Prepared in cooperation with the
New Jersey Department of Environmental Protection

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Scientific Investigations Report 2008-5145

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Conversion Factors, Datums, and Abbreviations

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon per day (gal/d)	0.003785	cubic meter per day (m^3/d)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
	Transmissivity*	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)
	Water -Quality Abbreviations	
mg/L	milligrams per liter (parts per million)	
g/cm^3	grams per cubic centimeter	

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above or below the vertical datum.

*Transmissivity: The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness [(ft^3/d)/ft^2]ft. In this report, the mathematically reduced form, foot squared per day (ft^2/d), is used for convenience.

Water-level conditions in selected confined aquifers of the New Jersey and Delaware Coastal Plain, 2003

By Vincent T. dePaul, Robert Rosman, and Pierre J. Lacombe

Abstract

The Coastal Plain aquifers of New Jersey provide an important source of water for more than 2 million people. Steadily increasing withdrawals from the late 1800s to the early 1990s resulted in declining water levels and the formation of regional cones of depression. In addition to decreasing water supplies, declining water levels in the confined aquifers have led to reversals in natural hydraulic gradients that have, in some areas, induced the flow of saline water from surface-water bodies and adjacent aquifers to freshwater aquifers. In 1978, the U.S. Geological Survey began mapping the potentiometric surfaces of the major confined aquifers of New Jersey every 5 years in order to provide a regional assessment of ground-water conditions in multiple Coastal Plain aquifers concurrently. In 1988, mapping of selected potentiometric surfaces was extended into Delaware.

During the fall of 2003, water levels measured in 967 wells in New Jersey, Pennsylvania, northeastern Delaware, and northwestern Maryland were used to estimate the potentiometric surface of the principal confined aquifers in the Coastal Plain of New Jersey and five equivalent aquifers in Delaware. Potentiometric-surface maps and hydrogeologic sections were prepared for the confined Cohansey aquifer of Cape May County, the Rio Grande water-bearing zone, the Atlantic City 800-foot sand, the Vincentown aquifer, and the Englishtown aquifer system in New Jersey, as well as for the Piney Point aquifer, the Wenonah-Mount Laurel aquifer, and the Upper Potomac-Raritan-Magothy, the Middle and undifferentiated Potomac-Raritan-Magothy, and the Lower Potomac-Raritan-Magothy aquifers in New Jersey and their equivalents in Delaware.

From 1998 to 2003, water levels in many Coastal Plain aquifers in New Jersey remained stable or had recovered, but in some areas, water levels continued to decline as a result of pumping. In the Cohansey aquifer in Cape May County, water levels near the center of the cone of depression underlying the southern part of the peninsula remained about the same as in 1998. To the south, recoveries up to 8 feet were observed in southern Lower Township as withdrawals had decreased since 1998. In the northern part of Cape May County, water levels had not changed substantially from historic conditions. In the Rio Grande water-bearing zone, water levels rose by as much as 13 ft at the Rio Grande well field; elsewhere across the aquifer, little change had occurred.

In the Atlantic City 800-foot sand, water-level changes were greatest in southern Cape May County; at the Cape May desalination wells, water levels were as much as 32 ft lower in 2003 than in 1998. In contrast, water levels at the center of a regional cone of depression near Atlantic City rose by as much as 10 ft. Within the Piney Point aquifer water levels rose by 46 ft near Seaside Park. Similarly, water levels increased by more than 30 ft in and around the major cone of depression underlying Dover, Delaware. In the Vincentown aquifer, water levels stabilized or recovered by 2 ft to 6 ft from 1998 to 2003 in most of the wells measured; the exception is near Adelphia in Monmouth County, where water levels rose by as much as 18 ft.

From 1998 to 2003, water levels near the center of a large cone of depression that extends from Monmouth to Ocean County recovered by as much as 20 ft in the Wenonah-Mount Laurel aquifer. Concurrently, ground-water levels within the Englishtown aquifer system declined by as much as 13 ft in the same area. Water levels across much of the Upper Potomac-Raritan-Magothy aquifer in the northern Coastal Plain remained about the same as 5 years previous, except in northern Ocean County where ground-water levels declined 10 ft to 33 ft. Water levels in the Middle Potomac-Raritan-Magothy aquifer declined from 5 to 9 ft along the border between Monmouth and Middlesex County. Elsewhere, across the northern part of the Coastal Plain, water levels stabilized within the Cretaceous-age aquifers.

In southern New Jersey, regional cones of depression persist in the Potomac-Raritan-Magothy aquifer system in Burlington, Camden, and Gloucester Counties. From 1998 to 2003, water levels in these large cones were generally stable or recovering across much of southern New Jersey; recoveries from 5 ft to 10 ft occurred in all three aquifers, and exceeded 20 ft in places within the Lower aquifer. In contrast, water

levels declined near the center of the cone of depression within the Lower aquifer in central Camden County. Water levels in the Middle Potomac-Raritan-Magothy aquifer declined by as much 7 ft in central New Castle County, Delaware; however, those within the major cone of depression in the Lower aquifer stabilized from 1998 to 2003. In general, water levels across the Wenonah-Mount Laurel aquifer recovered in Burlington, Camden, and Gloucester Counties from 1998 to 2003; rises of nearly 30 ft were observed in central Gloucester County.

Introduction

Ground-water withdrawals from the Coastal Plain aquifers in New Jersey have increased steadily from less than 50 Mgal/d prior to 1920 to more than 300 Mgal/d in the late 1980s and early 1990s (unpublished data on file at the U.S. Geological Survey (USGS), New Jersey Water Science Center). As a result of extensive ground-water development, water levels in the confined aquifers have steadily declined, and regional cones of depression have formed. In addition to decreasing water supplies, declining water levels in these aquifers have caused reversals in natural hydraulic gradients. These reversals have induced local incursion of brackish or saline water from surface-water bodies and adjacent aquifers.

Prior to 1978, ground-water levels were measured and cones of depression were mapped in response to local hydrologic issues. In order to provide water-supply managers, regulators, and scientists with a regional assessment of ground-water conditions in multiple aquifers as well as insight into past and future water-management practices, the USGS, in cooperation with the New Jersey Department of Environmental Protection (NJDEP), initiated a plan in 1978 to map the potentiometric surfaces of the major confined aquifers on a 5-year cyclical basis. In 1988, the plan of study was expanded to include water-level measurements in Delaware in order to better define cones of depression that propagated beneath the Delaware River and Bay. In 1998, wells in northeastern Maryland were added to the plan to further define the cones of depression in Delaware. To date potentiometric surfaces in 1978, 1983, 1988, 1993, and 1998 have been mapped.

In 1985, concern over the long-term decline in water levels in areas where ground water was the primary source of supply prompted the NJDEP to designate two water supply Critical Areas in the New Jersey Coastal Plain; Critical Area 1 (CA 1) is in the east-central part of the State, and Critical Area 2 (CA 2), is in the Camden area. Each Critical Area comprises a depleted zone and a threatened margin. The boundary of the depleted zone corresponds to the average 30-ft below potentiometric contour (referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29)) in each of the specified aquifers, based on the 1983 maps by Eckel and Walker (1986), and is composited at land surface (fig. 1). A 3-mi margin, known as the threatened margin, surrounds the depleted zone and addresses the potential for saltwater intrusion as a result of the decline in water levels.

CA 1, designated in 1985, encompasses parts of Middlesex, Monmouth, and Ocean Counties (fig. 1). Withdrawal restrictions for CA 1 apply to the Wenonah-Mount Laurel aquifer, the Englishtown aquifer system, and the Upper and Middle Potomac-Raritan-Magothy (PRM) aquifers. Ground-water withdrawals from production wells within the depleted zones of the Wenonah-Mount Laurel aquifer, the Englishtown aquifer system, and the Middle PRM aquifer were reduced by 50 percent of 1983 volumes, whereas those in the Upper PRM were reduced by 40 percent of 1983 volumes. Within the threatened margin, allocated withdrawals remain at 1983 volumes (New Jersey Administrative Code, 2005). Withdrawal restrictions in CA 1 were implemented in 1989, but because access to alternate water supplies was not initially available, compliance by most individual purveyors was deferred until 1991.

In an effort to stabilize declining water levels and retard the movement of saltwater from Gloucester County and downdip areas toward the Camden area cone of depression, CA 2 was designated in early 1993. The management area encompasses Camden, most of Burlington and Gloucester, and parts of Atlantic, Cumberland, Ocean, Monmouth, and Salem Counties (fig. 1), although regulations are most relevant to the first three counties. Restrictions on ground-water withdrawals apply only to the aquifers of the Potomac-Raritan-Magothy system and began in 1996. Ground-water withdrawals in the depleted zone were reduced by an average of 22 percent relative to 1983 volumes, whereas, within the threatened margin, withdrawals are limited to the maximum annual volume between 1983 and 1991 (New Jersey Administrative Code, 2005).

Specific water-supply measures introduced to curtail ground-water withdrawals include the use of the Manasquan Reservoir, completed in 1990 in Critical Area 1, which can supply the region with approximately 30 Mgal/d of surface water (New Jersey Water Supply Authority, 2005). The Tri-County Pipeline in Critical Area 2 began operation in 1996 and provides water from the Delaware River to users in Burlington, Camden, and Gloucester Counties. Reductions in ground-water withdrawals along with the use of these alternative surface-water sources have resulted in substantial rises in water levels in these State-regulated Critical Areas.

Purpose and Scope

The purpose of this report is to document ground-water levels and regional potentiometric surfaces during 2003 for 10 confined aquifers of the New Jersey Coastal Plain and 5 equivalent aquifers in northern Delaware. Selected hydrographs illustrate seasonal variations and the long-term effects of ground-water withdrawals. This report includes estimated water withdrawals from the 10 confined aquifers in New Jersey for 1978–2003. Withdrawals also are reported for the five equivalent aquifers in Delaware for 1978–2001. Basic well-characteristic and water-level data from 1978 to 2003 are presented in the appendixes. This report is the sixth in the series of reports that show the potentiometric surfaces for the major confined aquifers of the New Jersey Coastal Plain.

Description of Study Area

The study area (fig. 1) is about 7,700 mi^2 and encompasses the Coastal Plain of New Jersey and Pennsylvania, the Delaware Bay, and parts of the Coastal Plain in Maryland and Delaware, as well as the nearshore areas of both New Jersey and Delaware. The area of study focuses on Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Monmouth, Ocean, Salem, and parts of Mercer and Middlesex Counties in New Jersey; Kent and New Castle Counties in Delaware; parts of Philadelphia County in Pennsylvania; and Cecil, Kent, Queen Anne's, and Caroline Counties in Maryland. The New Jersey counties of Mercer, Middlesex, Monmouth and Ocean are referred to in this report as the northern counties; the remaining counties within the State are referred to as the southern counties.

Hydrogeologic Framework

The Coastal Plain Province of New Jersey and Delaware consists of a southeastward dipping and thickening wedge of unconsolidated deposits of sand, silt, and clay of Cretaceous to Tertiary age underlain by basement rocks and overlain by a veneer of locally occurring Quaternary sediments. Coastal Plain sediments were deposited in various shelf, marginal marine, nearshore or coastal beach, and deltaic environments, the extent of which fluctuated in response to relative changes in sea level. Units composed of distinctly less permeable sediments (predominantly clays and fine-grained silts) form the confining units, and the more permeable sand units form the aquifers. These deposits are less than 50 ft thick along the western limit of the Coastal Plain (Fall Line) and thicken to more than 6,500 ft in southern Cape May County. Coastal Plain sediments of Cretaceous and Tertiary age generally strike northeast-southwest and dip 10 to 60 ft/mi to the southeast (Zapecza, 1989); overlying Quaternary deposits are flat. Many of these units crop out near the Fall Line parallel to strike, transitioning into unconfined aquifers; others such as the Piney Point aquifer are wholly confined within the study area. Abundant freshwater available from these aquifers has enabled the development of many areas within the Coastal Plain by a large population.

The aquifers and confining units discussed in this report range in age from Cretaceous to Tertiary (table 1). A brief description of each aquifer is included in each section; for a more detailed discussion, Zapecza (1989) describes the hydrogeology of New Jersey and Vroblesky and Fleck (1991), the hydrogeology of Delaware and Maryland. Sections A-A', B-B', and C-C' in figure 2a–c show the relative positions of the aquifers and confining units in the northern, central, and southern New Jersey Coastal Plain.

Well-Numbering System

The well numbering system used in this report consists of a county code number followed by a sequence number for wells within that county. For example, well number 15-123 is the 123rd well inventoried in Gloucester County. The codes for New Jersey, Pennsylvania, and Maryland Counties used in this report are listed in table 2. Well identifiers in Delaware are assigned by the Delaware Geological Survey and are numbered on the basis of a coordinate system using 5-minute quadrangles of latitude and longitude.

Previous Investigations

Previous potentiometric-surface maps in this series show ground-water levels in the study area at 5-year intervals from 1978 through 1998: 1978, Walker (1983); 1983, Eckel and Walker (1986); 1988, Rosman and others (1996); and 1993 and 1998, Lacombe and Rosman (1997, 2001). This series is supplemented by water-table maps for the unconfined aquifers within the following basins of the New Jersey Coastal Plain: Mullica River Basin (Johnson and Watt, 1996); Salem River, Raccoon, Oldmans, Alloway, and Stow Creek Basins (Johnson and Charles, 1997); Upper Maurice River Basin (Lacombe and Rosman, 1995); Great Egg Harbor River Basin (Watt and Johnson, 1992); Rancocas, Crosswicks, Assunpink, Blacks and Crafts Creek Basins (Watt and others, 2003); and the Toms River, Metedeconk River, and Kettle Creek Basins (Watt and others, 1994).

Data Collection and Analysis

Static water-level altitudes were measured in 881 wells in New Jersey, Pennsylvania, and Maryland by USGS personnel. Water levels were measured in an additional 86 wells in Delaware by Delaware Geological Survey personnel. Water levels, which were measured during late October to mid-December 2003, approximate annual average water levels in the study area. Low water levels typically occur during the late summer and early fall, and high water levels are observed during spring.

Water levels were measured in industrial-, commercial-, irrigation-, and domestic-supply wells, production wells, and observation wells; wells were chosen on the basis of areal distribution within each aquifer. Water-level altitudes were measured using steel or electric measuring tapes, which are the most accurate devices, or by using an airline, which is the least accurate. Because accuracies of 1 ft or less are not typical, the airline method was used in limited instances and only at sites that were inaccessible for measuring by either electric or steel tape. Measurements made at observation wells represent

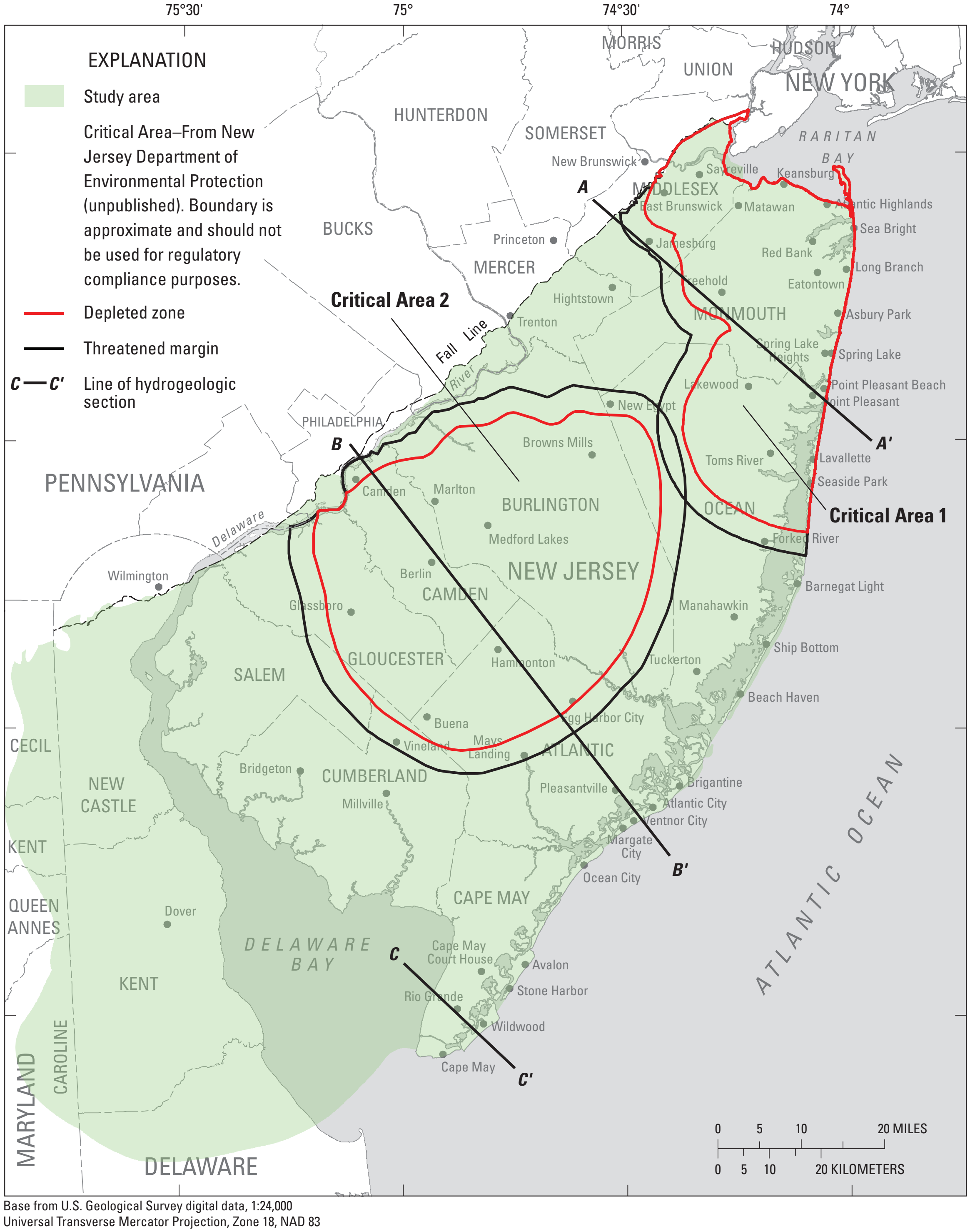


Figure 1. Location of the study area, New Jersey and Delaware Coastal Plain.

Table 1. Geologic and hydrogeologic units of the New Jersey Coastal Plain and hydrogeologic units of the Delaware Coastal Plain.

[Shaded units are those discussed in this report; *, not designated as a formal aquifer by Zapecza (1989)]

SYSTEM	SERIES	GEOLOGIC UNIT	NEW JERSEY HYDROGEOLOGIC UNIT	DELAWARE HYDROGEOLOGIC UNIT
Quaternary	Holocene	Alluvial deposits	Undifferentiated	
		Beach sand and gravel		
	Pleistocene	Cape May Formation	Kirkwood-Cohansey aquifer system	Columbia group
Tertiary	Miocene	Pennsauken Formation		Chesapeake Group
		Bridgeton Formation	Kirkwood-Cohansey aquifer system	Pocomoke aquifer
		Beacon Hill Gravel		
		Cohansey Sand		Manokin aquifer
		Kirkwood Formation	Cohansey aquifer	Confining unit
				Frederica aquifer
				Confining unit
			"Upper" Wildwood-Belleplain confining unit	Federalsburg aquifer
			Rio Grande water-bearing zone	Confining unit
			"Lower" Wildwood-Belleplain confining unit	Cheswold aquifer
			Atlantic City 800-foot sand	
	Oligocene	Piney Point Formation	Composite confining unit	
	Eocene	Shark River Formation	Piney Point aquifer	Piney Point aquifer
		Manasquan Formation		Rancocas aquifer
	Paleocene	Vincentown Formation	Vincentown aquifer	
		Hornerstown Sand	Hornerstown Sand*	Confining unit
Cretaceous	Upper Cretaceous	Tinton sand		
		Red Bank Sand	Red Bank Sand	
		Navesink Formation		
		Mount Laurel Sand	Wenonah-Mount Laurel aquifer	Mount Laurel aquifer
		Wenonah Formation		
		Marshalltown Formation	Marshalltown-Wenonah confining unit	Confining unit
		Englishtown Formation	Englishtown aquifer system	Englishtown aquifer
		Woodbury Clay	Merchantville-Woodbury confining unit	Confining unit
		Merchantville Formation		
		Magothy Formation	Potomac-Raritan-Magothy aquifer system: Upper aquifer	Magothy aquifer
		Raritan Formation	Confining unit	Confining unit
			Middle aquifer	Upper and Middle Potomac aquifers
		Potomac group	Confining unit	Confining unit
	Lower Cretaceous		Lower aquifer	Lower Potomac aquifer
Pre Cretaceous		Bedrock	Bedrock confining unit	Bedrock confining unit

Modified from Zapecza; 1989, Sugarman, 2001

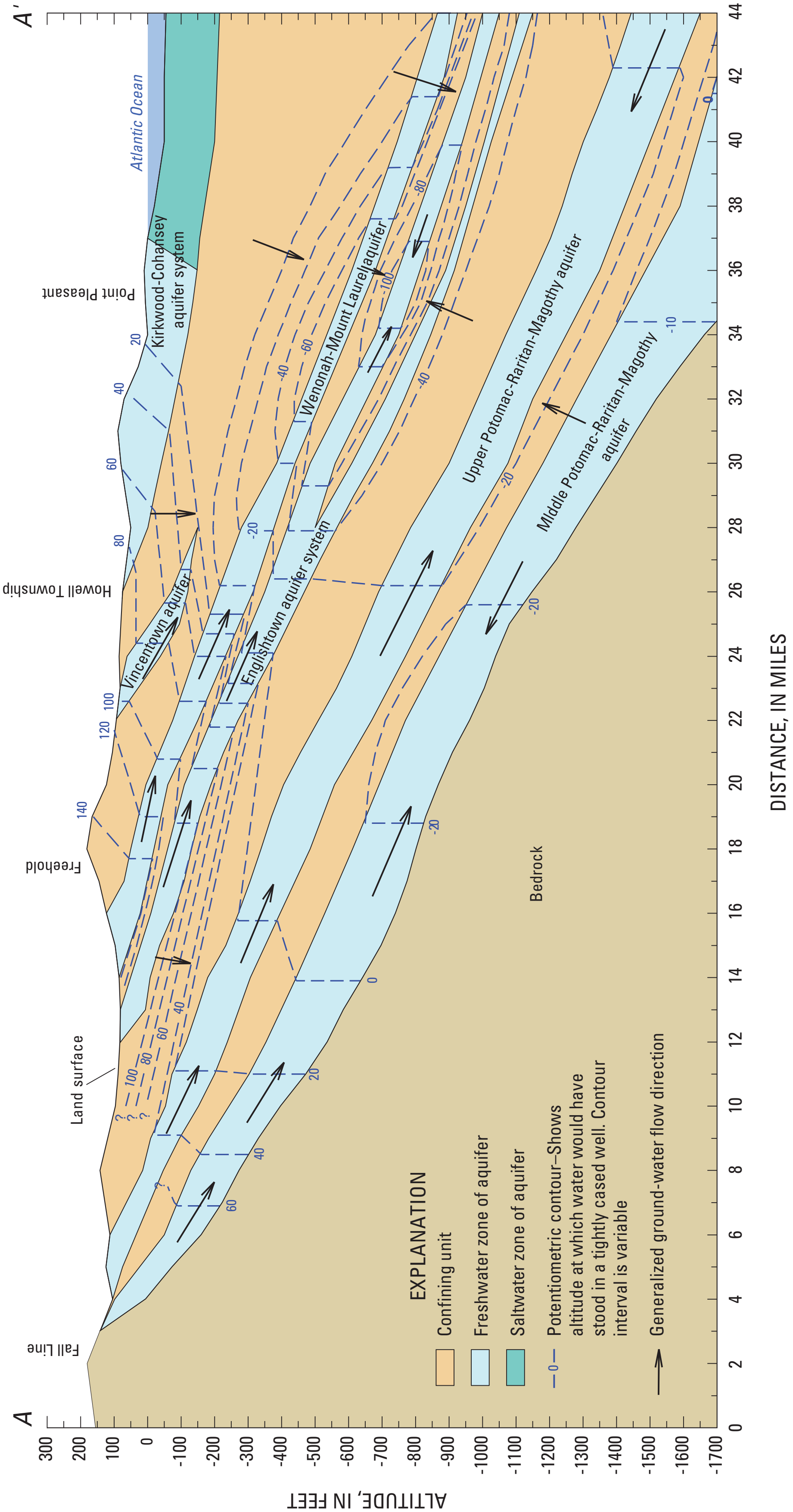


Figure 2a. Section *A-A′* showing potentiometric-surface contours in aquifers of the northern New Jersey Coastal Plain, 2003.

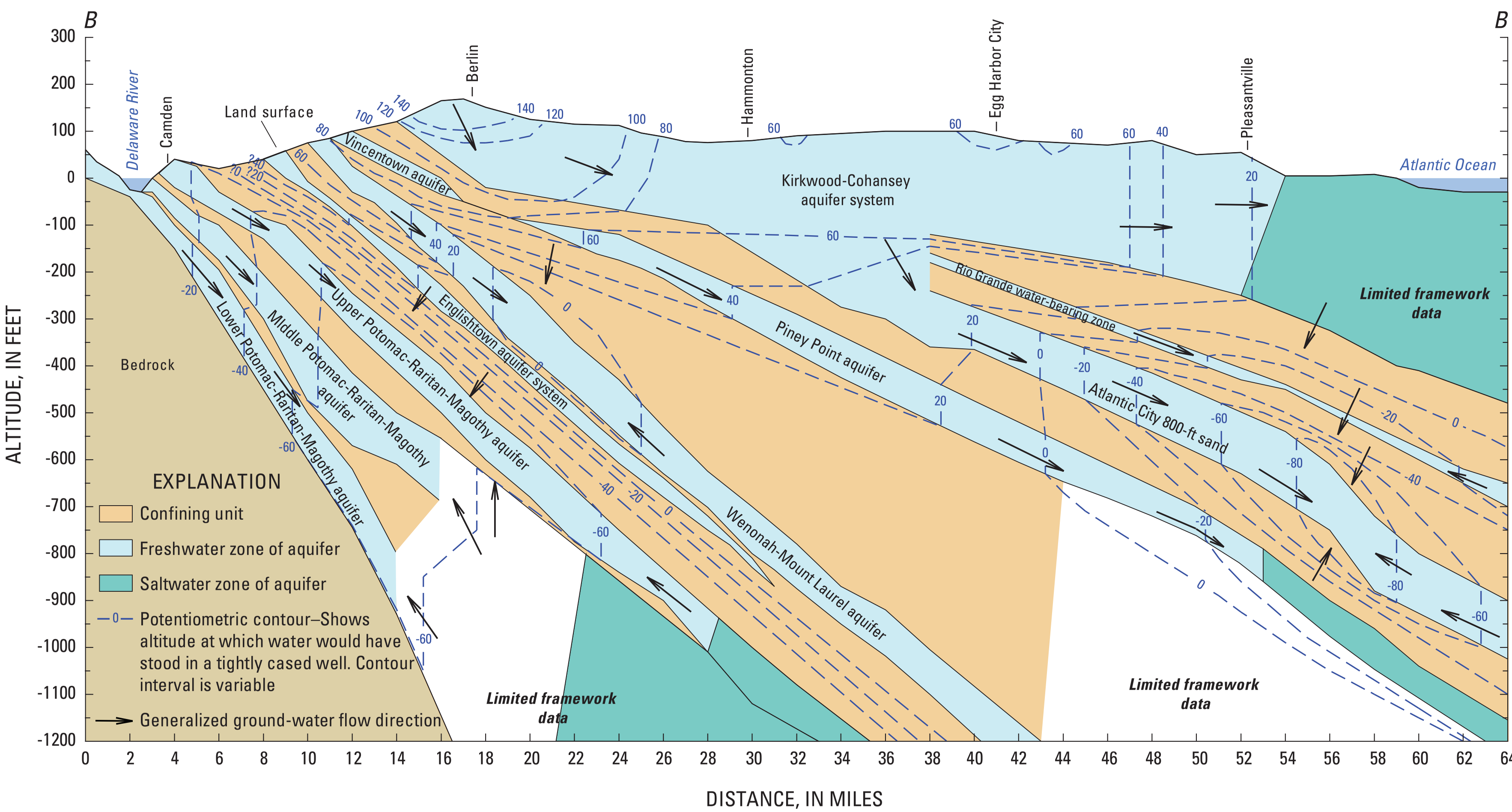


Figure 2b. Section *B-B′* showing potentiometric-surface contours in aquifers of the southern New Jersey Coastal Plain, 2003.

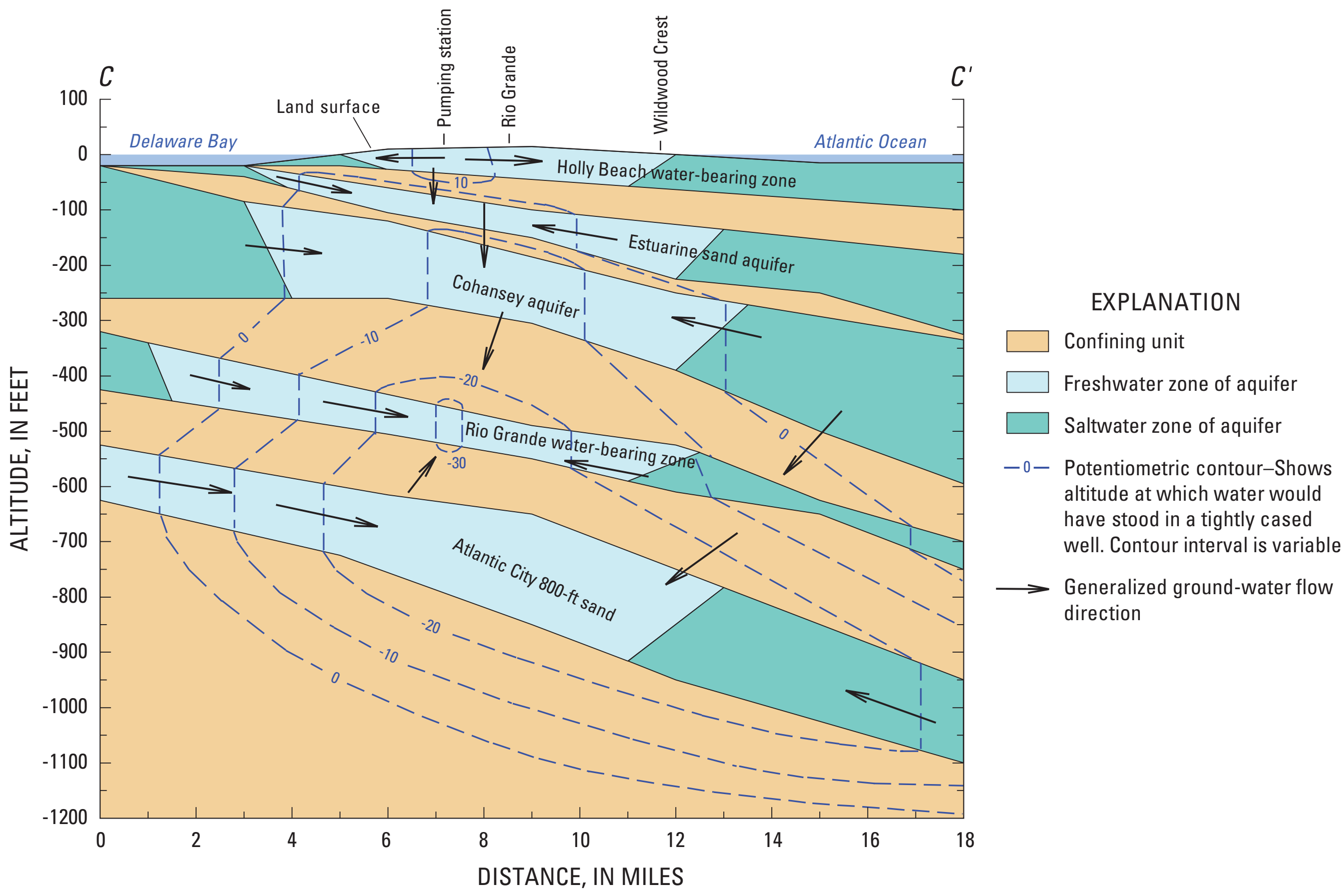


Figure 2c. Section *C-C′* showing potentiometric-surface contours in aquifers of Cape May County, New Jersey Coastal Plain, 2003.

only about 33 percent of the network; in order to maximize the geographic distribution and to capture low water levels associated with withdrawals, the network was augmented with production wells. To ensure that water levels in production wells closely represented static conditions, pumps were turned off for a minimum of 1 hour before measurement of the water level in the well. In addition, nearby pumping was controlled at the time of measurement; pumps in all other high-capacity production wells screened in the same aquifer within 0.25 mi of the measured well were turned off for at least 1 hour prior to measurement of the water level. In accordance with USGS methods for the collection of water-level data, measurements were made in each well until two consecutive and similar measurements were obtained at least 5 minutes apart. The resulting water-level measurement was considered representative of the local static conditions.

Ground water in four of the observation wells measured in this study had chloride concentrations in excess of 5,000 mg/L. Water levels in these wells were converted from a measured saltwater hydraulic head to a calculated freshwater head. The conversion equation follows a modification of the Ghyben-Herzberg relation (Todd, 1980) to determine the equivalent length of freshwater in a well filled with saltwater:

$$l_f = (p_s / p_f) l_s, \quad (1)$$

where l_f is length of the freshwater column in the well casing, p_s is the density of saltwater, p_f is the density of freshwater, and l_s is the length of saltwater column in the well casing. The density of freshwater is 1.00 g/cm^3, and the density of the saltwater increases with increasing solute concentrations. The measured water levels and the freshwater equivalents are presented in the appendixes of the report.

The water level in a well represents the hydraulic head in the screened part of the aquifer. Hydraulic heads at each well were calculated by subtracting the water level, in feet below land surface, from the land-surface altitude, in feet above NGVD 29. In confined aquifers, this level stands above the top of the aquifer as a result of an increase in pressure with depth and the presence of overlying, relatively impermeable strata. Maps then were constructed depicting the areal distribution of hydraulic head within each aquifer; lines of equal hydraulic head are represented on these maps by potentiometric-surface contours. From these maps ground-water flow in each aquifer can be inferred, as flow is from areas of high to low hydraulic head and is assumed to be perpendicular to the potentiometric-surface contours. Although most of the data used in this study are composed of measurements made in the confined parts

Table 2. County prefix codes used in well-numbering systems in New Jersey, Pennsylvania, and Maryland.

County name	Code	County name	Code
New Jersey			
Atlantic	01	Mercer	21
Burlington	05	Middlesex	23
Camden	07	Monmouth	25
Cape May	09	Ocean	29
Cumberland	11	Salem	33
Gloucester	15		
Pennsylvania			
Philadelphia	P		
Maryland			
Cecil	CE		
Caroline	CO		

of the aquifers, in some cases, measurements made in the unconfined parts are included in order to guide placement of potentiometric contours at the aquifer outcrops.

In 2003, a concerted effort was made to improve the locational accuracy, as well as the accuracy of land-surface-altitude data at measurement sites by using Global Positioning System (GPS). GPS was used at more than 350 sites in the field, and resulting locations were compared with those stored in the Ground Water Site Inventory (GWSI) database in the USGS New Jersey Water Science Center. Where GPS was not available, other checks were accomplished by comparing well locations with those in the NJDEP Public Community Water Supply (PCWS) database and land-surface-altitude data with those derived from the Digital Elevation Model (DEM) 10-meter grid of New Jersey (U.S. Geological Survey, 1999). Well locations and land-surface altitudes updated during this study are noted in the data tables for each aquifer, and water-level altitudes for previous studies were adjusted accordingly.

In this report, the term “observation well” refers not only to the original use of the well but to wells that had not been pumped during the 7 days prior to measurement. In addition, “production well” means a well that had not been pumped in the hour before water-level measurement but may have been pumped during the previous 7 days. In previous reports the term “observation well” referred to a well that had not been pumped within 24 hours prior to measurement. Because of widely varying characteristics among the aquifers within the study area, the residual effects of pumping also differ greatly, and therefore, this “idle period” for observation-well classification was lengthened to greater than 7 days.

The location of the 10,000-mg/L line of equal chloride concentration (hereafter referred to as isochlor) was estimated for each major aquifer in the New Jersey Coastal Plain by use of the USGS SHARP computer model (Pope and Gordon, 1999). The SHARP model is a quasi-three-dimensional finite-difference code that can be applied to layered coastal aquifer systems to simulate both fresh and saltwater flow separated by a sharp interface (Essaid, 1990). The represented locations of the 10,000-mg/L isochlors for the aquifers of the Delaware Coastal Plain are based on maps by Vroblesky and Fleck (1991). The location of the 250-mg/L isochlor, which designates the limit of potable water in each aquifer as defined by NJDEP secondary drinking-water standards (New Jersey Administrative Code, 2004), is based on published maps that are cited for each aquifer. Modifications were made to these lines as water-quality data warranted. If no map was available to show the location of the 250-mg/L isochlor in a particular aquifer, the line was determined from chloride data stored in the USGS Water Quality Data Base.

Ground-water withdrawal data cited in this report were obtained largely from unpublished sources, including files of the USGS New Jersey and Maryland Water Science Centers as well as the Delaware Department of Natural Resources and Environmental Control.

Cohansey Aquifer

The Cohansey aquifer in Cape May County is composed of gravel and coarse- to fine-grained sands and includes the lower part of the Cohansey Formation and the sand-rich uppermost section of the Kirkwood Formation (Zapecza, 1989). Within the study area Pleistocene deposits of sand and clays overlie the Cohansey aquifer, providing effective confinement from surficial recharge. In northern Cape May County, the Cohansey aquifer underlies the Holly Beach water-bearing zone and is confined by a singular unit, whereas in the southern part of the county two intervening confining units and the estuarine sand aquifer overlie the aquifer. The aquifer in Cape May County ranges in thickness from 50 ft near Ocean City to more than 150 ft near the southern tip of the peninsula (Lacombe and Carleton, 2002). The updip limit of the confined aquifer is approximately along a north-northeast trending line from the Delaware Bay to eastern Cumberland County, and the northernmost limit of confinement is in northern Cape May County, approximately bounded by the Tuckahoe River.

Water Withdrawals and Extent of Freshwater

The distribution of withdrawals from the Cohansey aquifer in Cape May County is shown in figure 3. The major users during 2003 withdrew water primarily for public supply with minor amounts for both industrial and irrigation purposes; most of these withdrawals occurred in the southern part of the peninsula in upland areas of Middle and Lower Townships. From 1978 to 2003, estimated ground-water withdrawals from the Cohansey aquifer ranged from 4.3 to 6.9 Mgal/d, with the maximum volume withdrawn in 1982 (fig. 4). Withdrawals from the aquifer were greatest during the 1980s when average daily ground-water withdrawals were in excess of 6 Mgal; with subsequent reductions in the early 1990s, the volume decreased to approximately 5 Mgal/d. Withdrawal volumes increased again during 1996–98, but decreased thereafter with the introduction of the Atlantic City 800-foot sand desalination wells. During 2003 withdrawals from the Cohansey aquifer totaled 4.8 Mgal/d. In 2003, the Wildwood Water Department, the largest user of ground water from the Cohansey, withdrew an average of nearly 3 Mgal/d. Much of these withdrawals were concentrated at the pumping station at Rio Grande and accounted for nearly 62 percent of all withdrawals from the aquifer in 2003. The second largest user of the Cohansey aquifer, Lower Township Municipal Utilities Authority (MUA), accounted for an additional 1.2 Mgal/d. Withdrawals by these utilities remained relatively constant from 1978 to 2003; however, substantial reductions after 1998 occurred in Cape May City farther to south.

The Cohansey aquifer contains freshwater throughout most of the extent underlying mainland Cape May County; however, saltwater is present in the aquifer beneath the extreme southern part of the peninsula, beneath the back bays and barrier islands north of Wildwood and south of Strathmere, and beneath near- and offshore areas of the Atlantic Ocean and the Delaware Bay (pl 1). Additionally, salt water has migrated into freshwater portions of the aquifer along the western coast of the peninsula. The 250-mg/L isochlor, originally mapped by Gill (1962) and updated by Lacombe and Rosman (2001) and Lacombe and Carleton (2002), has moved farther inland in the Villas area as indicated by the rapidly changing chloride concentrations observed in well 09-187, which increased from 190 mg/L in 1996 to 650 mg/L in 2003. A sample collected in early 2005 yielded a dissolved chloride concentration of 800 mg/L.

Water Levels

Water-level altitudes for 51 wells screened within the Cohansey aquifer (appendix 1) were used to map the 2003 potentiometric surface (fig. 1–1 on pl. 1). Previous studies in this series mapped the potentiometric surface underlying only the southern half of the Cape May peninsula; in 2003, additional confined Cohansey wells in the central and northern parts of Cape May County were added to the study. Water-level altitudes measured for all newly added wells ranged from 9 to 34 ft above NGVD 29. The configuration of the potentiometric surface in this area closely mimics that described by Gill (1962); a potentiometric high of greater than 30 ft is present near the northwestern limit of the confined aquifer from which ground water flows downdip and to the east, discharging to the Tuckahoe River and offshore to back bays and the Atlantic Ocean (fig. 1–1 on pl. 1). The maximum water-level altitude within the aquifer was 34 ft at well 09-325, located near the northwestern limit of the confined aquifer. The potentiometric map also shows a regional cone of depression centered at the major withdrawal locations in the southern part of the peninsula, encompassing all of Lower Township, Cape May, and West Cape May, as well as large portions of Middle Township and Wildwood Crest. The minimum water level observed near the center of this cone was -22 ft NGVD 29. The position of the -10-ft contour has shifted slightly to the north and east from its position in 1998; reductions in withdrawals at the Cape May City wells have moderated the cone of depression in this area.

Within the regional cone, water levels remained stable or had recovered relative to those observed during the previous study. At the center of the cone of depression and to the north, water levels typically had not changed from 1998, whereas those south of the Cape May Canal recovered from 3 ft to as much as 8 ft. Water level rises of 4 and 5 ft at wells 09-54 and 09-52, respectively, located near the western edge of the cone of depression, may correspond to moderate reductions in ground-water withdrawals in this area. Rises in water-level altitudes as great as 7 ft, resulting from substantial reductions (approximately 75 percent) in withdrawals that have occurred since 1998, were observed at the Cape May City wells in southern Lower Township. Recovering water levels in observation wells to the south in Cape May City, as well as in West Cape May also were attributed to these reductions.

Section C-C' (fig. 2c) shows a downward hydraulic gradient from the overlying estuarine sand aquifer to the Cohansey aquifer. A recent potentiometric surface has not been constructed for the estuarine sand aquifer; the potentiometric surface shown in figure 2c is based on previous work by Lacombe and Carleton (2002). Along the same section, a downward gradient from the Cohansey aquifer to the Rio Grande water-bearing zone also is present. The potential for downward flow is greatest in the northern part of the county, and weakens toward the southern tip of the peninsula.

Hydrographs for three observation wells located within the regional cone of depression at the southern end of the Cape are shown in figure 5. The hydrographs indicate that water levels in all three wells stood at or below 0 ft NGVD 29 since the initial study in 1978. Water levels have fluctuated as much as 19 ft seasonally; wells 09-60 and 09-150 are located closest to pumping centers and show the greatest variability. Water levels in well 09-80, located farthest from a pumping center near the northeast boundary of the cone of depression, show seasonal fluctuations from 5 to 7 ft. From 1978 to 2003, the annual high water levels at this well were at or slightly below 0 ft NGVD 29, whereas at the end of the summer pumping season, water levels generally had declined to -7 to -9 ft. During this 25-year period, water levels declined only about 2 ft. The hydrograph of observation well 09-150, which is located near the southern tip of the Cape, shows that water levels rose from 1979 to the mid-1980s, stabilized through to the mid-1990s, then rose again through 2003. The increase in water levels in this well during 1979-86 resulted from the abandonment of two nearby industrial supply wells (Lacombe and Carleton, 2002); the rising water level as well as the smaller fluctuations observed at the latter end of the hydrograph were a result of reduced withdrawals by the city of Cape May. Well 09-60, is located in northern Lower Township less than 1 mi from the major pumping center at Rio Grande. The hydrograph indicates that

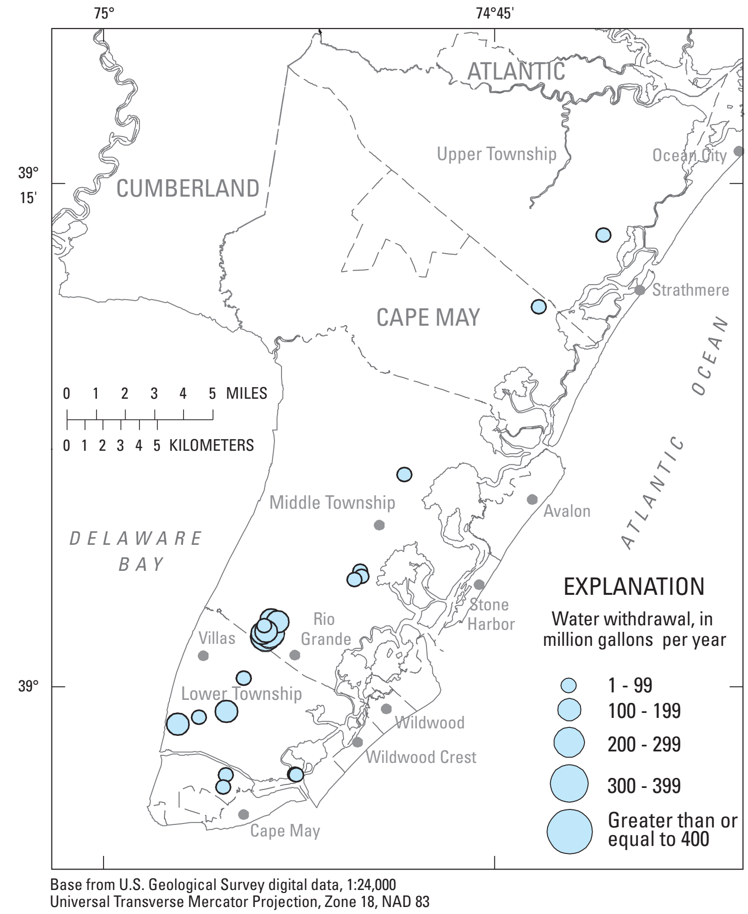


Figure 3. Location and amount of ground water withdrawn from the confined Cohansey aquifer, Cape May County and vicinity, New Jersey Coastal Plain, 2003.

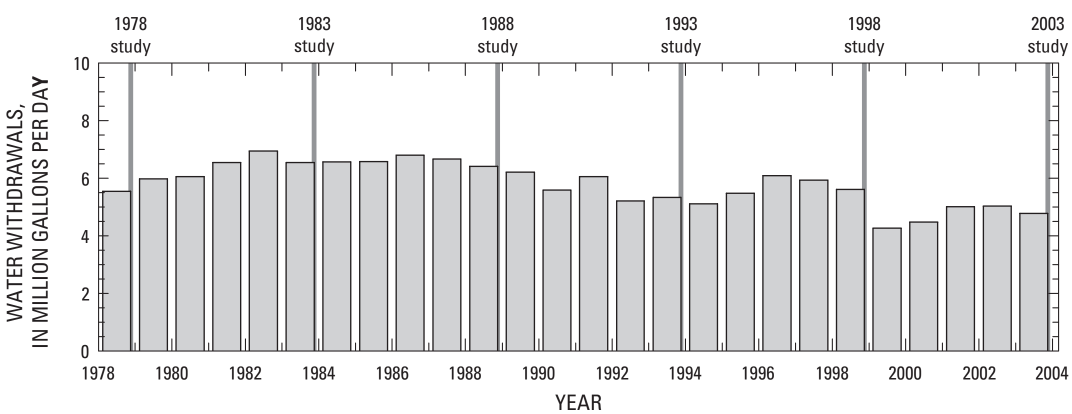


Figure 4. Estimated ground-water withdrawals from the confined Cohansey aquifer in Cape May County, New Jersey Coastal Plain, 1978–2003.

annual high water levels were typically -10 to -12 ft NGVD 29, and summer water levels ranged from 4 to 19 ft below the annual highs. Withdrawals from the nearby pumping center remained nearly constant from 1980 through 2003 at approximately 3.3 Mgal/d; consequently, the water levels in this well do not indicate either a distinct upward or downward trend.

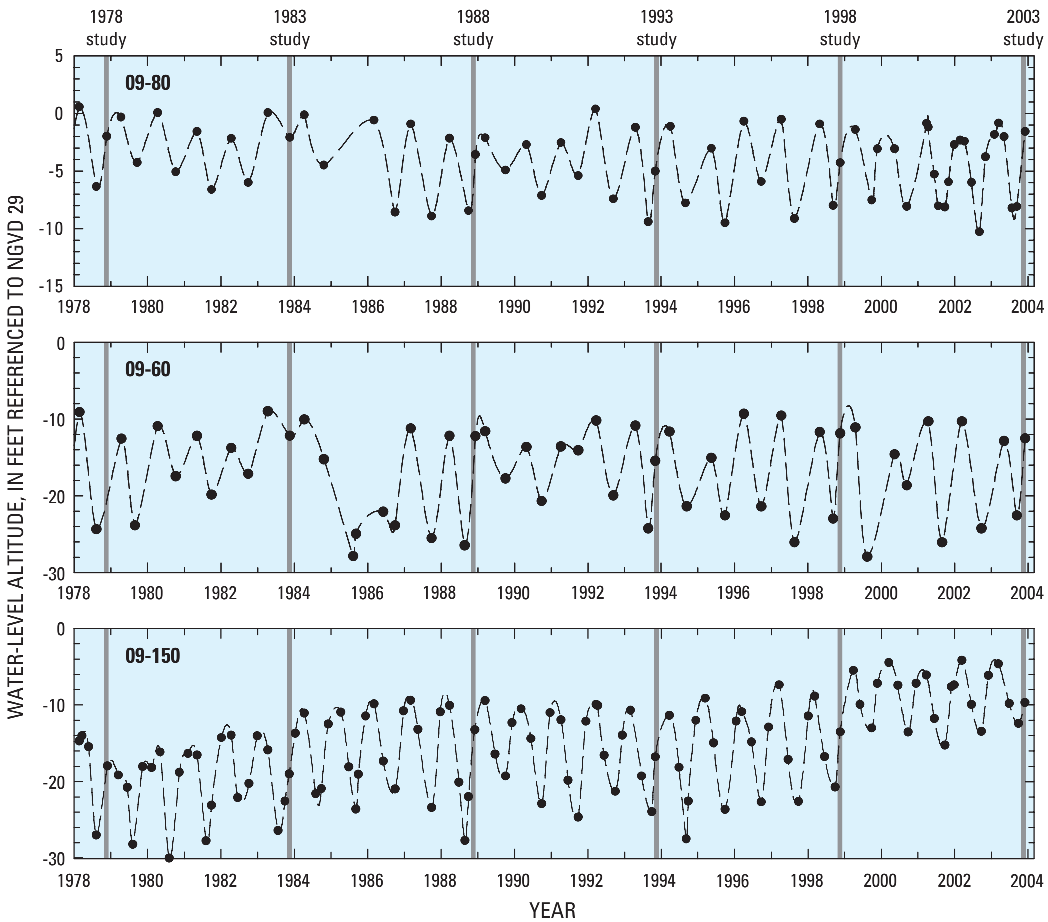


Figure 5. Water-level hydrographs for observation wells screened in the confined Cohansey aquifer, Cape May County, New Jersey Coastal Plain, 1978–2003.

