-80	1.7	22000	130	15	--	.07	.36	4.3	2.3	--	81	91
33-370	07-17-86	7.7	5	52	8.9	<.01	5.20	<.01	8.7	50	<.1	118	99
33-439	07-25-86	11	11	1000	10	<.01	22.0	<.01	27	52	.2	242	--
33-439	08-13-87	--	--	--	--	<.01	22.0	<.01	--	--	--	--	--
Middle aquifer of the Potomac-Raritan-Magothy aquifer system													
15-137	09-26-80	2.8	8700	63	13	--	.00	.00	17	17	--	118	130
15-137	10-11-83	--	--	--	--	--	--	--	20	--	--	--	--
15-137	09-26-84	--	--	--	--	--	--	--	23	--	--	--	--
15-137	09-09-86	--	--	--	--	--	--	--	19	--	--	--	--
15-140	03-14-85	.57	8200	110	6.3	.02	2.20	.01	31	16	<.1	68	97
15-140	11-20-85	.58	3300	33	6.4	<.01	2.30	--	33	4.7	<.1	84	78
15-143	09-30-80	2.4	48	21	8.6	--	5.90	.00	7.4	.6	--	68	58
15-143	10-31-84	2.4	440	58	7.1	--	--	--	7.1	1.7	<.1	62	36
15-144	09-26-80	.6	2400	26	8.8	--	.40	.00	34	4.3	--	87	88
15-144	09-16-81	--	--	--	--	--	--	--	34	--	--	--	--
15-144	10-11-83	--	--	--	--	--	--	--	35	--	--	--	--
15-144	09-26-84	--	--	--	--	--	--	--	34	--	--	--	--
15-144	07-14-86	.7	2500	30	8.6	<.01	.48	.01	34	7.5	<.1	87	88
15-144	09-09-86	--	--	--	--	--	--	--	37	--	--	--	--
15-146	10-01-80	8.5	2400	500	8.9	--	2.90	.00	81	46	--	238	230
15-161	10-20-82	1.8	21000	260	21	<.01	<.10	.22	7.8	<5.0	<.1	55	120
15-166	04-10-58	--	--	--	--	--	--	--	7.5	--	--	--	--
15-166	08-25-58	--	--	--	--	--	--	--	7.8	--	--	--	--
15-166	04-07-59	--	--	--	--	--	--	--	8.0	--	--	--	--
15-166	09-01-59	--	--	--	--	--	--	--	8.9	--	--	--	--
15-166	04-05-60	--	--	--	--	--	--	--	8.5	--	--	--	--
15-166	08-22-60	--	--	--	--	--	--	--	8.4	--	--	--	--
15-166	04-07-61	--	--	--	--	--	--	--	8.2	--	--	--	--
15-166	08-28-61	--	--	--	--	--	--	--	10	--	--	--	--
15-166	04-19-62	--	--	--	--	--	--	--	8.8	--	--	--	--

1 Results of analyses of ground-water samples form well 15-166 for 1958-79 also included.

Table 9.--Physical properties of, and common ions and nutrients in, water from wells in the Logan Township region, New Jersey, 1980-87[1]--Continued

USGS well number	Date	Specific conductance (µS/cm)	Ph (standard units)	Alkalinity total field as $CaCO_3$	Oxygen	Nitrogen, ammonia	Sodium	Potassium	Calcium
Middle aquifer of the Potomac-Raritan-Magothy aquifer system--Continued									
15-166	09-24-62	157	--	--	--	--	--	--	--
15-166	04-02-63	154	--	--	--	--	--	--	--
15-166	08-26-63	152	--	--	--	--	--	--	--
15-166	04-28-64	157	--	--	--	--	--	--	--
15-166	09-17-64	152	--	--	--	--	--	--	--
15-166	04-21-65	152	--	--	--	--	--	--	--
15-166	07-12-67	167	--	--	--	--	6.2	2.9	8.5
15-166	03-12-70	183	--	--	--	--	--	--	--
15-166	09-22-72	182	--	--	--	--	8.3	3.9	12.
15-166	05-23-73	193	--	--	--	--	--	--	--
15-166	08-29-74	196	--	--	--	--	--	--	--
15-166	05-13-75	229	7.00	--	--	--	--	--	--
15-166	09-21-77	196	--	--	--	--	--	--	--
15-166	09-01-78	190	6.90	--	--	--	--	--	--
15-166	08-15-79	187	5.00	--	--	--	--	--	--
15-166	09-16-80	186	5.10	3	--	--	9.1	4.0	8.7
15-166	09-16-81	177	5.20	--	--	--	--	--	--
15-166	08-13-82	196	5.00	--	--	--	--	--	--
15-166	12-22-82	200	4.70	2	7.5	<0.01	11	3.9	9.1
15-166	09-08-83	182	5.00	--	--	--	--	--	--
15-166	09-26-84	199	5.00	--	--	--	10	--	--
15-166	06-16-86	180	4.92	3	8.1	<.01	10	4.2	8.6
15-166	08-07-87	260	4.80	35	7.6	.01	--	--	--
15-167	10-19-82	635	6.40	47	--	.43	110	2.0	9.6
15-167	09-08-83	700	6.30	--	--	--	--	--	--
15-167	09-26-84	750	6.50	--	--	--	110	--	--
15-236	09-10-80	384	7.20	106	--	--	46	5.8	20
15-236	09-15-81	382	7.20	--	--	--	--	--	--
15-236	08-17-82	403	7.10	--	--	--	--	--	--
15-236	09-08-83	377	7.20	--	--	--	--	--	--
15-236	09-25-84	380	7.30	--	--	--	46	--	--
15-236	09-04-86	390	7.20	--	--	--	--	--	--
15-236	08-18-87	395	7.20	--	--	--	--	--	--
15-347	12-10-80	213	5.70	12	--	--	15	4.4	12
15-347	09-22-82	237	5.80	17	3.5	.48	20	4.5	12
15-347	07-25-85	225	5.80	17	3.1	.50	17	5.5	11
15-347	11-05-86	211	5.17	19	3.4	.29	16	4.5	12
15-348	09-18-80	128	4.40	0	--	--	4.8	2.2	3.9
15-348	12-22-82	134	4.10	0	1.7	<.01	5.4	2.2	4.1
15-348	07-14-86	188	4.17	0	1.8	.03	13	2.6	5.7
15-348	11-17-86	197	4.36	<1	1.3	.02	13	2.3	5.6
15-395	10-30-86	185	5.56	11	.3	.03	3.8	3.9	7.1
15-399	09-15-80	118	5.10	4	--	--	7.1	2.5	5.4
15-409	10-09-80	85	6.30	18	--	<.01	2.3	1.0	2.5
15-453	06-06-86	330	4.45	--	7.4	--	2.8	11	28
15-453	08-03-87	330	4.45	--	7.6	.01	--	--	--
15-539	05-17-84	158	5.80	20	.3	.35	4.1	2.8	7.8
15-540	12-10-85	84	4.52	2	--	.03	2.8	2.1	4.5
15-569	11-10-86	231	6.65	67	.4	.19	22	3.9	12
15-616	02-28-85	117	6.50	35	--	.01	3.8	3.2	7.2
15-616	11-20-85	100	6.20	32	.3	.06	2.6	2.2	5.3
15-616	11-26-86	99	6.46	41	<.1	.04	2.4	1.8	5.4
15-620	06-07-85	56	5.40	5	--	.06	3.0	1.6	2.8
15-620	11-25-86	49	5.57	8	2.7	.05	3.0	1.8	2.8
15-620	11-25-86	49	5.60	8	2.7	.05	--	--	--
15-713	12-03-86	168	6.60	73	<.1	.14	2.0	4.0	9.5
15-713	12-03-86	168	6.60	73	<.1	.17	--	--	--
33- 83	10-09-80	82	6.10	34	--	--	4.9	1.1	2.4
33- 83	10-21-82	90	6.10	29	.6	.11	6.0	1.1	3.0
33- 83	11-04-83	111	6.10	--	--	--	--	--	--
33- 83	11-02-84	126	6.20	--	--	--	8.1	--	--