Rio Grande Water-Bearing Zone

The Rio Grande water-bearing zone, as described by Zapecza (1989), is a relatively thin unit composed of coarse- to fine-grained sand situated midway within the confining bed that overlies the Atlantic City 800-foot sand. The updip extent of the Rio Grande water-bearing zone is generally coincident with that of the Atlantic City 800-foot sand; a line demarcating this limit extends from southern Ocean through eastern Cumberland County (fig. 1–2 on pl 1). The downdip limit of the aquifer is offshore and east of Ocean, Atlantic, and Cape May Counties. The Rio Grande water-bearing zone is generally 40 ft thick throughout its extent in coastal Ocean and Atlantic Counties (Zapecza, 1989) but thickens considerably in southeastern Cape May where, near Stone Harbor, it is as great as 170 ft thick (Lacombe and Carleton, 2002). Mapping of the potentiometric surface of this aquifer was initially included in the 1998 study. This aquifer is not present in Delaware.

Water Withdrawals and Extent of Freshwater

The Rio Grande water-bearing zone is of minor importance as a source of potable water in New Jersey. Withdrawals are made primarily by water purveyors in Long Beach and Little Egg Harbor Townships in southern Ocean County and in Middle Township in Cape May County (fig. 6). Additionally, several local wells withdraw water from the aquifer, although the amounts are not thought to be substantial; these wells are scattered primarily throughout Cape May and eastern Cumberland Counties. Estimated withdrawals from 1978 to 2003 averaged less than 1 Mgal/d; withdrawals in 2003 were approximately 0.6 Mgal/d (fig. 7). Withdrawal amounts were apportioned equally between Ocean and Cape May Counties from 1978 to 1988 (approximately 0.3 to 0.4 Mgal/d); thereafter, withdrawals generally were greater in Cape May County.

The location of the 250-mg/L isochlor is from Lacombe and Rosman (2001); limited data compiled following the 1998 study do not warrant a modification of this line. Fresh ground water is present within the aquifer underlying coastal regions of the mainland and the barrier islands from its northwestern limit in southern Ocean County southward through most of mainland Cape May County. The aquifer contains salty water south of the canal in southern Cape May County and likely beneath the back bays, barrier islands, and nearshore areas along the Atlantic Coast from Avalon to the city of Cape May. The location of the 10,000-mg/L isochlor has not been determined but may be at or near the location of the 10,000-mg/L isochlor in the underlying Atlantic City 800-foot sand.

Water Levels

Water-level data collected at 13 wells screened in the Rio Grande water-bearing zone (appendix 1) were used to construct the 2003 potentiometric surface (fig. 1–2 on pl. 1). The potentiometric-surface map shows an elongated cone of depression centered under the barrier island communities of coastal New Jersey from the Cape May peninsula northward to Ship Bottom in southern Ocean County. Water levels within the Rio Grande water-bearing zone ranged from a low of -33 ft (well 09-67) in southern Cape May to a maximum of 34 ft NGVD 29 (well 01-219) in central Atlantic County. As noted by Lacombe and Rosman (2001), the shape and magnitude of the regional cone of depression results from induced leakage due to withdrawals and depressed heads within the underlying Atlantic City 800-foot sand. Locally, withdrawals at the Rio Grande well field in southern Cape May may be contributing to the low water levels in this vicinity.

Water levels at the Rio Grande well field rose by as much as 13 ft (app. 1) subsequent to the 1998 study owing to a 25-percent reduction in ground-water withdrawals. Elsewhere, little change has occurred in the potentiometric surface.

There is a downward hydraulic gradient from the Rio Grande water-bearing zone to the Atlantic City 800-foot sand as shown in section B-B’ (fig. 2b); Lacombe and Rosman (2001) also indicate a downward vertical gradient from the overlying water-table aquifer into the Rio Grande water-bearing zone. Along section C-C', a downward vertical gradient from the Cohansey aquifer to the Rio Grande water-bearing zone is evident; this downward gradient strengthens to the northeast of this line and weakens toward the tip of the peninsula (fig. 2c). Along the same section an upward vertical gradient from the Atlantic City 800-foot sand to the Rio Grande water-bearing zone is present in the area of the Rio Grande well field; however, farther to the southeast, the gradient again reverses and is downward to the underlying Atlantic City 800-foot sand.

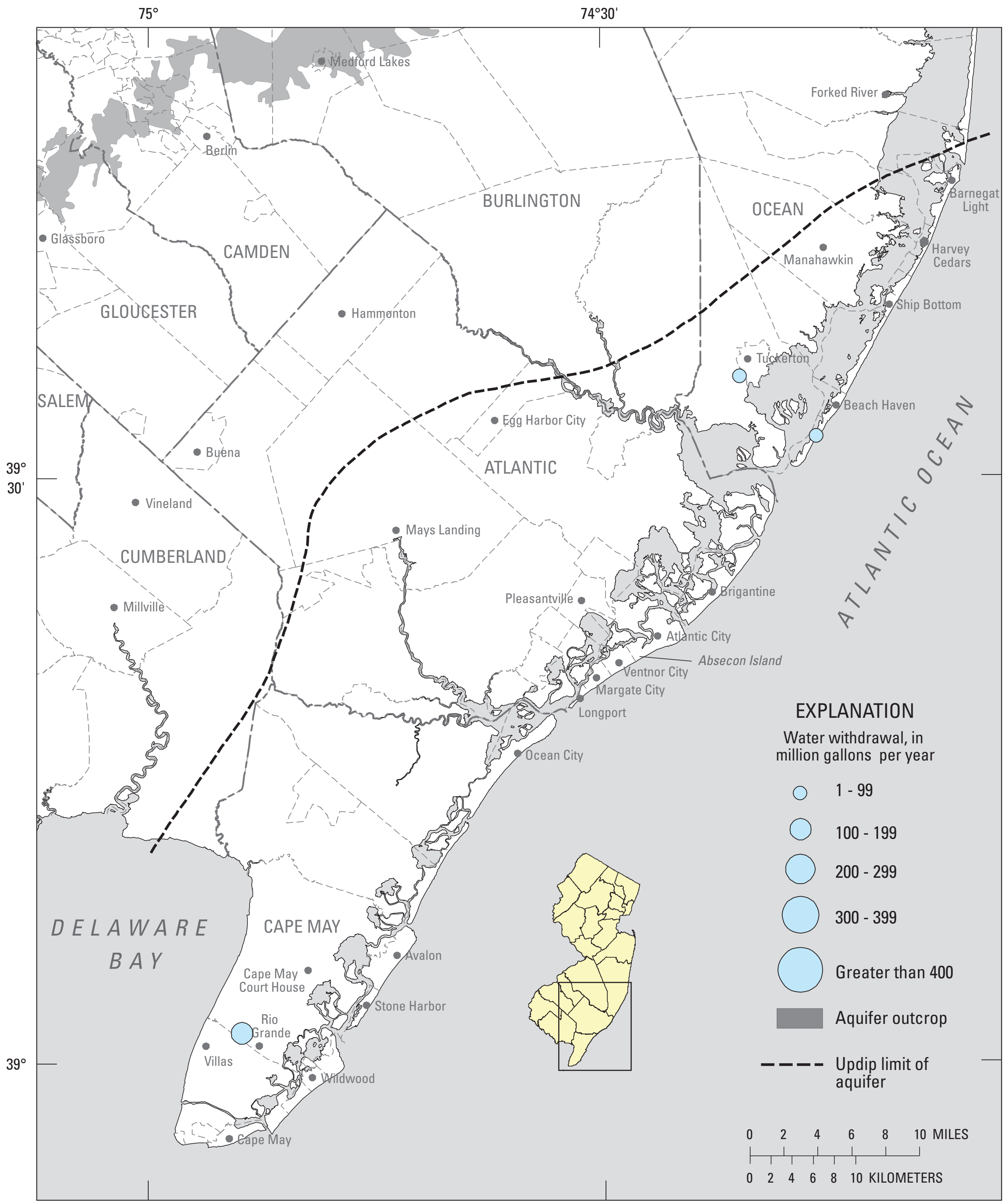
Hydrographs for two observation wells located in Cape May County are shown in figure 8. Data were collected intermittently at these two wells, and distinct long-term trends are difficult to evaluate. For 1990 to 1993, when data are denser, seasonal fluctuations are evident in both wells. These fluctuations are more pronounced in well 09-71 than in well 09-304 and range from 8 to 20 ft. Well 09-71 is located near production wells at the Rio Grande well field and the fluctuations reflect greater withdrawals during the summer tourist season. The most recent water-level data collected at well 09-71 indicate a rise in water levels from late 1991 to December 2003 of approximately 24 ft.

Atlantic City 800-Foot Sand

The Atlantic City 800-foot sand as defined by Zapecza (1989) is composed of medium- to coarse-grained quartz sands with interspersed shell material. The aquifer is confined throughout its extent. The updip limit of the aquifer is based on the updip limit of the overlying confining unit and extends, from northeast to southwest, from southern Ocean County 1.7 mi north of Barnegat Light to eastern Cumberland County (pl. 2). The downdip limit of the aquifer is offshore from Ocean, Atlantic, and Cape May Counties. The aquifer generally thickens downdip and down coast from a thickness of 40 ft near Barnegat Light to more than 200 ft at Cape May City (McAuley and others, 2001).

Water Withdrawals and Extent of Freshwater

The Atlantic City 800-foot sand is the principal confined aquifer supplying water to New Jersey’s barrier island communities from Harvey Cedars in southern Ocean County to Cape May City and as far inland as Mays Landing and Egg Harbor City in Atlantic County. Withdrawals from the aquifer ranged from 18 to 24 Mgal/d during 1978 to 2003 (fig. 9). Withdrawals have gradually increased since 1978; however, changes in volume typically were less than 5 percent from year to year. Estimated withdrawals in 2003 totaled nearly 24 Mgal/d; withdrawal amounts were greatest in Atlantic County and least in Ocean County, where the aquifer thins and becomes less transmissive. From 1978 to 2003, withdrawals in Atlantic County ranged from 7.8 to 11.3 Mgal/d, gradually increasing through 2001 before decreasing slightly. In 2003, withdrawals in Atlantic County totaled approximately 10.1 Mgal/d, with nearly 60 percent of the withdrawals distributed along the barrier islands. Three major production centers are within Atlantic County: Absecon Island, Brigantine, and Pleasantville (fig. 10). The Absecon Island center includes Atlantic City, Margate, Ventnor, and Longport; in 2003 total combined withdrawals here of 4 Mgal/d were the greatest of the three centers. Withdrawal trends for the Absecon Island production center were generally stable; from 1980 to 2003 estimated withdrawals fluctuated between 4 and 5 Mgal/d. Periods of increased withdrawal were typically followed by periods of reduced withdrawals. The Pleasantville production center includes both the Atlantic City MUA and New Jersey American Water Company-Atlantic production wells as well as production wells in eastern Hamilton Township; combined withdrawals in 2003 were 3.4 Mgal/d. From 1980 to 2003, withdrawals from this area of the aquifer increased from 2 to nearly 3.5 Mgal/d. At Brigantine, an average of 1.9 Mgal/d was withdrawn from the aquifer in 2003. Withdrawals increased from 1.5 to 2 Mgal/d



Base from U.S. Geological Survey digital data, 1:24,000
Universal Transverse Mercator Projection, Zone 18, NAD 83

Figure 6. Location and amount of ground water withdrawn from the Rio Grande water-bearing zone, New Jersey Coastal Plain, 2003.

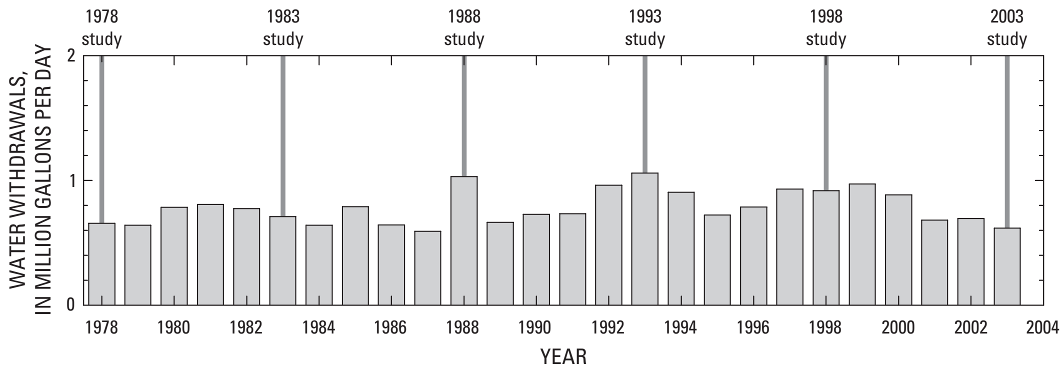


Figure 7. Estimated ground-water withdrawals from the Rio Grande water-bearing zone, New Jersey Coastal Plain, 1978–2003.

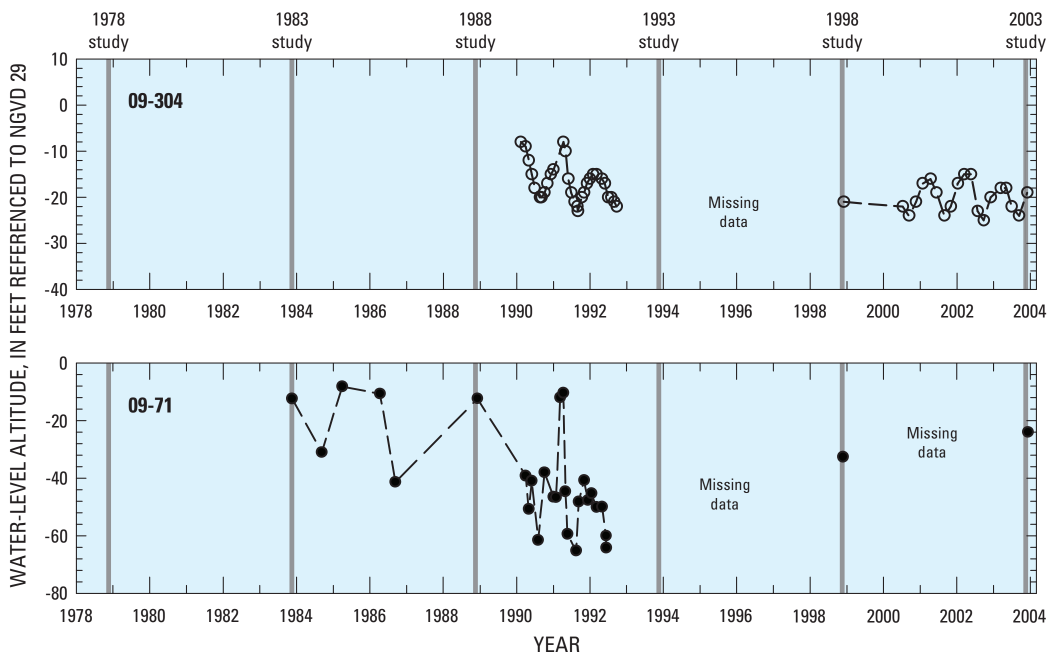


Figure 8. Water-level hydrographs for observation wells screened in the Rio Grande water-bearing zone, New Jersey Coastal Plain, 1978–2003.

during 1980–86; thereafter, combined withdrawals from the wells were approximately 2 Mgal/d.

In Cape May County, most ground-water withdrawals are distributed along the barrier islands; however, substantial withdrawals also occur near Cape May Court House and west of Cape May City at the southern end of the peninsula (fig. 10). Withdrawals from the aquifer decreased during 1986–92 to less than 6 Mgal/d; however, during 1992–2003 withdrawals increased by nearly 39 percent. In early 1998, a desalination plant in lower Cape May County began operation in order to augment the existing water supply, and by 2003, associated withdrawals were approximately 1 Mgal/d. Withdrawals within the county in 2003 totaled nearly 8 Mgal/d; this represents the highest total since 1978.

The Atlantic City 800-foot sand contains freshwater throughout southern Ocean, Atlantic, and northern Cape May Counties, where dissolved chloride concentrations typically range from 2 to 20 mg/L. South of Avalon, ground water within the aquifer becomes progressively more chloride-rich, and near the southern tip of the Cape May Peninsula, chloride concentrations range from 400 to more than 1,500 mg/L. The mapped position of the 250-mg/L isochlor has not changed from that previously described by Lacombe and Rosman (2001); the position of the freshwater-saltwater interface (hereafter referred to as saltwater front) lies approximately

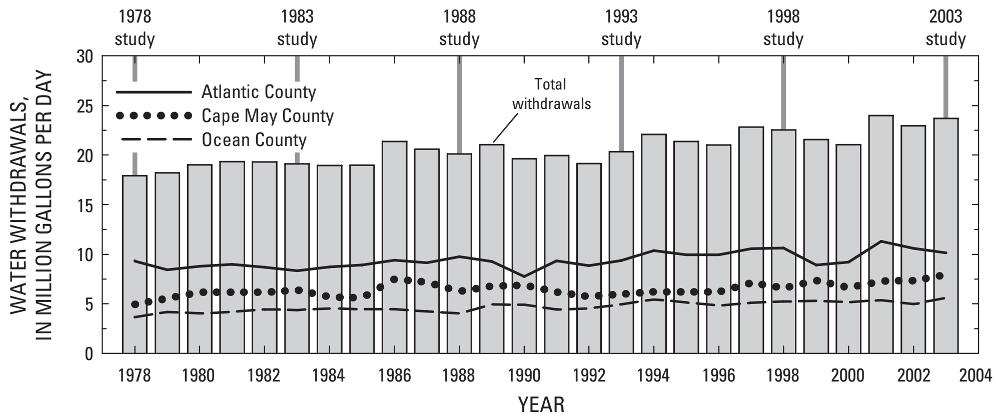


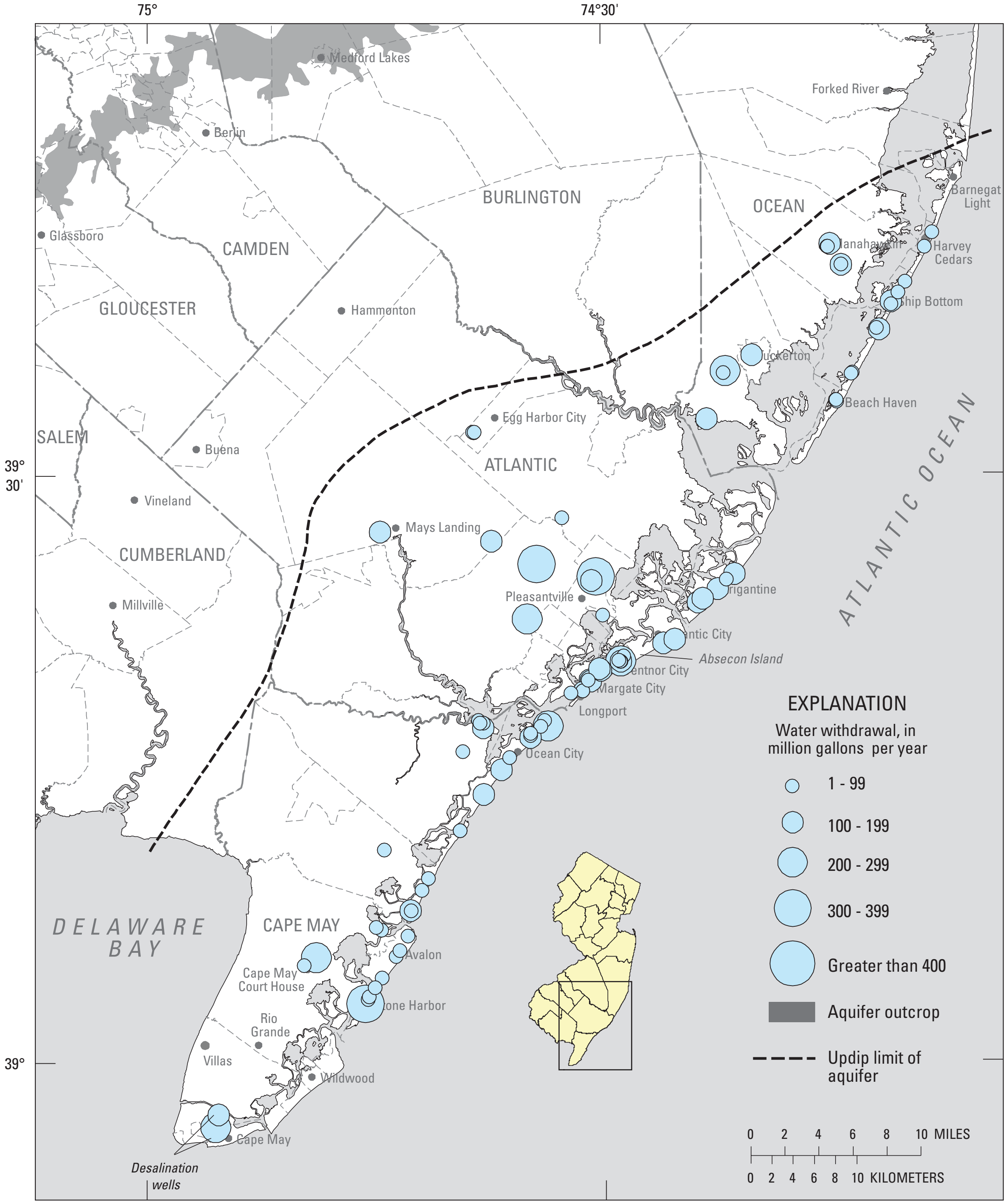
Figure 9. Estimated ground-water withdrawals from the Atlantic City 800-foot sand, New Jersey Coastal Plain, 1978–2003.

4 mi to the south-southeast of production wells at Stone Harbor. Chloride concentrations in the production well (09-135) nearest the front have remained largely consistent over time. From the mid-1960s through 2000, concentrations ranged from 30 to 40 mg/L, only occasionally exceeded these values, and subsequently returned to antecedent levels. Recently reported (2004–06) chloride concentrations in samples collected from a replacement well (09-521) nearer the front were as high as 87 mg/L and as low as 26 mg/L. Farther to the north and offshore of Atlantic County, the saltwater front is approximately 9.6 and 8 mi to the southeast of production wells in Ventnor and Brigantine, respectively. Dissolved chloride in samples from production wells at Brigantine remained at levels consistently below 10 mg/L for the period of record through 2003. Similarly, data from production wells at Ventnor showed little or no sustained increase in dissolved chloride concentrations through 2003; from 1993 to 2003, reported values typically were less than 10 mg/L. Farther to the south, the saltwater front traverses the lower part of the Cape May peninsula, trending approximately east-west from Wildwood to the south of Villas. Chloride concentrations in samples from wells south of this line in lower Cape May County, although elevated, also have remained stable. The location of the 10,000-mg/L isochlor was simulated by use of the USGS SHARP computer model of the aquifers of the New Jersey Coastal Plain (Pope and Gordon, 1999). This interface is located approximately 36 mi offshore and to the southeast of Atlantic City.

Water Levels

Water-level data from 74 wells screened in the Atlantic City 800-foot sand are presented in appendix 2 and were used to map the 2003 potentiometric surface (pl. 2). The dominant feature in the potentiometric surface is an elongated cone of depression that extends beneath the coastal barrier island communities from Barnegat Light in Ocean County south to Cape May City. The deepest part of the cone is centered beneath the eastern Atlantic County municipalities of Atlantic City, Margate, and Ventnor. Water levels as low as 94 ft below NGVD 29 were observed in well 01-1256 in the center of the cone. At the northern end of the cone of depression, south of Barnegat Light, water levels ranged from -26 ft (well 29-112) near the northern limit of the confined aquifer to -33 ft (well 29-9) near the southern end of Long Beach Island. Areas of even lower hydraulic head were observed near production wells on the island's central section. Previously published potentiometric surface maps depicted localized cones along Long Beach Island at Harvey Cedars and Ship Bottom (Eckel and Walker, 1986; McAuley and others, 2001); in 2003 a localized cone with water levels lower than -40 ft was present around production wells to the north and east of Beach Haven. Withdrawals at these and nearby wells did not increase appreciably from 1998 volumes, and the low water level may be an artifact of recent withdrawals at an adjacent well. Water levels rose slightly at both the north and south ends of this island; near the midsection of the island, the potentiometric surface was slightly lower than that observed in 1998. To the southwest from the center of the regional cone, water levels were progressively higher toward the southern end of the Cape May peninsula, where water levels ranged from -22 ft to less than -40 ft NGVD 29. The maximum water-level altitudes occurred near the updip limit of the aquifer in southern Ocean and central Atlantic County, where water levels were typically greater than 20 ft NGVD 29.

Water-level changes from 1998 to 2003 were calculated for 57 wells screened in the Atlantic City 800-foot sand. During this period, water levels had stabilized or had risen in most of the wells (82 percent) throughout the aquifer; however, changes in the potentiometric surface (declines) were greatest in southern Cape May County (fig. 11). Water levels at and in the vicinity of the Cape May City desalination wells were as much as 32 ft lower in 2003 than in 1998. Withdrawals at the desalination wells (09-480 and 09-507) began in 1998; by 2003 total withdrawals from these wells were approximately 1.1 Mgal/d. Water levels have recovered near the center of the



Base from U.S. Geological Survey digital data, 1:24,000
Universal Transverse Mercator Projection, Zone 18, NAD 83

Figure 10. Location and amount of ground water withdrawn from the Atlantic City 800-foot sand, New Jersey Coastal Plain, 2003.

cone of depression underlying Ventnor and Atlantic City. In 1998, water levels near the center of this cone were in excess of 100 ft below NGVD 29. By 2003, all water levels were higher than -100 ft, and the area encompassed by the closed 80-ft contour had contracted from approximately 60 mi^2 to 30 mi^2 or by about 50 percent. The seaward edge of the -80-ft contour has shifted from its position in 1998 of approximately 4 mi offshore of Ventnor; in 2003, it was approximately 2 mi offshore, similar to its position in 1993. Combined withdrawals from 25 production wells in this area had decreased from 1998 volumes by nearly 16 percent.

A downward hydraulic gradient from the Rio Grande water-bearing zone to the Atlantic City 800-foot sand and an upward hydraulic gradient from the Piney Point aquifer to the Atlantic City 800-foot sand is shown in section B-B' (fig. 2b). An upward vertical gradient from the Atlantic City 800-foot sand to the Rio Grande water-bearing zone exists in the area of the Rio Grande well field (section C-C', fig. 2c); however, to the southeast, the gradient again reverses and is downward from the Rio Grande to the underlying Atlantic City 800-foot sand.

Water-level hydrographs for seven observation wells screened in the Atlantic City 800-foot sand show long-term trends and seasonal fluctuations (fig. 12). Observation wells 01-37 and 01-702 are located on Absecon Island in Atlantic City and Margate at the center of the cone of depression. Seasonal water-level fluctuations due to interference from nearby production wells were substantial in both wells, occasionally varying by more than 30 ft in a given year, and reflect increased withdrawals during the summer tourist season. Water levels generally were stable during 1988–94; however, water levels declined in both wells from 1994 to 1998. This decline was probably a result of increased withdrawals during that period; however, estimated withdrawals indicate an overall stable trend during 1994–98. During 1998–2003, water levels again recovered as estimated withdrawals from Absecon Island decreased by nearly 1 Mgal/d. From 1978 to 2003, the net deficit in water levels on Absecon Island was approximately 20 ft. Observation wells 01-180 and 01-578 are located on the mainland and updip from withdrawal centers on the barrier islands. The hydrographs indicate water-level trends similar to those observed for wells 01-37 and 01-702; however, long-term decline and seasonal fluctuations were mitigated with distance away from the center of the cone.

The water-level hydrographs for wells in Cape May County (09-302, 09-306 and 09-337) indicate seasonal water-level fluctuations ranging from 2 ft to 9 ft during 1989–2003. A continuous 5 ft to 6 ft water-level decline in the hydrograph record starting in early 1999 likely can be attributed to the Cape May City Water Department desalination wells (09-480 and 09-507), which began withdrawals during this time. The net decline in water levels during 1989–2003 in these wells ranged from 5 ft to 14 ft, with the largest declines occurring near the southernmost part of the peninsula.

Piney Point Aquifer

The Piney Point aquifer, as described by Zapecza (1989), is composed of fine- to coarse-grained glauconitic sands

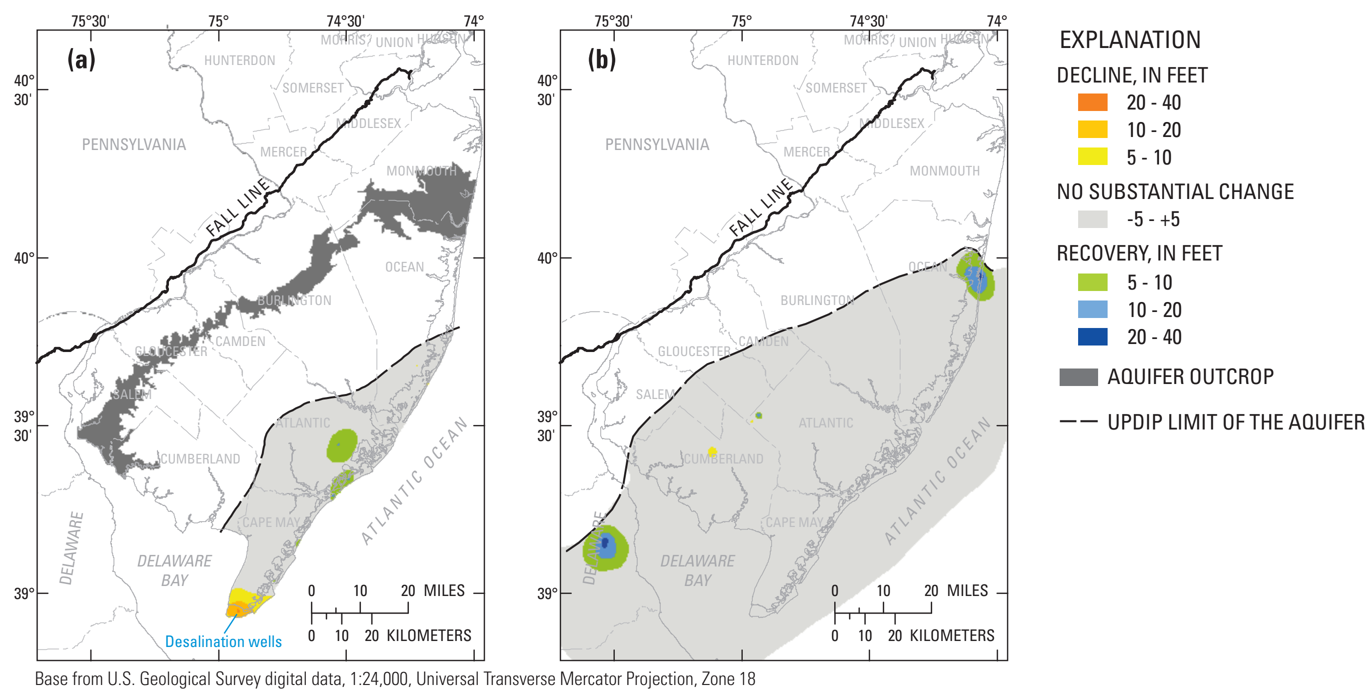


Figure 11. Water-level changes in the (a) Atlantic City 800-foot sand and (b) Piney Point aquifer, New Jersey Coastal Plain, 1998–2003.

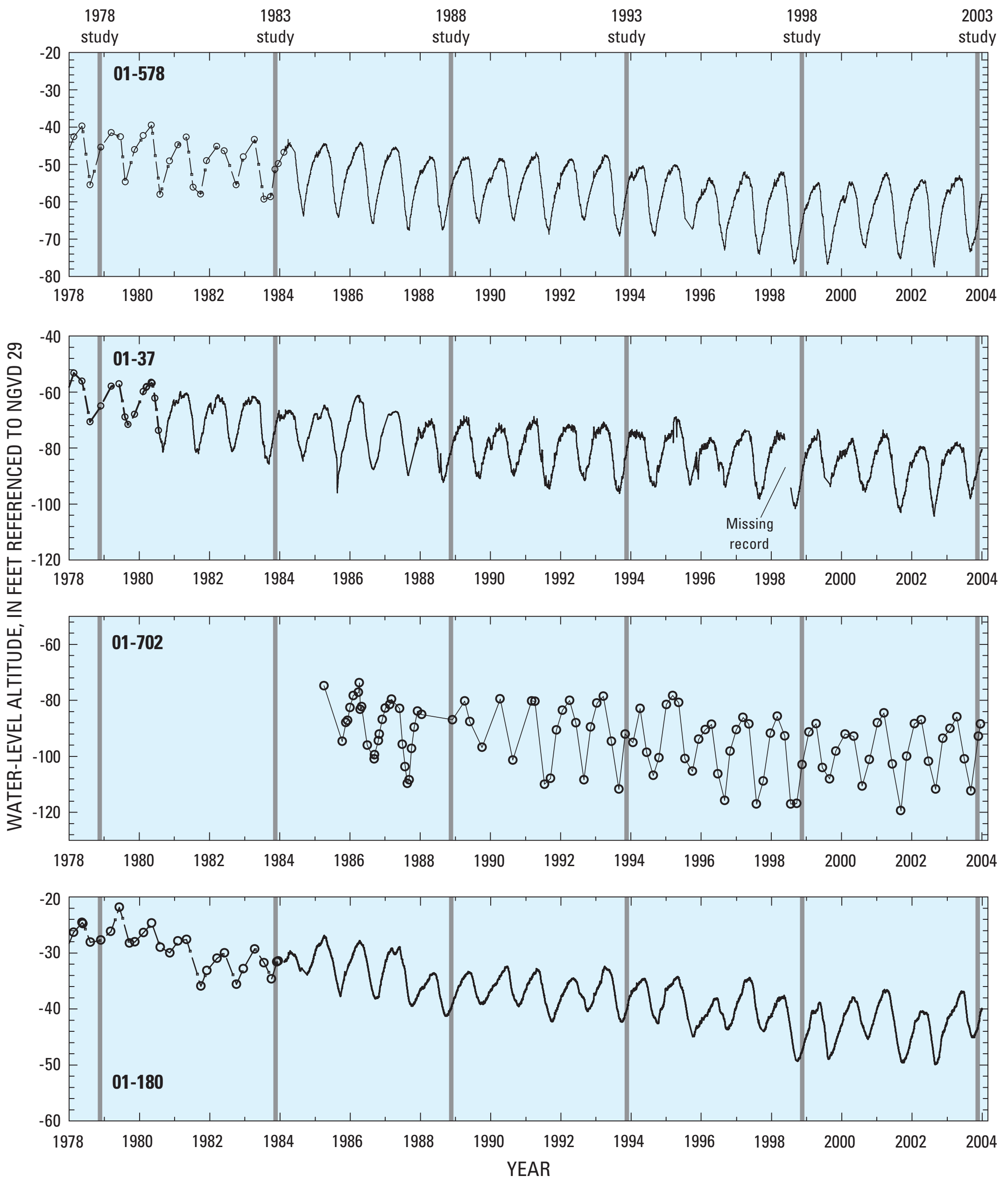


Figure 12. Water-level hydrographs for observation wells screened in the Atlantic City 800-foot sand, New Jersey Coastal Plain, 1978–2003.

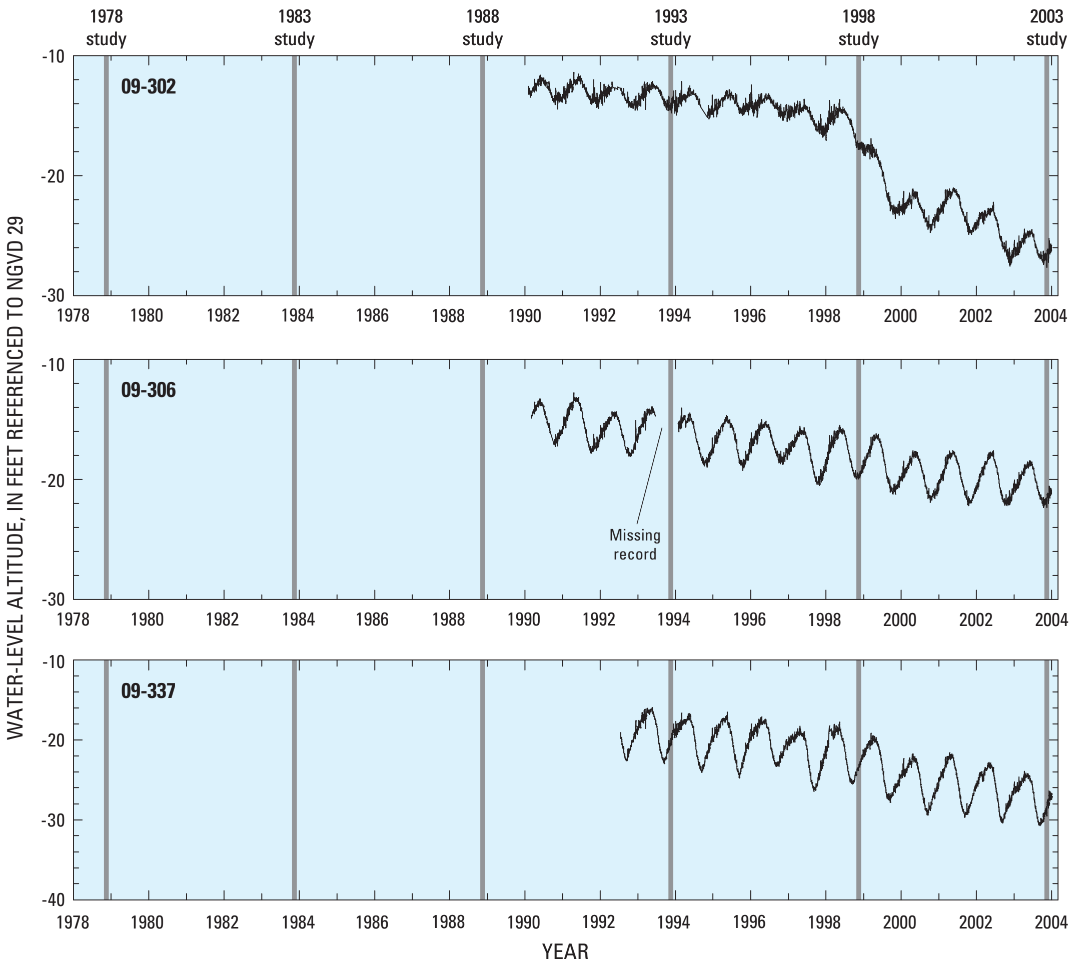


Figure 12. Water-level hydrographs for observation wells screened in the Atlantic City 800-foot sand, New Jersey Coastal Plain, 1978–2003.—Continued

interspersed with shell material. The Piney Point is a confined aquifer that does not crop out within the study area, and therefore, cannot be recharged directly by precipitation; recharge occurs by leakage from other aquifers through the bounding confining layers. The updip limit of the aquifer is in central Ocean, Burlington, Camden, Gloucester and Salem Counties and approximately near the downdip limit of the Vincentown aquifer. Near this updip limit the aquifer is generally less than 40 ft thick. The downdip limit of the aquifer is offshore of Ocean, Atlantic, and Cape May Counties. There are two areas within the aquifer extent in New Jersey of substantial sand accumulation (Zapecza, 1989)—southern Burlington and Ocean Counties where thicknesses can exceed 130 ft and to the southwest in southern Cumberland County where maximum thicknesses are greater than 200 ft. In Delaware, the updip limit of the Piney Point aquifer is in central Kent County, and the downdip limit in Delaware extends into southeastern Sussex County (Vroblesky and Fleck, 1991). The aquifer is confined throughout its entire extent in Delaware. The maximum thickness of the aquifer in Delaware, approximately 250 ft, occurs near Dover.

Water Withdrawals and Extent of Freshwater

Ground-water withdrawals from the Piney Point aquifer were made predominantly in coastal regions of Ocean County, New Jersey, particularly in the central Barnegat Bay area and in Dover, Delaware (fig. 13). Withdrawals also were made in Buena Borough in western Atlantic County as well as at scattered smaller capacity centers in updip parts of the aquifer in Burlington and Camden Counties where yields are favorable to development. Water-quality issues in the overlying Kirkwood-Cohansey aquifer have encouraged recent development of the Piney Point aquifer in and around the city of Bridgeton, in southern Cumberland County.

Withdrawals from the aquifer ranged from 1.8 to 4.8 Mgal/d during 1978 to 2003 (fig. 14). Estimated withdrawals for 2003 from the New Jersey portion of the aquifer totaled 4.8 Mgal/d. Withdrawals statewide were relatively constant from 1978 to 1992 at nearly 2 Mgal/d prior to a 50-percent increase in 1993. From 1993 to 2003, withdrawals steadily increased largely due to increased development of the aquifer in Ocean County where, in 2003, withdrawals were estimated to be 4.3 Mgal/d or 90 percent of all withdrawals within the State. Withdrawals increased in Buena from 0.1 to 0.5 Mgal/d during 1978–86 but have since remained stable at less than 0.5 Mgal/d. In Delaware, most withdrawals from the Piney Point aquifer occurred in and around the city of Dover. Water withdrawals in Delaware increased from 3 Mgal/d in 1978 to approximately 4 Mgal/d by 1994; withdrawals subsequently decreased to 3 Mgal/d in 2001 (fig. 15).

For this study, the location of the 250-mg/L isochlor in New Jersey was modified from Schaefer (1983) and Lacombe and Rosman (2001), and in Delaware, from Woodruff (1969). The location of this line lies more than 15 mi downdip from the production center at Buena; Lacombe and Rosman (2001) estimate the position of this line to the north at 12 mi downdip from production wells at Barnegat Light. Chloride concentrations in production wells at Barnegat Light range from 5 to 15 mg/L but are typically 10 mg/L or less; sustained increases have not occurred during the last decade. Similarly, chloride concentrations in ground water from observation wells near the saltwater front have not increased substantially, and the extent of freshwater remains similar to that in 1998. In Delaware, the position of the front is approximately 10 mi downdip from the major production center at Dover. The location of the 10,000-mg/L isochlor was simulated by Pope and Gordon (1999) using a saltwater model simulation of the aquifers underlying the New Jersey Coastal Plain.

Water Levels

The potentiometric surface of the Piney Point aquifer in late fall 2003 in New Jersey and Delaware is shown in plate 3; water-level data that were used to define this surface are listed in appendix 3. Maximum water-level altitudes within the Piney Point aquifer were observed near the updip boundary straddling the border between Burlington and Ocean Counties, and the lowest water- level altitudes were observed in Kent County, Delaware, and along the barrier islands of eastern Ocean County, New Jersey. Five regional cones of depression are present in the Piney Point aquifer. The northernmost cone underlies Seaside Park in Ocean County near the area where the aquifer is most heavily developed in New Jersey; the minimum water level at the center of this cone of depression was -48 ft. Water levels were substantially higher than in 1998; maximum increases observed at wells 29-808 and 29-537 of 46 and 41 feet, respectively (app. 3), reflect an overall reduction in withdrawals from production wells in Seaside Heights and Seaside Park. Lacombe and Rosman (2001) observed considerable decline in the water levels in this area during 1993–98; in 1998, the depth and breadth of this cone were at their maximum. By 2003, the configuration and magnitude of this cone was similar to that observed in 1983.

To the south, the cone of depression centered near Barnegat Light had a minimum water level of -40 ft (well 29-607). Slightly higher water levels subsequent to 1998 indicate a minor contraction of the cone's overall extent.

A cone of depression also is present in coastal Atlantic County, where the overlying Atlantic City 800-foot sand has experienced a sustained decline in water levels. The Piney Point aquifer is unused in this area, and the cone of depression may be in part a response to the decline in water levels in the overlying aquifer (Lacombe and Rosman, 2001). The 2003 water level at the center of this cone (well 01-834) was -34 ft NGVD 29, 2 ft lower than that observed during the previous study. Water levels in the overlying Atlantic City 800-foot sand in this area, however, were stable to recovering during the same period.

In western Atlantic County, a cone of depression characterized by water levels reaching below -20 ft is centered under the Borough of Buena and encompasses an area of approximately 90 mi^2 from Hamilton Township to the east to Vineland in the west. The cone's position and magnitude are similar to that in observed in 1998; however, its center has shifted nearly 1 mi to the west probably as a result of a short-term shift in withdrawal patterns within the borough. Rising water levels were observed in wells in northeastern Buena, and withdrawals from the aquifer to the south and west that began in 2003 contributed to declining water levels here. Water levels near the edge of the cone (the 0-ft contour) remained about the same.

In Delaware, a cone of depression with water levels as low as -160 ft NGVD 29 (well Jd34-18) persists in and around the city of Dover. The cone of depression is the deepest and most regionally extensive within the Piney Point aquifer. Substantial long-term withdrawals in this area have caused regional stresses within the aquifer to propagate over a large area and extend beneath the Delaware Bay into southern New Jersey that, until recently (2004), have been the primary cause of declining water levels in Cumberland County. Water levels at the center of this cone have recovered since 1998 (fig. 11); near the edge of the cone, water levels have stabilized or declined slightly during this period. Rises in water levels of 9 ft to more than 30 ft decreased the depth at the center of the cone and considerably reduced the area within the -120-ft potentiometric-surface contour. Away from the center of the cone of depression, water-level change was more moderate to stable, and the area encompassed by the closed -40-ft potentiometric-surface contour was similar in size (approximately 600 mi^2) to that in 1998.

Section B-B' (fig. 2b) shows a downward hydraulic gradient from the overlying Kirkwood-Cohansey aquifer system to the Piney Point aquifer and a downward gradient from the Piney Point to the underlying Wenonah-Mount Laurel aquifer in the updip portion of the Piney Point aquifer. In the downdip direction and toward coastal Atlantic County, an upward gradient from the Piney Point aquifer into the Atlantic City 800-foot sand is prevalent.

Hydrographs of wells showing long-term water-level trends in the Piney Point aquifer are shown in figures 16 and 17. Observation wells 29-425 and 05-676 are located near the potentiometric high in western Ocean and eastern Burlington Counties and distant from production centers to

Figure 13. Location and amount of ground water withdrawn from the Piney Point aquifer, New Jersey, Delaware, and Maryland Coastal Plain, 2003.

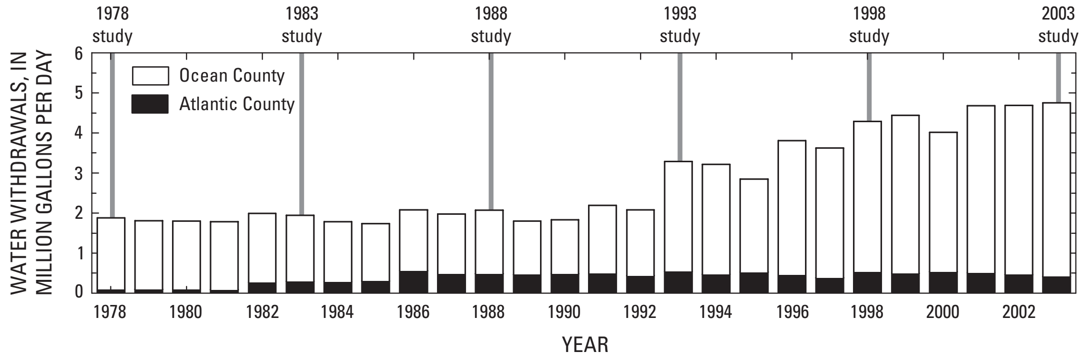


Figure 14. Estimated ground-water withdrawals from the Piney Point aquifer, New Jersey Coastal Plain, 1978–2003.

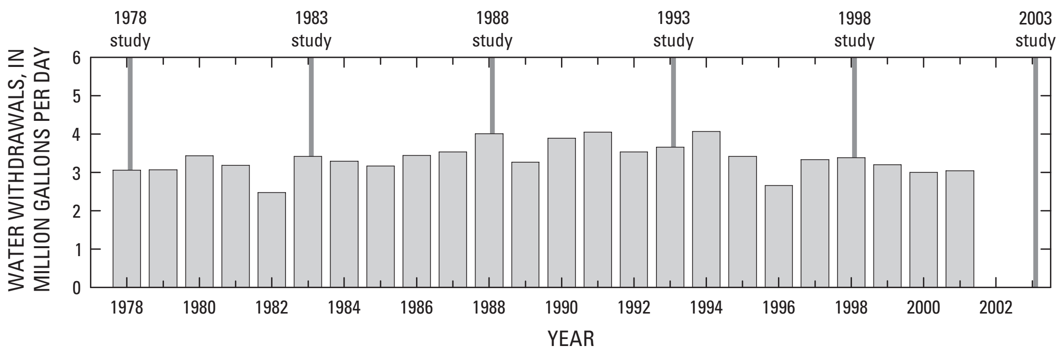


Figure 15. Estimated ground-water withdrawals from the Piney Point aquifer, Delaware Coastal Plain, 1978–2001.

the east (fig. 16). The hydrographs of both wells indicate stable water levels (approximately 120 ft NGVD 29) for the period of record. Similarly, the hydrograph of observation well 05-407, which is located in the updip portion of the aquifer in central Burlington County, shows little variation in water levels from 1978 to 2003.

Water levels in observation well 29-585, located west from the cones of depression at Seaside Park and Barnegat Light, were fairly constant prior to 1989 but declined about 8 ft during 1989–96 because of increased withdrawals from nearby production well(s). In early 1997, withdrawals were reduced in the nearby wells, and water levels quickly recovered to mid-1984 levels. The net change in water levels in well 29-585 during 1983-2003 was a decline of 1 ft. Observation well 29-18 is located near the midway point between the two cones of depression underlying the barrier islands of Ocean County. The net change from 1978 to 2003 was a decline of 4 ft. The nearly stable water levels for the duration of the record reflect the localized nature of the two cones.

Water levels have declined 2 ft to 7 ft in observation wells 11-44 and 11-163, respectively, in Cumberland County during 1998–2003 after declining at a constant rate of approximately 1 ft per year from 1978–97 (fig. 16). The water level in observation well 11-96, located near the shoreline in southern Cumberland County, also had declined at a rate of about 1 ft per year during 1978–93; from 1993 to 2003 the water level in this well remained unchanged at -34 ft. The water level in well Id55-01, located near the center of the cone of depression in Dover, Delaware, declined during 1978–91 but generally rose through 2003 (fig. 17). Despite seasonal fluctuations in water levels of as much as 22 ft, annual high water levels have increased by approximately 14 ft during 1991 to 2003. The rise in water levels in well Id55-01 and the stabilization of water levels in well 11-96 through 2003 are in response to a decrease in ground-water withdrawals since the early 1990s in the Dover, Delaware, area (Lacombe and Rosman, 2001). Observation wells Kc31-01 and Nc13-03 are located to the west and southwest of the regional production center, respectively. Water levels in both wells declined slowly during 1978–93; thereafter, water levels generally were stable. The net decline from 1978 to 2003 at both wells was approximately 12 ft. Near the western limit of the study area, water levels in observation wells in eastern Caroline County, Maryland, exhibit a similar trend. The hydrographs for wells CO Bd 53 and CO Dd 47 show gradually declining water levels from 1983 through 2003; the total decline for this 20-year period was approximately 13 ft at both wells. Seasonal fluctuations in water levels in well CO Dd 47 typically were 4 ft to 5 ft in response to withdrawals at a nearby production well in Denton, Maryland.

Vincentown Aquifer

The Vincentown aquifer is composed of the sandy portions of the Paleocene Vincentown Formation. Within the outcrop and from 8 mi to 10 mi downdip, the Vincentown Formation can yield quantities of ground water capable of sustaining small production and domestic-supply wells; beyond this extent, it functions primarily as a confining unit (Zapecza, 1989). In the outcrop and the shallow subsurface, the formation is composed primarily of a massive quartzose sand containing abundant glauconite, mica, and shell material. The formation grades to silty sand then to silt downdip from the outcrop (Sugarman, 1992). The aquifer is well defined in northern Ocean and southern Monmouth Counties but is less well defined in the rest of the Coastal Plain. The formation is thickest (more than 100 ft thick) in Monmouth County in east-central New Jersey, the area where it is used most often for water supply. Beyond Monmouth and Ocean Counties, the Vincentown Formation is silty and produces appreciable quantities of water only locally; the Vincentown aquifer is not a large source of water in any part of southwestern or south-central New Jersey. In Delaware and eastern Maryland, the local equivalent is referred to as the Aquia-Rancocas aquifer (Vroblesky and Fleck, 1991), and the aquifer consists of the permeable sands of the Paleocene Rancocas Group. The updip limit of the confined aquifer is bounded by the outcrop of the Vincentown Formation, and its downdip limit extends into central Kent County.