[1] Results of analyses of ground-water samples from well 15-166 for 1958-79 also included.

Table 9.--Physical properties of, and common ions and nutrients in, water from wells in the Logan Township region, New Jersey, 1980-87[1]--Continued

USGS well number	Date	Magnesium	Iron (µg/L)	Manganese (µg/L)	Silica	Nitrogen, nitrite	Nitrogen, NO_2+NO_3	Phosphorus, ortho	Chloride	Sulfate	Fluoride	Solids, residue at 180° C	Solids, sum of constituents
Middle aquifer of the Potomac-Raritan-Magothy aquifer system -- (continued)													
15-166	09-24-62	--	--	--	--	--	--	--	9.0	--	--	--	--
15-166	04-02-63	--	--	--	--	--	--	--	9.4	--	--	--	--
15-166	08-26-63	--	--	--	--	--	--	--	9.1	--	--	--	--
15-166	04-28-64	--	--	--	--	--	--	--	9.5	--	--	--	--
15-166	09-17-64	--	--	--	--	--	--	--	9.5	--	--	--	--
15-166	04-21-65	--	--	--	--	--	--	--	9.0	--	--	--	--
15-166	07-12-67	7.0	--	--	8.4	--	--	--	10	24	0.100	120	105
15-166	03-12-70	--	--	--	--	--	--	--	13	--	--	--	--
15-166	09-22-72	7.2	120	20	8.5	--	--	--	13	27	.100	114	116
15-166	05-23-73	--	--	--	--	--	--	--	15	--	--	--	--
15-166	08-29-74	--	--	--	--	--	--	--	15	--	--	--	--
15-166	05-13-75	--	--	--	--	--	--	--	15	--	--	--	--
15-166	09-21-77	--	--	--	--	--	--	--	14	--	--	--	--
15-166	09-01-78	--	--	--	--	--	--	--	14	--	--	--	--
15-166	08-15-79	--	--	--	--	--	--	--	13	--	--	--	--
15-166	09-16-80	6.7	19	30	8.7	--	8.20	0.00	13	28	--	128	120
15-166	09-16-81	--	--	--	--	--	--	--	14	--	--	--	--
15-166	08-13-82	--	--	--	--	--	--	--	14	--	--	--	--
15-166	12-22-82	7.1	15	28	8.4	<0.01	7.20	<.01	14	29	<.1	129	84
15-166	09-08-83	--	--	--	--	--	--	--	15	--	--	--	--
15-166	09-26-84	--	--	--	--	--	--	--	17	--	--	--	--
15-166	06-16-86	6.8	24	29	8.2	<.01	6.40	<.01	14	28	<.1	110	80
15-166	08-07-87	--	--	--	--	<.01	6.70	<.01	--	--	--	--	--
15-167	10-19-82	3.8	17000	330	25	.02	<.10	<.01	170	3.0	<.1	373	370
15-167	09-08-83	--	--	--	--	--	--	--	200	--	--	--	--
15-167	09-26-84	--	--	--	--	--	--	--	210	--	--	--	--
15-236	09-10-80	5.2	2800	37	11	--	.01	.04	43	22	--	211	220
15-236	09-15-81	--	--	--	--	--	--	--	45	--	--	--	--
15-236	08-17-82	--	--	--	--	--	--	--	43	--	--	--	--
15-236	09-08-83	--	--	--	--	--	--	--	46	--	--	--	--
15-236	09-25-84	--	--	--	--	--	--	--	45	--	--	--	--
15-236	09-04-86	--	--	--	--	--	--	--	48	--	--	--	--
15-236	08-18-87	--	--	--	--	--	--	--	41	--	--	--	--
15-347	12-10-80	6.0	440	100	7.7	--	5.00	.01	21	36	--	126	130
15-347	09-22-82	6.3	560	92	7.2	<.01	4.60	.02	26	35	<.1	142	120
15-347	07-25-85	5.6	510	84	6.8	<.01	3.90	.03	22	33	<.1	136	110
15-347	11-05-86	5.8	390	77	7.5	<.01	4.80	.03	18	33	--	131	110
15-348	09-18-80	4.5	19	68	12	--	1.60	.00	7.0	29	--	60	71
15-348	12-22-82	4.5	47	76	12	<.01	1.20	<.01	8.0	30	.1	90	67
15-348	07-14-86	5.5	59	140	14	.02	1.20	<.01	11	55	.1	109	--
15-348	11-17-86	5.4	960	150	13	<.01	1.10	<.01	11	57	--	123	--
15-395	10-30-86	5.1	21000	360	12	<.01	<.10	.03	9.4	62	--	126	130
15-399	09-15-80	2.7	530	380	14	--	.07	.05	29	1.9	--	74	67
15-409	10-09-80	2.2	6900	230	22	--	.74	.16	4.5	7.7	--	58	64
15-453	06-06-86	12	18	180	9.4	<.01	18.0	<.01	14	57	.2	219	--
15-453	08-03-87	--	--	--	--	<.01	18.0	<.01	--	--	--	--	--
15-539	05-17-84	7.2	240	53	4.5	<.01	<.10	.08	14	25	.1	110	82
15-540	12-10-85	2.5	21	56	8.5	<.01	3.70	<.01	8.9	5.5	<.1	52	36
15-569	11-10-86	3.9	--	78	14	<.01	<.10	<.01	15	29	--	142	140