Water Withdrawals and Extent of Freshwater

The distribution of ground-water withdrawals from the Vincentown aquifer is shown in figure 18. Withdrawals for public supply are most prevalent in Monmouth County and parts of northern Ocean County; the aquifer in this area also is an important source for self supply. Withdrawals for self supply and irrigation also are made in the sandy portions of the aquifer in Salem and Burlington Counties and, to a lesser extent, in Gloucester and Camden Counties. Ground-water withdrawals from the Vincentown aquifer ranged from 0.75 to 1.5 Mgal/d from 1978 to 2003 (fig. 19). During 2003, an estimated 1.2 Mgal/d of ground water was withdrawn from the aquifer. Production wells at two well fields located along the border between northern Ocean and southern Monmouth Counties accounted for nearly 60 percent (0.7 Mgal/d) of total withdrawals from the aquifer. Notable withdrawals also were made at a nearby golf course in Farmingdale and along the aquifer's outcrop and subcrop in Burlington County.

The 250-mg/L isochlor was not determined for the Vincentown aquifer; ground-water samples from the confined part of the aquifer contain chloride concentrations of 45 mg/L or less. The location of the 10,000-mg/L isochlor was not estimated for this aquifer.

Water Levels

Water-level data from 26 wells screened in the Vincentown aquifer were used to define the 2003 potentiometric surface (pl. 4, app. 4). Where data were sparse, particularly in central Salem County, simulated water levels from Martin (1998) were used to estimate the position and shape of the contours. The configuration of the potentiometric surface for the Vincentown aquifer is nearly identical to that interpreted for 1998, as there was little observed change in water levels from 1998 to 2003. The highest water levels (> 150 ft) within the aquifer area occurred near the updip limit in western Monmouth and northwestern Ocean County; the lowest observed water levels of 3 ft occurred in lower Salem County. Slightly to moderately higher water levels in several wells located within the Adelphia and Farmingdale quadrangles near the western limit of the aquifer caused the potentiometric contours to shift slightly in the downdip direction in this area. The potentiometric high of 160 ft in this area reflects the prevailing water levels in the outcrop near here (Watt and others, 1994). Data from several observation wells added to the study in central Gloucester County indicate a local potentiometric high similar to that depicted by Martin (1998). Decreasing water levels to the southwest from here indicate regional flow is toward the Delaware River.

The largest change observed within the aquifer occurred at the Aldrich well field, located along the border between Ocean and Monmouth Counties, where the water level in well 25-451 rose by approximately 18 ft. Withdrawals from this well were at their peak in 1998, but by 2003 withdrawals had decreased by nearly 120 Mgal. To the northwest and near the regional potentiometric high, the water level in well 29-660 rose 10 ft relative to 1998 levels. Water levels elsewhere within the aquifer generally were stable to rising since 1998.

A downward hydraulic gradient from the water-table aquifer to the Vincentown aquifer and a downward gradient from the Vincentown aquifer to the Wenonah-Mount Laurel aquifer are shown in section A-A' (fig. 2a). The downward gradient to the Wenonah-Mount Laurel aquifer is strongest near the downdip limit of aquifer as water-level altitudes in the underlying aquifer increasingly become depressed.

Long-term water-level data for the Vincentown aquifer are represented in figure 20. The hydrographs of observation wells 29-139 and 5-1250 show near constant water levels for the period of record. The hydrograph of observation well 25-636 shows a rise of 16 ft during 1988–91; thereafter, water levels remained constant. Seasonal variations in water levels were greatest (4 ft) in this well owing to its location near the area where the aquifer is most utilized. Long-term water-level data were not available for the southern extent of the aquifer.

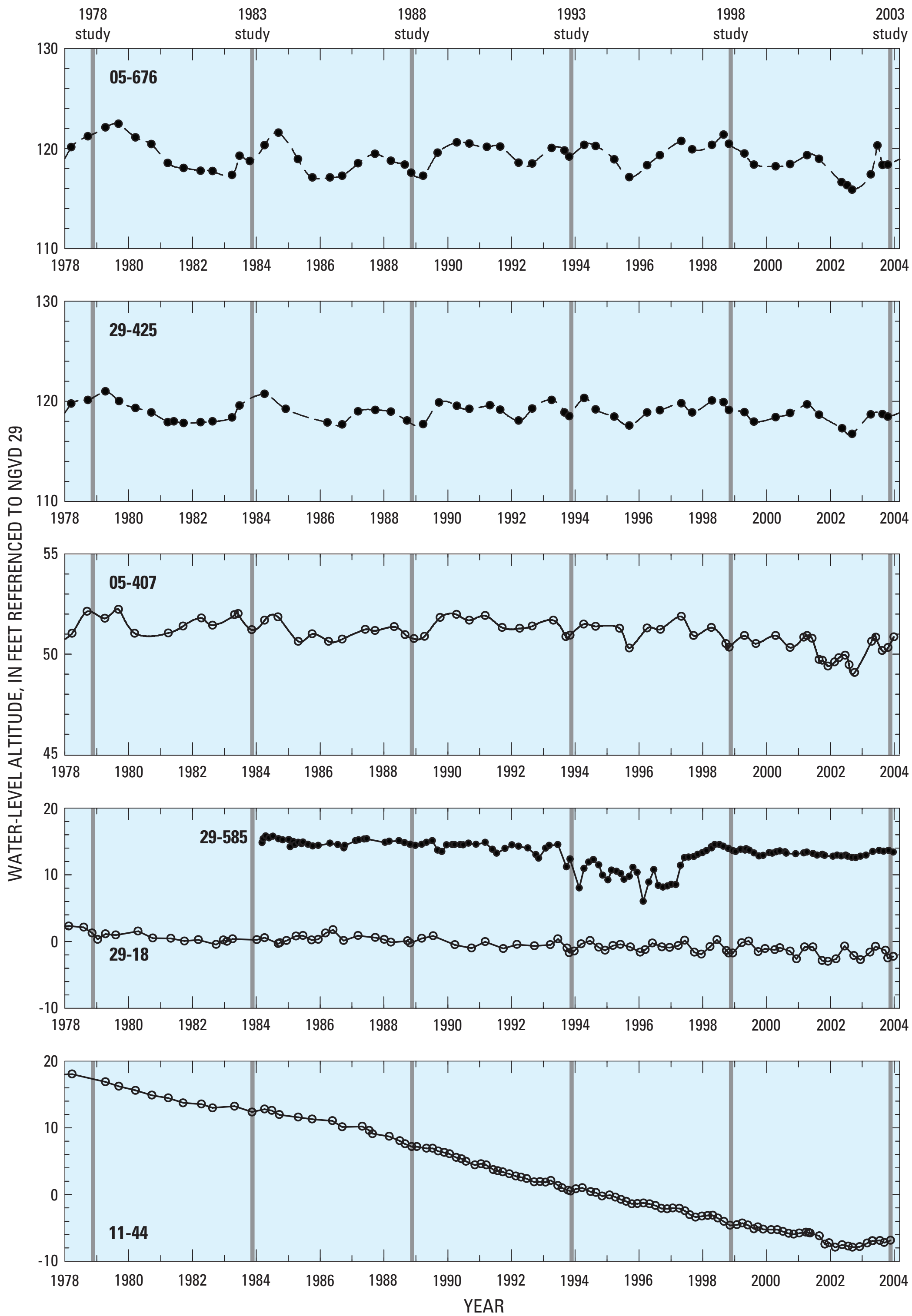


Figure 16. Water-level hydrographs for observation wells screened in the Piney Point aquifer, New Jersey Coastal Plain, 1978–2003.

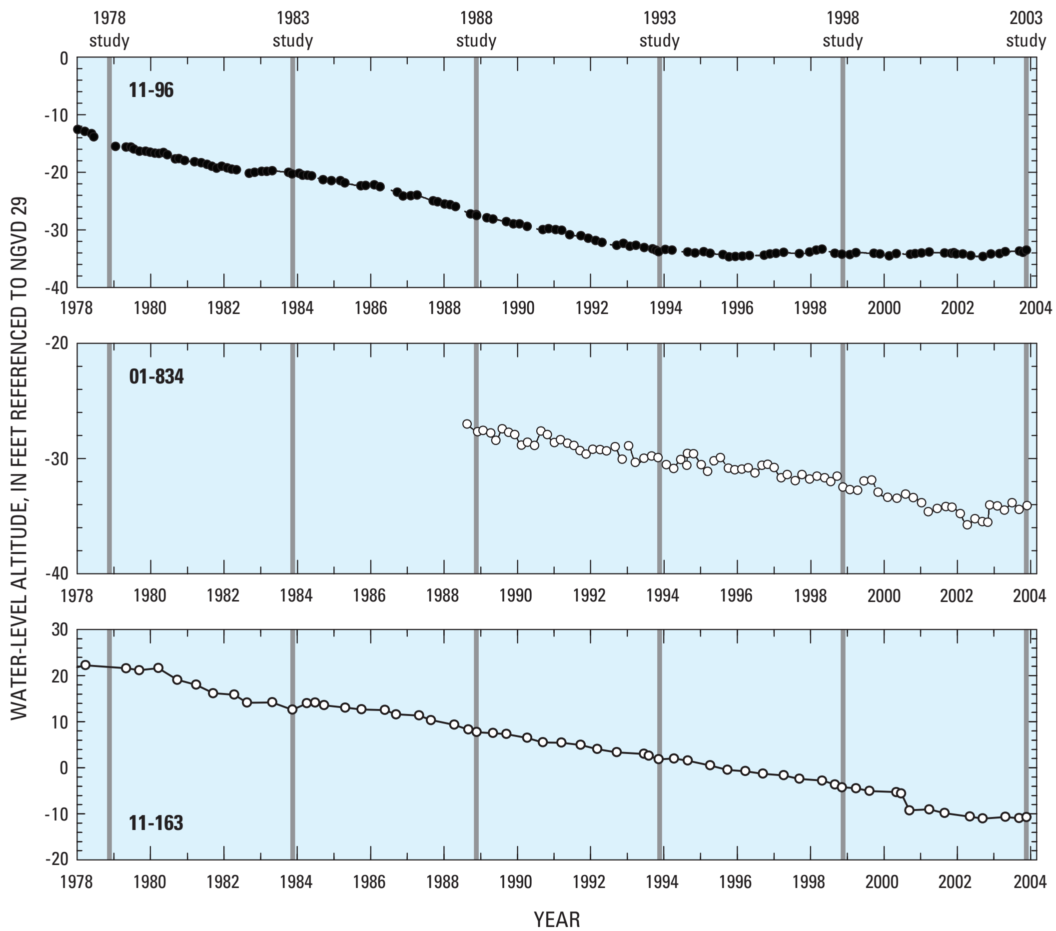


Figure 16. Water-level hydrographs for observation wells screened in the Piney Point aquifer, New Jersey Coastal Plain, 1978–2003.—Continued

Wenonah-Mount Laurel Aquifer

The Wenonah-Mount Laurel aquifer is composed of the sand of the Mount Laurel Formation and, locally, the upper part of the Wenonah Formation where the latter is not composed predominantly of silt. The Mount Laurel Formation is a slightly glauconitic, micaceous quartz sand; shell beds are fairly common throughout. The upper part of the Wenonah Formation consists of slightly glauconitic clayey fine sand or silt containing abundant lignite fragments and occasional pyrite (Owens and others, 1970); the formation grades to a silt at its base. The aquifer crops out within the exposures of the Mount Laurel and Wenonah Formations in Monmouth and Middlesex Counties in the northeastern portion of the Coastal Plain to Salem County in the southwest (pl. 5). The downdip limit of the aquifer is offshore of Monmouth and Ocean Counties; in the southern New Jersey Counties of Atlantic, Cumberland, and Cape May this limit is poorly defined. The productivity at any location is based on the thickness and silt content of the materials composing the aquifer. The aquifer is thickest in southwestern New Jersey (western Salem, and central Gloucester and Camden Counties) where it is used most often for water supply. In this area thicknesses of 100 ft to 200 ft are common (Zapecza, 1989). To the southwest in Salem County, the silt content increases, and the productive sands decrease accordingly. In the northeastern part of the Coastal Plain, the aquifer also is used for water supply in central and eastern Monmouth and northern Ocean Counties; the aquifer here is generally 60 ft to 80 ft thick (Zapecza, 1989) although thicknesses may exceed 100 ft in some areas of Monmouth County. Vroblesky and Fleck (1991) refer to the equivalent unit in Delaware and eastern Maryland, as the Severn aquifer; the aquifer corresponds to the sandy portions of the Severn Formation in eastern Maryland and the Monmouth Formation in Delaware. State agencies in Delaware currently refer to this unit as the Mount Laurel aquifer. The updip limit of the Mount Laurel aquifer in Delaware is located in central New Castle County south of the Chesapeake and Delaware Canal, and the downdip limit extends to the southeast of Sussex County. The aquifer here is typically less than 100 ft thick.

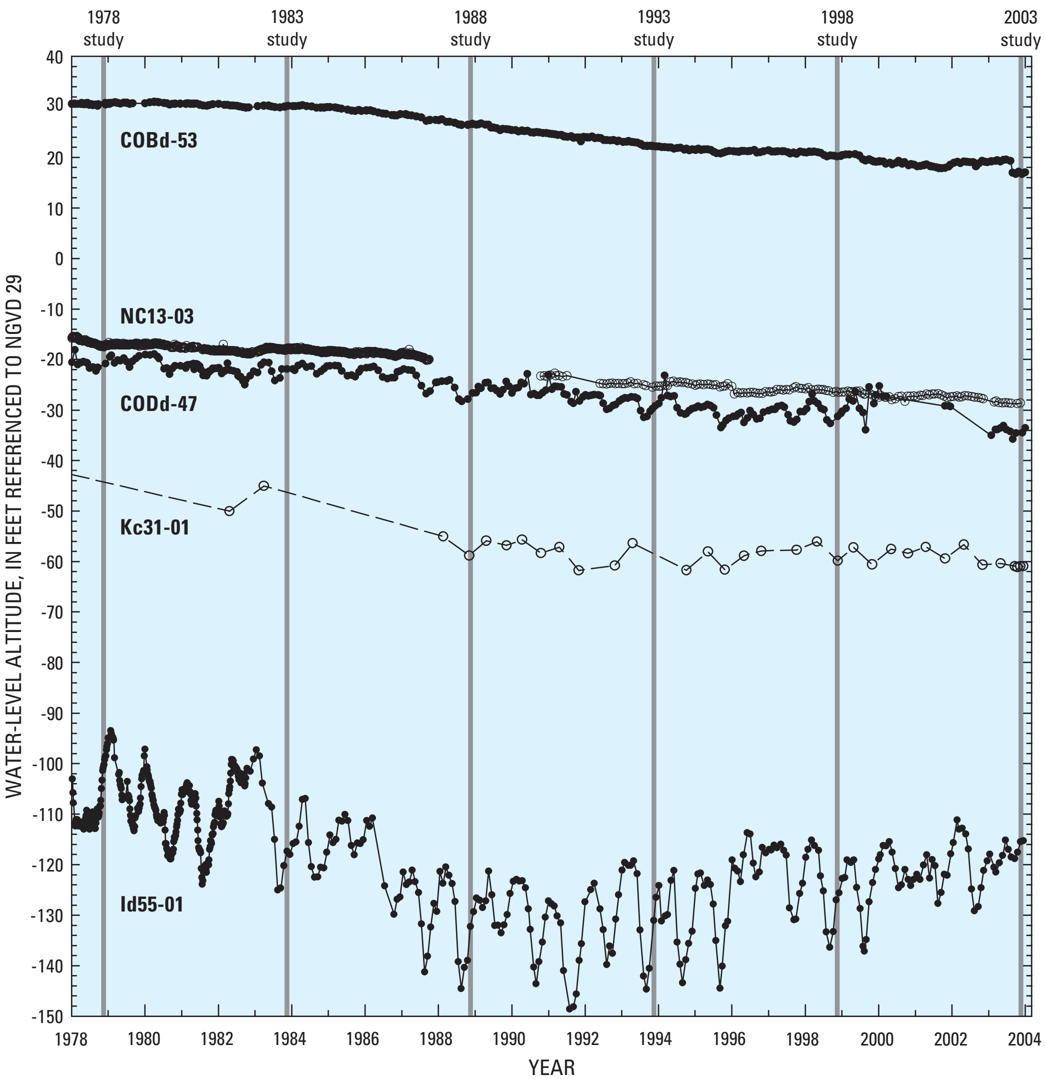
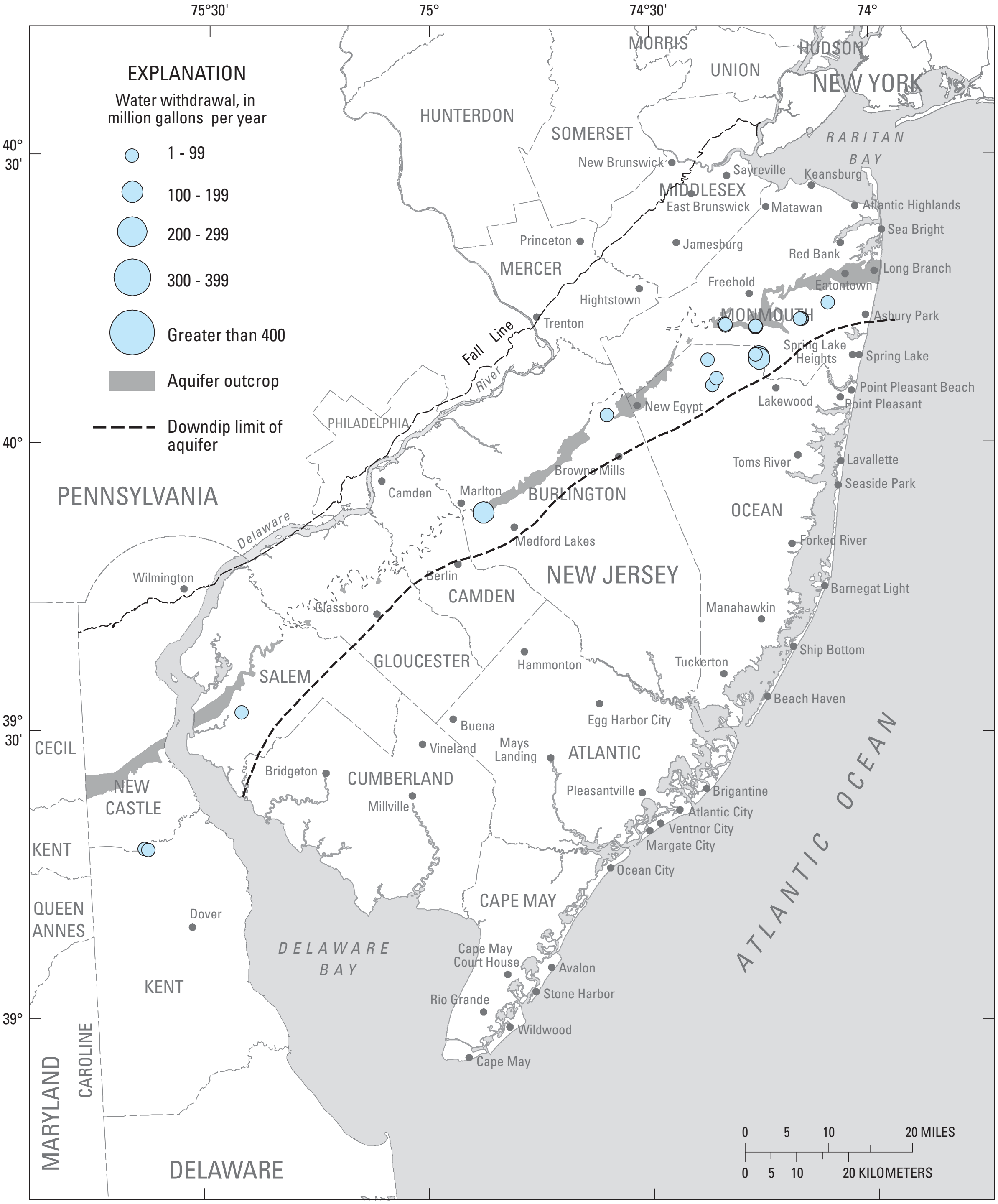


Figure 17. Water-level hydrographs for observation wells screened in the Piney Point aquifer, Delaware and eastern Maryland, 1978–2003.

Water Withdrawals and Extent of Freshwater

The major withdrawal centers for the Wenonah-Mount Laurel aquifer are in southern New Jersey in a narrow band from central Burlington County to central Salem County from the outcrop to less than 10 mi downdip (fig. 21). Another pumping center is located in eastern Monmouth County in close proximity to the coast. Average daily withdrawals for 2003 for the entire study area were estimated at 7.9 Mgal/d (fig. 22). This value does not include withdrawals in Delaware, which are thought to be insubstantial; at the time of compilation of this report, 2003 withdrawal data for Delaware were not available. Most withdrawals occurred in the southern counties of New Jersey; by 2003 the combined withdrawals from Monmouth and Ocean Counties totaled only 0.6 Mgal/d. From 1978 to 2003 estimated withdrawals ranged from 4.1 to 8.7 Mgal/d. Withdrawals in the northern counties decreased from about 1.4 Mgal/d in 1978 to 0.6 Mgal/d in 2003, with the largest decrease occurring in 1991 as a result of the implementation of CA 1 cutbacks. During the same period, groundwater withdrawals in the southern counties increased from 4.4 to 7.2 Mgal/d, with peak volumes of greater than 8 Mgal/d occurring during 1997–98. From 1996 to 1997, estimated withdrawals from the southern counties increased by 34 percent, the largest 1-year increase observed for the aquifer.

In Delaware, the aquifer is used principally in central New Castle County from the outcrop to about 4 mi downdip. Withdrawals are primarily for self supply and irrigation although the aquifer is used for public supply in the Middleton and Odessa areas. The aquifer is used only locally in northern Kent County. Reported usage from 1978 to 2001 ranged from less than 0.1 to 0.7 Mgal/d (fig. 23); withdrawals during this time period were typically less than 100,000 gal/d. Average daily withdrawals increased slightly subsequent to 1990 to



Base from U.S. Geological Survey digital data, 1:24,000
Universal Transverse Mercator Projection, Zone 18, NAD 83

Figure 18. Location and amount of ground water withdrawn from the Vincentown aquifer, New Jersey and Delaware Coastal Plain, 2003.

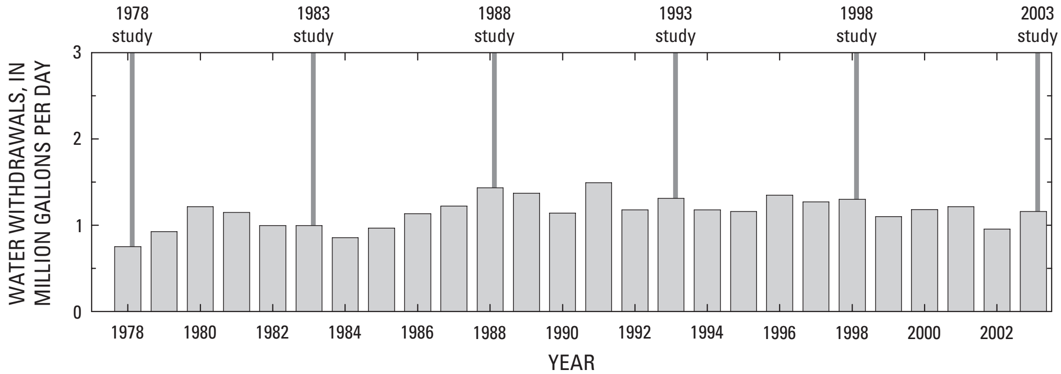


Figure 19. Estimated ground-water withdrawals from the Vincentown aquifer, New Jersey Coastal Plain, 1978–2003.

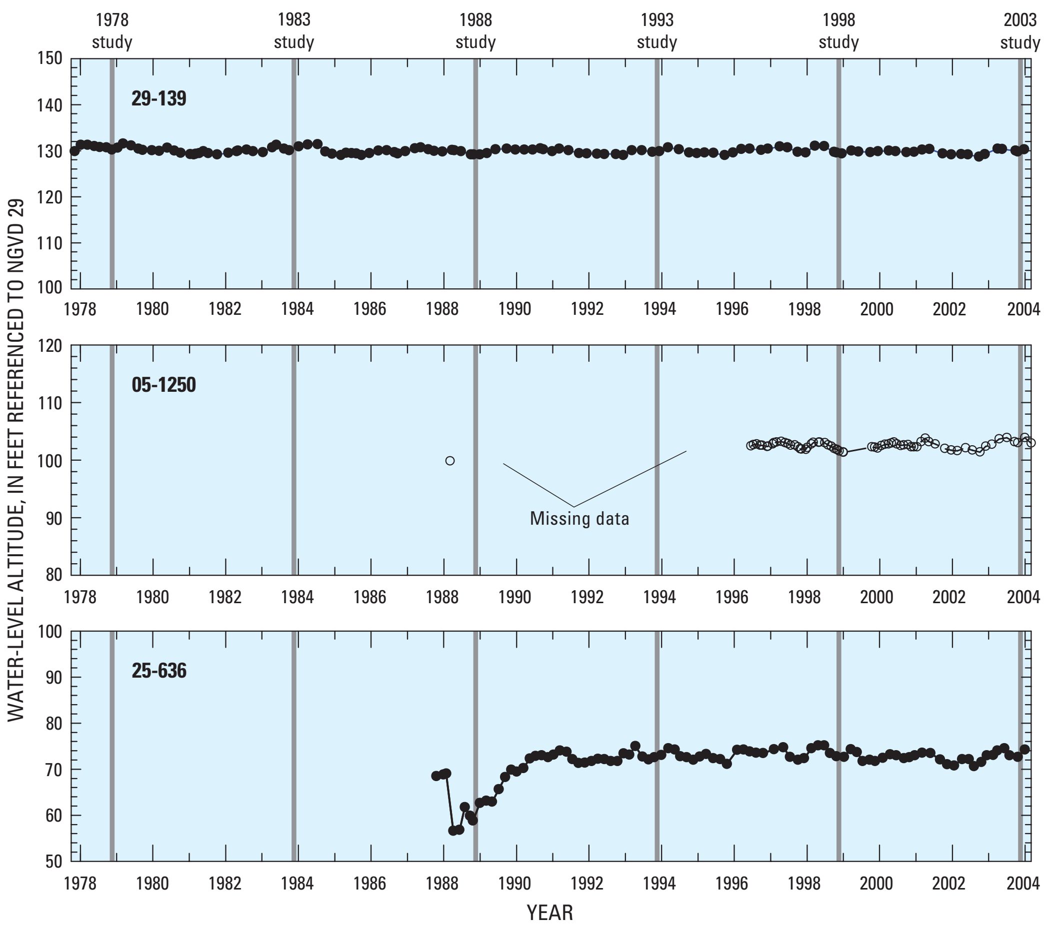
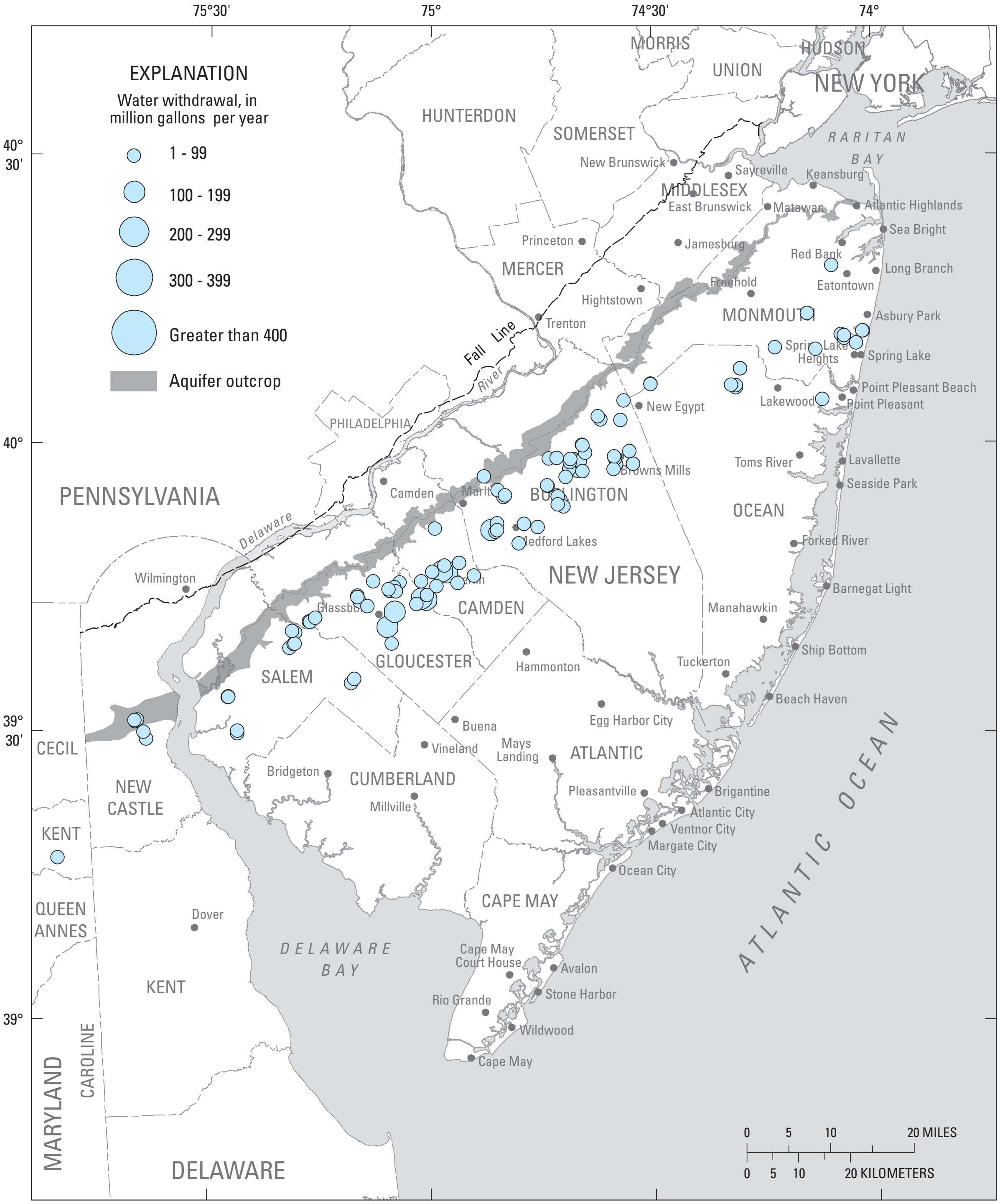


Figure 20. Water-level hydrographs for observation wells screened in the Vincentown aquifer, New Jersey Coastal Plain, 1978–2003.



Base from U.S. Geological Survey digital data, 1:24,000
Universal Transverse Mercator Projection, Zone 18, NAD 83

Figure 21. Location and amount of ground water withdrawn from the Wenonah-Mount Laurel aquifer, New Jersey and Delaware Coastal Plain, 2003.

the maximum of 0.7 Mgal/d in 2000. The reason for this peak in withdrawals is unclear; it could be due to discrepancies in allocation reporting.

The mapped location of the 250-mg/L isochlor is in southern Cumberland and Salem Counties. The position of this line, originally described by Lacombe and Rosman (1997), has not been moved landward but has been extended to the Delaware River in western Salem County on the basis of recent elevated chloride concentrations in ground water in the Artificial Island area. The aquifer contains salty water along the Delaware estuary and bay front in southern Cumberland and Salem Counties to more than 2 mi inland in the southwestern part of Salem County. Elevated chloride concentrations (> 50 mg/L) also are present in the ground water near the city of Salem, but elsewhere in southern New Jersey where the aquifer is utilized, the ground water is generally fresh, containing chloride in concentrations typically below 25 mg/L. The 250-mg/L isochlor was not determined for the northern extent of the aquifer as the highest chloride concentrations in water from production wells farthest downdip and along the coast in Monmouth County typically were less than 25 mg/L. The location of the 10,000-mg/L isochlor was simulated by use of the SHARP model (Pope and Gordon, 1999) and is located approximately 18 mi offshore of southern Ocean County. This line lies progressively closer to the coastline toward the southwest, where it is located onshore in lower Cape May County. Depth to the top of the aquifer in this area is considerable, and the aquifer here is poorly defined.

Water Levels

Water levels measured in 132 wells in New Jersey and 9 wells in Delaware (app. 5) were used to define the 2003 potentiometric surface of the Wenonah-Mount Laurel aquifer (pl. 5). Simulated contours by Voronin (2004) were used to guide the closure of contours at the eastern or offshore edges of the major cones of depression where data are sparse or absent. The map of the 2003 potentiometric surface shows high ground-water levels near the outcrop in the northern counties of New Jersey, a ground-water low near the outcrop in central Burlington County, and three major cones of depression within the aquifer. The highest water levels within the confined aquifer occur near the outcrop in Monmouth County (150 ft in well 25-412); the lowest water levels occur in coastal Monmouth County and along the border of central Camden and Gloucester Counties. The northernmost cone of depression, located in coastal Monmouth County, is elongate in shape and centered beneath the boroughs of Point Pleasant, Brielle, and Spring Lake Heights, extending throughout a broad (440 mi^2) area from Seaside Park in northern Ocean County north to Long Branch in Monmouth County and west to beyond Lakewood. Minimum water levels of -72 ft (well 25-391) and -76 ft (well 29-37) NGVD 29 observed near the deepest part of the cone represent a rise of 11 ft and 14 ft, respectively, from levels observed in 1998. Within the area encompassed by the 0-ft contour, ground-water withdrawals from the aquifer in 2003 were estimated to be 0.2 Mgal/d. This volume is not substantial when considering the depth and breadth of this cone; the relatively low transmissivity of the aquifer of 500 to 700 ft^2/d (Martin, 1998) coupled with long-term withdrawals from the underlying Englishtown aquifer system (nearly twentyfold that of the Wenonah-Mount Laurel aquifer) contribute to the size and persistence of the cone.

The central cone of depression, the smallest of the three, is centered under the community of Browns Mills and has a minimum water level of -32 ft NGVD 29 (well 05-366). This cone of depression has been represented on potentiometric-surface maps since the initial study in 1978. Ground-water withdrawals in 2003 from nine wells in the Browns Mills area were modest at approximately 0.7 Mgal/d. Since 1980, withdrawal amounts from these same wells have been fairly consistent. In 1980, withdrawals were estimated at 0.8 Mgal/d, peaking at 1.2 Mgal/d in the early 1990s and subsequently decreasing to the current amount. As a result, the area encompassed by the 0-ft contour has contracted from that in previous years.

The southern cone of depression, underlying parts of central Burlington, Camden, and Gloucester Counties, is demarcated by the 0-ft water-level contour. This elongated cone of depression is a recent phenomenon; it began to form following the 1983 study. Three smaller local cones have since merged to form the larger, more regionally extensive cone of depression present in 2003. The northernmost local cone of depression is located within the Medford Lakes quadrangle and has a minimum water level of -31 ft (well 05-1253). The two southern local cones of depression, centered within the Pitman East quadrangle, encompass parts of Camden and Gloucester Counties. The minimum water levels of -71 ft (well 07-847) and -23 ft (well 15-1060) NGVD 29 represent increases of 10 and 24 ft, respectively, from the previous study (Lacombe and Rosman, 2001).

Water levels in Delaware range from 25 ft (well Ec51-19) in the outcrop area in the southern St. Georges quadrangle to -13 ft (well Fc42-35) in the eastern Middletown quadrangle. A small localized cone of depression underlies the town of Odessa where water levels have declined to below NGVD 29.

A downward hydraulic gradient from the overlying Wenonah-Mount Laurel aquifer to the Englishtown aquifer system is shown along the entire section A-A' (fig. 2a). Along section B-B' a downward gradient is present in the updip area from the Wenonah-Mount Laurel aquifer to the Englishtown aquifer system (fig. 2b). Lacombe and Rosman (2001) noted an upward gradient from the Englishtown aquifer system to the Wenonah-Mount Laurel aquifer, based on data collected in 1998, that is still present in 2003.

Changes in water levels during 1998 to 2003 within the Wenonah-Mount Laurel aquifer are depicted in figure 24a. Within the northern counties, water levels rose in 65 percent of those wells measured. The potentiometric surface of the aquifer, in general, rose 5 to 10 ft near the center of the regional cone of depression underlying eastern Monmouth County.

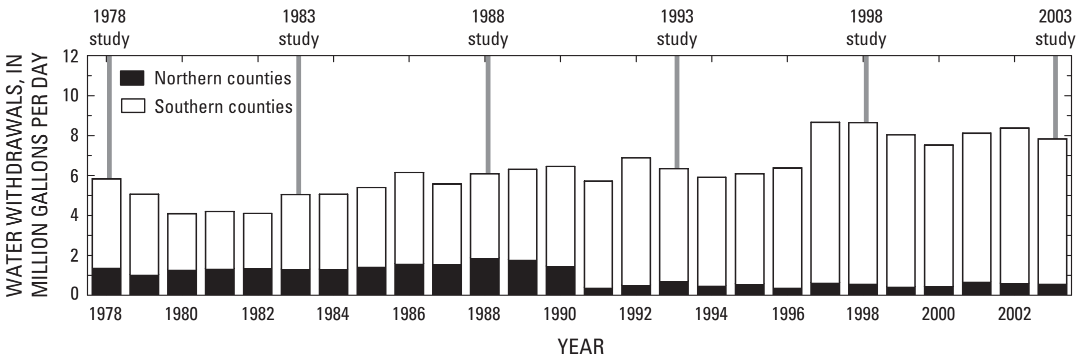


Figure 22. Estimated ground-water withdrawals from the Wenonah-Mount Laurel aquifer, New Jersey Coastal Plain, 1978–2003.

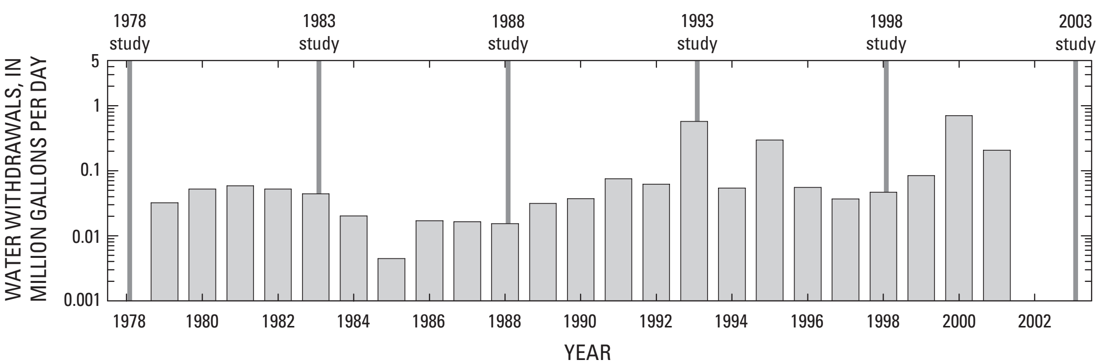


Figure 23. Estimated ground-water withdrawals from the Mount Laurel aquifer, Delaware Coastal Plain, 1978–2001.

Greater rises in water levels were observed at wells slightly to the north and west; rises of 21 ft (well 25-335) and 18 ft (well 25-14) in two wells may have been enhanced owing to prolonged inactivity at or near the production wells relative to the previous study, and actual recovery was likely less in magnitude. Away from the center of the cone, rises in water levels become more subtle. Ground-water withdrawals have declined appreciably from 1998 to 2003; estimated withdrawals from 15 production wells located within the 0-ft contour declined by 30 Mgal or 30 percent. Beyond the 0-ft contour and to the north and west, the potentiometric surface showed little to no change from 1998. This was an expected result as the aquifer was little used here. In a small area of central Jackson Township, water levels declined from 4 ft to 6 ft since the previous study in 1998. Ground-water withdrawals increased in this vicinity during this period.

Prior to the recovery of water levels in the early 1990s and the subsequent stabilization of heads in the Monmouth/Ocean County area during the last few years, water levels as low as -215 ft NGVD 29 observed during the late 1980s indicated a maximum decline of nearly 260 ft from predevelopment levels. In 1989, the NJDEP mandated reductions in ground-water withdrawals in the Wenonah-Mount Laurel aquifer and deeper aquifers in this area (CA 1) in response to steeply declining water levels and concern over the sustainability of the supply. Upon completion of the Manasquan reservoir in 1991, withdrawals from confined Coastal Plain aquifers in this area were reduced and replaced with surface-water withdrawals and to a lesser extent, withdrawals from shallower, unconfined aquifers (Watt, 2000), initiating a reversal in the long-term decline in water levels. By 1993 withdrawals from the Wenonah-Mount Laurel aquifer were reduced to approximately 50 percent of 1983 amounts. As a result, water levels in the aquifer recovered more than 50 ft during 1989–93, and the overall extent and depth of the cone of depression decreased. Water levels continued to rise in the cone of depression and by 2003 had recovered more than 140 ft from lows of -215 ft and -210 ft NGVD 29 in 1988. Water-level changes in the Wenonah-Mount Laurel aquifer and other Cretaceous-age aquifers from 1988 to 2003 are shown in figure 25. This 15-year period was chosen for representation because the 1988 study was the last cycle predating mandatory restrictions in CA 1. Water levels recovered, on average, 30 ft across CA 1, by more than 40 ft across 30 percent (200 mi^2) of the critical area, and by more than 80 ft in a 72-mi^2 area (11 percent) along coastal Monmouth and Ocean Counties.

In the southern counties of the New Jersey Coastal Plain, however, ground-water levels declined between 1988 and

2003 as withdrawals increased due to CA 2 restrictions placed on the deeper PRM aquifer system. Although the decline in water levels in the Wenonah-Mount Laurel aquifer has abated during the last 5-year cycle, water levels near the center of the cone of depression fell more than 80 ft during this 15-year period.

Ground-water withdrawals in and around the central cone of depression at Browns Mills have decreased slightly from volumes reported during the 1998 study. Consequently, moderate rises of 4 ft to 5 ft were observed during 1998 to 2003.

Water levels within the regional southern cone of depression generally have stabilized or risen subsequent to the 1998 study. Water levels rose in most of the wells within this area from 1998 to 2003. The greatest rises were observed in an area east of Glassboro, Gloucester County, near the southwestern edge of the regional cone of depression. However, some double-digit recoveries in this area may be artifacts of the measurement process as several production wells remained idle for longer periods prior to measurement in 2003 than in the previous study. The maximum rise in water level of 29 ft in this area occurred in observation well 15-1203 near the southwest edge of the regional cone of depression. This well is proximal to two production wells; withdrawals decreased from 1998 to 2003 but by only a few percent. This reduction in withdrawals was likely not the sole cause for this rise in water level. To the northeast and at the center of the southern cone, water levels rose approximately 10 ft. Elsewhere in this area, water levels typically were stable to slightly rising. One exception was well 05-1253, located near Medford Lakes, where the water level was 15 ft higher than in 1998. Withdrawals also decreased, albeit slightly, during this period. To the southwest, in Salem County, water levels remained stable.

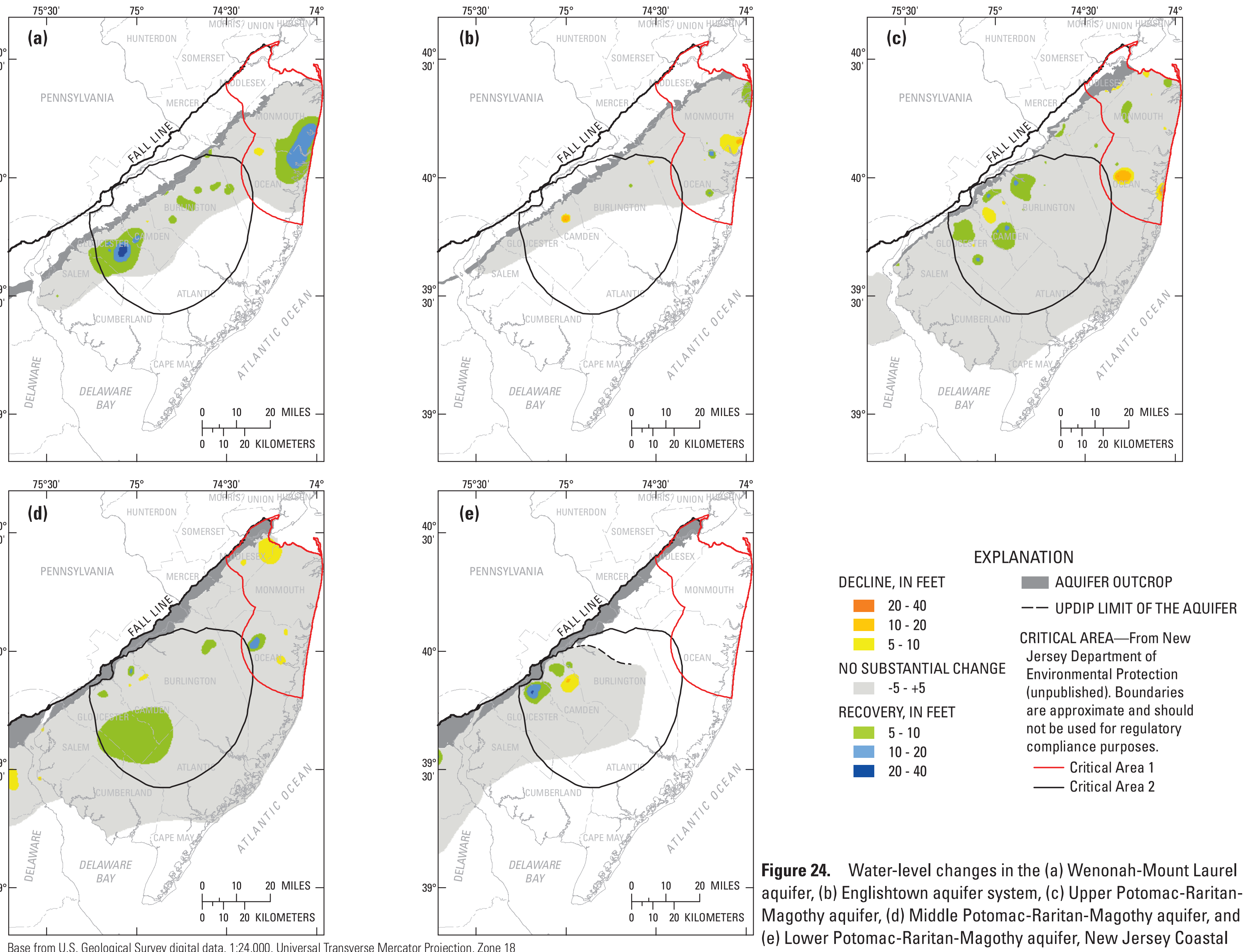
Ground-water withdrawals in the area underlain by the southern cone of depression peaked in the late 1990s at more than 4 Mgal/d; withdrawals had steadily increased from 0.5 Mgal/d in 1980 to approximately 2.7 Mgal/d in 1995. Mandated restrictions on withdrawals from aquifers in the PRM system in southern New Jersey effected a sharp increase in withdrawals from the Wenonah-Mount Laurel aquifer during 1996–97. From 1993–98 the potentiometric surface of the Wenonah-Mount Laurel aquifer had declined more than 40 ft in the greater Camden area. Stable to slightly declining withdrawals from 1999 to 2003 are a result of voluntary reductions in ground-water withdrawals in the aquifer and the introduction of surface water for supply into some areas by the expansion of New Jersey American Water Company's Delran Pipeline in the late 1990s. As a result, the cones of depression in the Wenonah-Mount Laurel aquifer have decreased in the greater Camden and Gloucester areas in recent years.

Water-level hydrographs for eight USGS observation wells for 1978 to 2003 indicate that water levels remained fairly constant since the previous study in 1998 (figs. 26 and 27). Observation well 07–478 is located approximately 4 mi from any major ground-water withdrawals but within the regional cone of depression in southern New Jersey. Following a 70-ft water-level decline over an 18-year period, water levels stabilized and, in fact, have begun to rise slightly during the last 2 years of record. Wells 33-20 and 33-252 are located in Salem County to the southwest of this regional cone. Water levels gradually declined about 8 ft in well 33-20 during 1978–98 before stabilizing; water levels in well 33-252 show virtually no change from 1978 to 2003. Well 07-118 is located near the outcrop in Camden County where ground-water withdrawals are minimal. The hydrograph of this well also indicates little change in water levels for the represented period of record. Seasonal fluctuations observed in these wells were moderate; variability was greatest in well 33-20 at 4 ft to 5 ft.

Hydrographs show that water levels increased 20 and 30 ft in wells 25-353 and 25-637, respectively, during 1990-94 and rose an additional 15 ft during 1994–98 (fig. 27). From 1998 to 2003 water levels stabilized or declined slightly. Both wells are located near the western edge of the northern cone of depression. The hydrograph of well 29-140, which is situated in an area away from substantial withdrawals, shows only slight decline for the period of record. Water levels in well 25-486, located near the center of the major cone of depression, were far below NGVD 29 at -180 ft during the mid-1980s. Owing to the aforementioned imposed restrictions on ground-water withdrawals in this region, water levels rose 90 ft during 1990–94. From 1994 to 1998, water levels recovered by an additional 25 feet in this well. Subsequent to 1998, water levels here generally have stabilized. Seasonal water-level fluctuations were greatest near the center of the cone of depression, with maximum fluctuations approaching 20 ft.

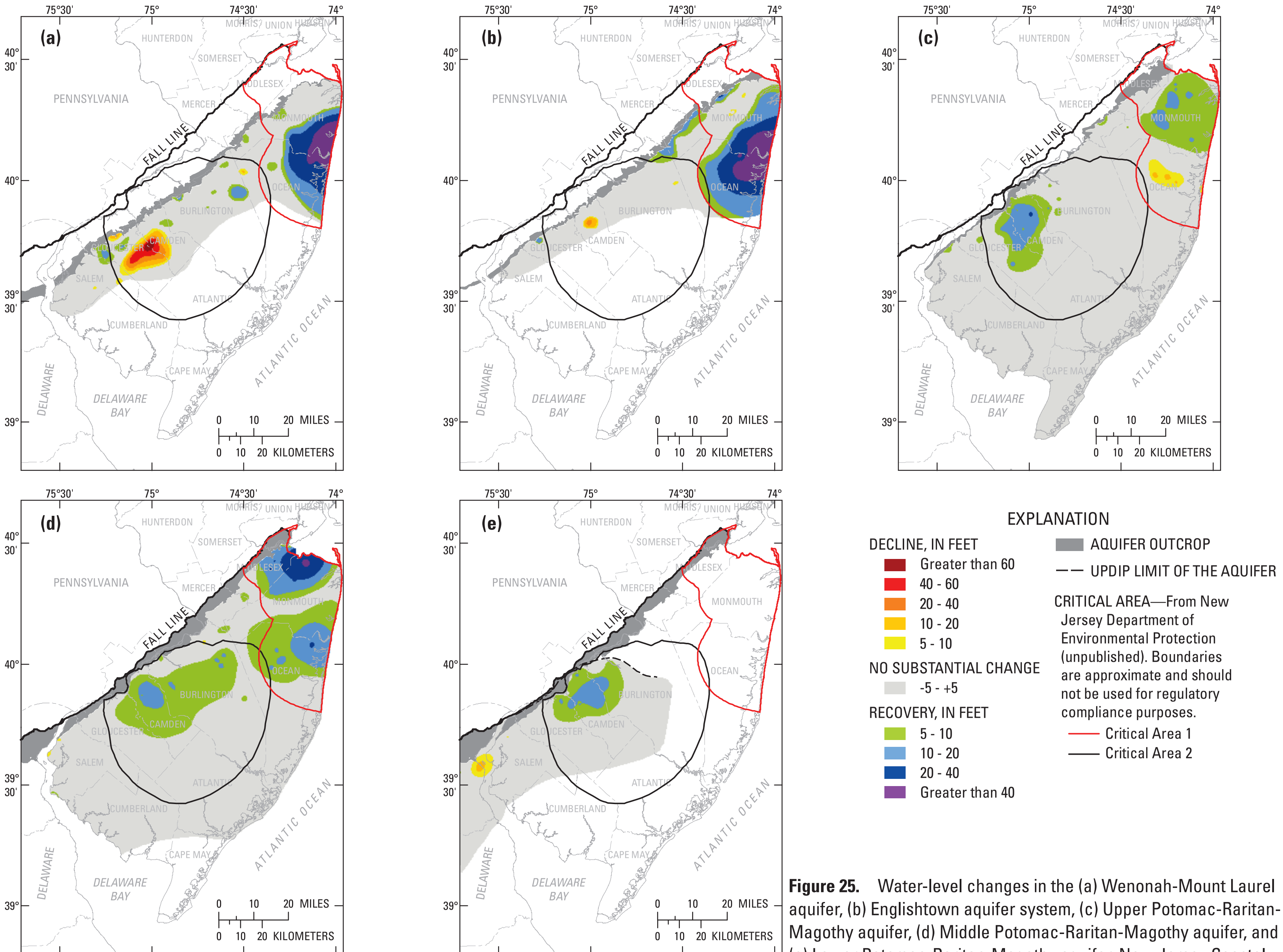
Englishtown Aquifer System

The Englishtown Formation is a fine- to medium-grained feldspathic and quartzose sand that in some places grades to a silt. The formation is thickest (200 ft) in Monmouth County and remains sandy and thick a substantial distance downdip from the outcrop; therefore, the aquifer yields large quantities of water in Monmouth and Ocean County. In central and southern Ocean County, a confining unit partitions the Englishtown into an upper and lower aquifer. The Englishtown Formation thins considerably to the southwest, where sandy units become thin and discontinuous in southwestern New Jersey (Zapecza, 1989), and silt beds predominate. The downdip limit of the aquifer is approximately 34 mi to the southeast of the outcrop area in Ocean County; in the southern portion of the Coastal Plain, the lateral extent of the aquifer decreases to about 12 mi in southern Salem County. Transmissivity in the Englishtown aquifer system decreases significantly to the southwest as the geologic material becomes finer-grained (Nichols, 1977), and little water is produced from the aquifer in the southwestern part of the State (Zapecza, 1989).
The Englishtown aquifer is recognized in Delaware; however, its usage is limited.



Base from U.S. Geological Survey digital data, 1:24,000, Universal Transverse Mercator Projection, Zone 18

Figure 24. Water-level changes in the (a) Wenonah-Mount Laurel aquifer, (b) Englishtown aquifer system, (c) Upper Potomac-Raritan-Magothy aquifer, (d) Middle Potomac-Raritan-Magothy aquifer, and (e) Lower Potomac-Raritan-Magothy aquifer, New Jersey Coastal Plain, 1998–2003.



Base from U.S. Geological Survey digital data, 1:24,000, Universal Transverse Mercator Projection, Zone 18

Figure 25. Water-level changes in the (a) Wenonah-Mount Laurel aquifer, (b) Englishtown aquifer system, (c) Upper Potomac-Raritan-Magothy aquifer, (d) Middle Potomac-Raritan-Magothy aquifer, and (e) Lower Potomac-Raritan-Magothy aquifer, New Jersey Coastal Plain, 1988–2003.

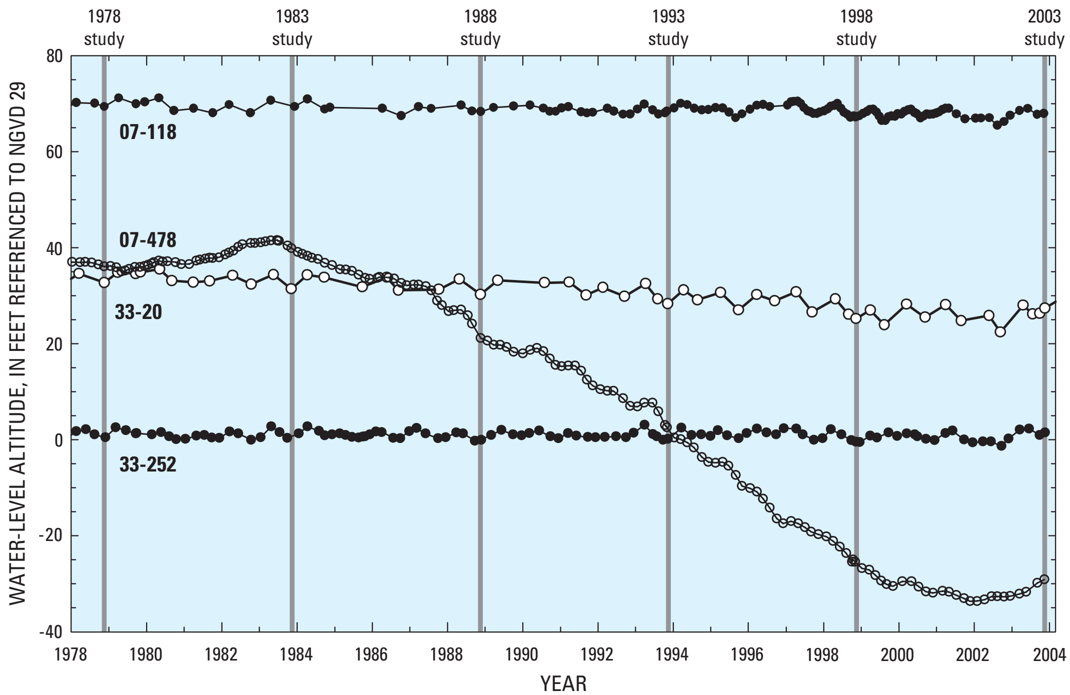


Figure 26. Water-level hydrographs for observation wells screened in the Wenonah-Mount Laurel aquifer in the southern counties of the New Jersey Coastal Plain, 1978–2003.

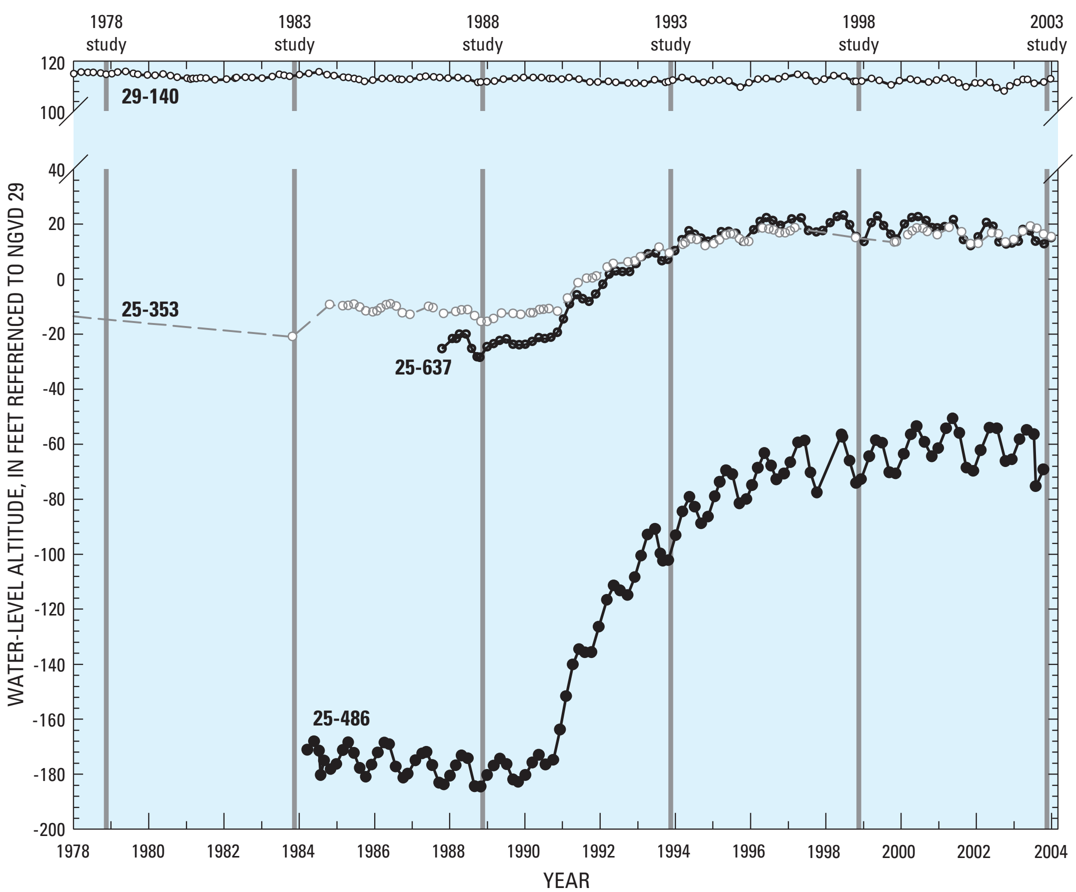


Figure 27. Water-level hydrographs for observation wells screened in the Wenonah-Mount Laurel aquifer in the northern counties, New Jersey Coastal Plain, 1978–2003.

Water Withdrawals and Extent of Freshwater

Withdrawals from the Englishtown aquifer system are made primarily in Monmouth and northern Ocean Counties and in central Camden County; however, scattered production centers are present throughout north-central Burlington County (fig. 28). The aquifer is used only locally in eastern Mercer County and near the outcrop in Salem and Gloucester Counties; usage here is limited primarily to domestic self supply. Total withdrawals from the Englishtown aquifer system in 2003 were estimated to be approximately 8 Mgal/d, with those from the northern counties accounting for 70 percent of this volume (fig. 29). Total statewide withdrawals decreased from approximately 11 Mgal/d in 1978 to less than 7 Mgal/d by 1996; withdrawals increased in 1997 to nearly 9 Mgal/d, then decreased and stabilized at approximately 8 Mgal/d through 2003. Total withdrawals from the northern counties have remained largely constant at about 5.5 Mgal/d since 1993; previously, withdrawals decreased from 10.3 Mgal/d in 1978 to 6.3 Mgal/d in 1992. Decreases in withdrawals from 1989 to 1991 are most notable.

Withdrawals from the aquifer system in the southern counties remained constant at approximately 0.5 Mgal/d from 1978 through 1987 (fig. 29); in 1988 withdrawal amounts began to increase gradually. By 1996, estimated withdrawals were nearly 1.7 Mgal/d; a sharp increase to 3.3 Mgal/d followed in 1997. In 1997 in Camden County, estimated withdrawals more than doubled from the previous year. This increase in the use of the Englishtown aquifer system is likely a consequence of restrictions placed on withdrawals from the deeper PRM system in 1996. Since then, withdrawals from this portion of the aquifer system have decreased gradually, and by 2003 total withdrawals were estimated at 2.4 Mgal/d.

Concentrations of dissolved chloride in samples from wells within the confined part of the aquifer only occasionally exceeded 25 mg/L along coastal Monmouth County, and concentrations in most samples were below this value. Therefore, the 250-mg/L isochlor is not represented on plate 6. A recent sample from well 25-771 on Sandy Hook confirmed a previous analysis of dissolved chloride in excess of 15,000 mg/L. The saline water is present below a 5-ft-thick clay lens (Lacombe and Rosman, 2001) and is effectively segregated from the upper part of the aquifer where the ground water is fresh. The 10,000-mg/L isochlor was not simulated by Pope and Gordon (1999) and, therefore, is not represented on plate 6.

Water Levels

Water-level data for 84 wells screened in the Englishtown aquifer system are listed in appendix 6. The highest water levels within the confined aquifer were measured near the outcrop in western Monmouth County (well 25-787, 114 ft) and the lowest, along the Monmouth/Ocean County boundary near Point Pleasant (well 29-52, -115 ft). The major feature of the ground-water flow system is a prominent cone of depression underlying northeastern Ocean and eastern Monmouth Counties (pl. 6). This large and deep cone of depression previously has been well documented; a 1958 piezometric map by Seaber (1965) showed water levels in this area in excess of 100 ft below NGVD 29. Nichols (1977) similarly documents declines in water levels from 1900 to 1959 greater than 100 ft near the border of Monmouth and Ocean Counties; from 1959 to 1983, ground-water levels in this vicinity declined an additional 150 ft.

The location and configuration of this cone is similar to that in the overlying Wenonah-Mount Laurel aquifer; vertical leakance through the confining unit is such that there is good hydraulic connection between the two aquifers. Closed contours on the potentiometric map east and seaward from the center of the cone were adapted on the basis of simulations by Pope and Gordon (1999) and Voronin (2004). This regional cone of depression is composed of several smaller cones underlying production centers located at Point Pleasant, Spring Lake, and Lakewood. The largest of the cones underlies coastal communities from Lavallette in northern Ocean County to Avon-by-the-Sea in southern Monmouth. Water levels at the center of this cone near Point Pleasant were observed at 115 ft below NGVD 29 (well 29-532); water levels in this area previously were measured as low as -259 ft in 1983. During the 1998 study, the center of this cone (the -100-ft contour) was located at Bay Head. By 2003, slightly recovering water levels at Bay Head and declining water levels at Point Pleasant and Brielle caused the center to migrate 1.3 mi to the west and north, the approximate position observed during the 1993 study. Five miles to the north, a small, ovate, local cone of depression underlies Spring Lake Borough, where a measured water level of -112 ft NGVD 29 (well 25-385) at a former supply well warranted a closed 100-ft contour. The two remaining local cones underlie areas near the town of Lakewood, and each is associated with a single well. Minimum water levels associated with the cones were -94 ft (well 29-449) and -90 ft NGVD 29 (well 29-438).

A local depression in the potentiometric surface at Freehold (well 25-727) is indicated on the map by the upswept 80-ft contour in the southeastern portion of the Freehold quadrangle (pl. 6). This feature was initially included on the 1993 potentiometric map and verified during the 1998 study (Lacombe and Rosman, 2001). The water-level altitude near this feature was 68 ft NGVD 29, a rise from the previous study of 8 ft.

The water level in observation well 25-771, located in Sandy Hook, New Jersey, was converted from a measured saltwater altitude of -1 ft to a freshwater equivalent altitude of 6 ft (appendix 6). Ground water at this well contained an extremely high concentration of dissolved chloride, in excess of 15,000 mg/L, resulting in a density of 1.018 g/cm^3.

In the southern part of the aquifer extent, water levels ranged from a high of 100 ft in northern Burlington County to a low of 3 ft NGVD 29 in central Camden County. A small, local cone of depression is present in central Camden County

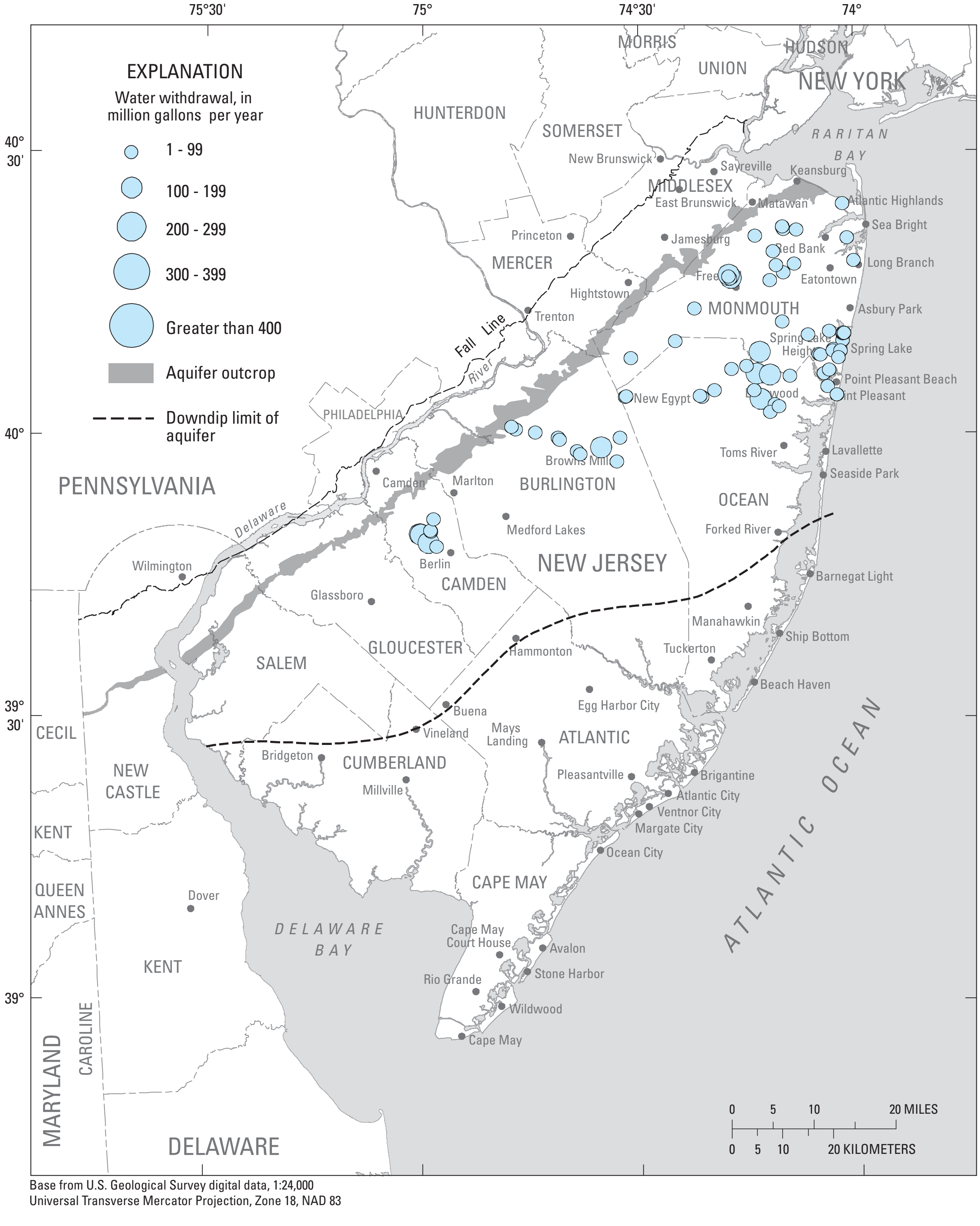


Figure 28. Location and amount of ground water withdrawn from the Englishtown aquifer system, New Jersey Coastal Plain, 2003.

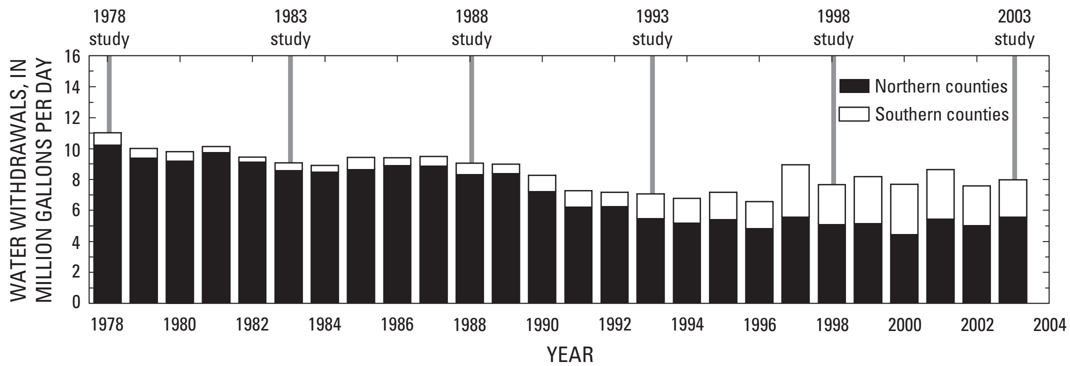


Figure 29. Estimated ground-water withdrawals from the Englishtown aquifer system, New Jersey Coastal Plain, 1978–2003.

centered beneath wells 07-673 and 07-672. This cone of depression may be ephemeral; it was not identified in previous studies, and nearby production wells had been idle for only a few hours prior to measurement. Further to the south and west, a ground-water potentiometric low is present near the outcrop in north-central Gloucester County.

A downward hydraulic gradient from the overlying Wenonah-Mount Laurel aquifer to the Englishtown aquifer system is shown along the entire section A-A' (fig. 2a). This downward gradient is strongest in central Howell Township, Monmouth County, where water levels in the Englishtown aquifer system are as much as 60 ft lower than in the Wenonah-Mount Laurel aquifer. Near the center of the cone of depression at Point Pleasant, water levels are approximately 30 ft to 32 ft lower in the Englishtown aquifer system than in the Wenonah-Mount Laurel aquifer. Along the same section, a downward gradient from the Englishtown aquifer system to the Upper PRM aquifer is present in the updip area of the aquifer system; water levels in the Englishtown aquifer system are as much as 100 ft higher that those in the underlying Upper PRM aquifer. Along the section in central Howell Township, the vertical gradient reverses and potential for ground-water flow is upward into the Englishtown aquifer system from the underlying unit. This potentiometric head differential increases downdip and toward the coast where it is at its maximum (80 ft) near the centers of the cones of depression in Spring Lake Heights and Point Pleasant Boroughs.

Along section B-B' a downward gradient exists in the updip area from the Wenonah-Mount Laurel aquifer to the Englishtown aquifer system. Lacombe and Rosman (2001) show an upward gradient from the Englishtown aquifer system to the Wenonah-Mount Laurel aquifer on the basis of data collected in 1998 (fig. 2b). Figure 2b also shows a downward gradient from the Englishtown aquifer system to the Upper PRM aquifer.

Water-level changes from 1998 to 2003 were calculated for 69 of the 84 wells screened in the aquifer. Water levels were stable over much of the extent of the aquifer system (fig. 24b). Declining water levels were observed, however, near the northern edge of the center of the regional cone of depression in Monmouth County. The largest declines occurred in and around Spring Lake Heights, where a maximum decline of 13 ft was observed in well 25-389. Although combined withdrawals from the aquifer system throughout the northern counties had stabilized in recent years, reported ground-water withdrawals in and around this area have steadily increased since 1996. A possible explanation for this increase is that, as development and water demand in this area increased during the late 1990s, purveyors tapped into the unused portion of their ground-water allocation to augment alternative sources mandated by Critical Area regulations in the early 1990s.

An apparent rise in water level of 49 ft occurred in well 29-236 from 1998 to 2003. This large rise is likely exaggerated; an anomalously low 1998 water level did not adhere to the general trend of recovery as indicated by water levels in other, nearby wells. Moreover, withdrawals at this site had ceased in 1988, and the moderate withdrawal amounts from nearby wells would not account for the low water level in this well. Although water levels, in general, are recovering in this area, the change here is likely more subtle. Elsewhere, within the northern extent of the aquifer, water levels generally were stable.

In southern New Jersey, water levels in central Camden County were as much as 25 ft lower than in 1998. Withdrawals in this area of the aquifer did not increase appreciably from 1998 to 2003; the large decline in water levels may be an artifact of nearby production wells in which water levels had not fully recovered at the time of measurement. Elsewhere throughout southern New Jersey, there was little change in the potentiometric surface.

Water-level changes from 1988 to 2003 in the Englishtown aquifer system are shown in figure 25b. Along the coast in southern Monmouth and northern Ocean Counties, water levels recovered more than 40 ft across a 245 mi^2 area, and recoveries of 80 ft or more occurred in a 110 mi^2 area as a result of CA 1 cutbacks. This pattern of recovery was similar to that of the Wenonah-Mount Laurel aquifer because both are connected hydraulically, though recovery was greater in magnitude and extent within the Englishtown aquifer system because most of the withdrawals affecting both aquifers were made from this aquifer (Spitz and others 2008).

Water-level hydrographs for nine observation wells show long-term and seasonal trends in the Englishtown aquifer system from 1978 to 2003 (fig. 30). Water levels remained relatively constant in wells 23-104, 25-715 and 29-138 during this period. Wells 23-104 and 25-715 are in the updip extent of the aquifer, and well 29-138 is within the central section of the aquifer system. All are far from the regional cone of depression in eastern Monmouth County.

The water levels in well 25-715 located well north of the major cone of depression in Monmouth County has remained relatively constant since it was installed in 1991. Long-term seasonal fluctuations range from 4 ft to 5 ft; however, the long-term water-level change was barely perceptible. Temporal fluctuations observed in well 23-104 are in response to changes in precipitation and subsequent recharge; this well is located near the outcrop and away from any substantial withdrawals. From 1978–2003, the water level in this well has remained essentially unchanged. Water levels in well 29-138 gradually declined 7 ft from 1978 to 1993 then rose 8 ft through 1998; thereafter, annual high water levels stabilized at 66 ft above NGVD 29. The water level in this well showed no net change during the period of record. Observation well 25-250 is located in Western Monmouth County far from the major cone of depression and away from areas of substantial withdrawals. Water levels were constant during 1978–83; thereafter, the hydrograph shows a gentle decline in water levels of about 9 ft during 1983 to 2003 in response to local ground-water withdrawals.

Observation well 05-259 is located in the Mount Holly area of Burlington County where this aquifer system is not a major source of supply. Water levels in well 05-259 declined approximately 5 ft during 1993–98. From 1998 to 2003, annual high water levels stabilized. Water levels fluctuated seasonally as much as 8 ft through 1988; from 1989 to 2003 water levels fluctuated 1 ft to 3 ft.

Observation well 25-638 is located in the center of the Farmingdale quadrangle near the updip edge of the regional cone of depression. The water-level altitude in this well was approximately 50 ft below NGVD 29 in the late 1980s. Owing to conservation measures introduced in the late 1980s to reduce ground-water withdrawals from the Cretaceous aquifers of the northern Coastal Plain, water levels rose sharply (55 ft) in this well from 1990 to 1996. From 1996 to 2003, the annual high water levels observed at this well stabilized. Seasonal water-level fluctuations were more moderate than those observed in wells closer to the regional pumping center and ranged from 7 ft to 10 ft. Observation well 25-429 is located in Allaire State Park in the southeastern section of the Farmingdale quadrangle approximately 6 miles from the center of the regional cone of depression. The hydrograph of this well shows that water levels were substantially below NGVD 29 by 1978. From 1978 to 1989, water levels declined an additional 16 ft, as withdrawals in and near the major cone of depression stabilized. Water levels in this well rose dramatically, by nearly 100 ft, during 1991–96. Subsequent to 1996, water levels had stabilized at -40 ft through 2001. During the latter part of 2001, water levels again began to decline. The hydrograph for well 29-530 exhibits a similar trend; water levels rose nearly 120 ft during the early to mid-1990s; stabilized, then declined from 2001 to 2003. Seasonal fluctuations were greatest in this well; during and following the period of substantial recovery, water levels fluctuated by as much as 60 ft in a given year. Observation well 29-534, located at the southern edge of the regional cone of depression, is screened in the lower hydrologic unit of the aquifer system. Water levels in this well declined approximately 10 ft during 1978–92; from 1992 to 2003, water levels increased by 37 ft.

Upper Potomac-Raritan-Magothy Aquifer

The upper aquifer of the Potomac-Raritan-Magothy aquifer system is generally equivalent to the Magothy Formation in New Jersey (Zapecza, 1989). The aquifer consists of coarse-grained permeable sands with thin interbedded clay and clayey silt layers present locally. The Upper PRM is the most extensive unit within the aquifer system. The outcrop of the aquifer extends in a northeast to southwest trending band from the Raritan Bay to the Delaware River adjacent to Salem County and is primarily coincident with the outcrop of the Magothy Formation. The aquifer is well defined in the offshore areas of Monmouth and Ocean Counties but less well defined in Atlantic, Cumberland, and Cape May Counties. The thickness of the sand interval ranges from more than 200 ft in eastern Monmouth County to about 50 ft in Cape May County. Transmissivity of the aquifer is greatest in the eastern part of Monmouth County; however, the aquifer remains highly transmissive throughout Monmouth as well as in western Camden and Gloucester Counties. In Monmouth and Middlesex Counties, the aquifer is locally referred to as the Old Bridge aquifer. In Delaware, Vroblesky and Fleck (1991) and Martin (1984) refer to the aquifer as the Magothy aquifer. The updip limit of the aquifer is within the outcrop of the Magothy Formation in northern New Castle County, and the downdip limit extends into eastern Sussex County.

Water Withdrawals and Extent of Freshwater

Withdrawals from the Upper PRM aquifer are made throughout its extent in Middlesex, Monmouth, and northern Ocean Counties (fig. 31); however, in the southern part of the study area, withdrawals are confined to a narrow band extending from the outcrop to about 12 mi downdip. Beyond this limit, depth to the top of the aquifer is sufficiently deep, and dissolved solids in the ground water are elevated such that use of shallower aquifers is more desirable. The primary production centers are located in eastern Middlesex County within

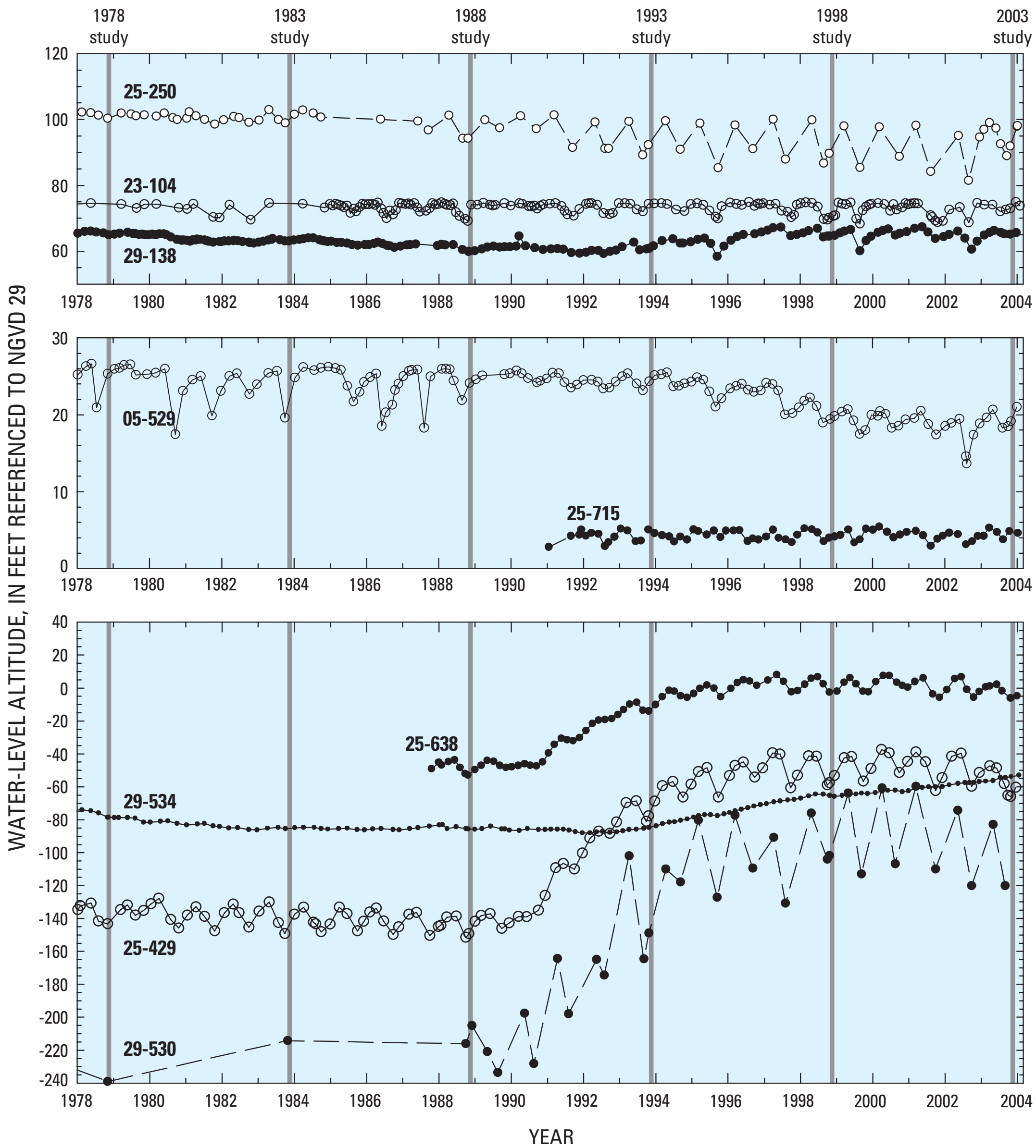


Figure 30. Water-level hydrographs for observation wells screened in the Englishtown aquifer system, New Jersey Coastal Plain, 1978–2003.

and near the outcrop of the Magothy Formation and in central Camden and Gloucester Counties. Substantial withdrawals also are made in northwestern Burlington, northern Ocean, and throughout Monmouth County. Minor withdrawals are made in Mercer and Salem Counties within close proximity to the updip limit of the aquifer. Minor withdrawals also are made in central New Castle County, Delaware. In Maryland, withdrawals are made in the bordering counties of Cecil, Kent, and Queen Anne's; however, the greatest use of the Magothy aquifer in Maryland occurs beyond the study area.

Estimated withdrawals in New Jersey from 1978 to 2003 ranged from 52 to 80 Mgal/d; withdrawals during 2003 were at a 25-year low of approximately 52 Mgal/d (fig. 32). Ground-water withdrawals in 2003 were greatest in Middlesex County; withdrawals here were nearly twice that of Gloucester, the county with the next highest withdrawal amounts. From 1978 to 1989 withdrawals ranged from 65 to 80 Mgal/d; thereafter, withdrawals statewide steadily decreased through 2003. In the northern counties, estimated withdrawals during 2003 of 30 Mgal/d were greater than those from southern counties. Withdrawals in the northern counties were at their greatest from 1981 to 1984 (approximately 47 Mgal/d); following 1984, withdrawals generally decreased to 2003 amounts. The largest decreases in withdrawals in the northern counties occurred during 1988–89 and 2002–03. In the southern counties, water withdrawals generally were stable (approximately 30 to 32 Mgal/d) from 1978 through 1995; in 1996 withdrawals decreased to 27 Mgal/d. Mandatory restrictions on withdrawals from the Upper PRM aquifer further reduced these amounts and, from 1997 to 2003, withdrawals ranged from 22 to 25 Mgal/d.

Estimated water withdrawals from the Upper PRM aquifer (Magothy aquifer) in Delaware remained at less than 0.75 Mgal/d during 1978 to 2001 (fig. 33). From 1978 to 1988, withdrawals were insubstantial, at much less than 0.5 Mgal/d.

The 250-mg/L isochlor is shown on plate 7. The location of this line in the Raritan Bay area was originally mapped by Schaefer and Walker (1981). Increased chloride concentrations in several wells in recent years indicate the slight landward movement (nearly 0.25 mi) of the saltwater front. The location of the 250-mg/L isochlor in southern New Jersey was determined on the basis of water-quality data stored in the USGS water-quality database. The previous position of this line bisected Salem County from west to east and did not extend beyond its border (Lacombe and Rosman, 2001); however, recent data warranted a modification of this line. The saltwater front arcs in an updip direction and toward the Delaware River in southern Gloucester County. The updated location of this line reflects a reinterpretation of existing, as well as the inclusion of new, data and does not imply movement of the front nor increased chloride concentrations in this area.

In Delaware, the 250-mg/L isochlor was mapped by Cushing and others (1973, pl. 3). The location of the 10,000-mg/L isochlor in New Jersey was simulated by Pope and Gordon (1999). The location of the 10,000-mg/L isochlor in Delaware is from Vroblesky and Fleck (1991).

Water Levels

Water-level measurements from 210 wells screened in the Upper Potomac-Raritan-Magothy aquifer were used to define the regional potentiometric surface during the fall of 2003 (app. 7). Maximum water-level altitudes were measured in and near the outcrop area within the Hightstown quadrangle; minimum water-level altitudes were measured in central Camden County. The major feature of the potentiometric surface is the extensive cone of depression that extends from the Raritan Bay in the northeastern section of the study area to eastern Maryland (pl. 7). This regional cone of depression can be divided into three subregional segments (Lacombe and Rosman, 2001), a northeastern, a central, and a southwestern segment.

The northeastern segment of this cone encompasses northern Ocean County and most of Monmouth County. In the northernmost section the position of both the 0-ft and -20-ft contours are similar to those represented in 1998. The slight contraction of the -20-ft contour at its northeastern edge reflects the small rises in water levels near this boundary. Within this segment, the lowest water levels occur in northern Ocean County where, near Seaside Park, a water level of -60 ft NGVD 29 was measured in a well (29-1365) around which a small cone of depression had formed. The water level was substantially lower than that observed in 1998. This well was not operational during the 1993 study, so further comparison was not possible. A subsequent measurement by the USGS as well as purveyor-reported data confirmed this water level. To the west a small cone of depression in the Lakehurst quadrangle reported in 1998 has expanded to the south and east to include four additional wells, forming an elongated cone of depression from Lakehurst to Toms River in Ocean County. Ground-water withdrawals in this area have substantially increased since the 1998 study. Elsewhere in the north, water levels typically ranged from 0 to -20 ft NGVD 29; however, the potentiometric surface is punctuated with several small cones of depression centered over single wells or well fields. Such localized cones are located in the Keyport, Marlboro, Adelphia, Long Branch, and Asbury Park quadrangles. Water levels at the centers of these cones were, for the most part, slightly below -20 ft NGVD 29, though water levels of -33 ft (well 25-360) and -41 ft NGVD 29 (well 25-334) were measured near Red Bank and Asbury Park, respectively. Recovering water levels near Red Bank have caused this cone to recede; however, the water level in well 25-334 near the center of the Asbury Park localized cone was lower than in 1998. In general, water levels across the aquifer in the northern Coastal Plain remained about the same as 5 years ago, except in northern Ocean County, where water levels declined 10 to 33 ft (fig. 24c).

The central segment of the regional cone of depression encompasses much of Burlington, Camden, Gloucester, and eastern Salem Counties. Where data are absent, maps of simulated water levels by Martin (1998) and Voronin (2004) were adapted to close the contours on the downdip edge of the regional cone. This central segment, centered under the Borough of Berlin in Camden County, has a minimum water-level altitude of -90 ft NGVD 29 (well 07-15). Water levels previously measured near the center of this cone were in excess of 100 ft below NGVD 29. From 1998 to 2003, water levels in this central segment, in general, remained stable or recovered modestly; however, water levels at the center of the cone rose by as much as 24 ft. The -100-ft contour line present on the 1998 potentiometric map has disappeared altogether, whereas the -80-ft contour surrounds a single production well in the Berlin well field. The -40 and -60-ft contour lines show contraction downdip and to the areas north and south of the central cones. A single-well cone of depression with a minimum water-level altitude of -86 ft (well 05-759) has formed in the Medford Lakes quadrangle. To the southwest, a small cone of depression also is present in Glassboro, New Jersey. This cone is a remnant part of the -60-ft contour line from 1998; water levels measured in wells here did not exhibit increases like many wells in the area in 2003. Although sporadic declines in water levels were observed in the central segment of the regional cone, in general, water levels rose during 1998 to 2003. Recovery typically was moderate; however, substantial rises occurred near the center of the cone in Camden County.

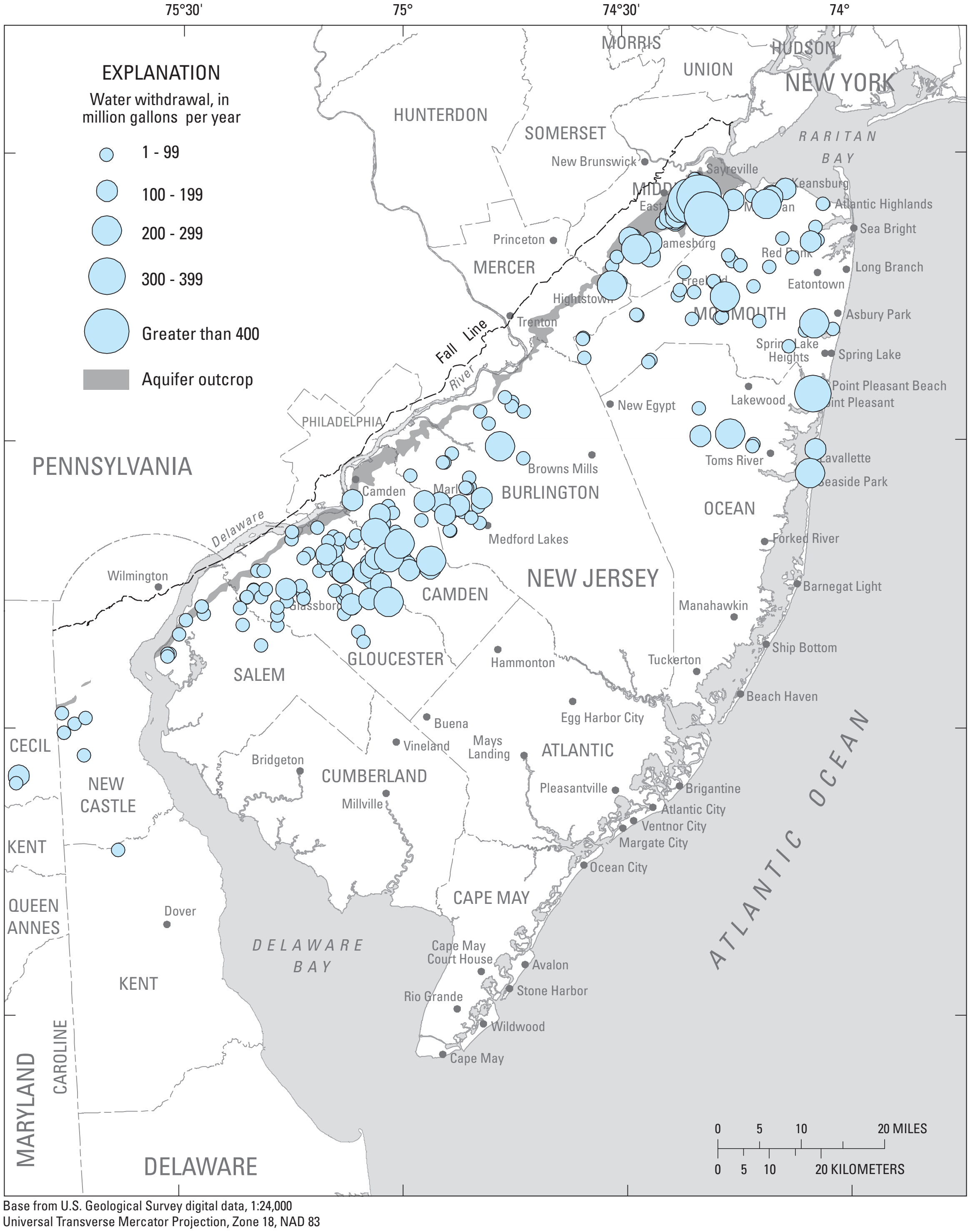


Figure 31. Location and amount of ground water withdrawn from the Upper Potomac-Raritan-Magothy aquifer, New Jersey, Delaware, and Maryland Coastal Plain, 2003.

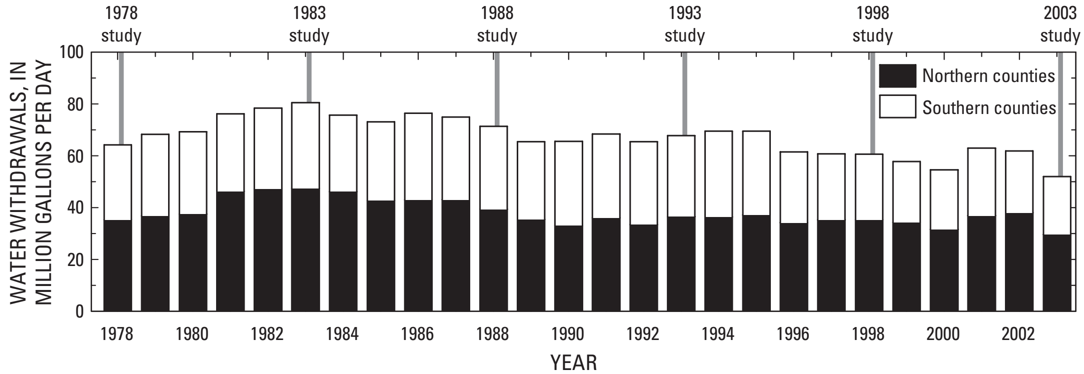


Figure 32. Estimated ground-water withdrawals from the Upper Potomac-Raritan-Magothy aquifer, New Jersey Coastal Plain, 1978–2003.

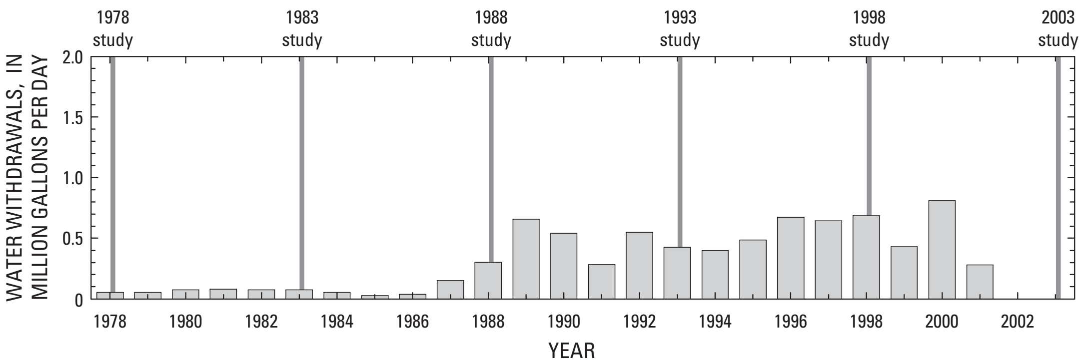


Figure 33. Estimated ground-water withdrawals from the Magothy aquifer, Delaware Coastal Plain, 1978–2001.

The southwestern segment of the regional cone of depression underlies New Castle, Delaware, and western Salem County, New Jersey. Water levels in this area typically ranged from -21 to -30 ft NGVD 29. A single well cone of depression exists in the Middletown, Delaware, well field probably due to recent ground-water withdrawals. With the exception of the Middletown well, water levels in this area had stabilized or recovered slightly since 1998.

A downward hydraulic gradient is present from the Englishtown aquifer system to the Upper PRM aquifer in the western part of the aquifer, but in near-shore areas, the hydraulic gradient is upward from the aquifer to the Englishtown aquifer system as shown in section A-A' (fig. 2a). The downward gradient is strongest in the updip part of the aquifer where water levels in the overlying Englishtown aquifer system were as much as 115 ft higher than those in the Upper PRM aquifer. This downward gradient weakens to the south and east, where in central Howell Township, Monmouth County, New Jersey, the gradient is nearly neutral for a short distance. The gradient reverses in the eastern part of the township and steepens toward the coast, where, near Point Pleasant, Ocean County, water levels are nearly 80 ft greater than in the Englishtown aquifer system. Similarly, the hydraulic gradient between the Upper PRM aquifer and the Middle PRM aquifer is downward in the updip areas and upward along the Coast (fig. 2a). However, the head differential between the Upper and Middle aquifers is much more temperate than that between the Upper PRM aquifer and the Englishtown aquifer system. A downward hydraulic gradient is present from the Englishtown aquifer system to the Upper PRM aquifer along the updip portion of section B-B' (fig. 2b); the lack of water-level data within the Englishtown aquifer system in downdip areas precludes interpretation of interaquifer flow here. Martin (1998) and Lacombe and Rosman (2001) note the continued potential for downward flow from the Englishtown aquifer system to the Upper PRM aquifer in the downdip areas. The hydraulic gradient between the Upper and Middle PRM aquifer is nearly neutral in the updip area and upward to the Upper PRM aquifer in the downdip area. This upward gradient is strongest in central Camden and western Atlantic Counties, where water levels are typically 10 ft higher in the Middle aquifer than in the Upper aquifer, but weakens somewhat near the downdip limit of the aquifer.

From 1988 to 2003, water levels in the aquifer recovered on average 10 ft to 20 ft across a large portion of Monmouth County; scattered areas in the western part of the county experienced slightly larger recoveries (fig. 25c). Ground-water withdrawals from the aquifer in the northern counties were reduced to approximately 75 percent of 1988 volumes; furthermore, withdrawals were reduced to approximately 60 percent of 1983 volumes due to CA 1 regulations. In southern New Jersey, within the central segment of the regional cone of depression (CA 2), water-level recovery was generally 10 ft to 30 ft, with maximum rises of nearly 40 ft in north-central Camden County.

Water-level hydrographs for seven observation wells located in the northern counties are shown in figure 34. Observation wells 23-292 and 23-228 are located near Jamesburg, New Jersey, within or near the outcrop area where water levels in the aquifer were typically at their highest. The two wells are located within 3 mi of one another, and their respective hydrographs indicate a similar trend in water levels. Water levels at both sites decreased about 8 ft to 10 ft during 1978–82 but remained relatively constant to slightly rising through 1998. Water levels in well 23-292 were stable from 1998 to 2003; however, water levels in 23-228 declined slightly during this period. Well 23-228 is situated in an area of substantial withdrawals; however, its location proximal to a recharge area likely tempers the effect of both seasonal and long-term withdrawals. The hydrographs for wells 23-351 and 23-180 show slight water-level increases of 1 ft to 3 ft during 1978–2003. Both wells are located near major pumping centers but away from the regional cone of depression. Because they are within the outcrop area, both wells are sensitive to recharge from precipitation, and seasonal fluctuations due to nearby withdrawals are restrained. Observation wells 25-316 and 25-206 are located within but near the northern edge of the regional cone of depression, along the Raritan Bay. Water levels were stable to slightly rising from 1978 to 1986; thereafter, following a brief period of decline through 1989, water levels rose 8 ft to 10 ft through 2003. Observation well 25-639 is located in the Farmingdale quadrangle near the center of the northern segment of the regional cone of depression. Water levels in this well rose approximately 20 ft from 1989 to 1994, then stabilized through 2001 before declining slightly during 2001–03. The recovery in water levels in the early to mid-1990s is a result of CA 1 reductions in ground-water withdrawals from the Cretaceous aquifers as well as the increased use of alternate surface-water sources such as the Manasquan, Swimming River, and Glendola Reservoirs.

Hydrographs for nine observation wells located in the southern counties of New Jersey and Delaware are shown in figure 35. Observation wells 15-728 and Eb23-22 are located near the updip limit of the aquifer in Gloucester County, New Jersey, and New Castle County, Delaware, respectively. The hydrographs show that, despite seasonal fluctuations of 4 ft to 6 ft., water levels remained constant from the beginning of the period of record through 2003. Observation well 33-253 is located in Salem County, New Jersey, in the area affected by the southwestern segment of the regional cone of depression. The aquifer is not used locally, and therefore, water levels did not vary seasonally; however, regional stresses from long-term withdrawals have caused water levels to decline by 6 ft from 1978–2003. Similarly, observation well Gd33-05, located in eastern Delaware along the border of New Castle and Kent Counties, lies within the area underlain by the regional cone but far from a production center. From 1978 to 2003, water levels gradually declined approximately 18 ft. Observation wells 05-258, 07-117, 07-322, 07-477, and 15-741 are located within the central segment of the regional cone of depression. Hydrographs for wells 05-258, 07-117, and 07-477 show water-level declines ranging from 10 ft to 16 ft from 1978 to 1994; from 1994 to 2003, water levels in the same wells rose 10 ft to 25 ft. Seasonal water-level fluctuations were greatest in wells 07-477 and 07-117 because of their location near the center of the Camden cone of depression. Annual variability ranged from 5 ft to 10 ft during the early portion of the period of record and ranged from 10 ft to 25 ft per year during the latter. Water levels in wells 07-322 and 15-741 rose 15 ft and 13 ft, respectively during this same period. Recovery of water levels subsequent to 1994 in these wells is the result of CA 2 restrictions.