15-616	02-28-85	2.1	9500	82	14	.01	0.10	.09	6.9	22	.2	79	90
15-616	11-20-85	2.1	10000	86	14	.01	.10	.01	6.3	27	.2	111	89
15-616	11-26-86	2.1	12000	92	15	<.01	<.10	.19	5.2	12	--	55	81
15-620	06-07-85	1.1	66	42	8.5	<.01	2.30	.03	2.6	5.9	<.1	28	29
15-620	11-25-86	1.1	320	99	7.7	<.01	1.90	<.01	4.3	2.7	--	34	29
15-620	11-25-86	--	--	--	--	<.01	2.00	<.01	--	--	--	--	--
15-713	12-03-86	3.5	11000	170	16	<.01	<.10	.06	7.5	14	--	98	--
15-713	12-03-86	--	--	--	--	<.01	<.10	.06	--	--	--	--	--
33- 83	10-09-80	1.3	9300	180	11	--	.04	.00	4.8	.3	--	48	56
33- 83	10-21-82	1.7	9700	170	11	<.01	<.10	.01	8.7	4.0	<.1	41	63
33- 83	11-04-83	--	--	--	--	--	--	--	12	--	--	--	--
33- 83	11-02-84	--	--	--	--	--	--	--	13	--	--	--	--

[1] Results of analyses of ground-water samples form well 15-166 for 1958-79 also included.

Table 9.--Physical properties of, and common ions and nutrients in, water from wells in the Logan Township region, New Jersey, 1980-87[1]--Continued

USGS well number	Date	Specific conductance (μS/cm)	Ph (standard units)	Alkalinity total field as $CaCO_3$	Oxygen	Nitrogen, ammonia	Sodium	Potassium	Calcium
Middle aquifer of the Potomac-Raritan-Magothy aquifer system--Continued									
33- 83	09-11-85	143	6.20	--	--	--	--	--	--
33- 83	09-29-86	172	6.00	--	--	--	--	--	--
33- 83	08-21-87	207	6.00	--	--	--	--	--	--
33- 85	10-09-80	180	6.10	32	--	--	7.6	1.2	4.2
33- 85	10-21-82	148	6.10	28	0.3	0.10	9.4	1.2	5.6
33- 85	11-04-83	165	6.00	--	--	--	--	--	--
33- 85	11-02-84	182	6.10	--	--	--	11	--	--
33- 85	09-11-85	195	6.20	--	--	--	--	--	--
33- 85	09-29-86	210	6.00	--	--	--	--	--	--
33- 85	08-21-87	343	6.00	--	--	--	--	--	--
33-419	11-21-80	84	6.20	32	--	--	2.6	1.8	9.5
33-420	11-21-80	52	5.70	11	--	--	2.9	1.2	2.8
Area in which the Middle and Lower aquifers of the Potomac-Raritan-Magothy aquifer system cannot be differentiated									
15-159	09-23-80	1320	6.50	78	--	--	230	5.0	14
15-159	10-19-82	1150	6.40	85	--	.53	200	4.1	15
15-159	09-08-83	1100	6.60	--	--	--	--	--	--
15-159	09-26-84	1050	6.40	--	--	--	170	--	--
15-163	10-28-82	980	6.70	250	.5	18	120	5.4	20
15-163	06-04-84	1060	6.60	266	.1	17	110	5.6	19
15-597	05-31-84	1370	6.70	112	.3	.52	210	2.9	13
Lower aquifer of the Potomac-Raritan-Magothy aquifer system									
15-139	09-26-80	2930	7.40	168	--	--	660	11	29
15-139	03-13-85	3050	7.30	166	--	.87	490	10	34
15-139	11-10-86	2680	7.49	131	.1	.71	530	13	35
15-349	10-01-80	461	5.30	6	--	--	66	3.3	10
15-350	09-30-80	1500	7.30	156	--	--	250	7.3	15
15-350	10-31-84	1240	6.70	176	--	--	280	6.8	16
15-398	11-17-86	769	6.50	192	.1	15	52	2.5	14
15-615	02-28-85	3000	7.10	280	--	.77	540	10	39
15-615	12-02-86	2550	7.15	165	<.1	.81	490	11	38
15-615	12-02-86	2550	7.20	135	<.1	--	490	11	38
15-618	03-01-85	1700	6.60	76	--	.37	260	6.3	23
15-618	11-24-86	1420	6.70	81	<.1	.37	250	6.8	21
15-634	10-08-86	2870	6.20	71	<.1	.8	490	11	94
15-712	12-16-86	2250	6.80	109	<.1	.98	370	12	63
15-712	12-16-86	2250	6.84	109	<.1	--	360	12	61
15-712	03-19-87	2160	6.74	90	.1	.99	360	13	63
15-712	03-19-87	2160	6.74	90	.1	--	370	13	64
33- 86	09-30-81	1150	7.30	--	--	--	--	--	--
33- 86	10-21-82	1190	7.10	130	.2	.34	240	4.6	18
33- 86	11-04-83	1240	7.20	--	--	--	--	--	--
33- 86	11-02-84	1180	7.20	--	--	--	210	--	--
33- 86	09-11-85	1190	7.00	--	--	--	--	--	--
33- 86	09-29-86	1190	7.00	--	--	--	--	--	--
33- 86	08-21-87	1250	7.20	--	--	--	--	--	--