Middle and undifferentiated Potomac-Raritan-Magothy Aquifer

The undifferentiated and Middle aquifer of the Potomac-Raritan-Magothy aquifer system extends from the Raritan Bay in the northeastern part of the study area to Maryland in the southwest. In the northern Coastal Plain northeast of Burlington County, the aquifer is locally referred to as the Farrington aquifer. The aquifer is well defined from the outcrop area to about 20 mi downdip, beyond this distance the aquifer cannot be separated from the underlying sediments within the PRM aquifer system. Zapecza (1989) refers to the aquifer east of the area as the undifferentiated PRM aquifer. Similarly, in southern New Jersey the aquifer can be traced in the subsurface from the outcrop to an area extending approximately 10 mi to 12 mi downdip, beyond which the aquifer is indistinguishable from the Lower PRM aquifer. Where the confining unit between the Lower and Middle aquifers is absent, the aquifer conformably overlies bedrock or weathered bedrock. The transmissivity of the aquifer is greatest in northern Ocean County (greater than 16,000 ft^2/d), but the aquifer is most productive in Burlington, Camden, and Gloucester Counties in and within a short distance from the outcrop area where the transmissivity ranges from 6,000 ft^2/d to more than 10,000 ft^2/d (Martin, 1998). To the southwest, discontinuous silt and clay beds within the Middle aquifer in Salem County inhibit its productivity. The Middle Potomac-Raritan-Magothy aquifer is continuous into Delaware and Maryland. In Delaware

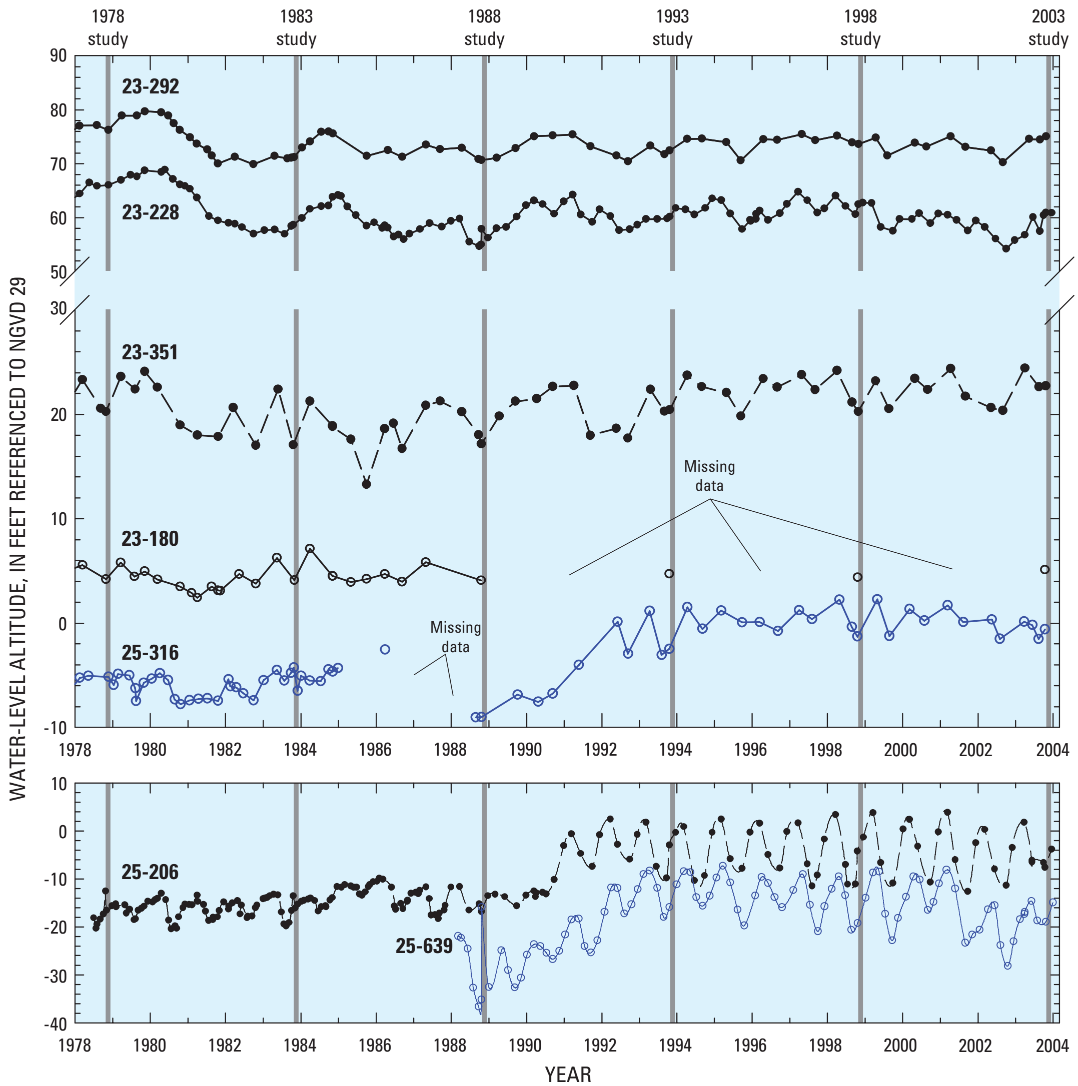


Figure 34. Water-level hydrographs for observation wells screened in the Upper Potomac-Raritan-Magothy aquifer in the northern counties, New Jersey Coastal Plain, 1978–2003.

and eastern Maryland, Vroblesky and Fleck (1991) refer to this unit as the Patapsco aquifer. The updip limit of the aquifer is within the outcrop of the Potomac Formation in northern New Castle County; the downdip limit extends into eastern Sussex County and is demarcated by the 10,000-mg/L isochlor of Meisler (1989).

Water Withdrawals and Extent of Freshwater

Ground-water withdrawals from the undifferentiated and Middle PRM aquifer occur throughout its extent from the Raritan Bay to Maryland. The distribution of withdrawals is similar to that in the Upper PRM aquifer, in that withdrawals are made in the updip and central areas of the aquifer throughout the northern counties of New Jersey but are confined to a narrow band extending from the outcrop to about 8 mi downdip in the southern counties (fig. 36). Beyond this limit, the presence of elevated dissolved solids in the ground water inhibits development of the aquifer. The primary production centers in New Jersey are located in eastern Middlesex and northern Monmouth Counties, northern Ocean County, and Burlington, Camden, Gloucester, and Salem Counties. In Delaware, withdrawals from the equivalent of the Middle PRM aquifer are made primarily within and near the outcrop in northern New Castle County; however, smaller production centers are present in the central part of the county.

Estimated ground-water withdrawals in New Jersey from 1978 to 2003 ranged from 61 to 84 Mgal/d. (fig. 37). Withdrawals from the aquifer were greatest during the early 1980s; from 1983 to 2000, ground-water withdrawals decreased from 82 to 63 Mgal/d. In 2001 withdrawals from the aquifer again

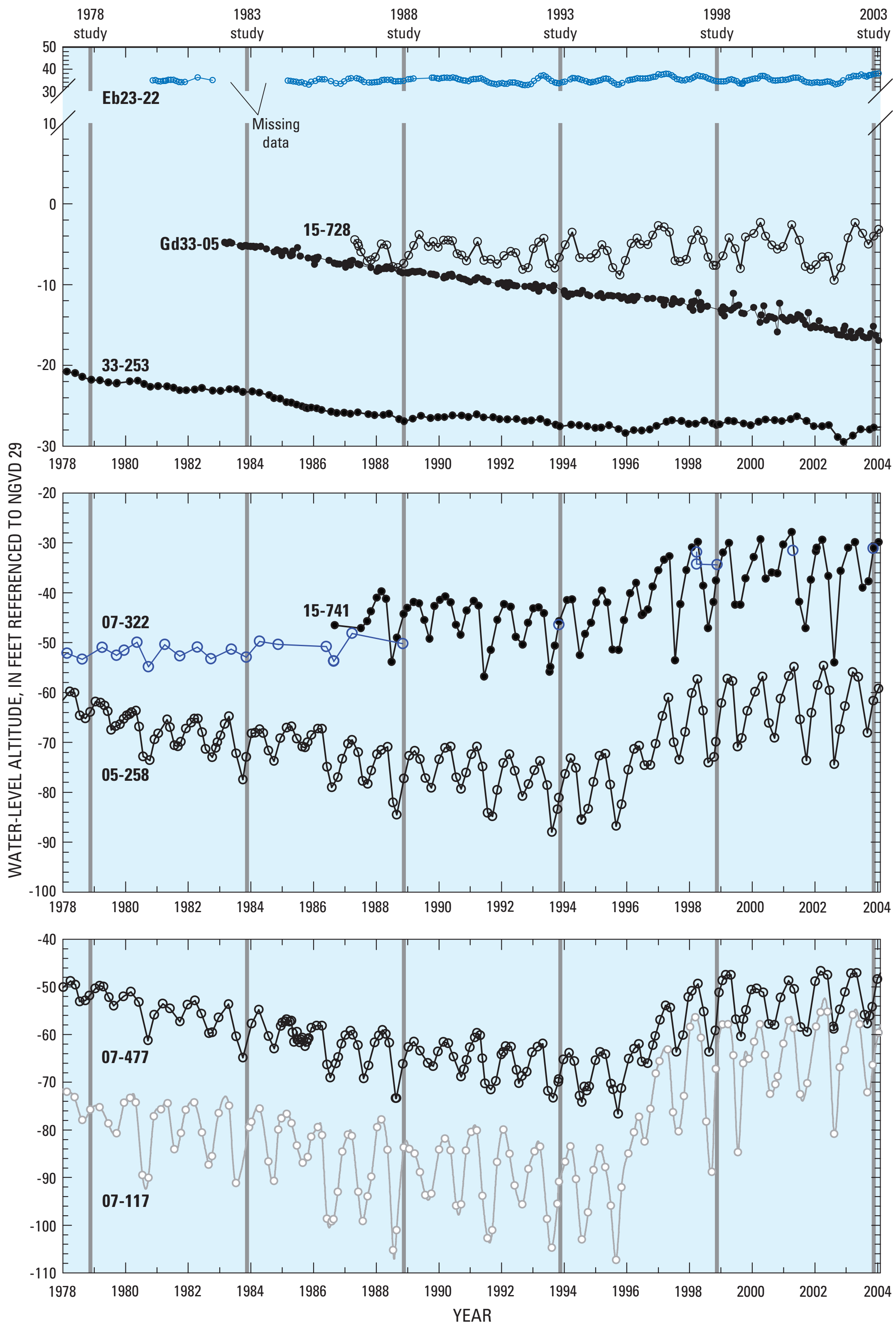


Figure 35. Water-level hydrographs for observation wells screened in the Upper Potomac-Raritan-Magothy aquifer in the southern counties, New Jersey Coastal Plain and Delaware, 1978–2003.

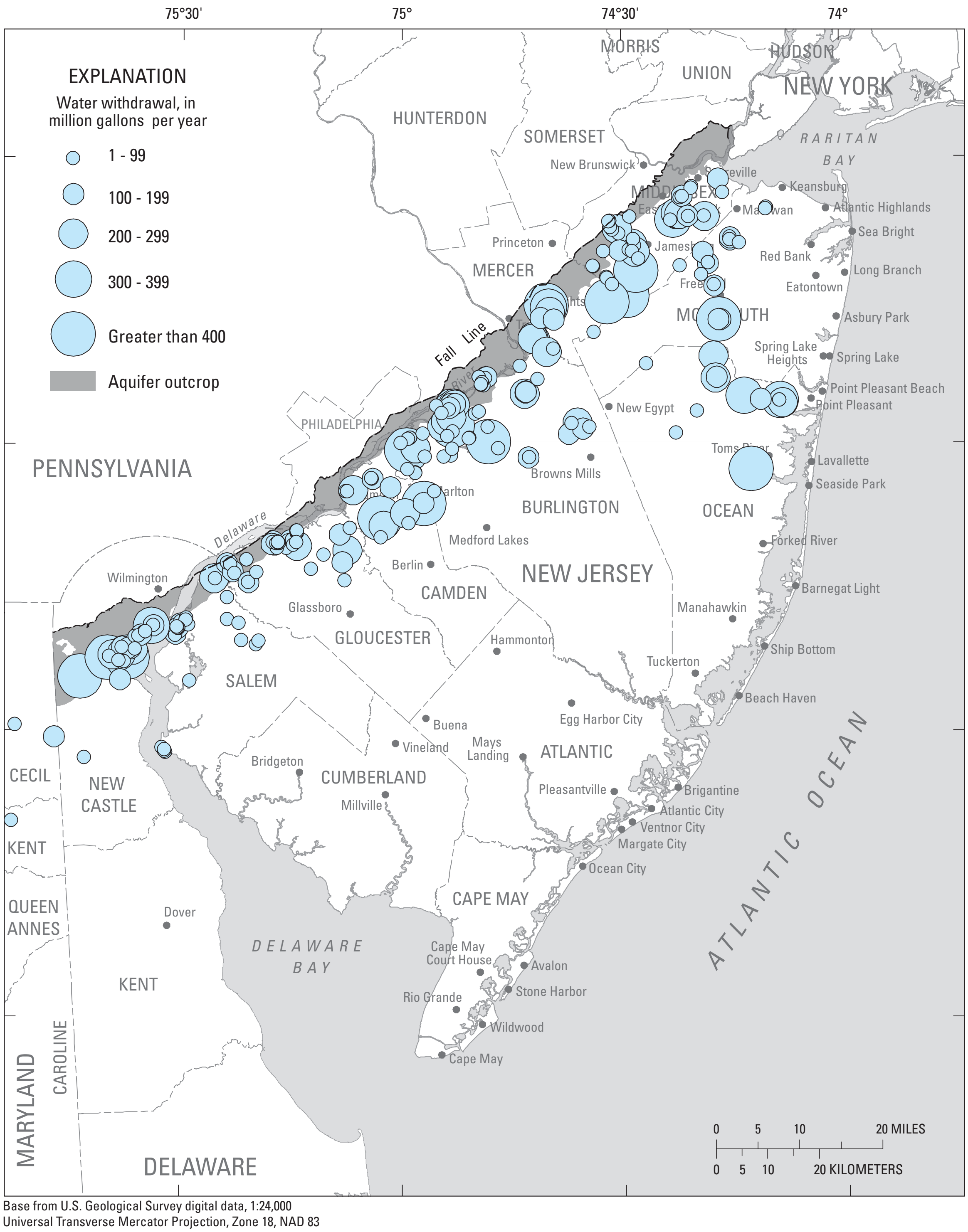


Figure 36. Location and amount of ground water withdrawn from the Middle and undifferentiated Potomac-Raritan-Magothy aquifer, 2003.

increased; in 2003 total withdrawals in New Jersey were estimated at 68 Mgal/d.

In the northern counties of New Jersey, estimated withdrawals ranged from 26 to 43 Mgal/d from 1978 to 2003. Withdrawals steadily decreased during 1980–96; the largest single-year reduction in withdrawals occurred between 1988 and 1989. From 1997 to 2003, however, withdrawals again increased and, by 2003, were estimated at 31 Mgal/d. In the northern counties, ground-water withdrawals typically were greatest in Middlesex County. At the maximum in 1980, withdrawals in Middlesex County were in excess of 17 Mgal/d. Declining water levels and saltwater encroachment along tidal reaches of the Raritan River and its tributaries led to the systematic reduction of withdrawals in this area, and by 1990, withdrawals were estimated at approximately 8 Mgal/d. Average daily withdrawals in Middlesex County have since stabilized at approximately 9 to 10 Mgal.

Ground-water withdrawals from the aquifer in the southern counties were slightly higher than those in northern counties during 1978 to 2003. Estimated ground-water withdrawals in the south ranged from 34 to 46 Mgal/d during this period. Ground-water withdrawals in the combined southern counties peaked in 1983; generally, withdrawals declined through 1999. Withdrawals from the aquifer in southern counties increased slightly from 2000 to 2003. Estimated withdrawals in 2003 were approximately 37 Mgal/d. Withdrawals from the aquifer typically were greatest in Burlington County and least in Salem County.

Ground-water withdrawals from the Middle PRM aquifer in Delaware ranged from approximately 6.5 to 12 Mgal/d during 1978 to 2001 (fig. 38). Withdrawal amounts varied throughout the 1980s and early 1990s; the lesser amounts, however, were probably an artifact of inconsistent allocation reporting. Lacombe and Rosman (2001) noted that withdrawals remained stable at about 9 Mgal/d during 1978–97. Estimated withdrawals from the aquifer in Delaware in 2001 were about 12 Mgal/d.

The extent of freshwater in the northern Coastal Plain remained about the same as in 1998. The location of the 250-mg/L isochlor in the Raritan Bay area (pl. 8) is modified from Schaefer (1983) and Lacombe and Rosman (2001). In southern New Jersey, the location of this line has been modified from Gill and Farlekas (1976) and Lacombe and Rosman (2001). Increased data coverage in Gloucester and Salem Counties necessitated the modification of the 250-mg/L isochlor in southern New Jersey. The saltwater front bends in an updip direction toward the Delaware River near the Salem and Gloucester County border, incorporating areas where ground water near Woodstown and Mullica Hill is known to contain elevated dissolved solids and chlorides. The 250-mg/L isochlor in Delaware is from Cushing and others (1973). The location of the 10,000-mg/L chloride line in New Jersey was simulated by Pope and Gordon (1999) using a saltwater model of the aquifers. In Delaware, the 10,000-mg/L isochlor is from Vroblesky and Fleck (1991).

Water Levels

Water levels measured in 204 wells screened in the undifferentiated and Middle PRM aquifer in New Jersey, Delaware, and eastern Maryland during the fall of 2003 are reported in appendix 8; the interpreted potentiometric surface is shown in plate 8. Maps of simulated water levels by Voronin (2004) and Martin (1984) guided the closure of potentiometric contours in the southeastern part of the study area as well as in New Castle County, Delaware. Maximum water levels of greater than 70 ft NGVD 29 were observed near the updip limit within the Hightstown and Jamesburg quadrangles, Middlesex County, New Jersey. This potentiometric high corresponds to the potentiometric high of the overlying Upper PRM aquifer. Water levels were lowest in central Camden County. The major feature of the potentiometric surface is the regionally extensive cone of depression that encompasses much of the study area and extends from the Raritan Bay in the northeast to eastern Maryland in the southwest. Much like the regional cone in the Upper PRM aquifer, several discrete subregional cones or areas of low water levels are present within the northern, north central, central, and southwestern parts of the larger cone.

The northern segment underlies eastern Middlesex and part of northwestern Monmouth County in New Jersey and lies within Critical Area 1. Water levels in the northern segment of the regional cone ranged from -12 to -38 ft NGVD 29 in 2003; water levels generally were lowest along the Raritan Bay front and somewhat higher toward the outcrop. The area encompassed by the -20-ft potentiometric contour has expanded slightly from that in the previous study; water levels in well fields in Sayreville and Old Bridge, Middlesex County, and north of Marlboro, Monmouth County, were at or slightly below this level in 2003. From 1998 to 2003, despite no appreciable increase in ground-water withdrawals, water levels declined throughout the area from 1 ft to nearly 10 ft (fig. 24d).

The north-central area of the regional cone of depression includes much of southern Monmouth County, New Jersey. Water levels in this segment ranged from 7 ft (well 25-728) to 30 ft (well 25-725) below NGVD 29. Minimum water levels occurred near a production center near Freehold; water levels to the north and west were slightly higher. The small circular cone in southern Monmouth County depicted on the 1998 map has expanded slightly and shifted to the east; water-level declines of 3 ft to 5 ft in this area resulted from steadily increasing ground-water withdrawals through 2003.

The central segment of the regional cone of depression underlies a broad area of the New Jersey Coastal Plain extending from Ocean County southwest to Gloucester and eastward to Atlantic County. Water levels in this segment ranged from 0 ft to -72 ft NGVD 29; the lowest water levels, below -60 ft NGVD 29, were measured in central Camden County and in the Mount Holly area of Burlington County. The shape and orientation of this cone is similar to that in the overlying Upper PRM aquifer, though water levels gener-

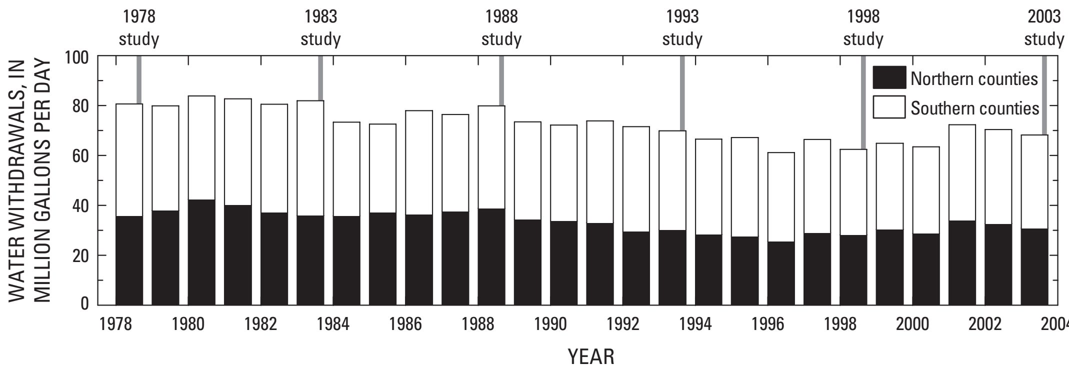


Figure 37. Estimated ground-water withdrawals from the Middle and undifferentiated Potomac-Raritan-Magothy aquifer, New Jersey Coastal Plain, 1978–2003.

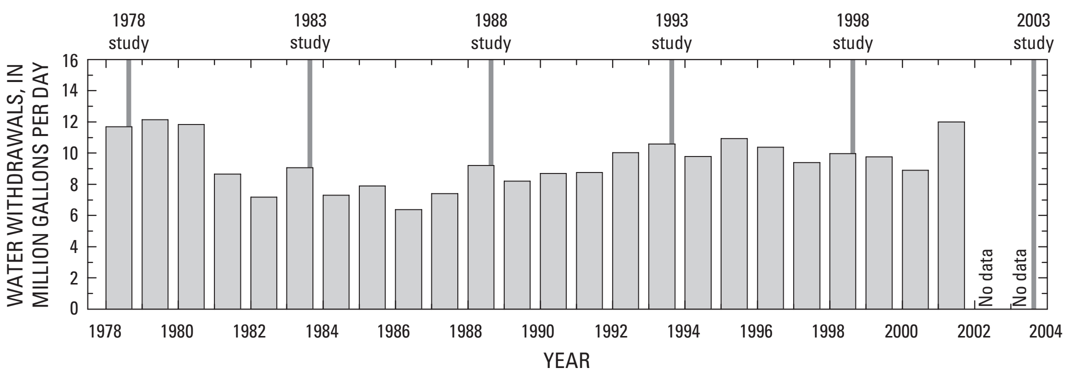


Figure 38. Estimated ground-water withdrawals from the Middle Potomac-Raritan-Magothy aquifer, Delaware Coastal Plain, 1978–2001.

ally are higher in the Middle aquifer, indicating a potential for upward flow from the aquifer. The center of this segment underlies central Camden County, straddling the boundary between the Clementon and Runnemede quadrangles. The potentiometric low of -65 ft in the center of the cone occurred in an area about 3.5 mi to the south and east of production centers that use the Middle aquifer; however, substantial withdrawals made from the underlying Lower PRM aquifer likely contribute to the depth of the cone. To the north and east, a single-well cone of depression persists in Burlington County near Mount Holly, where the water-level altitude was below -70 ft NGVD 29. Near the southeastern edge of this central segment, depths to the top of the aquifer are considerable, and the ground water is highly mineralized. Consequently, wells screened in the aquifer are sparse. Observation well 11-137, in eastern Cumberland County, New Jersey, is the farthest downdip well screened in the aquifer that was used in this study; the chloride concentration in the ground water of approximately 11,000 mg/L results in a density of 1.012 g/cm^3. Correcting for density, the saltwater level of -53 ft yields a freshwater equivalent altitude of -30 ft NGVD 29. The water level in well 01-1221, located in Buena to the north and approximately 13 mi updip, also was converted from a saltwater level for similar reasons. In northern Ocean County, water levels ranged from -21 ft to -33 ft NGVD 29, with lowest water levels occurring at or near production wells throughout Jackson Township.

The southwestern segment of the regional cone of depression encompasses Salem County in New Jersey and most of New Castle County in Delaware. Water levels in Salem County ranged from -15 ft (well 33-305) to -70 ft NGVD 29 (well 33-934) in 2003. Water levels were highest in the central part of the county and lowest along the Delaware River where localized cones of depression are present in Pennsville and on Artificial Island. In New Castle County, Delaware, water levels were below 0 ft NGVD 29 across much of the aquifer extent. Water levels ranged from greater than 60 ft near the updip limit of the aquifer in the northwestern part of the St. Georges quadrangle to -58 ft NGVD 29 in the Middletown area.

The 5-year change in water levels in the Middle PRM aquifer is shown in figure 24d. From 1998 to 2003, water levels were generally stable or had risen slightly throughout most of the central segment, except in limited areas near production centers in north-central Camden and northern Ocean Counties. In north-central Camden County water levels fell by 4 to 13 ft near production wells as a result of an 18 percent increase in withdrawals relative to 1998 volumes. Similarly, withdrawals increased by about 18 percent among seven production wells in northern Ocean County, resulting in water-level declines from 1 ft to 10 ft. Near the center of this regional cone of depression, water levels showed little change from 1998, as withdrawals from both the Upper and Lower aquifers in central Camden were reduced.

Near the outcrop in and around Camden, New Jersey, rises in water levels of 4 to 6 ft resulted from decreased withdrawals in the area, particularly those from the Lower aquifer. The water level at the localized cone near Mount Holly, Burlington County, was 5 ft higher (well 05-634) than in 1998 and, further to the east, in the vicinity of Browns Mills and New Egypt, water levels rose 7 (well 05-330) to 14 ft (well 05-388). During this period, withdrawals from the Middle aquifer near Browns Mills and New Egypt decreased by more than 30 percent. Water levels in this area had declined from 1978 through 1993 and were generally at their lowest during 1993; during the succeeding decade water levels recovered to levels observed in 1978.

Near the southeastern edge of this central segment near Buena in western Atlantic County, water levels increased by 5 ft (well 01-1221, freshwater equivalent) since the 1998 study. In eastern Cumberland County, far from areas of withdrawal, the water-level rise since 1998 was less than 5 ft (well 11-137).

Within the southwestern segment water levels declined 8 ft (well 33-119) and 10 ft (well 33-934) at the localized cones along the Delaware River in Pennsville and on Artificial Island, but at the potentiometric high in the central part of the county, water levels rose slightly. South of Wilmington, Delaware, and along the Delaware River, water levels near the outcrop area of the aquifer declined 2 ft to 3 ft from 1998 to 2003. South of the Chesapeake and Delaware Canal, water levels within the cone of depression were generally 1 to 7 ft lower than in 1998. Elsewhere, water levels within the aquifer in Delaware generally were stable.

Water-level changes from 1988 to 2003 are depicted in figure 25d. Water-level rises of at least 10 ft occurred across large parts of Middlesex, Monmouth, Ocean, Burlington, Camden, and Gloucester Counties. Water levels recovered 20 ft or more in a 116 mi^2 area along the border of Monmouth and Ocean Counties and in a large (180 mi^2) area along the border of Monmouth and Middlesex Counties. The most pronounced rises occurred in areas near the Raritan Bay, where recoveries of more than 80 ft were observed. In southern New Jersey, water levels recovered from 20 to 35 ft in a 42 mi^2 area of north-central Camden County, but most of the recovery ranged from 10 to 20 ft. Elsewhere across the aquifer, water levels did not substantially change.

In the northern part of the Coastal Plain a downward hydraulic gradient is present from the Upper PRM aquifer to the Middle PRM aquifer in the western part of the aquifer along cross section A-A' (fig. 2a). In nearshore areas, the hydraulic gradient is upward from the undifferentiated PRM aquifer to the Upper PRM aquifer. Near the Delaware River in northern Camden County, a slight downward hydraulic gradient from the Upper to the Middle aquifer is present along cross section B-B' (fig. 2b). The potential for downward flow from the Middle aquifer to the Lower aquifer also exists in this area. In downdip areas, the potential for vertical flow is upward from the Lower aquifer to the Middle aquifer and from the Middle aquifer into the Upper PRM aquifer.

Water-level hydrographs for 10 wells screened in the Middle aquifer and the undifferentiated portion of the PRM system in the northern counties of New Jersey are shown in figure 39. Observation wells 23-291, 23-229 and 23-273 are located in or near the aquifer outcrop area in southwestern Middlesex County (pl. 8). The hydrograph for well 23-273 shows near constant water levels for the entire period of record. Wells 23-291 and 23-229 are located downdip from the outcrop area and in close proximity to one another, and the hydrographs show similar trends. Water levels in both wells declined 8 ft and 7 ft, respectively, from the 1978 to the 1983 study, generally were stable from 1983 to 1988, then recovered from 1988 to 1998. Water levels in well 23-291 remained about the same from 1998 to 2003; however, water levels in 23-229 declined by 3 ft during the same period. Observation well 23-97 is located about 2 mi from the aquifer outcrop in central Middlesex County (pl. 8). Water levels in well 23-97 declined from 1980 to 1982 when a nearby production well screened in the Middle aquifer was active. From 1982 to 1983, water levels in well 23-97 rose 12 ft and remained stable through 1988. The frequency of measurement in this well was reduced to once during every 5-year cycle; however, the water level rose approximately 20 ft from 1988 to 1998 in response to reduced withdrawals in nearby wells screened in the Upper PRM aquifer. The water level altitude measured in 2003 was 9 ft lower than that in 1998. Observation well 23-482 is located north of the Raritan River near the Fall Line, in an area distant from any substantial withdrawals (pl. 8). The hydrograph for this well shows seasonally fluctuating water levels in the early 1980s during which nearby industrial wells were most active. From 1978 to 1983, the water level rose approximately 12 ft to an altitude of 9 ft in response to reductions in withdrawals. From 1983 to 2003, the water level in this well has remained nearly constant. Observation well 23-439 is located at the edge of the outcrop in central Middlesex County within the area affected by the northern segment of the regional cone of depression. By 1978, the water level in this well had declined to nearly 40 ft below NGVD 29. Despite seasonal fluctuations of approximately 10 ft to 12 ft, annual high water levels remained stable from 1978 to 1982. From 1983 to 1984, the water level in this well rose 10 ft but declined again slightly from 1984 to 1988 as withdrawals at a nearby pumping center increased. From 1990 to 1996, water levels recovered by nearly 40 ft owing to a reduction in withdrawals in nearby wells by approximately 50 percent. Slightly increasing withdrawals from 1998 to 2003 at the nearby production center once again caused the water level to decline.

The hydrograph for well 25-272, located in northwestern Monmouth County also within the northern segment of the regional cone, displays a water-level trend similar to that for well 23-439. Seasonal fluctuations in this well were greater, however, ranging from 10 ft to 15 ft during the early part of the period of record and increasing to nearly 40 ft during the latter, as a result of its location away from the aquifer outcrop area where the effects of withdrawals can be moderated. A dramatic rise in water level at this well was observed from 1990 to 1996; water levels recovered approximately 60 ft during this period. This rise corresponds proportionately to large-scale reductions in ground-water withdrawals at nearby production wells. By 1997, ground-water withdrawals had again increased, and the water level has since declined approximately 20 ft.

Observation wells 29-19, 25-635 and 29-85 are screened in the undifferentiated portion of the PRM aquifer system and within the area affected by the north-central segment of the regional cone of depression (pl. 8). The hydrographs for these wells show trends similar to those observed in wells 25-272 and 23-439, although responses to withdrawals and recovery are more subdued in the far downdip portion of the aquifer. Water levels declined from 1978 to 1989 and recovered from 1989 to 1998; subsequent to 1998, water levels again declined slightly.

Water-level hydrographs for 10 wells screened in the Middle and undifferentiated parts of the PRM system in the southern counties of New Jersey are shown in figure 40. All water levels for the period of record in each of the observation wells were below 0 ft NGVD 29. Water levels were highest at observation wells 05-63 and 15-713, located near the outcrop area in Burlington and Gloucester Counties, respectively. Water levels in well 15-713, located near the center of the Bridgeport quadrangle, fluctuated seasonally by 3 ft to 5 ft; however, no substantial long-term change was evident for the period of record. Several industrial and production wells located 1.6 mi to the north withdraw substantial amounts of water from the outcrop area of the aquifer; however, the effects of these withdrawals on the water level in well 15-713 are somewhat mitigated owing to the proximity of the well to recharge. The hydrograph for well 05-63 shows gently declining water levels from 1978 to 1992, followed by a slow recovery from 1993 to 2003. By 2003, the net change in the water level was a decline of less than 1 ft. Water levels in observation wells 05-261 and 07-413, located near the center of the regional cone of depression, were substantially below 0 ft NGVD 29 by 1978. Water levels in both wells further declined about 15 ft from 1978 to 1995, followed by a sharp rise during 1996 to 1997. Water levels since have stabilized or have risen slightly in these areas. Seasonal fluctuations were the most pronounced at these two wells, ranging from 4 ft in the late 1970s to nearly 24 ft by 1998. Water-level rises of as much as 20 ft observed at well 07-413 resulted from CA 2 restrictions that began in 1996 in order to encourage recovery of water levels in this aquifer in southern New Jersey.

Observation well 33-187 is located in north-central Salem County near the border with Gloucester, about 1.5 mi west of the saltwater front. The nearest production wells are more than 1 mi distant and are of small capacity; therefore, both long-term and seasonal responses to regional stresses in the aquifer are rather subdued. The water level in well 33-187 declined about 5 ft from 1978 to 1994, stabilized, then rose during 1997 to 2002. Water levels measured in 2003 indicate no net change from 1978. Observation well 33-251 is located in southern Salem County distant from areas of substantial withdrawals. Water levels observed in this well declined about 4 ft from 1978 to 1988; thereafter, water levels were constant through 2003. Due to the absence of large withdrawals in the vicinity, water levels show little seasonal variability.

Observation wells 05-683, 07-476 and 11-137, located in southern New Jersey along the downdip limb of the regional cone of depression, are screened in the undifferentiated portion of the aquifer. Of the three wells, well 11-137 lies farthest from the outcrop area and withdrawals. The hydrograph for this well indicates little seasonal effect from withdrawal wells, though water levels steadily declined nearly 18 ft during the 20-year period from 1978 to 1998. From 1998 to 2003 water levels rose approximately 2 ft. The hydrograph for well 05-683, shows declining water levels from 1978 to 1988 followed by a steady recovery through 2003. This trend is similar to those in observation wells to the north in Ocean and Monmouth Counties. Water-level changes in well 07-476 are similar to water-level changes observed in other wells screened in the Middle aquifer in the southern counties.

The hydrographs for two observation wells in Delaware and two wells in Maryland show annual and seasonal fluctuations that reflect the response of water levels to ground-water withdrawals and recovery (fig. 41). Water levels in well Eb23-24, which is screened in the Middle Potomac aquifer of Delaware, declined 17 ft during 1980 to 2003. The remaining three wells are screened in the Upper Potomac aquifer, which coincides with the Middle PRM in New Jersey. Well CE Ce 56 is located in eastern Maryland, beyond the edge of the regional cone of depression. Water levels in this well were relatively unchanged during 1983 to 2003. Observation well CE Ee 29 is located within but near the southwestern limit of the regional cone of depression in eastern Maryland. Water levels in this well exhibit a gentle, steady, downward trend during 1983–2003. Well Dc34-06 is located in the outcrop area adjacent to the Delaware River and several large capacity production wells. The hydrograph shows variable seasonal water-level fluctuations and a general downward trend since the early 1990s. The water level in this well declined 3 ft during 1998 to 2003.

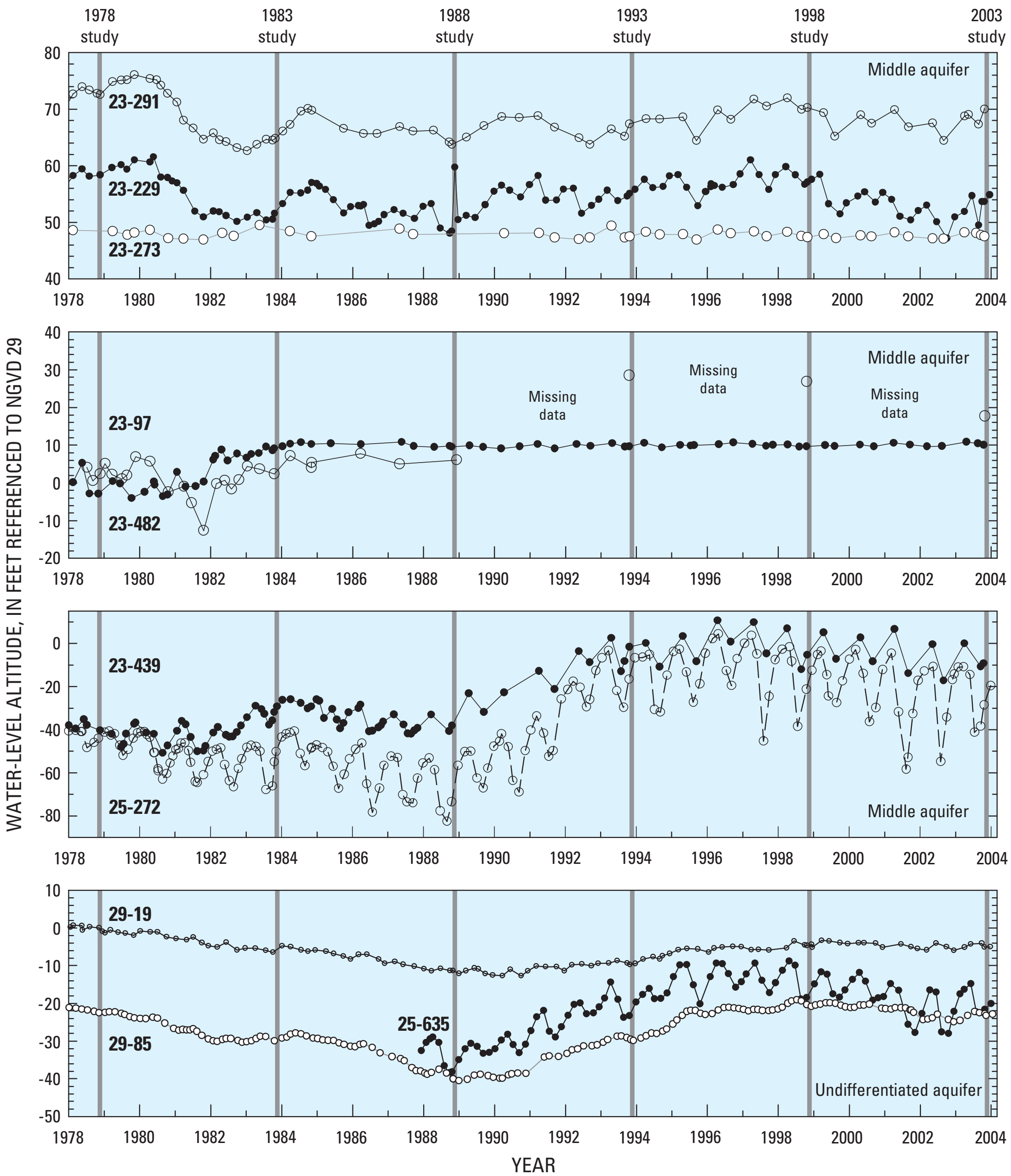


Figure 39. Water-level hydrographs for observation wells screened in the Middle and undifferentiated Potomac-Raritan-Magothy aquifer in the northern counties, New Jersey Coastal Plain, 1978–2003.

Lower Potomac-Raritan-Magothy Aquifer

The Lower PRM aquifer is the lowermost aquifer within the Coastal Plain of New Jersey and Delaware. The aquifer does not crop out in New Jersey and is entirely overlain by the confining bed separating the Middle and the Lower PRM aquifer. The updip limit of the aquifer in New Jersey is within the outcrop area of the Potomac and Raritan Formations (Zapecza, 1989; Martin, 1998). The aquifer is recognizable about 8 mi to 12 mi downdip from the Potomac and Raritan Formations (Zapecza, 1989); beyond this limit the aquifer cannot be differentiated from the overlying sediments of the Middle aquifer. The transmissivity of the aquifer is highest in northwestern and central Camden County and adjoining areas in Gloucester and Burlington Counties in New Jersey; this is where the aquifer is most productive. The Lower PRM is continuous into Delaware and coincides with the lower part of the Potomac Formation. In Maryland, the equivalent aquifer is referred to as the Patuxent aquifer. The updip limit of the aquifer in Delaware lies between the western edge of the Coastal Plain sediments and the updip limit of the Middle

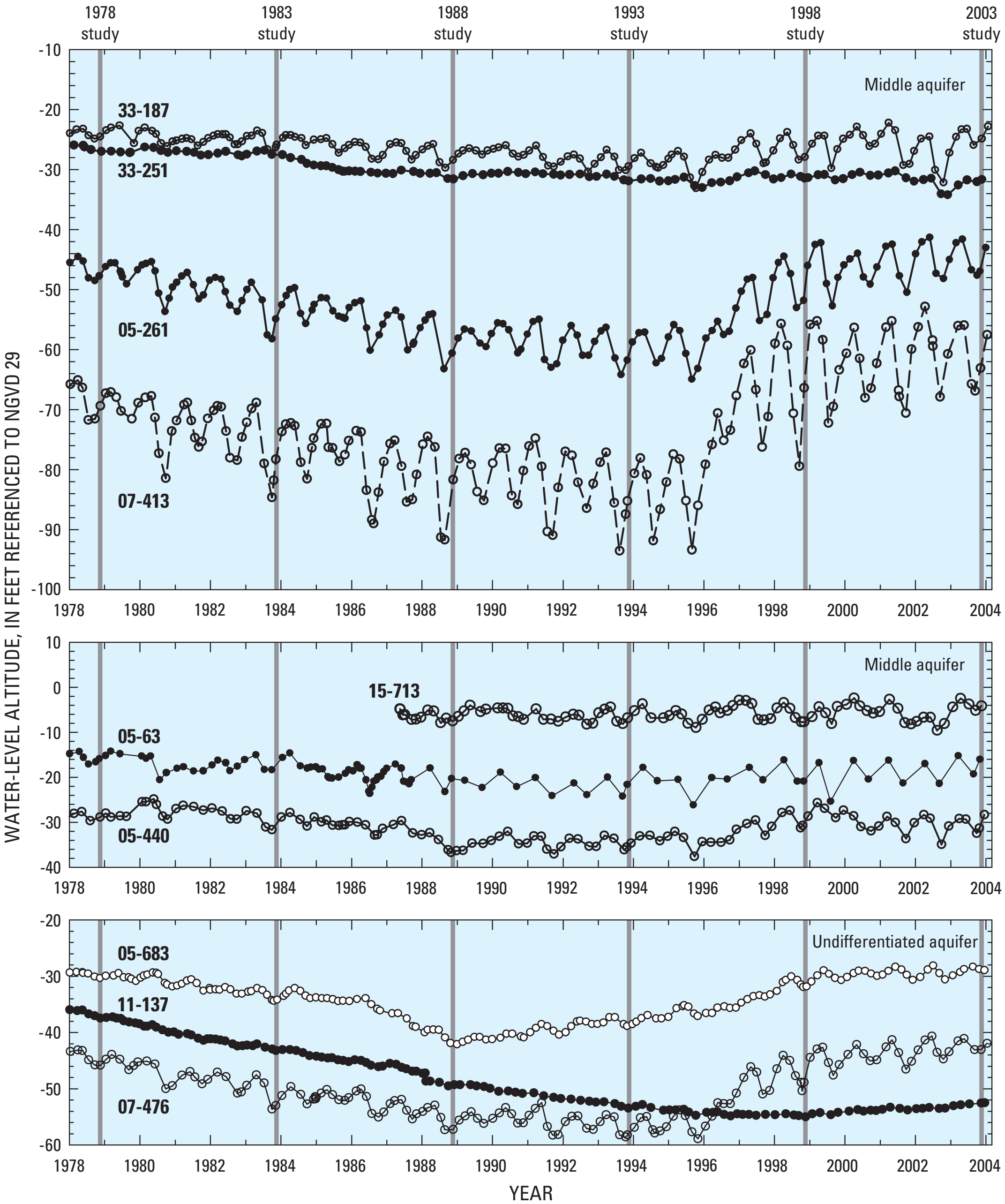


Figure 40. Water-level hydrographs for observation wells screened in the Middle and undifferentiated Potomac-Raritan-Magothy aquifer in the southern counties, New Jersey Coastal Plain, 1978–2003.

Potomac aquifer; the downdip limit is in northern Kent County (Vroblesky and Fleck, 1991).

Water Withdrawals and Extent of Freshwater

Ground-water withdrawals from the Lower PRM aquifer in New Jersey were made predominantly from areas adjacent to the Delaware River, and most withdrawals (approximately 70 percent) were made in the greater Camden County area (fig. 42). Much of this development occurs in the northwestern part of the county flanking the Delaware River; however, production centers are located as far as 11 mi downdip in the central part of the county. Substantial withdrawals also were made in Burlington County along the Camden border and near the northern limit of the aquifer. In Salem and Gloucester Counties, withdrawals were limited and were made in the extreme updip portion of the aquifer owing to the presence of saline water in downdip areas. Ground-water withdrawals from the aquifer in Delaware are made primarily within or near the outcrop area of the Potomac Formation; however, production

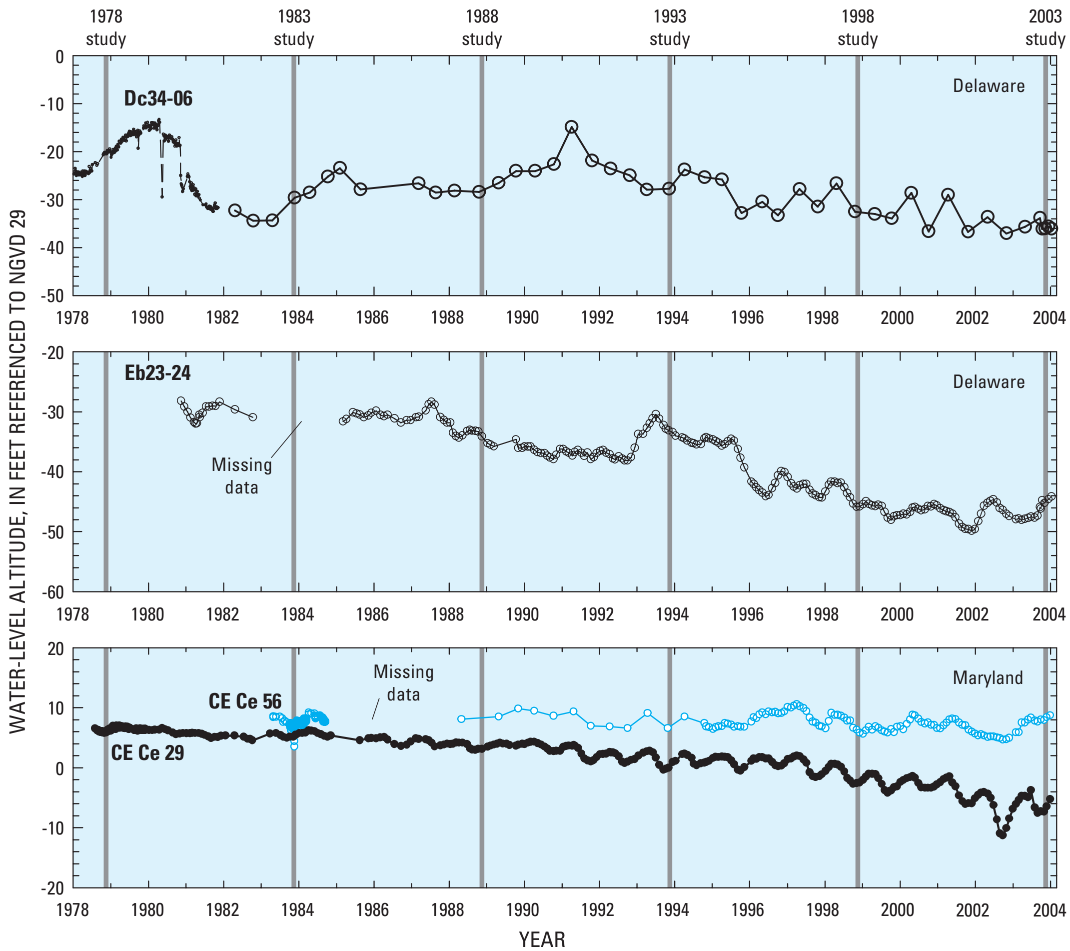


Figure 41. Water-level hydrographs for observation wells screened in the Middle Potomac-Raritan-Magothy aquifer in Delaware and Maryland, 1978 to 2003.

centers are located in downdip areas adjacent to the Delaware River (Delaware City) and near Middletown.

Estimated withdrawals in New Jersey from 1978 to 2003 ranged from 38 to 75 Mgal/d (fig. 43). Withdrawals from the Lower PRM aquifer peaked in the early and mid-1980s; thereafter, withdrawals generally decreased until 2000, and remained constant at approximately 38 Mgal/d during 2000–03. Withdrawal patterns in Camden and Gloucester Counties followed a similar trend; however, withdrawals from Burlington County generally increased from 1978 through 1990, where they remained constant throughout the ensuing decade. From 2000 to 2003 withdrawals decreased. In Salem County, withdrawals from the aquifer were nearly constant at approximately 1 Mgal/d from 1978 to 2003. Withdrawals from the aquifer in Delaware ranged from approximately 3.5 to more than 8 Mgal/d during 1978–2001(fig. 44). Lacombe and Rosman (2001) previously reported that withdrawals were nearly constant at 5 to 6 Mgal/d during 1978–97.

The extent of freshwater within the Lower PRM aquifer is shown in plate 9. The position of the saltwater front is based on available water-quality data and previously published 250-mg/L isochlors of Gill and Farlekas (1976) and Lacombe and Rosman (2001). The western boundary of the saltwater front has been expanded subsequent to 1998 to closely follow that of Gill and Farlekas (1976) and to incorporate sites having consistently elevated chloride concentrations (greater than 400 mg/L) in the Middle aquifer in western Salem County. The 250-mg/L isochlor is not represented for Delaware; its position is likely at or updip from that shown for the Middle aquifer (pl. 8).

Water Levels

Water-level data collected at 106 wells screened in the Lower PRM aquifer (app. 9) were used to define the 2003 potentiometric surface (pl. 9). Most of these wells are located in New Jersey (80) and Delaware (21); three wells were included from Pennsylvania and two from Maryland. Simulated water-level contours shown on maps by Martin (1984; 1998) and Pope and Gordon (1999) were adapted to close the contours at the eastern part of the study area.

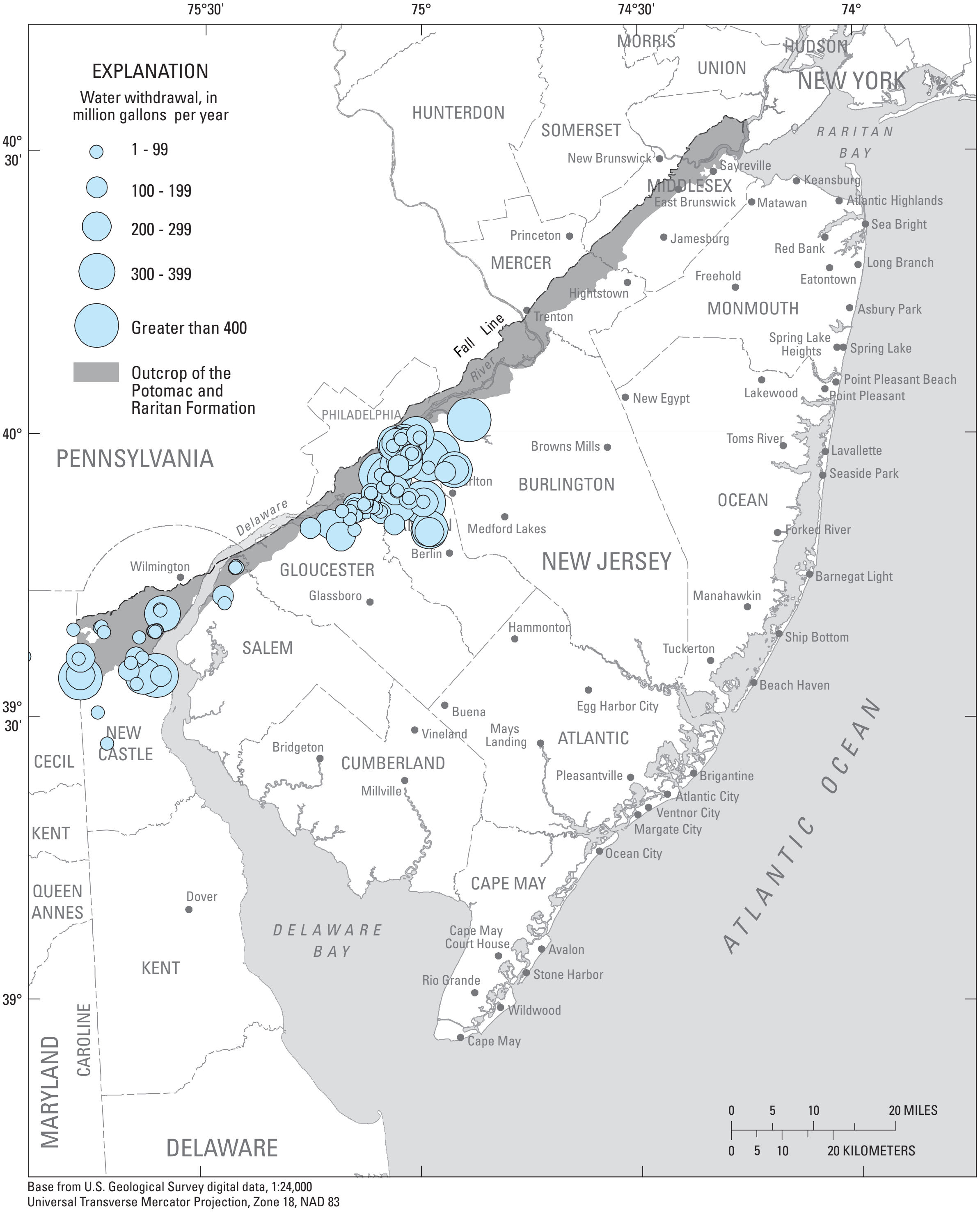


Figure 42. Location and amount of ground water withdrawn from the Lower Potomac-Raritan-Magothy aquifer, New Jersey, Delaware, and Maryland Coastal Plain, 2003.

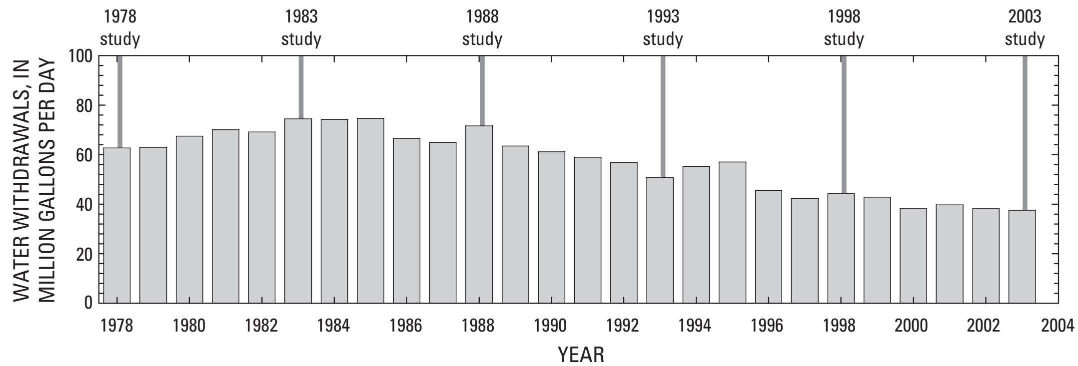


Figure 43. Estimated ground-water withdrawals from the Lower Potomac-Raritan-Magothy aquifer, New Jersey Coastal Plain, 1978–2003.

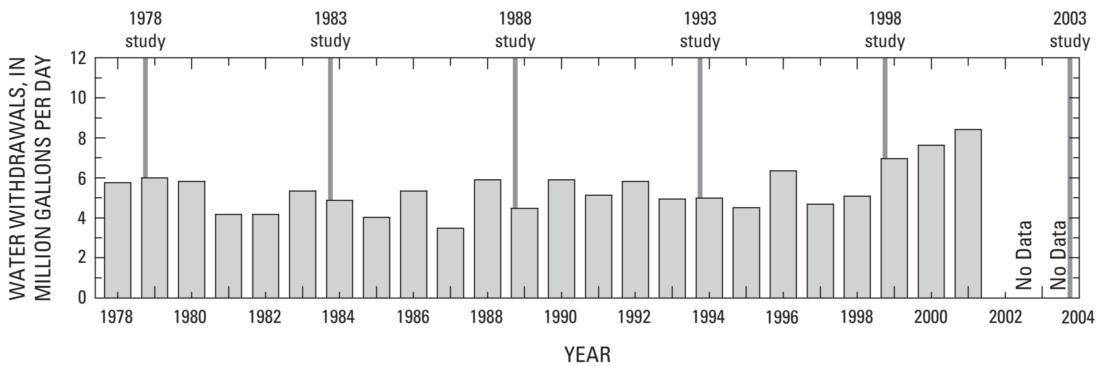


Figure 44. Estimated ground-water withdrawals from the Lower Potomac-Raritan-Magothy aquifer, Delaware Coastal Plain, 1978–2001.

Two regional cones of depression, one underlying the Camden area in southern New Jersey and the other, New Castle County, Delaware, characterize the 2003 potentiometric surface for the Lower PRM aquifer. Aquifer-wide water levels typically were at or below 0 ft NGVD 29; those above this datum occur only in the updip areas of western Delaware and eastern Maryland and adjacent to the western limit in Burlington County, New Jersey. Water-level altitudes ranged from 5 ft to -73 ft NGVD 29 within the extent of the Lower aquifer in southern New Jersey and southeastern Pennsylvania. The highest water levels were measured adjacent to the Delaware River along the updip limit of the aquifer; the lowest water levels were observed near the center of the regional cone of depression in central Camden County. Near the center of this cone of depression, water levels declined at several wells causing the expansion of the area encompassed by the -60 ft contour (fig. 24e; pl. 9). Withdrawals from the Lower aquifer within this area increased only marginally since 1998; withdrawals from the overlying Middle aquifer in this area remained constant. Away from the center of the cone, water levels typically increased relative to 1998. Recovery was greatest in the area of West Deptford, Gloucester County; water-level rises in several wells, ranging from 8 ft to 30 ft relative to 1998 levels, prompted the contraction of the lobate feature of the -40-ft potentiometric contour in this area. Large rises in water levels in and around this area were likely the result of the combination of substantial reductions in withdrawals from 1998 to 2003 and the lack of withdrawals from production wells for a longer duration prior to measurement than in the previous study. Water levels near the northern limit of the aquifer in Burlington County recovered approximately 8 ft. Changes throughout the remainder of the aquifer extent were more subtle as water levels generally rose from 1 ft to 7 ft. above 1998 levels. In Pennsylvania along the Delaware River, water levels remained the same in one well (P10113) and rose 1 and 6 ft in wells P10114 and P10103, respectively, during 1998 to 2003 (fig. 24e; app. 9)

Although restrictions in withdrawals from aquifers of the PRM system were not required until 1996, a water-level change map of the Lower aquifer from 1988 to 2003 is shown in figure 25e. Water levels within the regional cone of depression in southern New Jersey recovered, on average, 10 ft to 20 ft along the northern and southern edges of the cone in Burlington and Gloucester Counties; water levels in north-central Camden County recovered from 20 ft to 40 ft during the same period. Withdrawals from the aquifer in southern New Jersey in 2003 were reduced by approximately 18 percent from 1996; moreover, withdrawals decreased by nearly 48 percent of the volume withdrawn in 1988. Within Critical Area 2, withdrawal trends were similar. During this same period, ground-water withdrawals from the aquifer in Delaware increased; consequently, water levels within the regional cone of depression declined by 10 ft to more than 20 ft.

The center of the cone of depression underlying northern New Castle County is located in the Delaware City area near the eastern end and to the north of the Chesapeake and Delaware Canal. This cone of depression extends toward the northeast into Salem County, New Jersey, and to Cecil County, Maryland, in the southwest. Martin and Denver (1982) documented the rapid decline of water levels in this area during the late 1950s and early 1960s; water levels had declined nearly 100 ft during this period and, by 1980, had fallen by as much as an additional 100 ft to -200 ft NGVD 29. Lacombe and Rosman (2001) noted that the shape of this cone had changed slightly and that its center had migrated to the east from its simulated configuration in October 1980 (Martin, 1984). However, the cone of depression is likely centered near large refinery wells to the west that were not accessible for measurement in either 1998 or 2003, rather than on much lower capacity production wells adjacent to the Delaware River. Though the depth of the cone of depression in 2003 is nearly identical to that observed in 1998, its mapped position has been shifted slightly to the northwest, encompassing the larger capacity industrial wells in this area. The water level in well Ec15-27 (-178 ft), located near the eastern edge of the center of this cone, has remained essentially unchanged from 1998. Well Ec15-28, with a water-level altitude of -187 ft, is also located near the center of the cone of depression. Measurements were not made at this well in previous studies, and therefore, a water-level change could not be calculated. Approximately 3 mi to the southwest, no appreciable change from 1998 was observed in the water level at well Ec32-07. Similarly, the water level in well 33-330 (-34 ft), located near the northeastern edge of the cone of depression in New Jersey, showed no change from 1998. On the southern edge of the cone, however, water levels in wells Fb33-25 (-42 ft) and 33-458 (-45 ft) declined slightly, about 5 ft and 3 ft, respectively. Ground-water withdrawals from the aquifer near Middletown, Delaware, increased from the early 1990s through 2000; data for 2001 to 2003 were incomplete or unavailable. At the northern edge of this cone the levels in wells Db33-17 (-51 ft) and Dc34-05 (-74 ft) were 11 ft and 10 ft lower than observed during the 1998 study. In contrast, water levels were stable to rising toward the updip limit of the aquifer. Water levels in wells in the western part of the study area typically had recovered since 1998.

A downward vertical gradient from the Middle PRM aquifer to the Lower aquifer occurs in the updip portion of the aquifer along section B-B' (fig. 2b). This downward hydraulic gradient is subtle; water levels within the overlying Middle aquifer are generally 2 ft to 4 ft higher than in the Lower aquifer. This gradient increases slightly in central Cherry Hill Township, Camden County, where water levels in the Middle aquifer are as much as 12 ft higher than those in the Lower aquifer. In central Camden County, the hydraulic gradient reverses, and the potential for flow upward from the Lower aquifer to the Middle aquifer increases.

The water-level hydrographs for four observation wells in New Jersey show annual and seasonal fluctuations that reflect the response of the water levels to ground-water withdrawals and recovery (fig. 45). Observation wells 07-412 and 15-671 are located near the center of the cone of depression in central Camden County. The hydrograph for well 07-412 shows a water level of -62 ft during late fall 1978, declining water levels during 1978 to 1988, followed by a rapid rise from 1996 to 1998. From 1998 to 2003, water levels fluctuated from 10 ft to 15 ft during any given year. No apparent upward or downward trend was observed. The hydrograph of well 15-671, which is on the western edge of the center of the cone, exhibits a similar pattern; however, moderate rises continued from 1998 to 2003. Water levels in observation well 05-262 (-47 ft), located 5 mi to the northeast of the center of the cone, responded similarly, though seasonal fluctuations and periods of decline and recovery were less pronounced. Seasonal water-level fluctuations ranged from 5 ft to 21 ft/yr in wells 05-262, 15-671, and 07-412. Fluctuations were greatest in wells nearest the center of the cone and during the period of rapid water-level rise in the mid- to late 1990s.

Observation well 15-712 is located in southwestern New Jersey adjacent to the saltwater front and away from large production centers. Though seasonal fluctuations typically ranged from 2 ft to 7 ft, water levels in well 15-712 show no distinct upward or downward trend from the beginning of record through 1998; from 1999 to 2003 water levels recovered slightly. The stable or increasing water levels observed in these wells during 1996 to 2003 are indicative of aquifer-wide trends during this period. Further evidence of an upward trend is demonstrated by the rise in water levels in the majority (88 percent) of the wells in the aquifer measured during 2003. The sustained upward trends can in large part be attributed to CA 2 regulations that limit ground-water withdrawals in the aquifer in southern New Jersey.

Water-level hydrographs for three wells screened in the lower Potomac aquifer in Delaware are shown in figure 46. Fluctuating water levels indicate the effects of ground-water withdrawals from local production centers and the Delaware City well field. Water levels for 2003 in these wells range from 51 ft (well Db33-17) to 102 ft (well Ec32-07) below NGVD 29 depending on proximity to the well field. Two of the wells, Db33-17 and Dc34-05, are located in the outcrop area of the Potomac Formation. Water levels in well Db33-17 generally rose from 1990 to 1994, followed by recurrent periods of decline and recovery through 2003. The net change in water level during the period of record is a rise of about 4 ft. Water levels in well Dc34-05 rose sharply (nearly 40 ft) from 1978 to 1985 and, thereafter, followed a trend similar to that observed in well Db33-17. The net change in water level in this well from 1978 to 2003 was a rise of about 25 ft.

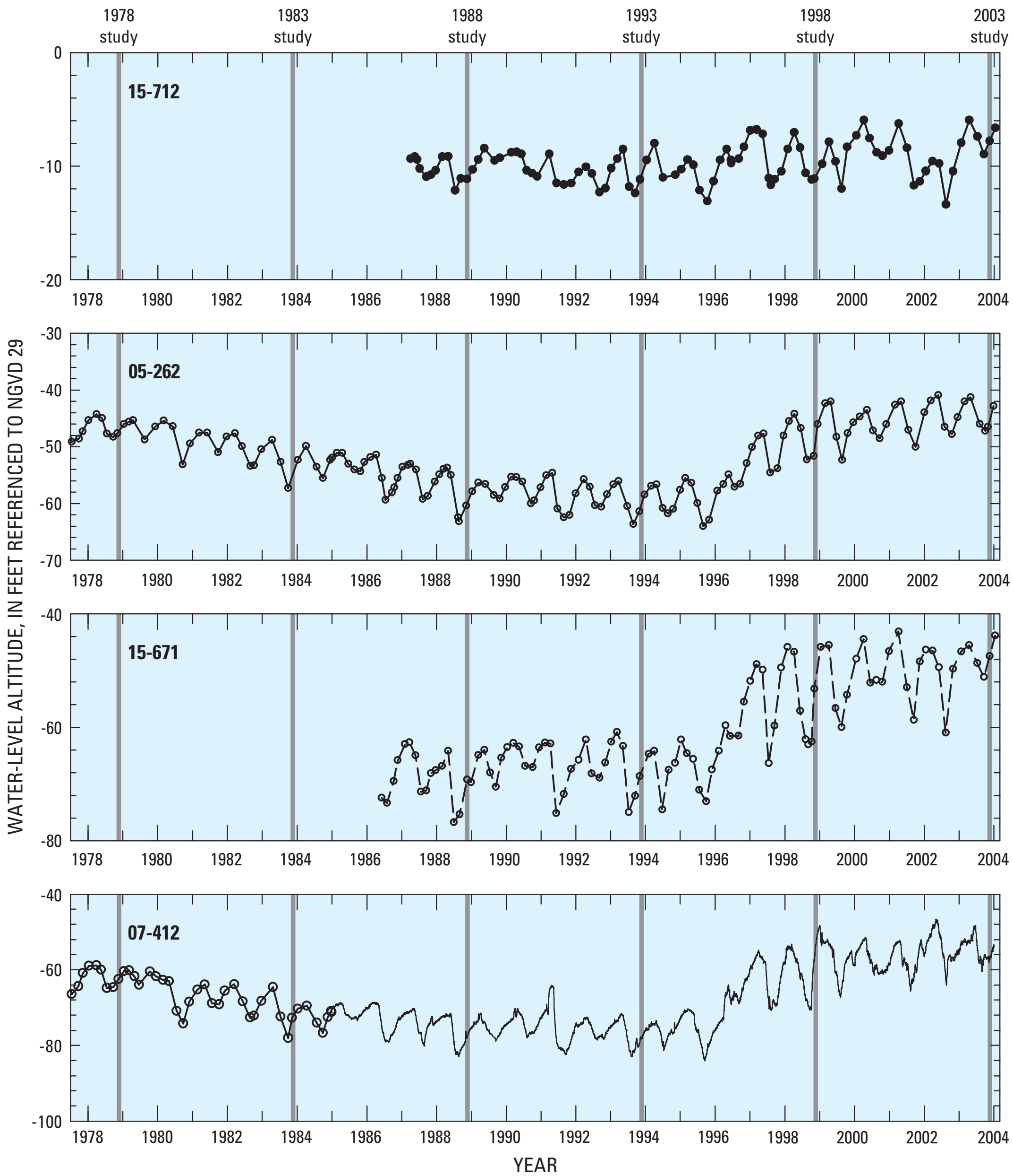


Figure 45. Water-level hydrographs for observation wells screened in the Lower Potomac-Raritan-Magothy aquifer, New Jersey Coastal Plain, 1978–2003.

Observation well Ec32-07 is located to the southwest of the center of the cone of depression in New Castle County, Delaware, within the confined portion of the aquifer. The water level in this well shows a pattern dissimilar to those of the aforementioned two wells; the hydrograph indicates a prevailing downward trend for the period 1978 to 1998. From 1998 to 2003 the hydrograph shows numerous water-level peaks and valleys ranging from 86 to 104 ft below NGVD 29; however, during this 5-year period, the water level remained about the same. The net decline in water levels for the period of record is approximately 20 ft.

Observation wells CE Bf 82 and CE Ce 55 are located in Cecil County, Maryland, at the western edge of the study area. Water levels in both wells were nearly constant during 1985 to 1994, declined during 1995, and stabilized before recovering somewhat in 2003 (fig. 46).

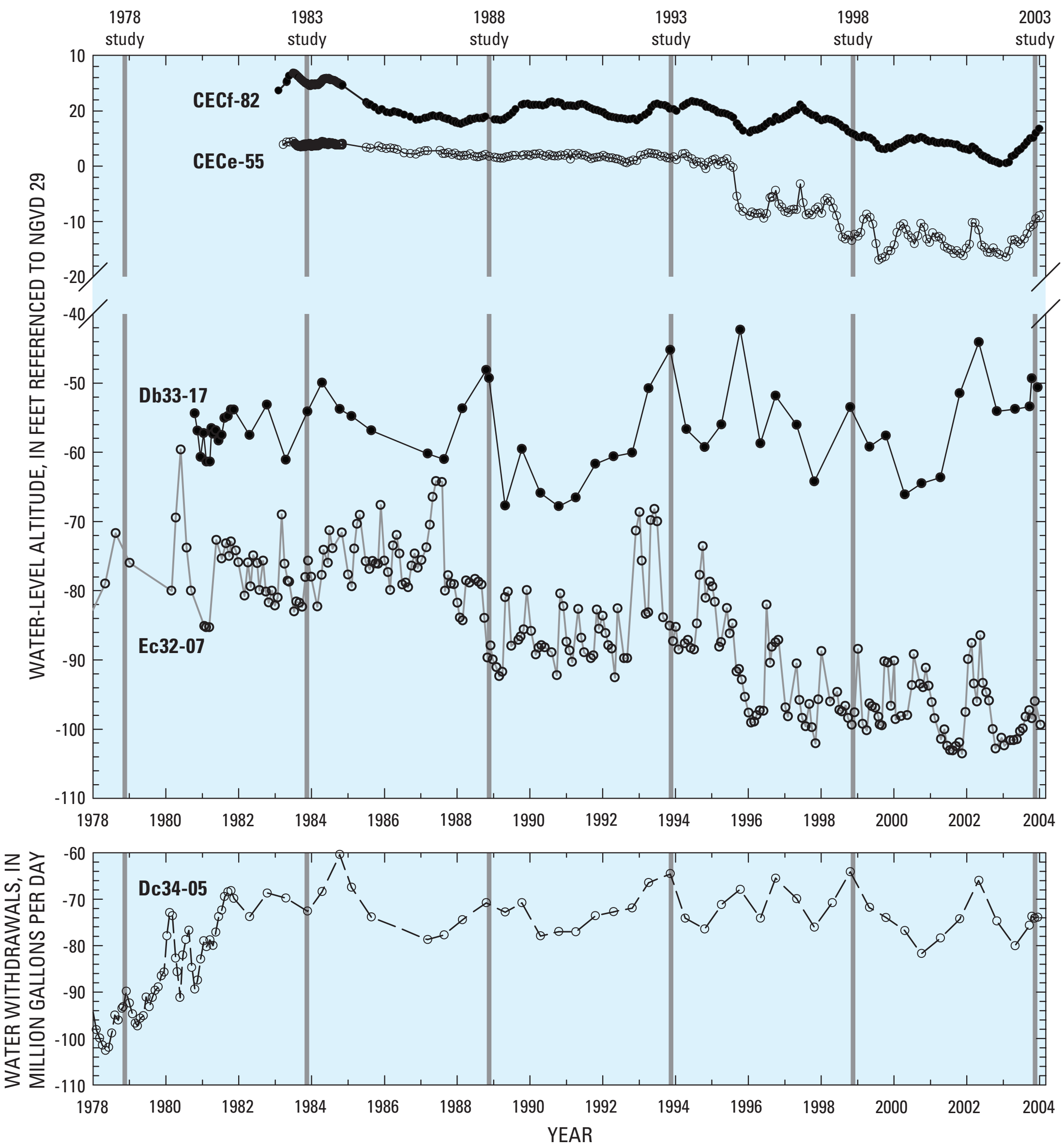


Figure 46. Water-level hydrographs for selected observation wells screened in the Lower Potomac-Raritan-Magothy aquifer, Delaware and Maryland Coastal Plain, 1978–2003.

Summary

Ground-water levels measured in 967 wells in New Jersey, and parts of Pennsylvania, northern Delaware, and northeastern Maryland, during fall 2003 were used to define the potentiometric surface of 10 confined aquifers in the Coastal Plain of New Jersey and Delaware. Potentiometric-surface maps were prepared for the confined Cohansey aquifer of Cape May County, the Rio Grande water-bearing zone, the Atlantic City 800-foot sand, the Piney Point aquifer, the Vincentown aquifer, and the Englishtown aquifer system in New Jersey, as well as for the Wenonah-Mount Laurel aquifer, the Upper Potomac-Raritan-Magothy (PRM), the Middle and undifferentiated PRM, and the Lower PRM aquifers in New Jersey and the equivalent aquifers in Delaware.

From 1978 to 2003, estimated ground-water withdrawals from the confined Cohansey aquifer ranged from 4.3 to 6.9 Mgal/d, with the maximum volume withdrawn in 1982. During 2003 withdrawals from the Cohansey aquifer totaled 4.8 Mgal/d, a decrease of nearly 1 Mgal/d or 15 percent of 1998 volumes. The 2003 potentiometric surface of the confined Cohansey aquifer shows a cone of depression underlying the southern part of the Cape May peninsula. From 1998 to 2003 water levels remained constant near the center of the cone of depression. To the south, water levels rose in Cape May City wells in southern Lower Township as withdrawals decreased since 1998. Measurements from wells screened in the aquifer in the northern part of Cape May County indicate that water levels have not changed substantially from historic conditions. The position of the freshwater-saltwater interface has migrated farther inland along the western part of the peninsula based on the rapidly increasing chloride concentrations observed in a well near Villas. Chloride concentrations in water from wells to the south in lower Cape May have remained stable.

Estimated ground-water withdrawals from the Rio Grande water-bearing zone from 1978 to 2003 averaged less than 1 Mgal/d; withdrawals in 2003 were approximately 0.6 Mgal/d. An elongated cone of depression, largely attributable to low water levels within the underlying Atlantic City 800-foot sand, persists beneath the barrier islands of Cape May, Atlantic, and southern Ocean Counties. Water levels at the Rio Grande well field have risen by as much as 13 ft from 1998 to 2003, as a result of a 25-percent reduction in ground-water withdrawals. Elsewhere, little change has occurred in the water levels across the aquifer. The location of the saltwater front within the Rio Grande water-bearing zone has not changed from that represented in the previous study; limited data compiled following the 1998 study do not indicate movement of the front.

The Atlantic City 800-foot sand is the principal confined aquifer supplying water to New Jersey's barrier island communities from Harvey Cedars in southern Ocean County to Cape May City. Ground-water withdrawals from the Atlantic City 800-foot sand ranged from 18 to 24 Mgal/d during 1978 to 2003. Withdrawals have gradually increased since 1978 and in 2003, were estimated to be approximately 24 Mgal/d. An elongated cone of depression underlies the coastal barrier island communities of New Jersey from Barnegat Light in Ocean County south to Cape May City, with the deepest water levels observed in eastern Atlantic County. From 1998 to 2003, water levels recovered by as much as 10 ft near the center of the cone of depression underlying Ventnor and Atlantic City. To the north and west, modest recoveries were observed in Egg Harbor Township. Water-level changes from 1998 to 2003 in the aquifer were greatest in southern Cape May County. Withdrawals at the Cape May desalination wells began in 1998, and by 2003, were estimated to be approximately 1 Mgal/d. Consequently, water levels at and near these wells were as much as 32 ft lower than in 1998. Elsewhere, water levels remained stable or have recovered throughout the remainder of the aquifer extent. In the Atlantic City 800-foot sand, the freshwater-saltwater interface (saltwater front) has not changed position from that in 1998. The saltwater front is located approximately 4 mi to the south-southeast of production wells at Stone Harbor, where chloride concentrations had remained largely consistent, typically ranging from 30 mg/L to 40 mg/L from the mid-1960s through 2000. Farther to the north and offshore from Atlantic County, the saltwater front is located approximately 10 mi and 8 mi to the southeast of production wells in Ventnor City and Brigantine, respectively. Chloride concentrations in ground water sampled from coastal areas of Atlantic and Ocean Counties have not shown substantial change from 1998 to 2003, and chloride concentrations in samples from wells south of the front in lower Cape May County also have remained stable.

Ground-water withdrawals from the Piney Point aquifer in New Jersey ranged from 1.8 to 4.8 Mgal/d during 1978 to 2003; in 2003 withdrawals totaled 4.8 Mgal/d, an increase of 11 percent from 1998 volumes. Withdrawals in Delaware decreased from about 4 to 3 Mgal/d during 1994 to 2001. As a result of ground-water withdrawals, five regional cones of depression are present in the aquifer and are centered beneath, from north to south, in New Jersey, Seaside Park, Barnegat Light, coastal Atlantic County, and Buena Borough in western Atlantic County and Dover in Delaware. The highest water levels in 2003 were measured in wells near the updip boundary along the border between Burlington and Ocean Counties and the lowest (-160 ft NGVD 29), near Dover, Delaware. From 1998 to 2003 substantial rises in water levels were observed in and around Seaside Heights in coastal Ocean County. Recoveries in excess of 40 ft resulted from an overall reduction in withdrawals from the aquifer in this area. Similarly, water levels increased by as much as 34 ft in and around the major cone of depression underlying Dover. Water levels also recovered in eastern Buena Borough, but to the southwest, where local withdrawals had shifted, they declined slightly from 1998 to 2003. Elsewhere across the aquifer, water levels did not change appreciably. The position of the saltwater front did not change from 1998 to 2003.

Ground-water withdrawals from the Vincentown aquifer ranged from less than 1 Mgal/d to 1.5 Mgal/d during 1978-2003. During 2003, an estimated 1.2 Mgal/d of ground water was withdrawn from the aquifer. The 2003 potentiometric surface shows a configuration similar to that of the 1998 study. Water levels stabilized or recovered by 2 ft to 6 ft from 1998 in most of the wells measured, the exceptions being those near Adelphia in Monmouth County, where water levels rose by as much as 18 ft. The 250-mg/L isochlor was not determined for the Vincentown aquifer; chloride concentrations in ground-water samples from the confined part of the aquifer are typically 45 mg/L or lower.

Ground-water withdrawals from the Wenonah-Mount Laurel aquifer ranged from 4.1 to 8.7 Mgal/d during 1978–2003. In 2003, withdrawals were estimated to be nearly 8 Mgal/d. Withdrawals in the northern counties of the Coastal Plain decreased from about 1.4 Mgal/d in 1978 to 0.6 Mgal/d in 2003, whereas those in the southern Coastal Plain increased from 4.4 to 7.2 Mgal/d. In late 2003, the potentiometric surface of the Wenonah-Mount Laurel aquifer was characterized by three cones of depression; the first and most extensive, underlies coastal Monmouth County, New Jersey, the second and smallest, is centered beneath Browns Mills, and the third, underlies parts of central Burlington, Camden, and Gloucester Counties. Minimum water levels in 2003 in the cones were -76 ft, -32 ft, and -71 ft, respectively. From 1998 to 2003, water levels near the center of the large cone of depression that extends from Monmouth to Ocean County rose by as much as 20 ft in the Wenonah-Mount Laurel aquifer. Water levels generally recovered in Burlington, Camden, and Gloucester Counties from 1998 to 2003; the most pronounced rises of nearly 30 ft occurred in central Gloucester County. Chloride concentrations in ground water did not substantially increase, and therefore, no movement of the saltwater front was observed.

Ground-water withdrawals from the Englishtown aquifer system decreased from approximately 11 Mgal/d in 1978 to less than 7 Mgal/d by 1996; in 2003 withdrawals were estimated to be approximately 8 Mgal/d, with those from the northern Coastal Plain counties accounting for 70 percent of this volume. Withdrawals from the aquifer system in the northern counties have remained largely constant at about 5.5 Mgal/d since 1993, whereas those in the southern counties increased substantially following 1996, partly a consequence of restrictions placed on withdrawals from the deeper Potomac-Raritan-Magothy aquifer system. The dominant feature of the 2003 potentiometric surface in the Englishtown aquifer system continues to be the prominent cone of depression underlying northeastern Ocean and eastern Monmouth Counties, New Jersey. The minimum water level in 2003, -115 ft NGVD 29, measured at Point Pleasant, New Jersey, shifted the center of the cone slightly to the north and west from its previous position beneath Bay Head. In and around the Borough of Spring Lake in coastal Monmouth County, water levels declined as much as 13 ft relative to 1998 levels. From 1998 to 2003 ground-water withdrawals increased substantially in this area; moreover, withdrawals from the Englishtown aquifer system had increased slightly throughout Critical Area 1 during this same period. Other minor, scattered declines and recoveries were observed in Ocean and Camden Counties; these were generally confined to a single well or well field. Concentrations of dissolved chloride in wells within the confined part of the Englishtown aquifer system occasionally exceeded 25 mg/L along coastal Monmouth County; however, concentrations in most water-quality samples were less than 25 mg/L, verifying that the aquifer contains freshwater in coastal New Jersey.

Total ground-water withdrawals from the Upper Potomac-Raritan-Magothy aquifer in New Jersey ranged from 52 to 80 Mgal/d from 1978 to 2003; during 2003, withdrawals were at a 25-year low of approximately 52 Mgal/d. Withdrawals from the northern Coastal Plain decreased from 47 Mgal/d in 1983 to about 30 Mgal/d in 2003 as a result of Critical Area 1 reductions. Withdrawals in the southern Coastal Plain remained fairly constant (30 to 32 Mgal/d) from 1978 through 1995; thereafter, in 1996 withdrawals decreased to 27 Mgal/d. Critical Area 2 restrictions on withdrawals from the Upper Potomac-Raritan-Magothy aquifer further reduced these amounts and, from 1997 to 2003, withdrawals ranged from 22 to 25 Mgal/d. Estimated water withdrawals from the Upper PRM aquifer (Magothy aquifer) in Delaware remained at less than 0.75 Mgal/d during 1978 to 2001.

Within the Upper Potomac-Raritan-Magothy aquifer, a regionally extensive cone of depression persists that extends from the Raritan Bay in the northern part of the study area into northeastern Maryland. The lowest water levels, -90 ft NGVD 29, were measured in Central Camden County, New Jersey, where during 1998 to 2003 water levels typically recovered from 5 to 15 ft. Water-level rises of 5 to 10 ft also were observed in western Burlington and northern Gloucester Counties, as well as in scattered areas of Monmouth County from 1998 to 2003. In contrast, declining water levels were observed in coastal and interior Ocean County as ground-water withdrawals increased in Seaside Heights and in communities to the west. Declines were more pronounced near Seaside Heights (up to 30 ft) since withdrawals from the aquifer began following the 1998 study. Declining water levels were also observed in parts of northern Monmouth County, central Camden County, and in Middletown, Delaware. Elsewhere, water levels within the aquifer were generally stable.

Concentrations of dissolved chloride in samples from several observation wells screened in the Upper PRM (Old Bridge) aquifer at Keyport and Union Beach have increased substantially since 1998, indicating the landward movement of the saltwater front. Although water levels have recovered and largely stabilized as a result of the reduction in withdrawals subsequent to 1991, water levels continue to fluctuate seasonally; in summer months water levels decline to as much as 12 ft. below 0 ft NGVD 29. The hydraulic gradient has not reversed sufficiently to allow freshening of the aquifer, and active saltwater intrusion continues in this area. In southern New Jersey, the position of the saltwater front has been updated subsequent to the 1998 study. The saltwater front arcs in an updip direction toward the Delaware River in southern Gloucester County. The updated position of this line reflects a reinterpretation of previously collected data, as well as the inclusion of new data; this new position does not imply movement of the front nor increasing chloride concentrations in this area.

Ground-water withdrawals from the undifferentiated and Middle Potomac-Raritan-Magothy aquifer in New Jersey in 2003 were estimated at 68 Mgal/d. Withdrawals from the northern Coastal Plain decreased from 39 Mgal/d in 1983 to about 26 Mgal/d in 1996; however, from 1997 to 2003 withdrawals again increased and, by 2003, were estimated at 31 Mgal/d. In the southern Coastal Plain, withdrawals decreased during 1983–98; thereafter, withdrawals increased slightly to 37 Mgal/d in 2003.

As a result of ground-water withdrawals, a regionally extensive cone of depression in the Middle Potomac-Raritan-Magothy aquifer encompasses much of the study area and extends from the Raritan Bay in the northeast to eastern Maryland in the southwest. Water-level altitudes ranged from highs of more than 70 ft NGVD 29 near the outcrop area in central Mercer and Middlesex Counties to -72 ft NGVD 29 at the center of the cone of depression in southern New Jersey. In New Castle County, Delaware, water levels ranged from 68 ft NGVD 29 near the northwestern limit of the aquifer to more than 50 ft below NGVD 29 in the Middletown area. Increases in withdrawals from 1998 to 2003 caused water levels to decline from 5 ft to 9 ft along the border between Monmouth and Middlesex County, and within the undifferentiated portion of the aquifer in parts of northern Ocean County, water levels were 2 to 10 ft lower than in 1998. Similarly, declines in water levels of up to 13 ft were observed in Camden County, though the declines occurred near individual wells or well fields and were limited in extent. Reduced ground-water withdrawals near the northern boundary of Critical Area 2 caused water levels to rise by as much as 10 ft. Elsewhere, within Critical Area 2 and the remainder of southern New Jersey, water levels in the Middle aquifer were stable to slightly recovering. Water levels in 2003 were 5 to 7 ft lower than in 1998 within the aquifer in central New Castle County, Delaware. The extent of freshwater in the Middle Potomac-Raritan-Magothy aquifer in the northern and southern counties of the New Jersey Coastal Plain remained about the same as in 1998.

Total ground-water withdrawals from the Lower Potomac-Raritan-Magothy aquifer in New Jersey ranged from 38 to 75 Mgal/d during 1978 to 2003. Withdrawal volumes peaked in the mid-1980s, decreased from 1985 to 2000; thereafter, withdrawals remained nearly constant at 38 Mgal/d. In 2003, two regional cones of depression, centered beneath the Camden area in southern New Jersey and in New Castle County, Delaware, characterized the potentiometric surface of the aquifer. Near the center of the Camden cone of depression, water levels declined during 1998–2003; however, near the western edge of this cone, water levels in many wells recovered, most notably in the West Deptford area. Water levels in some wells rose more than 20 ft relative to 1998 levels, as a result of local reductions in ground-water withdrawals. Elsewhere in New Jersey, water levels in the aquifer remained stable or had risen from 1 to 8 ft. Water levels near the center of the major cone of depression in Delaware have stabilized since 1998.

Acknowledgments

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Appendix 1

Water-level data for wells screened in the confined Cohansey aquifer and the Rio Grande water-bearing zone, New Jersey Coastal Plain, 1978–2003.

Appendix 1. Water-level data for wells screened in the confined Cohansey aquifer and the Rio Grande water-bearing zone, New Jersey Coastal Plain, 1978–2003.

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
Confined Cohansey aquifer															
01-835	35-05072	391820	744534	TUCKAHOE	15	116-126	--	--	--	--	--	9	--	12/04	E
09-11	57-04898	385612	745456	CAPE MAY	7.28	281-321	--	-20	-14	-17	-15	-11	4	12/02	E
09-18	--	385652	745326	CAPE MAY	*4	295-325	--	--	--	--	--	-14	--	12/10	E
09-27	37-00013	385642.7	745532	CAPE MAY	10	277-306	-21	-27	-17	-21	-18	-11	6	12/09	D
09-30	--	385650	745309	CAPE MAY	11	305-325	--	--	--	--	-14	-13	2	12/10	E
09-36	--	385701	745527	CAPE MAY	10	174-282	-26	-33	-20	-26	-17	-15	2	12/09	A
09-42	37-00268	385723	745239	CAPE MAY	5	259-289	--	-18	-12	--	-16	-19	-2	12/12	A
09-43	57-00011	385723.2	745519.8	CAPE MAY	18	246-276	--	-25	-13	-21	-16	-8	8	12/09	E
09-48	37-00159	385748	745532	CAPE MAY	17.48	242-252	--	-22	-17	-21	-17	-12	5	12/02	E
09-49	--	385804	745741	CAPE MAY	6	241-250	-16	-15	-13	-14	-13	-11	2	12/02	E
09-52	37-00113	385853.9	745711	CAPE MAY	18	241-262	--	-15	-16	-22	-19	-14	5	12/09	D
09-54	37-00223	385906.3	745621.7	CAPE MAY	14	212-247	--	-18	-16	-20	-21	-17	4	12/12	A
09-57	37-00293	385916	745519	CAPE MAY	20	263-303	--	-13	-13	-17	-12	-13	-1	12/12	A
09-60	--	390056	745425	RIO GRANDE	13.11	242-257	--	-12	-12	-15	-12	-13	-1	12/04	E
09-80	--	390213	745055	STONE HARBOR	13.67	242-252	-2	-2	-4	-5	-4	-2	3	12/04	E
09-89	37-00158	390425	745445	RIO GRANDE	7.37	195-210	-2	-2	-2	-1	-0	-2	-2	12/02	E
09-99	35-00680	390611	744837	STONE HARBOR	10.73	214-230	4	5	4	3	-2	5	7	12/04	E
09-150	37-00155	385607	745555	CAPE MAY	6.6	283-293	-18	-19	-13	-17	-14	-10	4	12/02	E
09-159	37-00241	385827	745020.4	WILDWOOD	*2	249-360	--	-8	-8	-11	-8	-6	2	12/10	D
09-187	--	390218	745608	RIO GRANDE	10	186-190	--	--	-6	-7	-3	-4	-1	12/09	E
09-188	--	390215	745439	RIO GRANDE	5.5	229-233	--	--	-10	-11	-9	-7	2	12/12	E
09-207	35-06772-1	391121	745113	WOODBINE	10.48	80-90	--	--	--	--	--	5	--	12/11	E
09-210	--	385946	745724	CAPE MAY	11.03	216-221	--	--	-8	-13	-12	-10	2	12/02	E
09-213	--	390128	745638	RIO GRANDE	12.23	203-208	--	--	--	-8	-7	-5	1	12/10	E
09-219	35-03380	390601	745244	RIO GRANDE	19	150-200	--	--	--	2	3	5	2	12/12	E
09-233	35-04815	390929	745004	WOODBINE	12	120-170	--	--	--	--	--	6	--	12/23	E
09-256	36-01106	391719	744513	TUCKAHOE	25	138-158	--	--	--	--	--	15	--	12/10	B

Appendix 1. Water-level data for wells screened in the confined Cohansey aquifer and the Rio Grande water-bearing zone, New Jersey Coastal Plain, 1978–2003.—Continued

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
09-281	37-00254	390710	745133	STONE HARBOR	11	176-181	--	--	5	5	4	6	2	12/01	E
09-292	37-03035	390337	744622	STONE HARBOR	5	251-261	--	--	1	2	1	0	-1	12/11	E
09-297	36-06829	391326	744050.7	SEA ISLE CITY	10	145-180	--	--	--	--	--	8	--	12/22	A
09-301	37-00831	385736.1	745122.4	WILDWOOD	2	190-245	--	--	--	--	-11	-10	1	12/10	A
09-308	35-06359	391213	745332	HEISLERVILLE	12	58-98	--	--	--	--	--	7	--	12/03	D
09-310	37-01781	390018.5	744747.9	STONE HARBOR	7	279-357	--	--	1	0	2	3	1	12/10	A
09-314	37-00640	385932.7	744849.5	WILDWOOD	*7	212-325	--	--	--	-1	0	1	1	12/10	A
09-315	35-01373	390317	745009	STONE HARBOR	10	228-248	--	--	--	--	--	7	--	12/22	B
09-317	35-02729	391421	744839	WOODBINE	42	135-158	--	--	--	--	--	27	--	12/23	B
09-325	35-13059	391701	745056	TUCKAHOE	55	109-119	--	--	--	--	--	34	--	12/11	E
09-350	36-16171	391218	744544	WOODBINE	16	227-237	--	--	--	14	13	15	2	12/09	E
09-353	37-04871	385855	745736	CAPE MAY	20	262-272	--	--	--	-12	-12	-8	4	12/02	E
09-354	37-04873	390147.7	744856.7	STONE HARBOR	4.67	230-240	--	--	--	2	2	4	2	12/22	E
09-358	37-02274	390356	744954	STONE HARBOR	15	240-270	--	--	--	--	-0	2	2	12/02	D
09-366	37-01039	385940	744953	WILDWOOD	5	270-290	--	--	--	--	-3	-2	1	12/10	D
09-372	--	390924	744202	SEA ISLE CITY	5	294-302	--	--	--	--	--	5	--	12/22	E
09-385	37-00861	390157	745322	RIO GRANDE	15	156-274	--	--	--	--	-14	-10	4	12/10	A
09-394	37-00327	385729	745200	WILDWOOD	5	250-275	--	--	--	--	-9	-11	-2	12/09	E
09-395	37-04368	385909	745358	CAPE MAY	15	255-275	--	--	--	-17	-15	-15	-0	12/02	D
09-402	36-07750	390901	744608	WOODBINE	17	110-120	--	--	--	--	--	14	--	12/10	E
09-412	36-07565	391319	744116	SEA LSLE CITY	21.62	155-165	--	--	--	--	--	7	--	12/22	A
09-492	35-16575	390811	744649	WOODBINE	22	105-135	--	--	--	--	--	7	--	12/23	E
09-520	35-17699	391823	744759	TUCKAHOE	10	95-115	--	--	--	--	--	15	--	12/11	E
09-525	--	390004	745444	RIO GRANDE	20	-260	--	--	--	--	--	-22	--	12/09	A
Rio Grande water-bearing zone															
01-219	--	392647	744041	MAYS LANDING	50	-378	--	--	31	--	33	34	1	11/20	E
09-67	37-00271	390135	745351	RIO GRANDE	10	461-590	--	--	--	--	-46	-33	13	11/25	A
09-71	--	390138	745347	RIO GRANDE	8	473-523	--	-12	-12	--	-33	-24	9	12/10	E

Appendix 1. Water-level data for wells screened in the confined Cohansey aquifer and the Rio Grande water-bearing zone, New Jersey Coastal Plain, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
09-149	37-00005	391815.3	744953	TUCKAHOE	20	250-290	--	20	18	--	18	18	-0	12/04	E
09-304	37-03763-3	390002	745409	RIO GRANDE	25	495-505	--	--	--	--	-21	-19	2	12/04	E
09-305	37-00214	390402.7	744706	STONE HARBOR	5	-590	--	--	--	--	-20	-21	-1	12/22	A
09-415	35-01233	391450	745129	WOODBINE	29	-306	--	--	--	--	6	7	1	12/03	C
09-519	36-22762	391554.2	743916	MARMORA	31	478-498	--	--	--	--	--	-25	--	12/03	E
09-526	--	390218	745609	RIO GRANDE	10	578-598	--	--	--	--	--	-18	--	12/10	E
11-737	35-03449	391237	745712	HEISLERVILLE	10	307-317	--	--	--	--	2	1	-1	12/02	A
29-775	32-08715	393340.3	742301	NEW GRETNA	5	293-318	--	-8	-6	--	-2	-1	1	12/11	E
29-813	32-11971	393509	742048	TUCKERTON	20	307-337	--	--	-3	--	1	3	2	12/11	E
29-1621	33-40378	393207	741547	TUCKERTON	5	417-456	--	--	--	--	--	-19	--	12/12	D

Appendix 2

Water-level data for wells screened in the Atlantic City 800-foot sand, New Jersey Coastal Plain, 1978–2003.

Appendix 2. Water-level data for wells screened in the Atlantic City 800-foot sand, New Jersey Coastal Plain, 1978–2003.