[1] Results of analyses of ground-water samples from well 15-166 for 1958-79 also included.

Table 9.--Physical properties of, and common ions and nutrients in, water from wells in the Logan Township region, New Jersey, 1980-87[1]--Continued

USGS well number	Date	Magnesium	Iron (µg/L)	Manganese (µg/L)	Silica	Nitrogen, nitrite	Nitrogen, NO_2+NO_3	Phosphorus, ortho	Chloride	Sulfate	Fluoride	Solids, residue at 180° C	Solids, sum of constituents
Middle aquifer of the Potomac-Raritan-Magothy aquifer system -- (continued)													
33- 83	09-11-85	--	--	--	--	--	--	--	18	--	--	--	--
33- 83	09-29-86	--	--	--	--	--	--	--	17	--	--	--	--
33- 83	08-21-87	--	--	--	--	--	--	--	24	--	--	--	--
33- 85	10-09-80	2.1	8800	280	11	--	0.03	0.01	13	8.1	--	63	76
33- 85	10-21-82	2.8	9000	500	11	<.01	<.10	.01	20	16	<0.1	76	92
33- 85	11-04-83	--	--	--	--	--	--	--	21	--	--	--	--
33- 85	11-02-84	--	--	--	--	--	--	--	18	--	--	--	--
33- 85	09-11-85	--	--	--	--	--	--	--	21	--	--	--	--
33- 85	09-29-86	--	--	--	--	--	--	--	23	--	--	--	--
33- 85	08-21-87	--	--	--	--	--	--	--	29	--	--	--	--
33-419	11-21-80	1.4	1300	460	11	--	.00	.01	6.2	0	--	52	54
33-420	11-21-80	0.68	3000	62	11	--	.01	.00	7.4	1.0	--	40	37
Area in which the Middle and Lower aquifers of the Potomac-Raritan-Magothy aquifer system cannot be differentiated													
15-159	09-23-80	5.9	26	570	18	--	.11	.34	360	5.0	--	702	690
15-159	10-19-82	6.8	23000	530	18	.03	.23	<.01	290	19	.1	566	630
15-159	09-08-83	--	--	--	--	--	--	--	300	--	--	--	--
15-159	09-26-84	--	--	--	--	--	--	--	300	--	--	--	--
15-163	10-28-82	8.9	39000	980	35	.01	.12	.19	140	3.0	.3	430	520
15-163	06-04-84	9.3	55000	1100	38	<.01	<.10	.04	160	2.2	.3	708	580
15-597	05-31-84	5.3	32000	570	15	<.01	<.10	<.01	350	19	.1	906	720
Lower aquifer of the Potomac-Raritan-Magothy aquifer system													
15-139	09-26-80	8.9	4600	39	9.0	--	.00	.00	810	9.6	--	1510	1600
15-139	03-13-85	9.5	4800	20	9.0	<.01	<.10	.01	800	13	.5	1490	1500
15-139	11-10-86	9.5	6700	63	9.0	<.01	<.10	<.01	820	9.0	--	1490	1500
15-349	10-01-80	6.3	1800	610	15	--	2.60	.00	110	34	--	264	260
15-350	09-30-80	3.6	<3	<1	<1	--	.33	.00	370	8.9	--	780	750
15-350	10-31-84	4.1	3000	42	8.5	--	--	--	380	12	.9	802	820
15-398	11-17-86	12	73000	1100	31	<.01	<.10	<.01	140	4.6	--	389	460
15-615	02-28-85	12	7300	120	9.0	<.01	<.10	.01	830	14	.2	1530	1600
15-615	12-02-86	12	8300	150	9.6	<.01	<.10	<.01	790	12	--	1450	1500
15-615	12-02-86	12	8200	150	9.6	--	--	--	790	12	--	1340	1500
15-618	03-01-85	7.8	12000	130	8.2	<.01	<.10	<.01	450	10	.1	842	820
15-618	11-24-86	7.3	12000	120	8.5	<.01	<.10	<.01	400	10	--	779	770
15-634	10-08-86	27	180	860	9.7	<.01	<.10	<.01	520	660	--	2100	1900
15-712	12-16-86	18	18000	230	10	<.01	<.10	<.01	670	16	--	1190	1200
15-712	12-16-86	18	18000	220	10	--	--	--	670	16	--	1250	1200
15-712	03-19-87	18	18000	200	10	<.01	<.10	<.01	660	17	--	1240	1200
15-712	03-19-87	20	18000	200	10	--	--	--	660	15	--	1320	1200
33- 86	09-30-81	--	--	--	--	--	--	--	320	--	--	--	--
33- 86	10-21-82	4.2	5400	36	9.9	<.01	<.10	.20	310	16	.7	592	690
33- 86	11-04-83	--	--	--	--	--	--	--	290	--	--	--	--
33- 86	11-02-84	--	--	--	--	--	--	--	310	--	--	--	--
33- 86	09-11-85	--	--	--	--	--	--	--	250	--	--	--	--
33- 86	09-29-86	--	--	--	--	--	--	--	280	--	--	--	--
33- 86	08-21-87	--	--	--	--	--	--	--	270	--	--	--	--