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
01-37	56-00071	392151	742458	ATLANTIC CITY	10	782-837	-65	-70	-80	-83	-88	-85	3	11/25	E
01-39	56-00012	392329.6	742346	OCEANVILLE	10	733-788	-60	-65	-74	-68	-78	-74	4	11/24	C
01-117	32-00477	393212.9	743830.5	EGG HARBOR CITY	40	350-432	23	21	19	20	17	18	1	11/18	B
01-180	36-00294	392754	742700	OCEANVILLE	27	560-570	-28	-32	-39	-41	-47	-43	4	11/25	E
01-367	56-00038	391859.3	743119.5	OCEAN CITY	10	750-800	-66	-68	-75	-80	-86	-81	5	11/24	B
01-578	36-00295	391826	743708	OCEAN CITY	10	670-680	-45	-51	-55	-59	-66	-64	2	11/25	E
01-593	36-00372	392030.5	742850.7	ATLANTIC CITY	9	740-790	--	-75	-96	--	--	-87	--	11/24	B
01-600	56-00016	392045.6	742837.8	ATLANTIC CITY	8	750-810	-69	-73	-79	-83	-93	-88	5	11/24	B
01-648	36-01084	392125	742603	ATLANTIC CITY	7	775-835	--	-74	-80	--	--	-83	--	12/02	B
01-650	--	392651	744253	MAYS LANDING	*22	-380	--	--	16	19	16	16	0	11/20	E
01-683	36-02091	392411.2	742226.3	BRIGANTINE INLET	8	725-775	--	--	-64	-70	-71	-70	1	11/24	B
01-702	--	392032	743007	OCEAN CITY	5	740-750	--	--	-87	-92	-103	-93	10	11/25	E
01-703	36-05092	392639	743231	PLEASANTVILLE	38	560-570	--	--	-45	-46	-58	-47	11	12/19	E
01-704	--	392343	743732	MAYS LANDING	51	596-606	--	--	-38	-37	-49	-50	-1	11/21	E
01-706	36-04982-1	392933	743129	PLEASANTVILLE	40	520-530	--	--	-25	-25	-35	-30	5	11/21	E
01-889	36-11871	392003.3	743009.8	OCEAN CITY	8	735-795	--	--	--	-86	-94	-87	7	11/24	E
01-967	36-13010	392456.1	742120.3	BRIGANTINE INLET	5	702-776	--	--	--	-62	-64	-60	4	11/24	C
01-990	36-16110	392308.2	743521	PLEASANTVILLE	*30	496-652	--	--	--	--	-55	-50	5	12/04	E
01-991	36-16204	392509.2	743412.1	PLEASANTVILLE	63	492-642	--	--	--	--	-55	-48	7	12/03	E
01-1218	36-17655	392620	743739	MAYS LANDING	*67	520-610	--	--	--	--	-48	-47	1	11/20	E
01-1220	36-17339	392647	743659	PLEASANTVILLE	65	552-603	--	--	--	--	-51	-49	2	11/20	B
01-1252	32-20165	393211.9	743826	EGG HARBOR CITY	41	337-441	--	--	--	--	--	16	--	11/18	B
01-1253	36-16750	392749.8	743240.3	PLEASANTVILLE	55	344-598	--	--	--	--	-43	-36	7	12/04	B
01-1256	36-17667	391932.6	743054.2	OCEAN CITY	6	649-796	--	--	--	--	--	-94	--	11/24	B
01-1455	36-25420	392749	744259	MAYS LANDING	22	396-436	--	--	--	--	--	17	--	11/20	E
01-1456	36-21156	392450	743028	PLEASANTVILLE	5	602-652	--	--	--	--	--	-64	--	11/21	B
09-2	37-00280	390420.9	744435	AVALON	5	821-861	-36	-40	-46	-44	-49	-50	-1	12/03	C
09-4	37-00265	390526.9	744340.5	AVALON	10	880-920	-40	-42	-40	-43	-51	-48	3	12/02	D

Appendix 2. Water-level data for wells screened in the Atlantic City 800-foot sand, New Jersey Coastal Plain, 1978–2003.—Continued

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
09-79	--	390210	744729	STONE HARBOR	2	833-876	--	--	--	-36	-46	-41	5	12/11	E
09-92	37-00240	390524.7	744855	STONE HARBOR	17	681-791	-32	-31	-34	-38	-41	-42	-1	12/03	C
09-106	56-00006	391342.9	743753.4	SEA ISLE CITY	8	760-810	-46	-46	-51	-54	-62	-61	1	12/03	C
09-108	36-00412	391459.1	743644	SEA ISLE CITY	7	774-840	--	-57	-58	-88	-70	-67	3	12/03	C
09-109	56-00008	391535.9	743609.4	OCEAN CITY	8	749-809	-49	-56	-57		-69	-65	4	12/03	E
09-116	56-00007	391637.7	743449.4	OCEAN CITY	7	760-810	--	-62	-64	-74	-75	-74	1	12/04	E
09-125	36-00314	391728	743351.2	OCEAN CITY	10	-800	--	--	-66	-76	-87	-73	14	12/03	E
09-127	37-00064	390848.5	744157.8	SEA ISLE CITY	7	742-830	-38	-44	-44	-45	-54	-48	6	12/10	E
09-135	37-00009	390323	744524	STONE HARBOR	9	838-878	-30	-34	-31	-38	-43	-40	3	12/22	D
09-136	56-00147	391152	743925.7	SEA ISLE CITY	7	802-834	--	-45	-45	-47	-54	-54	0	12/02	C
09-144	36-00451	391721.3	743805	MARMORA	9	650-690	-47	-54	-50	-60	-70	-66	4	12/04	B
09-161	--	390705.4	744748	STONE HARBOR	16	639-654	--	-26	-32	-35	-38	-37	1	12/22	B
09-185	37-01340-8	391621.4	744354.5	MARMORA	15	640-650	--	--	-35	--	-41	-41	0	12/04	E
09-291	36-09846	390630	744251.8	AVALON	7	764-941	--	--	--	-45	-49	-49	0	12/02	C
09-296	35-06073	390500	744941.7	STONE HARBOR	20	682-812	--	--	-27	-33	-35	-36	-1	12/02	C
09-302	37-03628-9	385709	745127	WILDWOOD	5	883-893	--	--	--	-14	-18	-27	-9	12/04	E
09-306	35-09239	390422	745446	RIO GRANDE	6	656-666	--	--	--	-17	-19	-22	-3	12/02	E
09-311	36-10378	390748.9	744243.3	SEA ISLE CITY	8	732-896	--	--	--	-46	-50	-48	2	12/10	B
09-337	37-04660	390012	744719	STONE HARBOR	10	910-960	--	--	--	-20	-24	-28	-4	12/04	E
09-359	36-07286	390656.1	744458.3	AVALON	5	708-773	--	--	--	-46	-52	-50	2	12/09	B
09-423	37-05244	390136.4	745235.7	RIO GRANDE	20	825-875	--	--	--	-19	-21	-23	-2	12/23	E
09-459	36-00377	391712.9	743722.6	OCEAN CITY	7	-620	--	--	--	--	-67	-66	1	12/04	B
09-461	36-15182	391729	743812.6	MARMORA	8	639-710	--	--	--	-58	-67	-65	2	12/04	B
09-479	37-06313	385636.2	745527.5	CAPE MAY	7	655-825	--	--	--	--	-17	-37	-20	12/23	E
09-480	37-06314	385643.7	745531.3	CAPE MAY	14	621-820	--	--	--	--	-17	-49	-32	12/09	B
09-481	36-17001	391553.5	743915	MARMORA	33	603-738	--	--	--	--	--	-55	--	12/03	D
09-482	36-20238	390926	744131.8	SEA ISLE CITY	8	724-884	--	--	--	--	--	-49	--	12/10	B
09-507	37-06563	385723.1	745520.4	CAPE MAY	*18	615-810	--	--	--	--	--	-33	--	12/09	A

Appendix 2. Water-level data for wells screened in the Atlantic City 800-foot sand, New Jersey Coastal Plain, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
09-508	37-06564	385728	745733	CAPE MAY	10	585-765	--	--	--	--	--	-23	--	12/02	E
09-521	37-07541	390302.6	744542.2	STONE HARBOR	10	830-880	--	--	--	--	--	-40	--	12/22	C
29-9	53-00031	393346.7	741431	BEACH HAVEN	5	572-656	-28	-30	-31	-32	-34	-33	1	12/12	C
29-111	33-01180	394134	740835	SHIP BOTTOM	9	465-500	-22	-52	-23	-27	-30	-26	4	12/02	B
29-112	33-00674	394218.6	740806.4	SHIP BOTTOM	5	451-493	-20	-36	-24	-27	-29	-26	3	12/02	B
29-457	33-01275	393509.8	741326.1	BEACH HAVEN	8	551-650	-26	-27	-26	--	--	-43	--	12/18	D
29-557	33-01132	394041.9	741408.1	SHIP BOTTOM	8	385-428	22	16	16	14	13	8	-5	12/11	B
29-561	33-01268	393948.2	740953.2	SHIP BOTTOM	10	520-562	-25	-28	-24	-20	-30	-28	2	12/03	B
29-597	32-05858	393610.4	742019.7	TUCKERTON	25	400-500	--	-6	-3	--	--	-18	--	12/10	B
29-598	33-00967	394202.2	741207.7	SHIP BOTTOM	2	--	--	--	-21	-25	-26	-26	-0	12/03	E
29-814	32-12329	393252.3	742307	NEW GRETNA	10	512-552	--	--	--	-24	-26	-24	2	12/11	C
29-936	33-24693	393725.8	741148.8	BEACH HAVEN	9	528-594	--	--	-25	-25	-26	-31	-5	12/18	E
29-1063	32-15207	393518.8	742150.7	TUCKERTON	*33	475-521	--	--	-24	-25	-27	-28	-1	12/11	C
29-1078	33-26875	394137.1	741458.8	SHIP BOTTOM	24	366-429	--	--	--	--	26	28	2	12/03	E
29-1421	32-22507	393536.5	742017.9	TUCKERTON	12	405-511	--	--	--	--	--	-19	--	12/10	E
29-1433	33-41143	394336.3	741610.1	WEST CREEK	58	375-415	--	--	--	--	--	48	--	12/03	E
29-1624	33-42213	393840	741052	SHIP BOTTOM	5	510-582	--	--	--	--	--	-35	--	12/02	E
29-1729	33-40839	393615.1	741236.8	BEACH HAVEN	6	518-634	--	--	--	--	--	-33	--	12/18	E

Appendix 3

Water-level data for wells screened in the Piney Point aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

Appendix 3. Water-level data for wells screened in the Piney Point aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measurement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
01-270	31-03648	393713	744721.5	NEWTONVILLE	*93	390-410	--	33	33	31	22	18	-4	12/12	E
01-700	35-04274	392933	744603	DOROTHY	40	479-539	--	--	17	12	18	18	0	11/20	E
01-701	35-03992	393148.8	745617	BUENA	*120	410-460	--	--	--	--	--	-26	--	11/13	E
01-713	35-04656	392902	745050	DOROTHY	100	525-535	--	--	-2	-4	-6	-8	-2	11/20	E
01-834	--	392017	743001	OCEAN CITY	5	970-991	--	--	-28	-30	-32	-34	-2	11/25	E
01-836	35-04559	393149.1	745617.1	BUENA	*120	405-455	--	--	-6	-18	-38	-21	17	11/13	B
01-1219	36-16546	392640	743723	PLEASANTVILLE	68	722-742	--	--	--	-14	-16	-18	-2	11/25	E
01-1238	55-00008	393150.9	745551.1	BUENA	108	391-463	--	--	--	--	-31	-17	14	11/18	E
01-1405	36-23678	392748.77	744303.69	MAYS LANDING	23	545-620	--	--	--	--	--	-6	--	11/20	E
01-1445	35-21013	393041.5	745732.5	BUENA	99	360-540	--	--	--	--	--	-29	--	11/13	B
05-407	--	394422	744308	ATSION	47	240-260	52	51	51	51	50	50	-0	10/23	E
05-488	32-00913	393845	743854.5	ATSION	*37	419-449	51	50	50	54	48	47	-1	11/18	A
05-676	--	394914	742545	WOODMANSIE	199	530-540	121	119	118	119	120	118	-2	10/21	E
05-800	32-04454	394732	744525	MEDFORD LAKES	85	200-210	--	73	72	73	72	73	1	11/18	A
05-1162	32-05879	394636.1	744409.1	INDIAN MILLS	60	215-235	--	--	--	55	51	55	4	11/24	A
07-572	31-14078	394056.6	745028.3	HAMMONTON	*108	304-314	--	60	55	53	50	51	1	11/19	B
07-980	31-09893	394109	745034	HAMMONTON	*102	274-294	--	--	--	--	--	49	--	11/19	A
11-44	35-01197	392732	750928	BRIDGETON	82	361-376	17	12	7	0	-5	-7	-2	11/21	E
11-092	--	391746	751509	BEN DAVIS POINT	5	397-417	--	-28	-37	-44	-44	-46	-2	12/16	C
11-96	34-00852	391829	751207	CEDARVILLE	10	365-375	-15	-20	-28	-34	-34	-34	0	11/21	E
11-138	--	392514	745216	DOROTHY	85	-574	--	8	--	--	--	4	--	12/19	E
11-163	35-01196	392526	750642	MILLVILLE	80	463-473	22	13	8	2	-4	-11	-7	11/21	E
11-341	34-00991	391936.6	751920.2	BEN DAVIS POINT	4	300-357	--	-35	-44	-49	-50	-50	-0	12/16	E
11-349	34-01463	391654.8	751422.5	CEDARVILLE	5	380-410	--	-28	-35	-42	-42	-44	-2	12/16	B
11-1151	34-01814	391549.8	751231.9	CEDARVILLE	5	466-476	--	--	--	--	-40	-42	-2	12/16	E
11-1220	34-06736	392432.4	751312.1	BRIDGETON	29	235-375	--	--	--	--	--	-22	--	12/10	E
11-1221	34-06556	392439.3	751238.9	BRIDGETON	36	250-390	--	--	--	--	--	-21	--	12/10	E
29-2	33-01206	394522	740634	BARNEGAT LIGHT	7	597-654	--	-40	-33	-38	--	-38	--	12/02	E

Appendix 3. Water-level data for wells screened in the Piney Point aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measurement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
29-18	--	394829	740533	BARNEGAT LIGHT	9	468-474	1	0	-0	-2	-2	-3	-1	10/21	E
29-23	33-01494	395422.8	740456.3	SEASIDE PARK	7	490-527	--	--	--	-57	-58	-43	15	12/04	B
29-116	53-00020	395641	740852	TOMS RIVER	3	267-293	--	-1	-1	-2	-22	-13	9	10/15	E
29-425	--	395322	742251	WHITING	128	-348	--	--	--	119	119	118	-1	10/21	E
29-537	53-00001	395635.5	740439.1	SEASIDE PARK	4	400-430	--	-35	-30	-35	-58	-17	41	12/04	E
29-582	33-04511	395547.8	740432.1	SEASIDE PARK	12	435-485	--	--	--	-51	--	-48	--	12/04	B
29-585	--	395028	741043	FORKED RIVER	15	412-422	--	15	15	12	14	14	0	10/29	E
29-607	33-07876	394454.3	740653.9	LONG BEACH NE	5	597-662	--	-41	-34	-38	-44	-40	4	12/02	B
29-616	53-00005	395527.8	740819.6	TOMS RIVER	7	340-360	--	-6	-12	--	--	-17	--	10/16	D
29-739	33-01247	400044.4	740954.9	LAKEWOOD	20	200-220	--	13	11	13	8	11	3	10/15	D
29-808	33-06595	395607	740444.1	SEASIDE PARK	5	395-475	--	--	-29	-46	-76	-30	46	12/04	D
29-935	33-22528	395451	740454.4	SEASIDE PARK	*5	474-514	--	--	--	--	-53	-36	17	12/04	D
29-1096	33-29653	395357.8	740940.9	TOMS RIVER	*32	345-440	--	--	--	--	-1	-9	-8	10/28	B
29-1114	29-24912	400046.5	740326	POINT PLEASANT	10	206-276	--	--	--	--	-3	1	4	10/15	E
29-1210	36-20855	393115	741909	TUCKERTON	6	860-880	--	--	--	--	-14	-16	-2	10/22	E
29-1217	33-29690	395151.6	741105.5	FORKED RIVER	*32	468-583	--	--	--	--	--	17	--	12/11	E
29-1579	33-41928	394345.5	741604.9	WEST CREEK	61	595-645	--	--	--	--	--	25	--	12/10	E
						Delaware wells									
Id55-01	10225	391026	753048	DOVER	20	329-349	--	--	-132	-128	-127	-115	12	12/12	E
Jc43-06	189531	390702	753724	DOVER	60	330-400	--	--	--	--	--	-78	--	11/25	D
Jd14-15	10211	390917	753109	DOVER	21	370-450	--	--	--	--	-155	-121	34	12/03	--
Jd25-03	--	390845	753031	DOVER	20	327-484	--	--	--	--	-130	-117	13	12/03	--
Jd34-18	D010208	390729	753157	DOVER	20	330-337	--	--	--	--	-177	-160	17	12/27	--
Jd51-06	192655	390521	753449	DOVER	55	355-395	--	--	--	--	--	-93	--	11/25	D
Je12-03	D031640	390920	752858	LITTLE CREEK	22	340-502	--	--	--	--	-123	-114	9	12/06	--
Je32-05	10075	390740	752858	DOVER	22	459-561	--	--	--	--	--	-112	--	11/25	--
Je33-01	51796	390746	752731	DOVER	26	450-550	--	--	--	--	--	-111	--	11/25	--

Appendix 3. Water-level data for wells screened in the Piney Point aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measurement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
Kc31-01	Kc31-01	390224	753915	MARYDEL	55	370-380	--	--	--	--	-56	-61	-5	12/12	E
Nc13-03	10223	384935	753658	GREENWOOD	63	620-630	--	--	--	--	-26	-29	-3	11/21	E
Maryland wells															
CO Bd 53	C073-0541	390227	754702	GOLDSBORO	60	300-312	30	30	26	22	20	17	-3	12/02	E
CO Dd 47	--	385217	754905	HOBBS	46	370-380	-21	-22	-27	-29	-31	-35	-4	12/02	E

Appendix 4

Water-level data for wells screened in the Vincentown aquifer, New Jersey Coastal Plain, 1978–2003.

Appendix 4. Water-level data for wells screened in the Vincentown aquifer, New Jersey Coastal Plain, 1978–2003.

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
05-1250	28-20189-2	400148	743519	NEW EGYPT	112	45-55	--	--	--	--	102	103	1	10/21	E
15-123	31-00216	394253.8	750934	PITMAN WEST	140	121-150	--	--	--	--	75	77	2	11/13	B
15-1005	30-03319	394044.6	751326.3	PITMAN WEST	148	140-156	--	--	70	--	62	70	8	11/12	B
15-1360	31-42096	394347	750803	PITMAN WEST	*120	166-191	--	--	--	--	78	80	2	11/12	E
15-1544	31-32489	394308	750832	PITMAN WEST	138	130-140	--	--	--	--	--	83	--	11/25	E
25-448	29-04725	401134	740721	ASBURY PARK	125	219-235	--	--	--	--	70	72	2	11/06	D
25-451	29-10756	400903.3	741517.4	ADELPHIA	95	114-174	--	--	81	--	67	85	18	11/06	B
25-636	29-18404-5	401105	741201	FARMINGDALE	112	85-95	--	--	59	--	73	73	-0	10/21	E
25-691	29-15843-5	401104	741108	FARMINGDALE	50	5-25	--	--	43	--	45	46	1	10/29	E
25-702	29-09528	401339.1	740248.1	ASBURY PARK	45	129-140	--	--	--	--	44	42	-2	11/04	B
25-703	29-11712	401317.3	740650	ASBURY PARK	80	167-187	--	--	--	--	70	70	1	11/04	B
25-717	29-28188	401046	742001	ADELPHIA	150	38-43	--	--	--	--	131	133	2	11/03	E
25-788	29-36417	401506.9	740115.1	LONG BRANCH	50	120-166	--	--	--	--	29	31	2	11/04	D
25-789	29-06311	401059	741111	FARMINGDALE	70	-198	--	--	--	--	--	46	--	10/29	A
25-793	29-24333	401722.1	735920.9	LONG BRANCH	23	70-80	--	--	--	--	--	14	--	11/05	E
29-139	28-04784	400414	742701	CASSVILLE	136	161-171	--	129	129	--	130	130	0	10/20	E
29-230	28-05038	400724.4	742340.4	CASSVILLE	150	85-100	--	--	130	--	132	133	1	10/31	D
29-241	29-07425	400910.8	741538.8	ADELPHIA	*82	115-165	--	--	--	--	--	83	--	11/03	E
29-658	29-08966	400700	741845	LAKEHURST	115	202-215	--	--	96	--	94	94	0	10/30	A
29-660	28-07193	400853.1	742211.6	ADELPHIA	155	132-138	--	--	--	--	141	151	10	11/05	E
29-698	28-11275	400600.3	742454.3	CASSVILLE	*152	120-132	--	--	141	--	137	137	0	10/30	B
29-916	29-13024	400850	741645	ADELPHIA	125	139-155	--	--	106	--	111	110	-1	12/15	E
29-917	29-16962	400850	741514.7	ADELPHIA	75	126-186	--	--	75	--	63	69	6	11/03	B
33-240	--	393253.6	752422.5	SALEM	7	-140	--	--	--	--	1	3	2	11/19	E
33-292	30-00397	393814	751521	WOODSTOWN	142	190-218	--	--	--	--	--	43	--	11/10	A
33-368	--	393253.7	752421.9	SALEM	7	-133	--	--	--	--	2	3	1	11/19	E

Appendix 5

Water-level data for wells screened in the Wenonah-Mount Laurel aquifer, New Jersey and Delaware Coastal Plain, 1978–2003.

Appendix 5. Water-level data for wells screened in the Wenonah-Mount Laurel aquifer, New Jersey and Delaware Coastal Plain, 1978–2003.

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
05-257	51-00156	395514.9	745058.9	MOUNT HOLLY	80	-90	27	25	27	54	50	54	4	11/14	E
05-354	32-00103	395813.5	743948.2	PEMBERTON	62	178-198	40	39	36	40	36	39	3	11/12	B
05-355	52-00004	395826	744107.1	PEMBERTON	81	155-185	39	38	38	41	39	42	3	11/14	B
05-359	32-00539	395725	744114	PEMBERTON	70	181-242	36	35	37	34	37	42	5	11/17	B
05-365	32-00386	395753.1	743454.4	BROWNS MILLS	*95	290-330	18	-3	-11	-12	0	6	6	11/10	E
05-366	32-00775	395755	743238	BROWNS MILLS	*91	301-323	-41	-47	-60	-49	-35	-31	4	11/10	B
05-427	32-00749	395330.3	744204	PEMBERTON	70	260-348	11	-8	-13	-5	-5	3	8	11/17	E
05-695	32-01240	395328	743719	BROWNS MILLS	*102	428-496	24	18	15	9	7	8	1	11/13	E
05-711	31-05707	395128	744738	MEDFORD LAKES	75	260-275	--	--	--	--	--	-12	--	12/04	B
05-718	32-00361	395736	743035	BROWNS MILLS	95	376-388	--	--	--	--	-8	-4	4	11/05	B
05-720	31-11574	395112	744534	MEDFORD LAKES	125	-410	20	22	-8	0	-15	-15	-0	11/24	A
05-724	32-03118	395414.5	744227.5	PEMBERTON	43	199-275	18	15	6	6	-6	-1	5	11/17	B
05-725	48-00021	400212.9	743708.5	NEW EGYPT	145	142-162	128	126	125	126	125	126	1	11/18	E
05-744	32-00520	395639.3	742950.7	WHITING	100	-456	9	-13	-21	-21	-9	-6	3	10/28	A
05-1004	32-08631	395714	744012.4	PEMBERTON	*84	209-254	--	--	29	36	36	31	-5	11/17	B
05-1082	31-19052	400001.3	744731.1	MOUNT HOLLY	*48	82-92	--	--	22	23	18	24	6	11/14	A
05-1086	32-10112	395753	743705	BROWNS MILLS	55	242-247	--	--	6	--	8	12	4	11/14	A
05-1087	32-09937	395333	744440	PEMBERTON	55	227-232	--	--	11	9	-2	5	7	11/14	B
05-1155	31-39849	395315	744945	MOUNT HOLLY	46	120-180	--	--	--	31	23	25	2	10/31	E
05-1165	32-00490	395855.9	743519.2	BROWNS MILLS	120	275-307	--	--	--	6	14	17	3	11/10	A
05-1166	28-17342	400430.5	743352.7	NEW EGYPT	135	119-129	--	--	--	100	97	100	3	12/10	A
05-1178	32-13264	395540.2	744412.8	PEMBERTON	40	140-180	--	--	--	30	19	21	2	11/07	D
05-1186	32-15968	395914.8	743305.5	BROWNS MILLS	90	267-358	--	--	--	-27	-6	-1	5	11/10	E
05-1245	52-00082	395450	744509	MOUNT HOLLY	39	--	--	--	--	--	10	19	9	11/20	E
05-1253	31-46953	394940	744806	MEDFORD LAKES	118	357-417	--	--	--	--	-47	-32	15	11/18	B
05-1387	31-40373	394800	745245	CLEMENTON	119	335-355	--	--	--	--	2	1	-1	11/07	E
05-1414	31-49988	395052	745117	MEDFORD LAKES	65	199-259	--	--	--	--	--	-12	--	11/18	B
05-1415	31-50015	395146.5	745101.2	MEDFORD LAKES	50	162-212	--	--	--	--	--	3	--	11/18	B

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
05-1449	32-12425	395636	744152	PEMBERTON	45	160-198	--	--	--	--	--	27	--	11/20	E
05-1475	32-18506	395834	743512	BROWNS MILLS	110	276-326	--	--	--	--	7	12	5	11/17	E
05-1491	28-10497	400545	743445	NEW EGYPT	136	206-222	--	--	--	--	105	108	3	12/05	B
05-1495	32-06317	395607.8	742840.8	WHITING	*120	512-522	--	--	--	--	2	5	3	10/28	A
07-22	31-00513	394737.6	745611.4	CLEMENTON	147	310-360	34		11	-7	4	3	-1	11/19	D
07-118	31-04898	395229	745711	CLEMENTON	158	137-147	69	69	68	68	68	68	0	11/07	E
07-308	51-00014	394928.7	750019.3	RUNNEMEDE	77	-126	57	58	56	55	49	50	1	11/12	E
07-391	31-05628	394642.2	745752.3	CLEMENTON	*168	315-335	36	37	16	2	-14	-9	5	12/19	E
07-401	31-02371	394722	745809	CLEMENTON	85	-267	36	43	23	9	-6	-3	3	11/24	B
07-414	51-00010	394922.9	745628.9	CLEMENTON	150	237-275	60	52	36	51	58	52	-6	11/12	E
07-421	--	395109	745714	CLEMENTON	175	220-234	91	91	89	89	87	88	1	11/19	B
07-449	31-04749	394617.7	745410.7	CLEMENTON	159	420-460	20	19	-4	--	-10	-9	1	11/19	E
07-478	--	394215	745616	WILLIAMSTOWN	111	520-530	36	40	21	3	-25	-29	-4	11/13	E
07-513	31-07766	394532	745622	CLEMENTON	166	410-460	--	--	-4	-19	-31	-34	-3	12/25	B
07-526	31-06193	394933.5	745852.3	CLEMENTON	*85	138-158	70	73	68	69	66	66	-0	12/12	E
07-685	31-22273	394513.3	745912.7	WILLIAMSTOWN	144	322-427	--	--	--	-20	-62	-50	12	11/17	B
07-847	31-36246	394359	750117	PITMAN EAST	150	329-380	--	--	--	--	-81	-71	10	11/17	B
07-993	--	394522	745626	CLEMENTON	162	394-448	--	--	--	--	--	-33	--	11/19	B
07-1079	--	394814	750111	RUNNEMEDE	67	120-130	--	--	--	--	--	51	--	11/14	B
15-367	30-00649	394233.9	751306.5	PITMAN WEST	73	-500	--	68	66	68	66	70	4	11/12	E
15-542	31-16873	394147	750653	PITMAN EAST	150	265-295	--	--	73	51	25	36	11	11/19	E
15-910	30-02454	394152.8	751412.7	PITMAN WEST	*108	140-160	--	--	82	81	78	85	7	11/18	E
15-953	31-06570	394718	750603	RUNNEMEDE	81	86-100	--	--	56	55	54	55	1	11/10	E
15-1009	31-22018	394426.8	750630.1	PITMAN EAST	100	149-178	--	--	65	62	58	62	4	12/22	B
15-1040	30-05046	394257	751824	WOODSTOWN	120	77-87	--	--	77	79	78	81	3	11/10	A
15-1060	31-30571	394100.2	750552.9	PITMAN EAST	136	335-386	--	--	--	20	-47	-23	24	11/19	B
15-1104	30-02422-6	394350	751915	WOODSTOWN	102	-40	--	--	--	81	79	82	3	11/10	E
15-1119	31-44252	394338.9	750937.2	PITMAN WEST	141	159-199	--	--	--	--	68	81	13	11/06	B

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
15-1126	31-34033-4	394119	750626	PITMAN EAST	146	328-338	--	--	--	--	-22	-3	19	11/13	E
15-1203	31-34604	394234	750453	PITMAN EAST	147	298-308	--	--	--	--	-31	-3	29	11/20	E
15-1206	31-39283	394340.1	750940.5	PITMAN WEST	139	195-215	--	--	--	--	--	82	--	11/06	E
15-1223	31-33093-2	393912	750517	PITMAN EAST	137	485-495	--	--	--	--	--	-7	--	11/18	E
15-1349	31-33937	394327	750201	PITMAN EAST	160	680-690	--	--	--	--	--	-63	--	11/20	E
15-1357	31-25418	394057	750554	PITMAN EAST	137	340-390	--	--	--	--	--	-23	--	11/19	E
15-1358	31-25672-4	394057	750554	PITMAN EAST	137	355-365	--	--	--	--	--	-21	--	11/19	E
15-1367	31-45997	394234.3	750457	PITMAN EAST	140	278-342	--	--	--	--	--	-11	--	11/20	E
15-1384	31-45999	394320.3	750156.3	PITMAN EAST	160	342-382	--	--	--	--	--	-47	--	11/20	E
15-1452	31-36292	394307.9	750832.3	PITMAN WEST	*142	198-258	--	--	--	--	--	74	--	11/25	B
15-1517	30-11753	394325.4	751319.5	PITMAN WEST	*88	112-132	--	--	--	--	65	67	2	11/12	E
15-1524	--	394553	750448	RUNNEMEDE	90	174-225	--	--	--	--	--	66	--	11/12	A
15-1547	31-55130	394650.7	750640.2	RUNNEMEDE	84	105-115	--	--	--	--	--	61	--	11/25	E
15-1548	31-55132	394656.4	750619.7	RUNNEMEDE	100	115-125	--	--	--	--	--	66	--	11/25	E
15-1549	31-54052	394706.5	750553.7	RUNNEMEDE	119	130-150	--	--	--	--	--	60	--	11/25	E
15-1550	31-55138	394727.1	750551.8	RUNNEMEDE	122	150-170	--	--	--	--	--	56	--	11/25	E
25-14	49-00017	401137.9	740120.4	ASBURY PARK	*20	424-504	-153	-170	-210	-91	-85	-67	18	11/05	D
25-88	29-05886	401440.4	741658.4	ADELPHIA	150	143-163	--	--	114	112	113	113	0	11/06	E
25-95	29-04709	401618	741643	FREEHOLD	162	128-140	--	--	--	133	134	133	-1	10/22	A
25-166	29-04381	400952.2	741404.1	FARMINGDALE	*123	336-396	--	--	-29	21	21	23	2	11/04	E
25-168	29-03105	400957.5	741315.7	FARMINGDALE	160	354-440	-46	-44	-56	--	-2	11	13	12/10	E
25-185	29-02607	401438	741024	FARMINGDALE	119	229-250	59	60	56	65	66	65	-1	12/02	E
25-335	--	401215	740408	ASBURY PARK	90	465-480	-110	-118	-136	-56	-59	-38	21	11/03	E
25-353	--	401542	740529	LONG BRANCH	140	321-327	-7	-21	-15	10	15	16	1	10/15	E
25-391	29-07506	400928.7	740210.2	ASBURY PARK	25	485-561	-190	-161	-215	-104	-83	-72	11	11/07	E
25-396	28-06896	400658	743134	NEW EGYPT	122	92-102	85	85	83	86	83	86	3	11/18	E
25-405	--	401005	742912	ROOSEVELT	158	-124	127	128	126	127	145	147	2	11/14	E
25-412	28-05835	401046.8	742819.4	ROOSEVELT	*194	100-140	153	152	151	152	150	150	0	10/30	E

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
25-443	29-02871	401053.8	740351.4	ASBURY PARK	75	435-465	-147	-158	--	--	--	-63	--	10/04	D
25-486	--	400711	740200	POINT PLEASANT	10	604-614	--	-171	-185	-102	-74	-69	5	10/15	E
25-521	29-09867	401020	741936	ADELPHIA	150	222-228	--	--	99	102	103	102	1	11/03	A
25-533	29-05113	400816	741333	FARMINGDALE	120	349-365	--	-61	-74	-21	-16	-8	8	10/30	A
25-542	--	400951.3	740727.5	ASBURY PARK	*68	430-450	--	-99	-115	-51	-34	-25	9	11/05	C
25-637	29-18400-2	401105	741201	FARMINGDALE	112	307-317	--	--	-28	7	16	13	-3	10/21	E
25-687	29-15008	401807.8	740250.9	LONG BRANCH	*20	177-187	--	--	1	8	11	11	0	11/03	C
25-829	29-36936	400832.4	740942.1	FARMINGDALE	61	395-402	--	--	--	--	--	-32	--	12/19	B
29-31	29-04663	400234.6	740812.4	LAKEWOOD	13	605-625	-117	-124	-133	-120	-73	-59	14	10/23	C
29-36	29-06021	400414.1	740912.2	LAKEWOOD	30	518-548	--	-131	-146	-115	-75	-63	12	10/23	C
29-37	29-04283	400430.4	740652.7	POINT PLEASANT	20	576-591	-136	-141	-155	-129	-90	-76	14	10/24	E
29-49	29-06022	400503.8	740703.8	POINT PLEASANT	29	556-586	--	-135	-149	-122	-82	-69	13	10/23	C
29-140	28-04785	400414	742701	CASSVILLE	135	257-267	115	114	112	112	112	112	-0	10/20	E
29-227	29-05007	400606.3	741913	LAKEHURST	110	-358	42	38	--	47	46	39	-7	11/05	A
29-234	28-08255	400809	742531	ROOSEVELT	140	180-200	123	130	122	121	121	119	-2	10/29	B
29-699	28-07966	400917.4	742330.5	ROOSEVELT	160	214-226	--	124	121	123	122	118	-4	10/30	B
29-713	28-10063	400636	742101	LAKEHURST	130	318-324	--	83	82	84	84	78	-6	10/31	B
29-740	29-08522	400332.3	742117.4	LAKEHURST	105	340-380	--	41	39	42	52	53	1	12/19	E
29-781	29-09069	400622	741956	LAKEHURST	110	302-325	--	--	40	36	42	59	17	11/06	A
29-782	29-09348	400709	741524	LAKEHURST	120	375-381	--	--	--	--	--	-1	--	11/07	A
29-783	29-09681	400746.2	741758.8	ADELPHIA	*112	310-325	--	49	39	39	48	46	-2	10/30	A
29-784	29-10449	400550	741807	LAKEHURST	90	341-347	--	--	2	4	9	6	-3	11/07	A
29-786	29-08581	400630	741729	LAKEHURST	110	364-379	--	-0	-3	4	13	9	-4	11/04	E
29-926	28-18902	400610	742727	CASSVILLE	105	127-160	--	--	109	110	110	110	0	10/30	A
29-1138	28-23392	400616	743010	NEW EGYPT	95	100-120	--	--	--	--	96	97	1	12/05	B
29-1578	28-41095	400207.2	743031.5	NEW EGYPT	80	218-238	--	--	--	--	--	62	--	11/07	E
33-2	--	393202	751629	ALLOWAY	85	462-472	23	22	20	19	14	15	1	11/21	E
33-8	30-00030	393329.5	751821.9	ALLOWAY	*62	322-345	--	--	12	10	7	9	2	12/01	B

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							1978	1983	1988	1993	1998	2003			
33-20	--	393534	751751	ALLOWAY	77	-283	33	32	30	28	25	27	2	11/18	E
33-22	31-04612	393533.8	751018.5	ELMER	105	460-500	28	30	27	20	6	14	8	11/21	D
33-50	--	393535.5	752637.7	SALEM	20	73-97	5	6	4	5	6	7	1	11/17	E
33-56	--	393606.7	752523.1	SALEM	25	-93	7	7	7	7	7	8	1	11/17	A
33-241	--	393255.3	752422.6	SALEM	10	-248	6	4	6	5	4	6	2	12/10	E
33-249	50-00042	393342.8	752717	SALEM	5	110-150	0	-2	-5	--	--	-6	--	11/19	B
33-252	--	393348	752754	SALEM	3	91-96	1	0	-0	0	-1	1	2	11/20	E
33-381	30-01505	393453	752708	SALEM	10	85-125	--	-0	1	1	-0	1	1	11/17	E
33-384	30-01356	393138	752459.9	SALEM	*15	-320	--	1	--	0	-1	1	2	11/18	E
33-407	34-01600	393009.3	752600.7	SALEM	5	250-300	--	--	--	--	-7	-2	5	11/17	A
33-456	31-19206	393507.7	751045.9	ELMER	125	443-503	--	28	27	22	8	9	1	11/21	B
33-664	30-01454	393734	752110	WOODSTOWN	70	123-166	--	--	--	--	36	38	2	11/06	B
33-886	30-06741	393751.8	751338.7	PITMAN WEST	144	358-378	--	--	--	--	--	38	--	11/13	B
33-902	30-09510	393845.3	751903.6	WOODSTOWN	48	100-143	--	--	--	--	36	38	2	11/06	B
33-904	30-05669	393859.9	751406.9	PITMAN WEST	143	300-310	--	--	--	--	--	48	--	12/10	B
33-932	30-05631	393603.9	752527.3	SALEM	30	70-80	--	--	--	--	9	11	2	11/17	A
33-937	30-08556	393422.7	751704.5	ALLOWAY	102	318-338	--	--	--	--	--	15	--	11/20	E
33-938	34-00970	392743.5	753146	TAYLORS BRIDGE	18	270-290	--	--	--	--	2	3	1	11/21	E
33-973	30-05372	393332	752151	ALLOWAY	39	230-240	--	--	--	--	--	14	--	11/20	A
33-974	30-14867	393338	752715	SALEM	5	108-168	--	--	--	--	--	-9	--	11/19	D
						Delaware wells									
Ec51-19	82242	393035	753911	ST GEORGE	56	70-80	--	--	--	--	--	25	--	12/09	--
Fb14-14	110686	392929	754117	MIDDLETOWN	50	122-142	--	--	--	--	13	14	1	12/29	D
Fc12-16	78984	392958	753840	ST GEORGE	58	100-160	--	--	--	--	--	19	--	12/09	--
Fc15-05	96840	392910	753534	TAYLORS BRIDGE	5	128-178	--	--	--	--	--	0	--	12/23	E
Fc43-04	110612	392642	753747	MIDDLETOWN	52	200-270	--	--	--	--	--	-10	--	12/23	D
Fc43-05	157829	392641	753747	MIDDLETOWN	52	200-270	--	--	--	--	3	-11	-14	12/23	E
Fc43-07	185186	392643	753748	MIDDLETOWN	50	195-265	--	--	--	--	--	-10	--	12/23	D

Appendix 5. Water-level data for wells screened in the Wenonah-Mount Laurel aquifer, New Jersey and Delaware Coastal Plain, 1978–2003.—Continued

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
Gd33-04	Gd3304	392212	753241	SMYRMA	18	395-427	--	--	--	--	--	-1	--	12/12	E
Fc42-35	185232	392644	753848	MIDDLETOWN	35	180-230	--	--	--	--	--	-13	--	12/09	--

Appendix 6

Water-level data for wells screened in the Englishtown aquifer system, New Jersey Coastal Plain, 1978–2003.

Appendix 6. Water-level data for wells screened in the Englishtown aquifer system, New Jersey Coastal Plain, 1978–2003.

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
05-195	31-01164	395833.8	745040.5	MOUNT HOLLY	60	70-74	25	23	22	26	22	22	0	11/13	E
05-197	31-01191	395653	744920	MOUNT HOLLY	41	148-159	26	25	19	26	24	26	2	11/14	A
05-256	31-01399	395514.8	745058.4	MOUNT HOLLY	79	-440	--	--	--	--	19	20	1	11/14	B
05-259	--	395524	745024	MOUNT HOLLY	73	253-263	25	20	24	24	20	19	-1	10/31	E
05-375	32-00276	395807	743836	PEMBERTON	70	343-378	19	29	25	20	12	21	9	11/13	E
05-387	32-01103	395943	744119	PEMBERTON	50	208-228	52	54	49	52	49	48	-1	11/13	A
05-437	28-03831	400210	744137	COLUMBUS	74	94-105	62	61	61	66	58	62	4	11/04	B
05-754	--	395941.4	743246.3	BROWNS MILLS	100	419-447	50	46	43	37	32	31	-1	11/07	B
05-1390	32-21804	395309	743520	BROWNS MILLS	107	615-635	--	--	--	--	10	11	1	10/23	E
05-1427	27-11807	400052	744743	BRISTOL	55	40-60	--	--	--	--	--	51	--	11/05	E
05-1434	28-07339	400015	744429	COLUMBUS	*60	-150	--	--	--	--	--	57	--	11/04	E
05-1437	28-11130	400652	743432	NEW EGYPT	170	165-245	--	--	--	--	--	100	--	11/14	E
05-1492	32-22557	395915	743307	BROWNS MILLS	88	411-451	--	--	--	--	23	23	-0	11/10	E
05-1493	32-22560	395915.8	743300.9	BROWNS MILLS	100	430-470	--	--	--	--	--	28	--	11/10	E
05-1547	32-27283	395706	743329	BROWNS MILLS	*91	460-495	--	--	--	--	--	26	--	11/06	E
07-166	31-01202	394808.1	745805.8	CLEMENTON	150	367-457	0	47	11	15	13	10	-3	11/24	C
07-529	31-13543	394832	745914	CLEMENTON	55	250-283	1	50	26	3	0	4	4	11/05	B
07-672	31-24779	394928.5	750022	RUNNEMEDE	76	195-215	--	--	49	46	28	3	-25	11/12	E
07-673	31-24778	394928.6	750022.2	RUNNEMEDE	76	195-215	--	--	50	--	--	6	--	11/12	E
07-731	31-29319	394951.2	745856	CLEMENTON	*69	216-236	--	--	--	52	46	27	-19	10/25	B
15-188	31-02415	394605.4	751055.4	WOODBURY	80	134-160	--	--	31	31	31	32	1	11/21	B
15-344	30-00064	394518	751639	BRIDGEPORT	80	69-83	--	--	--	--	67	69	2	12/16	B
15-676	--	394631.5	751148.5	WOODBURY	28	68-78	--	--	30	30	30	30	0	12/09	E
23-104	--	402143	741848	FREEHOLD	77	0-11	--	--	69	74	70	73	3	10/22	E
23-211	28-07520	401820.1	742245.9	JAMESBURG	105	43-49	90	93	91	--	95	94	-1	10/22	B
25-16	29-00045	401034	740146.6	ASBURY PARK	20	563-594	-188	-196	-202	-91	-68	-68	0	11/03	E
25-28	29-05292	400623.7	740428.1	POINT PLEASANT	90	770-820	-219	-220	-207	-119	-93	-100	-7	10/30	B

Appendix 6. Water-level data for wells screened in the Englishtown aquifer system, New Jersey Coastal Plain, 1978–2003.—Continued

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
25-30	29-00069	400645.2	740343.1	POINT PLEASANT	33	690-750	-233	-249	-225	-116	-91	-100	-9	10/30	D
25-46	29-04196	401747	741220	MARLBORO	122	212-232	70	68	61	--	58	52	-6	11/06	B
25-63	29-04386	401147.7	741018.1	FARMINGDALE	75	420-460	--	--	-83	-39	-27	-29	-2	10/31	B
25-80	29-05417	401415	741500	ADELPHIA	120	294-334	75	78	73	73	78	75	-3	11/05	E
25-96	29-04435	401624	741501	FREEHOLD	200	327-356	87	88	81	74	68	70	2	11/03	B
25-107	29-03177	401701.5	741415.6	MARLBORO	163	249-257	81	81	73	70	64	65	1	10/28	B
25-132	29-02079	402202	741001	MARLBORO	120	191-221	64	64	63	63	62	62	0	10/29	B
25-144	49-00031	402143.2	740956	MARLBORO	*104	-154	--	--	59	--	57	58	1	10/29	E
25-162	29-07043	400815	741042	FARMINGDALE	69	500-560	-114	-120	-125	-66	-48	-51	-3	11/03	E
25-165	29-05346	400842	741322.4	FARMINGDALE	135	363-550	--	--	-94	-46	-36	-30	6	11/04	E
25-184	29-04186	401429	741253	FARMINGDALE	140	360-380	--	69	65	69	69	69	-0	12/15	E
25-250	29-04437	401918	741528	FREEHOLD	139	185-215	100	99	95	92	90	92	2	10/21	E
25-277	29-00030	402231	741432.7	KEYPORT	180	138-152	--	--	--	--	92	91	-1	10/31	E
25-365	29-04513	402046	740103	LONG BRANCH	8	268-333	--	--	--	6	2	8	6	11/06	D
25-374	29-04102	400804.9	740226.4	ASBURY PARK	20	660-710	-205	-218	-216	-113	-91	-94	-3	11/03	E
25-385	49-00016	400915.1	740144.2	ASBURY PARK	20	640-705	-197	-208	-210	-106	-100	-112	-12	11/07	E
25-389	29-00398	400857.1	740306	ASBURY PARK	60	660-711	-203	-232	-224	-109	-83	-96	-13	11/07	B
25-408	28-06655	401007	743200	ALLENTOWN	105	96-119	--	100	100	99	--	99	--	10/29	B
25-429	29-04140	400834	740833	FARMINGDALE	98	623-633	-143	149	-149	-78	-58	-66	-8	10/28	E
25-441	29-05289	401030	740635.1	ASBURY PARK	120	549-649	-162	-163	-170	-74	-65	-73	-8	11/04	C
25-442	49-00032	401052.1	740341.2	ASBURY PARK	70	627-657	--	-177	--	--	--	-67	--	10/04	D
25-638	29-18401-1	401105	741201	FARMINGDALE	112	483-493	--	--	-53	-14	-3	-6	-3	10/21	E
25-686	29-15362	401757	740753	MARLBORO	80	320-340	--	--	--	31	--	27	--	10/29	B
25-692	29-14852	401804.7	741811.2	FREEHOLD	110	120-150	--	--	90	85	85	86	1	10/22	A
25-697	29-13591	401942.1	740430.8	LONG BRANCH	*77	247-277	--	--	25	28	29	29	0	11/04	E
25-704	29-15337	401450	741831	ADELPHIA	195	290-320	--	--	105	107	107	106	-1	10/31	B
25-710	29-16728	400606.5	740909.6	LAKEWOOD	45	594-644	--	--	-164	-96	-70	-71	-1	11/18	E

Appendix 6. Water-level data for wells screened in the Englishtown aquifer system, New Jersey Coastal Plain, 1978–2003.—Continued

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
25-714	29-25383	402424.5	740142.9	SANDY HOOK	80	198-248	--	--	--	--	--	10	--	10/23	B
25-715	29-25384	402426	740017	SANDY HOOK	229	350-360	--	--	--	5	4	5	1	10/14	E
25-727	29-24425	401645.2	741735.3	FREEHOLD	*112	149-206	--	--	--	--	--	68	--	11/03	D
25-733	29-28556	401620	741152	MARLBORO	135	316-366	--	--	--	--	47	48	1	10/30	E
25-735	29-26191	402103.3	741350	MARLBORO	140	140-191	--	--	--	33	83	84	1	10/29	B
25-771	29-36217	402350	735837	SANDY HOOK	*8.4	258-278	--	--	--	--	-1	2	--	10/14	E
25-771			Freshwater equivalent water level								4	6	2		
25-782	28-14424	400807	743113	ALLENTOWN	150	215-245	--	--	--	--	--	104	--	10/30	C
25-786	29-30436	401801	740813	MARLBORO	87	233-273	--	--	--	--	32	33	1	10/30	A
25-787	28-36906	401055.1	743133.8	ALLENTOWN	133	90-100	--	--	--	--	113	114	1	10/26	B
29-5	49-00002	400406.2	740241.3	POINT PLEASANT	*4	750-834	-232	-225	-208	-159	-110	-100	10	11/04	C
29-138	--	400414	742701	CASSVILLE	137	417-427	65	63	60	61	65	65	0	10/20	E
29-236	29-03883	400824	741531.3	ADELPHIA	170	541-577	--	-43	-53	-16	-56	-7	49	11/03	E
29-430	29-05721	400219.5	741154	LAKEWOOD	*104	752-817	--	-182	-176	-105	--	-76	--	11/19	E
29-433	29-05110	400309.1	741118.2	LAKEWOOD	45	673-741	-207	-202	-184	-105	-78	-75	3	11/19	E
29-434	29-04304	400340.1	741315.8	LAKEWOOD	*123	697-757	-189	-160	--	-93	-68	-72	-4	11/04	E
29-438	29-04834	400439	741405.4	LAKEWOOD	78	600-758	-152	-170	-161	-112	-79	-90	-11	11/04	B
29-441	29-05068	400505.2	741112.7	LAKEWOOD	30	726-736	-136	-141	-140	-112	-70	-61	9	11/05	E
29-449	29-05496	400614.7	741155.7	LAKEWOOD	55	569-698	-170	-218	-189	-161	-118	-94	24	11/04	E
29-450	29-03324	400623.5	741347.2	LAKEWOOD	70	520-582	-135	-153	-133	-87	-61	-70	-9	11/06	B
29-451	29-02207	400636	741514	LAKEHURST	60	510-530	-102	-108	-103	-64	-52	-54	-2	11/04	E
29-503	29-01325	400210	740308	POINT PLEASANT	5	845-906	--	-194	-194	-133	-98	-94	4	10/15	E
29-518	--	400401	743159	NEW EGYPT	75	218-238	--	--	61	62	62	54	-8	11/07	B
29-530	29-04530	400452.8	740413.3	POINT PLEASANT	*17	730-790	-236	-211	-202	-146	-99	-102	-3	10/29	E
29-532	49-00075	400458.9	740357.8	POINT PLEASANT	10	748-798	--	-259	-216	--	--	-115	--	10/24	D
29-534	33-01117	395609	741239	TOMS RIVER	18	1080-1146	-79	86	-86	-85	-66	-54	12	10/29	E
29-938	28-20499	400357.6	742121	LAKEHURST	*123	487-527	--	--	-15	0	15	16	1	11/07	B

Appendix 6. Water-level data for wells screened in the Englishtown aquifer system, New Jersey Coastal Plain, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
29-1316	29-26316	400440	741937	LAKEHURST	105	512-553	--	--	--	--	4	2	-2	11/06	E
29-1336	28-34164	400429.4	742936.7	CASSVILLE	130	305-355	--	--	--	--	76	76	-0	10/30	E
33-168	30-00029	393940.3	752225.6	PENNS GROVE	40	113-124	--	--	--	--	17	19	2	12/01	B
33-581	30-01467	393931.7	752238.5	PENNS GROVE	*22	95-115	--	--	16	11	--	15	--	12/11	A

Appendix 7

Water-level data for wells screened in the Upper Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

Appendix 7. Water-level data for wells screened in the Upper Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

[--, data not available; **bold** type indicates that the water-level hydrograph is included in the report; *, Altitude of land surface was modified from 1998 report; Shutdown period: A, 1 hour; B, greater than 1 hour and less than 12 hours; C, greater than 12 hours and less than 24 hours; D, greater than 24 hours and less than 1 week; E, greater than 1 week; USGS, US Geological Survey; ft, feet]

USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
05-76	31-01751	400320.3	745205.2	BRISTOL	62	59-80	9	8	6	1	1	4	3	12/08	E
05-116	28-02847	400708	743835	COLUMBUS	*102	247-253	7	6	3	4	5	-1	-6	11/03	D
05-165	31-05458	395229.9	745416.9	MOORESTOWN	*121	464-500	-64	-70	-94	-93	-74	-74	0	11/13	C
05-167	31-07883	395246.5	745150.8	MOUNT HOLLY	46	478-548	-74	-83	-88	-92	-73	-77	-4	11/13	D
05-207	28-03986	400356	744038	COLUMBUS	95	-325	-13	-16	-20	-20	-18	-19	-1	11/05	E
05-209	28-06599	400411.9	744320.7	COLUMBUS	73	259-274	-18	-18	-22	-32	-28	-20	8	11/07	E
05-212	28-03560	400515	744108	COLUMBUS	83	290-310	-13	-15	-18	-18	-17	-21	-4	11/03	E
05-218	--	400718	744452	COLUMBUS	65	-100	3	1	1	3	2	3	1	11/03	E
05-229	31-08922	395631.8	745856.2	MOORESTOWN	40	160-200	-47	-57	-56	-53	-48	-37	11	12/02	C
05-249	31-05282	395208	745042.1	MEDFORD LAKES	55	523-541	-65	-75	-84	-86	-68	-60	8	12/05	C
05-254	31-10560	395424.3	744855	MOUNT HOLLY	32	451-471	--	--	--	-77	-66	-60	6	11/14	B
05-258	31-04627	395524	745024	MOUNT HOLLY	71	400-410	-52	-65	-66	-69	-59	-54	5	10/31	E
05-317	31-00212	395850	745317	MOORESTOWN	45	192-222	--	--	-45	-46	-46	-32	14	12/16	D
05-438	--	400218	744603	BRISTOL	41	220-230	-22	-23	--	--	--	-23	--	11/04	E
05-707	31-14627	395344.2	745502.4	MOORESTOWN	100	405-441	--	-86	-94	--	-71	-67	4	11/17	D
05-728	--	395819	744340	PEMBERTON	55	485-500	-31	-31	-37	-42	-43	-33	10	11/14	A
05-729	31-00060	395726	745913.5	MOORESTOWN	*12	91-121	--	--	-44	-44	--	-33	--	11/25	E
05-731	--	400739	744227	TRENTON EAST	93	118-128	5	4	3	3	3	2	-1	10/30	E
05-745	27-05937	400157	744818	BRISTOL	102	260-290	-18	-17	-21	-23	-23	-20	3	11/05	D
05-759	31-16976	395134	744933	MEDFORD LAKES	65	593-672	--	--	--	--	--	-86	--	12/05	C
05-795	31-09595	395309	745335.7	MOORESTOWN	60	416-463	-79	-96	-97	-97	-76	-74	2	11/13	C
05-820	31-06841	395045.7	745330.3	CLEMENTON	*87	545-591	--	-81	-83	--	--	-78	--	11/13	B
05-1157	28-28845	400312	744332	COLUMBUS	45	251-266	--	--	--	-25	--	-27	--	11/03	B
05-1159	28-15286	400346.7	744507.2	BRISTOL	50	165-205	--	--	--	-9	-9	-9	0	11/07	A
05-1181	31-41329	395935.7	744649.8	MOUNT HOLLY	19	313-343	--	--	--	-79	-53	-48	5	11/07	A
05-1183	28-28543	400333	744628	BRISTOL	75	200-220	--	--	--	-16	-14	-14	-0	11/04	B
05-1194	31-29146	395549.7	745342.2	MOORESTOWN	80	300-310	--	--	--	-64	-53	-48	5	11/18	B

Appendix 7. Water-level data for wells screened in the Upper Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
05-1389	32-22005	395309	743520	BROWNS MILLS	107	900-920	--	--	--	--	-42	-38	4	10/23	E
05-1391	32-21805	394904	742535	WOODMANSIE	187	1416-1436	--	--	--	--	-32	-26	6	10/22	E
05-1490	31-17792	395651	744922	MOUNT HOLLY	41	364-376	--	--	--	--	-57	-50	7	11/14	E
07-13	51-00032	395222.1	750634.4	RUNNEMEDE	31	111-160	--	-46	-44	-39	-30	-27	3	11/10	E
07-15	31-06208	394651	745619.2	CLEMENTON	150	675-745	-78	-89	-97	-97	--	-90	--	12/19	B
07-18	31-02079	394739	745612.3	CLEMENTON	*147	650-713	--	--	-93	-96	-100	-76	24	11/19	D
07-115	31-00051	395149	745908	CLEMENTON	70	400-420	--	-84	-101	-95	-62	-58	4	12/22	E
07-117	31-04897	395229	745711	CLEMENTON	158	552-562	-75	-79	-84	-91	-67	-66	1	11/07	E
07-131	31-05096	395353	745707	MOORESTOWN	71	-342	-74	-87	-83	-86	-54	-65	-11	11/07	E
07-151	51-00094	395514	750212	CAMDEN	30	-158	-51	-54	-54	--	-44	-32	12	11/17	E
07-249	31-02703	394755.3	750343.3	RUNNEMEDE	65	426-447	--	--	-86	-86	-63	-64	-1	11/17	D
07-252	31-05581	394801.5	750153	RUNNEMEDE	*65	407-477	-83	-94	-91	-96	-66	-68	-2	11/17	B
07-274	31-05226	395031.9	750344.4	RUNNEMEDE	*55	269-349	-86	-92	-86	-91	-58	-63	-5	11/10	B
07-275	31-03375	395230.8	750310.2	CAMDEN	60	236-267	-77	-78	-81	-72	--	-61	--	11/10	B
07-279	31-04798	395238.3	750314.8	CAMDEN	65	224-275	-76	-72	-77	--	-47	-53	-6	11/10	B
07-285	31-03308	395246.8	750434	CAMDEN	*37	144-191	-50	-51	-51	-45	-29	-29	0	11/10	E
07-293	31-04986	395416	750335	CAMDEN	15	142-162	-56	-57	-57	-55	-43	-36	7	11/12	E
07-311	31-04723	394927	750025.3	RUNNEMEDE	75	395-473	-80	-86	-91	-88	-63	-72	-9	11/12	B
07-316	31-05100	395131.8	750229.5	RUNNEMEDE	75	271-348	--	-87	-83	-79	-52	-59	-7	11/12	C
07-322	31-04283	395359.3	750444	CAMDEN	33	101-112	--	-53	-50	-46	-34	-31	3	11/10	E
07-398	31-06646	394726.8	745909.1	CLEMENTON	200	668-698	-81	-96	-97	--	--	-75	--	11/25	E
07-404	31-03307	395056	750417	RUNNEMEDE	67	297-339	-78	-83	-82	-75	-50	-54	-4	11/10	E
07-410	31-02360	395041.5	750055	RUNNEMEDE	95	-441	-90	-95	-94	-93	-63	-69	-6	11/10	E
07-422	31-03306	395127.8	745951.7	CLEMENTON	*71	379-421	-84	-88	-104	-109	-58	-62	-4	11/10	E
07-423	31-04947	395128	745953	CLEMENTON	70	-459	--	--	--	--	-61	-65	-4	11/10	E
07-477	--	394215	745616	WILLIAMSTOWN	111	829-839	-64	-73	-77	-81	-70	-62	8	11/13	E
07-521	31-12301	394745.6	745934.3	CLEMENTON	*186	600-629	--	--	-97	-98	-81	-78	3	11/24	E