[1] Results of analyses of ground-water samples form well 15-166 for 1958-79 also included.

Table 11.--Purgeable organic compounds in water from wells in the Logan Township region, New Jersey, 1980-87

[--, data not available; <, less than the detection limit; for example, "<1.0" means that the concentration in the sample is less than the detection limit of 0.01 µg/L; well locations shown on plate 1; all units micrograms per liter; USGS, U.S. Geological Survey; tot rec, total recoverable]

USGS well number	Date	Benzene total	Bromoform total	Carbontetrachloride total	Chlorobenzene total	Chlorodibromomethane total	Chloroethane total	2-Chloroethylvinylether total	Chloroform total	Dichlorobromomethane total
Upper aquifer of the Potomac-Raritan-Magothy aquifer system										
15-240	09-10-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-337	10-14-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-340	10-20-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-342	09-10-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-342	09-26-85	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-345	10-27-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-345	12-04-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-366	11-17-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-366	10-13-81	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-392	09-08-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-417	09-25-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
33- 74	10-03-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
33- 76	10-20-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
33- 76	08-13-87	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Middle aquifer of the Potomac-Raritan-Magothy aquifer system										
15-137	09-26-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-143	09-30-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-146	10-01-80	<1.0	<1.0	<1.0	--	<1.0	--	--	<1.0	<1.0
15-161	10-20-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-166	09-16-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-166	08-07-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-167	09-23-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-167	10-19-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-236	09-10-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-347	12-10-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-347	09-22-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-347	04-23-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-347	11-05-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-347	11-05-86	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-348	09-18-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-395	09-24-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-399	09-15-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-409	10-09-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-453	08-03-87	<15	<15	<15	<15	<15	<15	<15	<15	<15
15-539	05-17-84	<3.0	<3.0	<3.0	<3.0	<3.0	--	--	<3.0	<3.0
33- 83	10-09-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
33- 83	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33- 85	10-09-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
33- 85	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33-419	11-21-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
Area in which the middle and lower aquifers of the Potomac-Raritan-Magothy aquifer system are undifferentiated										
15-159	09-23-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-159	10-19-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-163	10-28-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-163	06-04-84	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-597	05-31-84	<3.0	<3.0	<3.0	<3.0	<3.0	--	--	<3.0	<3.0
Lower aquifer of the Potomac-Raritan-Magothy aquifer system										
15-139	09-26-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-139	11-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-349	10-01-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-350	09-30-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
15-615	04-17-87	.20	<.20	<.20	1.4	<.20	<.20	<.20	.20	<.20
15-615	12-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-618	04-22-87	0.30	<0.20	<0.20	0.40	<0.20	<0.20	<0.20	<0.20	<0.20
15-618	11-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-634	10-08-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-712	03-19-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
33- 86	10-09-80	<1.0	--	<1.0	--	<1.0	--	--	<1.0	<1.0
33- 86	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 11.--Purgeable organic compounds in water from wells in the Logan Township region, New Jersey, 1980-87--Continued

USGS well number	Date	Di-chloro-di-fluoro-methane total	1,1-Di-chloro-ethane total	1,2-Di-chloro-ethane total	1,1-Di-Chloro-ethyl-ene total	1,2 Cis and transdi-chloro-ethene total	1,2-Di-chloro-propane total	1,3-Di-chloro-propene total	Ethyl-benzene total	Methyl-bromide total
Upper aquifer of the Potomac-Raritan-Magothy aquifer system										
15-240	09-10-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-337	10-14-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-340	10-20-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-342	09-10-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-342	09-26-85	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-345	10-27-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-345	12-04-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-366	11-17-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-366	10-13-81	<1.0	<1.0	<1.0	--	<1.0	<1.0	<1.0	<1.0	<1.0
15-392	09-08-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-417	09-25-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
33- 74	10-03-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
33- 76	10-20-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
33- 76	08-13-87	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Middle aquifer of the Potomac-Raritan-Magothy aquifer system										
15-137	09-26-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-143	09-30-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-146	10-01-80	--	<1.0	<1.0	<1.0	<1.0	--	--	--	--
15-161	10-20-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-166	09-16-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-166	08-07-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-167	09-23-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-167	10-19-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-236	09-10-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-347	12-10-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-347	09-22-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-347	04-23-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-347	11-05-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-347	11-05-86	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-348	09-18-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-395	09-24-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-399	09-15-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-409	10-09-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-453	08-03-87	<15	<15	<15	<15	<15	<15	<15	42	45
15-539	05-17-84	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0	--
33- 83	10-09-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
33- 83	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33- 85	10-09-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
33- 85	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33-419	11-21-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
Area in which the middle and lower aquifers of the Potomac-Raritan-Magothy aquifer system are undifferentiated										
15-159	09-23-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-159	10-19-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-163	10-28-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-163	06-04-84	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-597	05-31-84	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--	<3.0	--
Lower aquifer of the Potomac-Raritan-Magothy aquifer system										
15-139	09-26-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-139	11-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-349	10-01-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-350	09-30-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
15-615	04-17-87	<.20	.20	.80	<.20	<.20	<.20	<.20	<.20	<.20
15-615	12-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-618	04-22-87	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20	<.20
15-618	11-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-634	10-08-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-712	03-19-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
33- 86	10-09-80	--	<1.0	<1.0	--	<1.0	--	--	--	--
33- 86	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 11.--Purgeable organic compounds in water from wells in the Logan Township region, New Jersey, 1980-87--Continued

USGS well number	Date	Methylene chloride total	1,1,2,2 tetrachloroethane total	Tetrachloroethylene total	Toluene total	1,1,1-Trichloroethane total	1,1,2-Trichloroethane total	Trichloroethylene total	Trichlorofluoromethane total	Vinyl chloride total
Upper aquifer of the Potomac-Raritan-Magothy aquifer system										
15-240	09-10-80	<1.0	--	<1.0	4.0	<1.0	--	<1.0	--	--
15-337	10-14-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-340	10-20-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-342	09-10-80	<1.0	--	<1.0	3.0	<1.0	--	<1.0	--	--
15-342	09-26-85	<3.0	<3.0	<3.0	<3.0	4.2	<3.0	<3.0	<3.0	<3.0
15-345	10-27-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-345	12-04-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-366	11-17-80	<1.0	--	<1.0	1.7	<1.0	--	<1.0	--	--
15-366	10-13-81	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-392	09-08-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-417	09-25-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
33- 74	10-03-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
33- 76	10-20-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
33- 76	08-13-87	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.20	<0.20
Middle aquifer of the Potomac-Raritan-Magothy aquifer system										
15-137	09-26-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-143	09-30-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-146	10-01-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-161	10-20-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-166	09-16-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-166	08-07-87	<.20	<.20	<.20	<.20	<.20	<.20	<.2	<.20	<.20
15-167	09-23-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-167	10-19-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-236	09-10-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-347	12-10-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-347	09-22-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-347	04-23-87	<.20	<.20	<.20	<.20	.20	<.20	2.6	<.20	<.20
15-347	11-05-87	<.20	<.20	<.20	<.20	.20	<.20	2.6	<.20	<.20
15-347	11-05-86	<.20	<.20	<.20	<.20	.40	<.20	2.5	<.20	<.20
15-348	09-18-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-395	09-24-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-399	09-15-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-409	10-09-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-453	08-03-87	43	<15	<15	270	<15	<15	<15.0	<15	<15
15-539	05-17-84	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--
33- 83	10-09-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
33- 83	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33- 85	10-09-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
33- 85	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33-419	11-21-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
Area in which the middle and lower aquifers of the Potomac-Raritan-Magothy aquifer system are undifferentiated										
15-159	09-23-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-159	10-19-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-163	10-28-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15-163	06-04-84	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-597	05-31-84	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--
Lower aquifer of the Potomac-Raritan-Magothy aquifer system										
15-139	09-26-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-139	11-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-349	10-01-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-350	09-30-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
15-615	04-17-87	<.20	<.20	.20	<.20	<.20	<.20	<.2	<.20	<.20
15-615	12-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-618	04-22-87	<.20	<.20	<.20	.40	<.20	<.20	<.2	<.20	<.20
15-618	11-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-634	10-08-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-712	03-19-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
33- 86	10-09-80	<1.0	--	<1.0	<1.0	<1.0	--	<1.0	--	--
33- 86	10-21-82	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 11.--Purgeable organic compounds in water from wells in the Logan Township region, New Jersey, 1980-87--Continued

USGS well number	Date	Methyl-chloride total	1,2-Dibromo ethylene total	1,2-Dichlorobenzene total	1,3-Dichlorobenzene total	1,4-Dichlorobenzene total	Cis 1,3-Dichloropropene total	Trans-1,3-Dichloropropene total	Styrene total	Xylene total water whole tot rec
Upper aquifer of the Potomac-Raritan-Magothy aquifer system										
15-240	09-10-80	--	--	--	--	--	--	--	--	--
15-337	10-14-80	--	--	--	--	--	--	--	--	--
15-340	10-20-80	--	--	--	--	--	--	--	--	--
15-342	09-10-80	--	--	--	--	--	--	--	--	--
15-342	09-26-85	--	--	--	--	--	--	--	--	--
15-345	10-27-80	--	--	--	--	--	--	--	--	--
15-345	12-04-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-366	11-17-80	--	--	--	--	--	--	--	--	--
15-366	10-13-81	--	--	--	--	--	--	--	--	--
15-392	09-08-80	--	--	--	--	--	--	--	--	--
15-419	09-25-89	--	--	--	--	--	--	--	--	--
33- 74	10-03-80	--	--	--	--	--	--	--	--	--
33- 76	10-20-80	--	--	--	--	--	--	--	--	--
33- 76	08-13-87	<0.20	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2
Middle aquifer of the Potomac-Raritan-Magothy aquifer system										
15-137	09-26-80	--	--	--	--	--	--	--	--	--
15-143	09-30-80	--	--	--	--	--	--	--	--	--
15-146	10-01-80	--	--	--	--	--	--	--	--	--
15-161	10-20-82	--	--	--	--	--	--	--	--	--
15-166	09-16-80	--	--	--	--	--	--	--	--	--
15-166	08-07-87	<.20	<.2	<.20	<.20	<.20	<.20	<.20	<.2	<.2
15-167	09-23-80	--	--	--	--	--	--	--	--	--
15-167	10-19-82	--	--	--	--	--	--	--	--	--
15-236	09-10-80	--	--	--	--	--	--	--	--	--
15-347	12-10-80	--	--	--	--	--	--	--	--	--
15-347	09-22-82	--	--	--	--	--	--	--	--	--
15-347	04-23-87	<.20	<.2	<.20	<.20	<.20	<.20	<.20	<.2	<.2
15-347	11-05-87	<.20	<.2	<.20	<.20	<.20	<.20	<.20	<.2	<.2
15-347	11-05-86	<.20	<.2	<.20	<.20	<.20	<.20	<.20	<.2	<.2
15-348	09-18-80	--	--	--	--	--	--	--	--	--
15-395	09-24-80	--	--	--	--	--	--	--	--	--
15-399	09-15-80	--	--	--	--	--	--	--	--	--
15-409	10-09-80	--	--	--	--	--	--	--	--	--
15-453	08-03-87	<15.0	<15	<15.0	<15.0	<15.0	<15.0	<15.0	<15	850
15-539	05-17-84	--	--	--	--	--	--	--	--	--
33- 83	10-09-80	--	--	--	--	--	--	--	--	--
33- 83	10-21-82	--	--	--	--	--	--	--	--	--
33- 85	10-09-80	--	--	--	--	--	--	--	--	--
33- 85	10-21-82	--	--	--	--	--	--	--	--	--
33-419	11-21-80	--	--	--	--	--	--	--	--	--
Area in which the middle and lower aquifers of the Potomac-Raritan-Magothy aquifer system are undifferentiated										
15-159	09-23-80	--	--	--	--	--	--	--	--	--
15-159	10-19-82	--	--	--	--	--	--	--	--	--
15-163	10-28-82	--	--	--	--	--	--	--	--	--
15-163	06-04-84	--	--	<1.0	<1.0	<1.0	--	--	--	--
15-597	05-31-84	--	--	--	--	--	--	--	--	--
Lower aquifer of the Potomac-Raritan-Magothy aquifer system										
15-139	09-26-80	--	--	--	--	--	--	--	--	--
15-139	11-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-349	10-01-80	--	--	--	--	--	--	--	--	--
15-350	09-30-80	--	--	--	--	--	--	--	--	--
15-615	04-17-87	<.20	<.2	<.20	<.20	<.20	<.20	<.20	<.2	<.2
15-615	12-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-618	04-22-87	<.20	<.2	<.20	<.20	<.20	<.20	<.20	<.2	<.2
15-618	11-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15-634	10-08-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	--
15-712	03-19-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
33- 86	10-09-80	--	--	--	--	--	--	--	--	--
33- 86	10-21-82	--	--	--	--	--	--	--	--	--

Table 12.--Selected pesticides and herbicides in water from wells in the Logan Township region, New Jersey, 1980-87

[Total constituents; all units micrograms per liter; well locations shown on plate 1; DDD, Dichlorodiphenyldichloroethane; DDE, Dichlorodiphenyldichloroethylene; DDT, Dichlorodiphenyltrichloroethane; PCB's, Polychlorinated biphenyls; --, data not available; < Less than the detection limit; for example, "<0.01 " means that the concentration in the sample is less than the detection limit of 0.01 μg/L; USGS, U.S. Geological Survey]

Upper aquifer of the Potomac-Raritan-Magothy aquifer system

Organochlorine insecticides

USGS well number	Date	Aldrin	Lindane	Chlordane	DDD	DDE	DDT	Perthane	Mirex
15-345	12-04-86	--	--	--	--	--	--	--	--
15-564	11-25-86	--	--	--	--	--	--	--	--
15-564	11-25-86	--	--	--	--	--	--	--	--
15-728	04-22-87	--	--	--	--	--	--	--	--
33-370	07-17-86	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.1	<0.01
33-439	07-25-86	<.01	<.01	<.1	<.01	<.01	<.01	<.1	<.01
33-439	08-13-87	<.01	<.01	<.1	<.01	<.01	<.01	<.1	<.01

USGS well number	Date	Dieldrin	Endosulfan	Endrin	Toxaphene	Heptachlor	Heptachlor epoxide	Methoxychlor	PCB's Total
15-345	12-04-86	--	--	--	--	--	--	--	--
15-564	11-25-86	--	--	--	--	--	--	--	--
15-564	11-25-86	--	--	--	--	--	--	--	--
15-728	12-03-86	--	--	--	--	--	--	--	--
33-370	07-17-86	<0.01	<0.01	<0.01	<1	<0.01	<0.01	<0.01	<0.1
33-439	07-25-86	<.01	<.01	<.01	<1	<.01	<.01	<.01	<.1
33-439	08-13-87	<.01	<.01	<.01	<1	<.01	<.01	<.01	<.1

Organophosphorus insecticides

USGS well number	Date	Parathion	Diazinon	Total trithion	Methyl trithion	Malathion	Ethion
15-345	12-04-86	--	--	--	--	--	--
15-564	11-25-86	--	--	--	--	--	--
15-564	11-25-86	--	--	--	--	--	--
15-728	12-03-86	--	--	--	--	--	--
33-370	07-17-86	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
33-439	07-25-86	<.01	<.01	<.01	<.01	<.01	<.01
33-439	08-13-87	<.01	<.01	<.01	<.01	<.01	<.01

Triazine herbicides

USGS well number	Date	Propazine	Simetryne	Simazine	Prometon	Prometryne	Atrazine	Cyanazine	Ametryne
15-345	12-04-86	<0.10	<0.1	<0.10	<0.1	<0.1	<0.10	<3.0	--
15-564	11-25-86	<.10	<.1	<.10	<.1	<.1	.50	<.10	<.10
15-564	11-25-86	<.10	<.1	<.10	<.1	<.1	.40	<.10	<.10
15-728	12-03-86	<.10	<.1	<.10	<.1	<.1	<.10	<.10	<.10
33-370	07-17-86	<.10	<.1	<.10	<.1	<.1	<.10	<.10	<.10
33-439	07-25-86	<.10	<.1	<.10	<.1	<.1	<.10	<.10	<.10
33-439	08-13-87	<.10	<.1	<.10	<.1	<.1	.10	<.10	<.10

Chlorophenoxy acid herbicides

USGS well number	Date	2,4-D	2,4-DP	Silvex	2,4,5-T
33-439	08-13-87	<0.01	<0.01	<0.01	<0.01

Table 12.--Selected pesticides and herbicides in water from wells in the Logan Township region, New Jersey, 1980-87--Continued

Middle aquifer of the Potomac-Raritan-Magothy aquifer system

Organochlorine insecticides

USGS well number	Date	Aldrin	Lindane	Chlor-dane	DDD	DDE	DDT	Per-thane	Mirex
15-144	07-14-86	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.1	<0.01
15-166	06-16-86	<.01	<.01	<.1	<.01	<.01	<.01	<.1	<.01
15-166	08-07-87	<.01	<.01	<.1	<.01	<.01	.01	<.1	<.01
15-348	07-14-86	<.01	<.01	<.1	<.01	<.01	<.01	<.1	<.01
15-453	06-06-86	<.01	<.01	<.1	<.01	<.01	<.01	<.1	<.01
15-453	08-03-87	<.01	<.01	<.1	<.01	<.01	<.01	<.1	<.01
15-713	12-03-86	--	--	--	--	--	--	--	--

USGS well number	Date	Di-eldrin	Endo-sulfan	Endrin	Tox-aphene	Hepta-chlor	Hepta-chlor-epoxide	Meth-oxy-chlor	PCB's total
15-144	07-14-86	<0.01	<0.01	<0.01	<1	<0.01	<0.01	<0.01	<0.1
15-166	06-16-86	.01	<.01	<.01	<1	<.01	<.01	<.01	<.1
15-166	08-07-87	.04	<.01	<.01	<1	<.01	<.01	<.01	<.1
15-348	07-14-86	<.01	<.01	<.01	<1	<.01	<.01	<.01	<.1
15-453	06-06-86	<.01	<.01	<.01	<1	<.01	<.01	<.01	<.1
15-453	08-03-87	<.01	<.01	<.01	<1	<.01	<.01	<.01	<.1
15-713	12-03-86	--	--	--	--	--	--	--	--

Organophosphorus insecticides

USGS well number	Date	Para-thion	Di-azinon	Total tri-thion	Methyl tri-thion	Mala-thion	Ethion
15-144	07-14-86	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
15-166	06-16-86	<.01	<.01	<.01	<.01	<.01	<.01
15-166	08-07-87	<.01	<.01	<.01	<.01	<.01	<.01
15-348	07-14-86	<.01	<.01	<.01	<.01	<.01	<.01
15-453	06-06-86	<.01	<.01	<.01	<.01	<.01	<.01
15-453	08-03-87	<.01	<.01	<.01	<.01	<.01	<.01
15-713	12-03-86	--	--	--	--	--	--

Triazine herbicides (total)

USGS well number	Date	Pro-pazine	Sime-tryne	Sima-zine	Prome-ton	Prome-tryne	Atra-zine	Cyan-azine	Ame-tryne
15-144	07-14-86	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
15-166	06-16-86	<.1	<.1	<.1	<.1	<.1	.1	<.1	<.1
15-166	08-07-87	<.1	<.1	.2	<.1	<.1	.2	<.1	<.1
15-348	07-14-86	<.1	<.1	<.1	<.1	<.1	<.1	--	--
15-453	06-06-86	<.1	<.1	.1	<.1	<.1	.8	<.1	<.1
15-453	08-03-87	<.1	<.1	.1	<.1	<.1	<.1	<.1	<.1
15-713	12-03-86	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1

Table 12.--Selected pesticides and herbicides in water from wells in the Logan Township region, New Jersey, 1980-87--Continued

Middle aquifer of the Potomac-Raritan-Magothy aquifer system--Continued

Chlorophenoxy acid herbicides

USGS well number	Date	2,4-D	2,4-DP	Silvex	2,4,5-T
15-166	08-07-87	<0.02	<0.01	<0.01	<0.01
15-453	08-03-87	<.01	<.01	<.01	<.01

Area in which the middle and lower aquifers of the Potomac-Raritan-Magothy aquifer system are undifferentiated

Organochlorine insecticides

USGS well number	Date	Aldrin	Lindane	Chlor-dane	DDD	DDE	DDT	Per-thane	Mirex
15-163	06-04-84	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.1	<0.01

USGS well number	Date	Di-eldrin	Endo-sulfan	Endrin	Tox-aphene	Hepta-chlor	Hepta-chlor-epoxide	Meth-oxy-chlor	PCB's Total
15-163	06-04-84	<0.01	<0.01	<0.01	<1	<0.01	<0.01	<0.01	<0.1

*U.S. GOVERNMENT PRINTING OFFICE:1991-612-329