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
07-573	--	395356.1	750736.7	PHILADELPHIA	11	-89	--	-10	-9	-5	-3	-2	1	11/07	E
07-727	31-31110	395455.6	745922.4	MOORESTOWN	40	175-202	--	--	--	-70	-53	-52	1	11/07	E
07-824	31-37826	394642.1	745908.2	CLEMENTON	150	590-665	--	--	--	--	-90	-72	18	12/19	B
15-1	31-02889	393912.8	750518	PITMAN EAST	133	746-800	-62	-69	-77	-80	-65	-53	12	11/18	--
15-3	31-06676	394013.6	750559.3	PITMAN EAST	140	670-740	-63	-33	-71	-74	-62	-53	9	11/18	B
15-8	51-00101	394628.2	750812	WOODBURY	21	244-307	-50	-53	-61	--	-52	-46	6	11/21	B
15-28	30-00432	394754.5	751325.1	WOODBURY	70	191-216	-21	-23	-23	-27	-24	-19	5	11/24	D
15-60	31-02358	394206	750757	PITMAN WEST	150	562-612	-60	-70	-66	-70	-63	-65	-2	11/19	B
15-63	31-04176	394308	750659.3	PITMAN EAST	150	549-599	-59	-65	-64	-67	-57	-63	-6	11/19	B
15-127	31-03280	394346.9	750955.1	PITMAN WEST	140	-524	-46	-49	-50	--	-45	-37	8	11/21	E
15-187	--	394543	750745	WOODBURY	45	325-355	--	--	-69	-66	--	-53	--	11/24	B
15-194	31-05309	394731.9	751035.4	WOODBURY	*16	230-265	-42	-47	-45	-46	-35	-34	1	11/06	D
15-227	31-04061	394427.5	750742.2	PITMAN WEST	99	447-487	-60	-64	-71	-68	-62	-55	7	11/06	E
15-240	30-00973	394510	751837	BRIDGEPORT	32	190-231	-21	-19	-21	-21	-19	-16	3	12/04	D
15-248	51-00029	394342.8	750432.3	PITMAN EAST	125	559-618	-63	-68	-80	-73	--	-54	--	11/20	C
15-275	31-00170	394750.5	750904.9	WOODBURY	*59	268-310	-42	-44	-53	-54	-57	-36	21	12/05	D
15-276	31-04567	394820.7	751023.5	WOODBURY	60	242-289	-39	-44	-46	-48	-40	-32	8	12/04	C
15-281	31-03021	394911.1	751023.4	WOODBURY	61	227-243	-35	-40	-37	-38	-30	-25	5	12/04	E
15-303	--	395030	751235	WOODBURY	10	84-114	-6	-8	-9	-8	-7	-4	3	12/03	E
15-330	31-06356	394858.3	750845.7	WOODBURY	40	190-235	-44	-50	-49	-47	-38	-31	7	12/09	B
15-339	30-01161	394350	751909	WOODSTOWN	90	247-267	-19	-19	-20	-21	-20	-18	2	11/10	B
15-346	30-01565	394526.2	751336.6	WOODBURY	80	267-343	--	-24	-29	-35	-27	-21	6	11/21	E
15-355	30-01426	394821	751247.5	WOODBURY	42	205-245	-28	-30	-28	-28	-29	-19	10	11/24	B
15-378	--	394523	751609	BRIDGEPORT	105	-239	--	--	-21	-21	-19	-15	4	12/16	A
15-433	31-17801	394629.1	750516.4	RUNNEMEDE	*149	512-552	--	-55	-64	-68	-53	-51	2	12/08	B
15-617	30-03533-3	394637	751915	BRIDGEPORT	31	60-70	--	--	-7	-7	-8	-4	4	11/25	E
15-728	30-04549	394808	751723	BRIDGEPORT	4	46-56	--	--	-7	-7	-8	-4	4	11/17	E

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measurement date	Shut-down period
							1978	1983	1988	1993	1998	2003			
15-741	--	394652	751003	WOODBURY	82	293-313	--	--	-44	-46	-38	-31	7	11/17	E
15-773	31-26238	395206	751117	WOODBURY	10	30-50	--	--	-7	-1	0	2	2	11/17	E
15-779	31-26239	395222.2	751118.5	WOODBURY	5	25-35	--	--	-8	-1	-1	0	1	11/17	E
15-1000	31-21614	394646	750630	RUNNEMEDE	75	354-359	--	--	-71	-70	-56	-52	4	12/16	E
15-1031	30-03412	394553	751919	BRIDGEPORT	47	95-105	--	--	-9	-10	-9	-6	3	11/23	E
15-1088	50-00050	394408	751334	PITMAN WEST	*40	-285	--	--	--	--	--	-18	--	11/25	E
15-1089	31-37705	395016	750616.9	RUNNEMEDE	45	198-258	--	--	--	--	-45	-42	3	11/13	E
15-1105	30-04335	394244	751658	WOODSTOWN	145	357-377	--	--	--	-25	-22	-19	3	11/12	A
15-1106	30-07949	395115.2	751252.8	WOODBURY	*10	101-111	--	--	--	-9	-9	-6	3	12/03	E
15-1346	30-03764	394826	751610	BRIDGEPORT	10	60-90	--	--	--	--	-11	-7	4	11/25	E
15-1365	31-45998	394320	750156.4	PITMAN EAST	160	628-712	--	--	--	--	--	-62	--	11/20	D
15-1482	30-12607	394433	752010	WOODSTOWN	100	192-220	--	--	--	--	-15	-18	-3	11/10	E
15-1483	30-12606	394433	752011	WOODSTOWN	*102	186-216	--	--	--	--	-17	-12	5	11/10	E
15-1513	30-05444	394126	751613	WOODSTOWN	78	357-367	--	--	--	--	-33	-30	3	11/10	A
15-1543	31-49895	394332	750303	PITMAN EAST	150	616-703	--	--	--	--	--	-67	--	11/20	D
15-1545	30-06144	394109.4	751408.9	PITMAN WEST	130	476-486	--	--	--	--	--	-35	--	12/08	B
21-1	--	401348.9	743050.2	ALLENTOWN	125	285-315	--	--	--	--	36	35	-1	10/29	E
21-19	28-05897	401610.8	743358.8	HIGHTSTOWN	90	133-181	71	68	69	70	71	69	-2	10/23	A
21-46	28-02489	401119	743809	TRENTON EAST	60	138-141	32	--	-70	--	26	35	9	10/29	E
21-84	48-00063	401621	743127.9	HIGHTSTOWN	84	181-205	61	54	51	56	57	56	-1	10/23	B
21-103	28-00801	401309.1	743700.8	ALLENTOWN	110	183-186	61	--	58	60	59	65	6	10/24	A
23-15	48-00064	401842.2	743052.9	HIGHTSTOWN	95	-110	59	65	64	67	69	68	-1	10/29	E
23-98	28-01426	402050.6	742602.8	JAMESBURG	50	99-120	47	44	41	45	42	46	4	10/28	B
23-101	28-07904	402027.3	742109.2	FREEHOLD	50	211-223	17	--	11	19	18	19	1	10/22	A
23-109	--	402302	742255	NEW BRUNSWICK	24	-101	1	-2	-2	-2	17	7	-10	10/16	E
23-142	49-29698	402346	741831	SOUTH AMBOY	90	199-249	8	4	9	8	--	2	--	10/15	B
23-143	--	402347	742037	SOUTH AMBOY	30	81-91	--	5	5	7	6	8	2	10/15	E

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
23-173	--	402406.4	741617.3	SOUTH AMBOY	60	173-193	-4	-7	-8	1	-1	-0	-1	12/01	E
23-180	--	402438	742128	SOUTH AMBOY	19	57-67	4	4	4	5	4	5	1	10/15	E
23-182	--	402449	741818	SOUTH AMBOY	31	66-71	17	15	13	16	17	16	-1	10/28	E
23-213	28-06470	401847.5	742338.9	JAMESBURG	100	195-198	--	--	--	--	15	16	1	10/22	B
23-228	28-04251	402015	742756	JAMESBURG	147	128-138	66	58	55	60	62	61	-1	10/23	E
23-292	28-04250	402109	743011	HIGHTSTOWN	107	93-104	76	71	71	72	74	75	1	10/23	E
23-344	--	402558	742012	SOUTH AMBOY	22	31-37	15	13	14	17	16	17	1	10/22	E
23-351	--	402605	741958	SOUTH AMBOY	35	76-82	20	17	17	20	20	23	3	10/22	E
23-490	28-08490	401924.6	742618.9	JAMESBURG	167	287-325	51	--	--	--	--	49	--	10/24	E
23-508	--	401801.3	743153.1	HIGHTSTOWN	105	-90	68	65	63	65	66	65	-1	10/23	E
23-565	28-11720	402009.7	742810	JAMESBURG	*137	165-197	--	52	--	--	56	54	-2	10/24	B
23-775	28-11436	401717.7	742718.5	JAMESBURG	*118	182-190	--	--	--	--	39	39	-0	10/22	B
23-1156	29-12379	402235.4	741821.1	FREEHOLD	60	230-238	--	--	-4	4	3	1	-2	10/23	E
23-1200	28-17439	401811.1	742957.6	JAMESBURG	*111	166-176	--	--	--	--	66	65	-1	10/22	A
25-4	28-08915	401052	743524.5	ALLENTOWN	*68	212-262	--	21	--	--	26	20	-6	10/24	B
25-13	29-07461	401137.2	740120.3	ASBURY PARK	29	1105-1165	-16	-27	-29	-15	-17	-15	2	11/05	E
25-37	29-04068	401608	741206.1	MARLBORO	137	686-706	-30	-35	-21	-14	-18	-15	3	10/30	E
25-56	28-05400	401743.1	742134.7	FREEHOLD	70	363-384	9	1	18	16	12	14	2	10/28	A
25-62	29-03492	401134	741013	FARMINGDALE	80	831-885	-20	-34	-29	-11	-15	-16	-1	10/31	E
25-91	29-05708	401516	741529	FREEHOLD	140	632-685	-38	-47	-34	-13	-15	-15	0	11/05	E
25-97	29-04708	401625	741500	FREEHOLD	195	596-656	-42	-47	-38	-19	-23	-19	4	11/03	E
25-103	29-07494	401645.6	741735.4	FREEHOLD	107	478-575	-53	-36	-39	-14	-17	-11	6	11/03	E
25-112	29-03096	402538.2	740934.3	KEYPORT	44	312-352	-41	-36	-39	-14	-12	-20	-8	11/03	D
25-116	29-03509	402400	735909.8	SANDY HOOK	10	600-660	-15	-18	-16	--	-4	-5	-1	10/22	E
25-121	29-03033	402023	741059	MARLBORO	80	560-590	-26	-33	-35	-15	-17	-16	1	10/28	E
25-175	29-05851	401246	741516.6	ADELPHIA	*102	681-762	-27	-32	-38	--	--	-12	--	12/10	E
25-195	29-01297	402621.2	740742.7	KEYPORT	15	290-350	--	-35	-32	-21	-18	-19	-1	10/31	B

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
25-197	29-08379	402535.9	741214	KEYPORT	35	304-354	-27	-26	-25	-10	-10	-12	-2	10/23	E
25-206	--	402625	741144	KEYPORT	14	225-249	-13	-14	-15	-3	-4	-8	-4	10/14	E
25-214	28-07184	401434.3	742144.9	ADELPHIA	*195	585-641	-1	0	--	--	8	8	-0	10/28	D
25-218	--	401557	742317	JAMESBURG	250	510-527	20	13	12	--	22	22	0	10/24	B
25-220	28-06114	401536.6	742012.2	FREEHOLD	*125	539-569	-16	-24	-24	-5	-8	-7	1	10/23	B
25-244	29-05790	401848	741503.9	FREEHOLD	*161	524-594	-34	-42	-47	-19	-25	-18	7	11/18	B
25-259	29-00073	402034.3	741425.9	MARLBORO	155	508-593	-18	-26	-27	-5	-5	-5	0	10/29	B
25-284	29-01731	402516	741447.2	KEYPORT	90	231-271	-7	-7	-11	4	4	0	-4	10/31	B
25-288	29-05350	402349.7	741230.7	KEYPORT	83	345-425	-31	-33	-36	-11	-14	-14	-0	10/22	E
25-290	--	402402.9	741244.5	KEYPORT	71	-353	--	--	--	--	--	-8	--	12/09	E
25-292	29-03729	402358.9	741232.9	KEYPORT	87	341-414	-33	-33	-34	--	--	-12	--	12/09	E
25-303	29-05164	402106	740809	MARLBORO	70	527-600	--	--	-61	-19	-14	-22	-8	10/31	E
25-316	29-04299	402536	735903	SANDY HOOK	11	371-397	-5	-4	-9	-2	-1	-1	0	10/14	E
25-322	28-01842	401157	742417	ROOSEVELT	210	667-697	4	-2	-4	7	7	5	-2	10/29	E
25-334	29-00137	401214	740354	ASBURY PARK	23	1013-1065	-21	-37	-37	--	-29	-41	-12	10/22	E
25-360	29-07941	402054.5	740317.7	LONG BRANCH	146	668-759	-31	-34	-34	--	--	-33	--	11/06	B
25-436	29-06193	400951	740725.1	ASBURY PARK	60	990-1033	-26	-41	-43	-17	-21	-19	2	11/05	C
25-459	29-09335	402218.7	740335.1	LONG BRANCH	80	551-612	--	-24	-25	-15	-19	-13	6	11/05	C
25-493	29-07784	401231	741125	FARMINGDALE	115	-860	--	-35	-38	-17	-19	-19	0	11/04	C
25-500	28-12215	400850	743403.1	ALLENTOWN	88	270-305	--	4	0	--	4	2	-2	10/29	B
25-502	29-11033	401412.8	741607.4	ADELPHIA	*117	616-671	--	-59	-51	--	-28	-22	6	11/03	--
25-509	28-12280	401315.9	742809.9	ROOSEVELT	*167	390-430	--	26	24	34	33	31	-2	10/30	B
25-513	29-11230	402443.9	740240.9	SANDY HOOK	20	506-548	--	--	--	-3	1	10	9	10/23	E
25-514	29-12732	402641	740910	KEYPORT	14	266-312	--	-26	-27	-15	-9	-16	-7	10/22	E
25-550	29-13610	401258	741628	ADELPHIA	105	636-656	--	--	-39	-12	-16	-13	3	11/03	E
25-567	29-15851	402630	741028	KEYPORT	10	250-270	--	--	-23	-9	-7	-14	-7	10/22	E
25-568	29-16343	402652	741059	KEYPORT	10	245-265	--	--	-12	-2	0	-5	--	10/31	E

Appendix 7. Water-level data for wells screened in the Upper Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
25-568	Freshwater equivalent water level										0	-4	-4		
25-639	29-18403-7	401105	741201	FARMINGDALE	112	891-901	--	--	-35	-16	-19	-19	0	10/21	E
25-712	29-21610	401901.1	740656	LONG BRANCH	*43	598-668	--	--	--	--	--	-21	--	10/22	E
25-721	29-15170	401130.6	740509.6	ASBURY PARK	130	999-1149	--	--	--	--	-17	-15	2	10/22	E
25-724	29-17817	401923	741529.8	FREEHOLD	130	446-551	--	--	--	-12	-18	-13	5	11/18	D
25-726	29-24703	401412	741602	ADELPHIA	*125	584-673	--	--	--	--	-24	-19	5	11/03	D
25-729	29-21611	401907.5	740647.8	LONG BRANCH	35	575-655	--	--	--	-17	-18	-17	1	10/22	E
25-736	29-21612	401907.9	740708.8	LONG BRANCH	*40	569-669	--	--	-31	--	--	-21	--	10/22	E
25-749	48-00045	400844	743224	ALLENTOWN	100	-350	--	--	--	--	-0	-2	-2	11/06	D
25-823	29-48464	402046.9	740420.2	LONG BRANCH	40	605-700	--	--	--	--	--	-14	--	12/09	D
25-828	29-44304	402442.5	741000.3	KEYPORT	63	399-428	--	--	--	--	--	-20	--	11/03	E
25-830	28-18879	401025	743230.2	ALLENTOWN	102	330-340	--	--	--	--	--	16	--	11/06	D
29-70	33-01159	395906.3	740358	SEASIDE PARK	5	1375-1495	-21	-28	-26	-22	-27	-29	-2	11/05	C
29-100	33-00360	395956	740342	SEASIDE PARK	8	1428-1479	-18	-27	-24	-21	-23	-26	-3	10/29	A
29-134	29-03570	400328.9	741943.7	LAKEHURST	*97	846-962	-22	-26	-29	-41	-50	-42	8	11/03	B
29-238	28-08229	400820	742632.9	ROOSEVELT	130	584-648	-10	-4	-8	-5	-14	-7	7	11/03	A
29-504	29-03142	400211.2	740308.3	POINT PLEASANT	5	1263-1368	-18	-27	-25	-18	-22	-23	-1	10/15	E
29-524	29-05445	400409.7	740403.9	POINT PLEASANT	8	1183-1260	-20	-33	-30	--	--	-25	--	10/24	E
29-531	29-03345	400452.5	740413	POINT PLEASANT	18	1256-1342	-19	-33	-29	-18	-25	-22	3	10/29	B
29-577	33-05553	395742.2	740435	SEASIDE PARK	7	1394-1498	--	-22	-20	-20	-21	-33	-12	12/04	B
29-1040	29-23401	400039	741512.6	LAKEHURST	38	1013-1184	--	--	--	-27	-38	-49	-11	10/16	B
29-1309	33-37783	395926.5	741229.6	TOMS RIVER	*75	-1340	--	--	--	--	--	-47	--	10/16	E
29-1365	33-37776	395637	740441.7	SEASIDE PARK	4	1389-1580	--	--	--	--	-27	-60	-33	12/04	B
29-1380	29-39030	400036	741934	LAKEHURST	65	937-1024	--	--	--	--	-32	-52	-20	10/31	B
29-1577	29-45818	400143.6	741927.5	LAKEHURST	78	905-985	--	--	--	--	--	-40	--	10/30	E
29-1623	29-48193	400409.4	740403.7	POINT PLEASANT	8	1190-1280	--	--	--	--	--	-26	--	10/24	E
33-76	30-00661	394328	752445	PENNS GROVE	27	118-123	3	0	2	1	1	3	2	11/25	A

Appendix 7. Water-level data for wells screened in the Upper Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longitude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 measure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
33-111	30-01253	393746	752954	PENNS GROVE	10	190-235	-14	-15	-17	-19	-20	-21	-1	11/21	E
33-253	--	393349.5	752753	SALEM	3	335-340	-22	-23	-27	-28	-27	-28	-1	11/20	E
33-342	--	394238.1	752724.1	PENNS GROVE	18	46-51	-5	1	-1	-1	3	9	6	11/21	E
33-355	--	393914	751929	WOODSTOWN	58	-360	-29	-22	-24	-17	-24	-22	2	11/06	E
33-361	30-01815	394203.9	752657.9	PENNS GROVE	13	44-54	-9	-8	-9	-6	1	4	3	11/24	D
33-671	30-05148	393954.5	753012.4	WILMINGTON SO	7	87-102	--	--	--	-3	-7	-3	4	11/21	E
33-686	30-08335	393750.3	753146.3	WILMINGTON SO	10	110-130	--	--	--	-10	-7	-1	6	11/21	C
33-697	30-01113	394204.5	752653.1	PENNS GROVE	12	47-62	--	--	--	--	--	2	--	11/24	A
33-841	35-17766	393055	750834	ELMER	77	1005-1025	--	--	--	--	-48	-43	5	11/18	E
33-920	30-11400	394238.7	752200.8	WOODSTOWN	*79	184-204	--	--	--	--	--	-6	--	11/06	B
33-952	30-13727	393648.8	753232.5	DELAWARE CITY	*24	147-152	--	--	--	--	--	-8	--	11/20	E
33-953	30-13726	393724.83	753224.97	DELAWARE CITY	*7	109-114	--	--	--	--	--	2	--	11/20	E
P10116	--	395443	750831	PHILADELPHIA	9	60-75	--	--	-6	--	-6	-7	-1	11/07	E
						Delaware wells									
Dc43-20	81386	393603	753752	ST GEORGES	54	130-140	--	--	--	--	--	1	--	12/09	E
Dc52-56	81385	393551	753809	ST GEORGES	52	126-136	--	--	--	--	--	2	--	12/09	E
Ea45-04	100389	393133	754558	ELKTON	40	85-105	--	--	--	--	-5	-7	-2	12/09	--
Eb23-22	46613	393316	754215	ST GEORGES	*59	101-105	--	--	--	--	34	37	3	12/12	E
Eb43-20	190201	393105	754249	ST GEORGES	70	197-227	--	--	--	--	--	-27	--	12/09	--
Fb11-08	106955	392928	754425	MIDDLETOWN	70	213-299	--	--	--	--	--	-30	--	12/23	D
Fb11-10	157175	392923	754427	MIDDLETOWN	70	200-230	--	--	--	--	-25	-25	0	12/23	E
Fb33-12	10453	392710	754257	MIDDLETOWN	62	245-345	--	--	--	--	--	-80	--	12/23	B
Gd33-05	Gd33-05	392212	753241	SMYRNA	18	628-660	--	--	--	--	-11	-16	-5	12/12	E

Appendix 8

Water-level data for wells screened in the Middle and undifferentiated Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

Appendix 8. Water-level data for wells screened in the Middle and undifferentiated Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
01-1221	35-14298	393122.4	745520	BUENA	*97	1532-1980	--	--	--	-53	-46	-41	5	11/13	E
01-1221			Freshwater equivalent water level							-40	-33	-28	5		
05-63	--	400213	745107	BRISTOL	45	284-294	-16	-16	-21	-21	-21	-16	5	10/31	E
05-70	27-05259	400313	745003	BRISTOL	60	140-200	-13	-11	-16	--	-16	-17	-1	11/05	B
05-87	27-03694	400407.4	745246.7	BEVERLY	10	50-60	--	-8	-13	-9	-11	-16	-5	11/05	E
05-114	28-02901	400606	743922	COLUMBUS	85	388-392	-7	-8	-12	-13	-11	-11	0	11/04	A
05-119	28-04082	400821	743844	TRENTON EAST	100	-305	--	--	--	--	8	6	-2	10/30	E
05-122	28-05042	400940.9	744013.8	TRENTON EAST	75	337-367	4	0	-1	-4	-0	-1	-1	10/30	B
05-126	31-04276	395928.5	745921.8	MOORESTOWN	73	157-196	-8	-15	-16	-16	-15	-13	2	11/07	C
05-128	31-04733	395938.1	745808.5	MOORESTOWN	35	166-225	--	--	--	--	--	-16	--	11/07	B
05-206	28-03595	400324.8	744456.1	COLUMBUS	62	370-380	-24	-25	-23	-29	-27	-25	2	12/08	A
05-214	--	400530.1	744428.9	COLUMBUS	60	-319	-10	--	-13	-12	-12	-18	-6	12/08	E
05-232	31-06020	395725.7	745913.2	MOORESTOWN	*9	210-270	-40	-46	-44	-46	-46	-36	10	11/25	B
05-261	--	395525	745024	MOUNT HOLLY	73	740-750	-48	-58	-61	-62	-51	-47	4	10/31	E
05-265	31-04727	395702.3	745805.2	MOORESTOWN	*24	248-288	-56	-65	-65	--	-54	-51	3	11/13	E
05-273	31-04770	395836.4	745641.1	MOORESTOWN	70	274-302	-27	-29	-32	-33	-26	-23	3	11/18	E
05-284	31-03806	395936.8	745450.9	MOORESTOWN	62	298-338	-26	-29	-28	--	-28	-23	5	11/13	E
05-290	31-06674	395936.3	744652.2	MOUNT HOLLY	15	545-615	-55	-57	-63	-60	-48	-45	3	12/05	B
05-297	31-01610	395526.8	745411.1	MOORESTOWN	*51	441-457	--	--	-68	-66	-54	-49	5	11/18	E
05-330	52-00008	395949.2	743653.5	BROWNS MILLS	140	1056-1086	-49	-51	-65	-65	-59	-53	6	11/14	E
05-332	48-00269	400105.8	743718.8	NEW EGYPT	150	1064-1104	-39	-42	-52	-51	-39	-33	6	11/14	E
05-333	32-07668	400128	743653.4	NEW EGYPT	*128	1030-1051	-50	-51	-64	--	-49	-42	7	11/07	D
05-336	28-00795	400150.3	743425.8	NEW EGYPT	105	1036-1089	--	--	-55	-63	-53	-43	10	11/07	E
05-385	32-03778	395839	744248	PEMBERTON	30	747-823	--	-52	-61	-70	-52	-51	1	11/20	C
05-388	52-00009	395939	743741.2	PEMBERTON	160	1090-1140	-42	-47	-62	-50	-52	-38	14	11/14	E
05-436	--	400118	744009	COLUMBUS	96	757-800	--	--	--	-42	-33	-31	2	11/04	E

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
05-440	28-05128	400243	744223	COLUMBUS	72	603-613	-29	-29	-36	-35	-30	-31	-1	10/23	E
05-634	47-00001	400039.1	744808.1	BRISTOL	55	-516	-56	-58	-60	-64	-77	-72	5	11/07	E
05-683	--	395122	743016	CHATSWORTH	141	2102-2117	-30	-34	-42	-39	-32	-29	3	10/22	E
05-726	28-08443	400212.7	743652.8	NEW EGYPT	140	667-732	--	--	-41	-36	-37	-23	14	11/18	E
05-749	31-07140	395508.5	745537.4	MOORESTOWN	75	-425	-60	-69	-75	-73	-61	-54	7	11/18	E
05-801	27-06877	400020	750113	FRANKFORD	20	5-25	--	0	-1	-4	-3	-1	2	11/13	E
05-1089	27-08534	400201	745308.5	BEVERLY	19	176-251	--	--	-25	-25	-35	-15	20	11/05	E
05-1158	28-28844	400316	744333	COLUMBUS	45	450-460	--	--	--	-28	-24	-26	-2	11/03	B
05-1172	28-20985	400713	744526	BRISTOL	42	270-290	--	--	--	--	1	-0	-1	11/03	C
05-1184	27-12174	400701	744832	BRISTOL	30	110-120	--	--	--	2	-2	2	4	11/05	E
05-1410	28-35141	400531	744310.2	COLUMBUS	95	439-522	--	--	--	--	--	-34	--	11/07	B
05-1430	28-35104	400813	744354	TRENTON EAST	55	160-170	--	--	--	--	--	8	--	10/30	B
05-1472	27-20750	400051.3	745346.7	BEVERLY	*25	190-240	--	--	--	--	--	-25	--	11/05	D
05-1484	27-14624	400249.6	745319.5	BEVERLY	39	215-253	--	--	--	--	-17	-12	5	11/05	B
05-1524	27-15940	400110	745711	BEVERLY	70	155-175	--	--	--	--	--	6	--	11/10	D
05-1525	28-19074	400300	743512	NEW EGYPT	130	800-820	--	--	--	--	--	-27	--	12/18	D
05-1527	27-15342	400539	744728	BRISTOL	47	70-110	--	--	--	--	--	1	--	11/05	E
07-48	31-00013	395528.8	750640.9	CAMDEN	14	111-135	-26	-26	-20	-18	-11	-8	3	12/12	E
07-124	31-07020	395249.8	745934.1	MOORESTOWN	77	483-626	-77	-84	-92	-85	-55	-60	-5	11/10	B
07-132	31-05095	395353	745707	MOORESTOWN	71	-500	-82	-81	-81	--	-53	-66	-13	11/07	E
07-135	31-05218	395352.7	745701.7	MOORESTOWN	72	443-493	--	--	-73	-81	-50	-64	-14	11/07	B
07-142	31-04098	395438.5	750102	CAMDEN	32	321-378	--	--	-66	-64	-48	-44	4	11/07	E
07-186	--	394950	745854	CLEMENTON	70	-680	-77	-85	-88	-89	-64	-65	-1	11/12	E
07-304	31-05108	395404	750201	CAMDEN	50	307-372	--	--	-72	-75	-59	-46	13	11/13	E
07-329	31-04836	395626.6	750405	CAMDEN	16	110-140	-36	-31	-34	-29	-21	-17	4	11/12	E
07-413	31-04561	394922	745629	CLEMENTON	149	706-717	-69	-78	-82	-85	-66	-63	3	11/07	E

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
07-476	--	394215	745616	WILLIAMSTOWN	111	1485-1495	-46	-53	-57	-58	-49	-43	6	11/13	E
07-534	--	395553	750206	CAMDEN	40	198-219	--	-48	-49	-45	-38	-29	9	11/07	E
07-726	31-31111	395452.9	745918.7	MOORESTOWN	40	276-422	--	--	--	-70	-53	-52	1	11/07	E
07-733	31-40817	395130.6	750229.5	RUNNEMEDE	75	452-535	--	--	--	-82	-53	-61	-8	11/12	C
07-734	31-40970	395218.1	750300.4	RUNNEMEDE	*55	333-499	--	--	--	--	-54	-58	-4	11/10	B
07-986	31-43797	395630	750408	CAMDEN	28	102-180	--	--	--	--	-25	-19	6	11/12	E
07-1007	31-58577	395755.5	750231	CAMDEN	33	99-109	--	--	--	--	--	-12	--	11/14	E
07-1040	31-59619	395744.3	750232.6	CAMDEN	40	105-115	--	--	--	--	--	-15	--	11/14	E
07-1057	31-59365	395818	750334.8	CAMDEN	66	78-83	--	--	--	--	--	-8	--	11/14	E
11-137	--	392514	745216	DOROTHY	85	2083-2093	-37	-43	-49	-53	-55	-53	2	11/13	E
11-137			Freshwater equivalent water level				-14	-19	-25	-30	-32	-30	2		
15-24	31-05513	395114.7	750704.2	RUNNEMEDE	*35	282-345	-53	-55	-51	-45	-36	-33	3	11/25	E
15-135	30-01314	394516	752240	MARCUS HOOK	7	130-180	--	-1	-2	-2	-3	-1	2	11/12	E
15-140	30-01248	394608	752134	BRIDGEPORT	6	132-184	2	-1	-2	-11	-2	-1	1	11/14	E
15-213	30-00602	394947.6	751420.2	WOODBURY	10	135-175	-10	-10	-10	-10	-10	-6	4	11/24	E
15-236	30-01177	394434.5	751839.8	WOODSTOWN	75	241-312	-21	-20	-22	-12	-20	-19	1	11/10	B
15-279	30-00916	394857	751249	WOODBURY	17	315-320	-23	-24	-26	-26	-25	-17	8	12/03	E
15-348	30-01776	394910	751539.4	BRIDGEPORT	20	105-135	-9	-10	-11	-10	-10	-7	3	11/23	A
15-374	31-13385	394854.1	750727.1	RUNNEMEDE	50	430-486	--	-65	-63	-63	-50	-46	4	11/25	C
15-415	31-14478	394834	751043	WOODBURY	40	287-307	--	-42	-39	-42	-34	-27	7	12/04	E
15-444	30-02032	394756	752343	MARCUS HOOK	16	65-70	--	--	--	--	-8	-7	1	11/14	E
15-569	30-02405	394533.7	752050.8	BRIDGEPORT	32	161-201	--	--	-12	-9	-8	-5	3	11/13	E
15-585	30-02522	394704	752057	BRIDGEPORT	8	79-89	--	--	1	1	-1	1	2	11/20	E
15-616	30-03532-5	394637	751915	BRIDGEPORT	31	230-240	--	--	-8	-8	-8	-5	3	11/23	E
15-620	30-03677	394804	751932	BRIDGEPORT	7	131-141	--	--	2	2	1	4	3	11/23	E
15-679	30-03624	394946	751611	BRIDGEPORT	10	118-128	--	--	-3	-7	-5	-2	3	12/04	E

Appendix 8. Water-level data for wells screened in the Middle and undifferentiated Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
15-713	30-04348	394808	751723	BRIDGEPORT	6	125-155	--	--	-8	-7	-7	-4	3	11/17	E
15-727	30-04548	394808	751723	BRIDGEPORT	5	195-216	--	--	-8	-8	-8	-5	3	11/17	E
15-774	31-26241	395206	751117	WOODBURY	10	93-113	--	--	-1	--	--	-1	--	11/17	E
15-780	31-26244	395223	751116	WOODBURY	5	75-85	--	--	-2	-5	-4	-3	1	11/17	E
15-998	--	394031.2	750607	PITMAN EAST	141	820-837	--	--	-64	--	-56	-47	9	12/10	E
15-1015	--	394944	751727	BRIDGEPORT	5	137-142	--	--	--	--	--	-4	--	11/25	E
15-1036	31-22504	394741	750806.8	WOODBURY	60	259-319	--	--	--	-63	-51	-45	6	11/13	E
15-1176	31-43251	394930.2	751014.9	WOODBURY	*44	174-184	--	--	--	--	-27	-21	6	11/21	D
15-1484	30-12608	394434	752011	WOODSTOWN	104	280-300	--	--	--	--	-14	-14	0	11/10	A
15-1485	31-48720	395037	750829	WOODBURY	30	160-306	--	--	--	--	-33	-29	4	11/21	D
15-1504	30-12671	394527	751539	BRIDGEPORT	92	458-478	--	--	--	--	-29	-27	2	11/25	E
15-1540	--	395038.8	751416.6	WOODBURY	16	130-140	--	--	--	--	--	-4	--	12/09	E
21-12	28-07034	401536.7	742915.9	JAMESBURG	115	520-560	28	27	23	25	37	32	-5	11/06	B
21-22	28-05440	401702.8	743104.5	HIGHTSTOWN	103	337-367	50	45	35	41	47	46	-1	10/23	A
21-25	28-01262	401717	743351	HIGHTSTOWN	100	205-226	65	64	67	64	64	64	0	10/23	B
21-43	28-05409	401101.6	744150.1	TRENTON EAST	*6	118-138	--	2	4	4	3	3	0	10/30	B
21-54	28-04602	401306.3	743917.7	TRENTON EAST	85	194-243	--	--	--	40	39	36	-3	10/24	B
21-73	28-02927	401420.1	744005.5	TRENTON EAST	80	128-144	--	--	--	47	40	45	5	10/24	E
21-101	28-06030	401241.5	743443.1	ALLENTOWN	*140	366-421	35	42	40	43	42	41	-1	10/29	A
21-120	28-05368	401556	743703.3	HIGHTSTOWN	*74	96-121	71	69	57	--	68	71	3	10/28	E
21-122	28-06455	401554	743658.3	HIGHTSTOWN	75	75-126	--	--	--	--	67	71	4	10/29	E
21-554	28-33402	401457	743202	ALLENTOWN	140	353-443	--	--	--	--	--	50	--	12/11	E
21-561	28-14731	401518.3	743118.8	HIGHTSTOWN	*113	230-270	--	--	--	--	--	56	--	10/23	D
23-9	28-00180	401802.3	743210.7	HIGHTSTOWN	*98	250-280	69	--	62	65	65	67	2	10/23	E
23-16	28-07800	401842.2	743054.2	HIGHTSTOWN	95	230-260	66	60	58	62	63	63	-0	10/29	E
23-17	28-04589	401842.6	743051.8	HIGHTSTOWN	98	268-298	67	61	60	--	65	64	-1	10/29	E

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
23-70	--	402555	742718	NEW BRUNSWICK	73	0-21	57	56	56	57	57	58	1	10/22	E
23-97	--	402247	742502	NEW BRUNSWICK	39	236-301	2	2	6	29	27	18	-9	10/28	E
23-106	--	402251	742247	NEW BRUNSWICK	27	-132	--	--	--	4	13	7	-6	10/15	E
23-107	--	402252	742245	NEW BRUNSWICK	28	311-334	--	-3	-0	--	8	6	-2	10/15	E
23-132	--	402335	742135	SOUTH AMBOY	25	262-267	-44	-38	-36	-3	4	13	9	10/15	E
23-147	29-04998	402352.1	741837.8	SOUTH AMBOY	80	425-475	--	-79	-65	-16	-18	-28	-10	10/16	B
23-176	29-06429	402407	741923	SOUTH AMBOY	45	321-363	-61	--	--	--	--	-29	--	10/15	E
23-194	--	402536	742017	SOUTH AMBOY	18	201-281	-76	-46	-59	-8	-14	-17	-3	10/22	E
23-206	29-00768	402700.6	741451.6	KEYPORT	60	360-395	-75	-78	-86	-31	-25	-30	-5	10/03	E
23-229	28-04252	402015	742756	JAMESBURG	147	319-330	58	51	48	55	57	54	-3	10/23	E
23-273	--	401932	743528	HIGHTSTOWN	76	70-75	--	--	--	47	47	48	1	10/23	E
23-291	28-04249	402109	743012	HIGHTSTOWN	107	192-203	73	65	64	67	70	70	-0	10/23	E
23-306	28-06538	402147	742846	JAMESBURG	120	201-207	75	69	69	72	76	75	-1	10/23	E
23-365	--	402633	742119	SOUTH AMBOY	6	148-160	-52	-43	-51	-9	-14	-19	-5	10/16	E
23-380	48-36510	402659.5	742020.1	SOUTH AMBOY	48	181-237	-57	-43	-38	-5	-12	-12	0	12/01	B
23-401	29-05352	402744.8	741627.1	SOUTH AMBOY	44	254-288	-75	-80	-77	--	-14	-38	-24	10/20	E
23-438	28-09722	402600.8	742141.7	SOUTH AMBOY	20	132-182	-49	-38	-46	-4	-8	-11	-3	10/20	B
23-439	28-05987	402633	742159	SOUTH AMBOY	21	121-126	-40	-32	-38	-2	-5	-9	-4	10/16	E
23-482	--	403242	741616	PERTH AMBOY	11	44-76	-3	9	10	10	10	10	0	10/16	E
23-552	28-10991	402017.9	743019.8	HIGHTSTOWN	105	116-166	--	--	59	88	68	64	-4	10/20	D
23-1160	28-20882-0	402720	741949	SOUTH AMBOY	86	210-230	--	--	-54	-13	-13	-19	-6	10/28	E
23-1181	29-19615-9	402742	741905	SOUTH AMBOY	70	127-137	--	--	--	-24	-20	-25	-5	10/28	E
23-1346	--	402009.8	742809.4	JAMESBURG	130	276-337	--	--	--	--	44	41	-3	10/24	B
25-153	29-05942	402444	741008	KEYPORT	65	635-690	-47	-75	-116	-20	-21	-21	0	12/19	B
25-230	29-06353	402004.6	741853.3	FREEHOLD	125	580-670	-41	-36	-49	-14	-16	-13	3	11/18	B
25-247	29-04285	401900.5	741806.4	FREEHOLD	146	762-832	-26	-34	-48	-8	-16	-14	2	11/18	E

Appendix 8. Water-level data for wells screened in the Middle and undifferentiated Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.—Continued

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
25-262	29-05023	402103.3	741350.6	MARLBORO	140	730-810	-36	--	--	--	--	-22	--	10/29	E
25-268	29-06361	402122.6	741507.3	FREEHOLD	114	632-698	-40	-50	-64	-12	9	-24	-33	10/22	E
25-272	29-06527	402208	741451	MARLBORO	117	670-680	-44	-55	-73	-17	-21	-29	-8	10/21	E
25-320	--	402705	735957	SANDY HOOK	14	838-878	-4	-9	-10	-1	-1	0	1	10/23	B
25-495	--	401851	740300.1	LONG BRANCH	10	-1000	--	--	-11	-3	-2	-2	-0	11/03	E
25-562	29-13329	402540.5	741212.3	KEYPORT	30	500-555	--	--	--	--	--	-37	--	10/23	E
25-634	29-16237	401520	741711	FREEHOLD	170	877-914	--	--	--	-22	-20	-25	-5	11/18	E
25-635	29-18402-9	401105	741201	FARMINGDALE	111	1226-1330	--	--	-38	-23	-18	-22	-4	10/21	E
25-711	29-14303	401744	741902	FREEHOLD	90	649-756	--	--	-35	-4	-8	-7	1	11/18	B
25-725	29-24426	401302.7	741630.9	ADELPHIA	100	918-997	--	--	--	--	-27	-30	-3	11/03	E
25-728	28-21488	401743.2	742134.1	FREEHOLD	70	541-621	--	--	-24	-1	-3	-4	-1	10/28	B
25-731	28-22008	401840.7	742158.5	FREEHOLD	*71	541-628	--	--	--	--	3	2	-1	10/22	B
29-19	--	394829	740533	BARNEGAT LIGHT	9	2736-2756	0	-6	-11	-10	-5	-5	0	10/21	E
29-47	--	400429.6	740833.4	LAKEWOOD	8	1709-1749	-36	-41	-65	-45	-40	-17	23	10/24	E
29-85	--	395929	741419	TOMS RIVER	67	1460-1480	-23	-29	-40	-30	-20	-23	-3	10/29	E
29-118	29-04322	400200	742109	LAKEHURST	96	1397-1583	-27	-28	-41	-29	-41	-23	18	12/10	E
29-132	29-03726	400328.9	741944.8	LAKEHURST	*98	1606-1728	-30	-34	-48	-42	-38	-29	9	11/03	D
29-440	29-06549	400501.7	741324.7	LAKEWOOD	72	1357-1602	-20	-31	-44	-29	-20	-21	-1	11/05	B
29-490	33-01343	395911.7	742130.4	KESWICK GROVE	*100	1436-1636	-30	-47	-33	-18	-19	-21	-2	10/28	E
29-576	29-08936	400653.1	741714.6	LAKEHURST	135	1276-1462	-32	-35	-48	-40	-36	-33	3	11/03	B
29-581	48-00056	400826.2	742641.9	ROOSEVELT	130	876-976	-1	-16	-26	-17	-14	-12	2	11/03	C
29-588	29-09259	400438.5	741106	LAKEWOOD	73	1410-1620	--	-24	-53	-33	-21	-25	-4	11/09	C
29-626	33-10224	395721.5	741228	TOMS RIVER	9	1700-1875	--	-23	-33	-23	-14	-24	-10	10/31	B
29-1113	29-25859	400046.6	740326.4	POINT PLEASANT	10	1852-1974	--	--	--	--	-7	-7	0	10/15	E
29-1265	28-37964	400111.1	742237.6	CASSVILLE	95	1315-1552	--	--	--	--	--	-23	--	10/30	B
33-65	--	393912	752435	PENNS GROVE	30	501-512	-14	-15	-18	--	-18	-17	1	11/24	E

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
33-106	--	393514	752916	SALEM	5	359-365	--	--	--	-31	-31	-31	0	11/28	A
33-119	30-00018	394009	753041.2	WILMINGTON SO	7	210-230	-46	-39	-43	-44	-38	-46	-8	11/21	D
33-158	30-00763	393848	752009	WOODSTOWN	62	562-575	--	--	-25	-17	-25	-23	2	11/06	E
33-166	--	393942	752233	PENNS GROVE	47	568-578	-14	-15	-18	--	-18	-16	1	11/24	E
33-187	--	394037.7	751913.3	WOODSTOWN	73	664-672	-25	-26	-28	-29	-28	-25	3	11/18	E
33-198	30-01383	394117	752206	WOODSTOWN	51	337-362	-21	-23	-25	-26	-25	-25	0	11/14	E
33-251	--	393349.3	752752.8	SALEM	3	699-709	-27	-28	-32	-32	-31	-32	-1	11/20	E
33-305	30-01083	394013	752458	PENNS GROVE	14	381-457	-13	-14	-16	--	-16	-15	1	11/24	A
33-918	34-01512	392802	753208	TAYLORS BRIDGE	12	1115-1135	--	--	--	--	--	-44	--	11/21	D
33-933	30-12200	393846.2	751908	WOODSTOWN	48	535-670	--	--	--	--	-33	-31	2	11/06	B
33-934	34-04055	392743.7	753147.2	TAYLORS BRIDGE	16	826-836	--	--	--	--	-60	-70	-10	11/21	E
P10105	--	395342	751020	PHILADELPHIA	9	-101	-9	--	-7	-4	-4	-6	-2	11/07	E
Delaware wells															
Cc55-17	000137	394008	753529	WILMINGTON SOUTH	55	89-115	--	--	--	--	-10	-12	-2	12/15	E
Cd42-17	040146	394133	753310	WILMINGTON SOUTH	45	100-125	--	--	--	--	-28	-28	0	12/22	E
Cd42-41	197105	394136	753302	WILMINGTON SOUTH	46	100-110	--	--	--	--	--	-20	--	10/31	E
Cd43-72	196848	394135	753215	WILMINGTON SOUTH	16	87-97	--	--	--	--	--	-12	--	11/25	E
Cd51-08	010060	394006	753453	WILMINGTON SOUTH	15	65-82	--	--	--	--	--	-16	--	12/15	E
Cd52-27	033721	394058	753349	WILMINGTON SOUTH	12	128-141	--	--	--	--	--	1	--	12/15	E
Db52-27	035417	393539	754335	ST GEORGES	73	70-90	--	--	--	--	59	68	9	12/22	E
Db53-43	172122	393557	754258	ST GEORGES	70	53-61	--	--	--	--	--	67	--	12/18	E
Db53-45	172124	393549	754257	ST GEORGES	70	90-105	--	--	--	--	--	66	--	12/18	E
Dc14-77	052445	393952	753610	WILMINGTON SOUTH	62	80-112	--	--	--	--	--	-4	--	12/23	E
Dc15-16	035665	393954	753533	WILMINGTON SOUTH	45	99-109	--	--	--	--	--	3	--	12/15	E
Dc22-23	043067	393824	753842	NEWARK EAST	70	90-130	--	--	--	--	--	-12	--	12/23	E
Dc23-02	035081	393839	753706	WILMINGTON SOUTH	58	129-154	--	--	--	--	--	-37	--	12/23	E

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-sure-ment date	Shut-down period
							1978	1983	1988	1993	1998	2003			
Dc24-70	156751	393823	753613	WILMINGTON SOUTH	8	100-200	--	--	--	--	--	-32	--	12/23	E
Dc31-10	030005	393746	753939	NEWARK EAST	69	108-138	--	--	--	--	--	19	--	12/23	E
Dc32-35	177379	393721	753823	ST GEORGES	55	117-142	--	--	--	--	--	-12	--	12/28	E
Dc34-06	010231	393755	753648	WILMINGTON SOUTH	25	183-188	--	--	-31	--	-36	-39	-3	12/12	E
Ea35-21	102148	393241	754544	ELKTON	55	99-162	--	--	--	--	--	31	--	12/22	E
Ea35-38	102438	393248	754546	ELKTON	60	102-152	--	--	--	--	--	39	--	12/22	E
Eb23-24	010404	393316	754215	ST GEORGES	60	432-436	--	--	--	--	-46	-45	1	12/12	E
Eb51-19	161819	393026	754416	ST GEORGES	56	600-740	--	--	--	--	--	-31	--	12/09	E
Eb55-08	098124	393037	754043	ST GEORGES	58	400-420	--	--	--	--	-29	-31	-2	12/28	E
Eb55-09	098123	393039	754050	ST GEORGES	56	400-420	--	--	--	--	--	-34	--	12/28	E
Ec32-03	Ec3203	393241	753802	ST GEORGES	*8	318-348	--	--	-35	--	-31	-30	1	01/12	E
Ec41-17	156288	393106	753901	ST GEORGES	52	422-452	--	--	--	--	--	-26	--	12/29	E
Ec52-23	099469	393048	753814	ST GEORGES	*40	482-532	--	--	--	--	-24	-26	-2	12/29	E
Ec52-24	101153	393037	753812	ST GEORGES	15	424-454	--	--	--	--	--	-33	--	12/29	E
Ec52-25	099470	393053	753818	ST GEORGES	*30	400-450	--	--	--	--	-24	-26	-2	12/29	E
Ec52-26	105156	393025	753805	ST GEORGES	50	436-466	--	--	--	--	--	-32	--	12/28	E
Ec53-17	157984	393033	753749	ST GEORGES	50	420-470	--	--	--	--	-33	-32	1	12/28	E
Fb11-11	157176	392923	754428	MIDDLETOWN	70	257-297	--	--	--	--	-25	-24	1	12/23	E
Fb14-11	096841	392929	754118	MIDDLETOWN	40	410-443	--	--	--	--	--	-48	--	12/29	E
Fb14-15	157833	392930	754116	MIDDLETOWN	30	410-440	--	--	--	--	--	-58	--	12/29	E
Fb33-24	039685	392710	754257	MIDDLETOWN	60	460-536	--	--	--	--	-36	-43	-7	12/23	E
Fc11-25	157831	392918	753944	MIDDLETOWN	40	374-424	--	--	--	--	-26	-32	-6	12/29	E
Fc51-27	099806	392531	753906	MIDDLETOWN	50	692-733	--	--	--	--	-27	-34	-7	12/23	E
Maryland wells															
CE Ce 56	CE-81-0466	393026	755231	ELKTON	38	116-121	--	--	--	--	6	8	2	11/25	E
CE Ee 29	CE-73-2266	392403	755217	CECILTON	75	515-525	--	--	--	--	-3	-6	-3	11/25	E

Appendix 9

Water-level data for wells screened in the Lower Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

Appendix 9. Water-level data for wells screened in the Lower Potomac-Raritan-Magothy aquifer, New Jersey and Delaware Coastal Plain and vicinity, 1978–2003.

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down pe-riod
							1978	1983	1988	1993	1998	2003			
05-123	31-05321	395904.6	750008.8	CAMDEN	25	226-261	-10	-12	-16	-16	-16	-12	4	11/07	E
05-125	31-03835	395928.1	745919.8	MOORESTOWN	79	239-281	-11	-15	-16	-19	-17	-15	2	11/07	E
05-129	27-04844	395945	750010	CAMDEN	60	-174	--	--	--	--	--	-0	--	11/13	B
05-130	31-04576	400000.2	750039.5	FRANKFORD	70	167-198	-4	-3	-14	-12	-14	-9	5	11/07	A
05-146	27-03080	400122.5	745805.1	BEVERLY	25	89-130	3	2	0	--	--	5	--	11/12	E
05-228	31-08923	395631	745856.4	MOORESTOWN	40	440-500	-47	-51	-60	-53	-55	-38	17	12/03	E
05-262	--	395524	745024	MOUNT HOLLY	72	1125-1145	-48	-58	-60	-61	-52	-47	5	10/31	E
05-274	31-03674	395841	745904	MOORESTOWN	40	241-262	-20	-26	-29	-31	-28	-25	3	11/07	E
05-645	--	400010	745215	BRISTOL	40	431-441	-31	-35	-41	-41	-38	-30	8	10/31	E
05-648	--	400102.5	745407.8	BEVERLY	34	306-316	-20	-23	-29	-28	-29	-19	10	11/05	E
05-746	31-12925	395726.5	745915	MOORESTOWN	13	389-450	-29	-41	-43	-43	-38	-32	6	11/28	D
05-819	31-19212	395607.1	745645.4	MOORESTOWN	20	499-590	--	-59	-68	-65	--	-47	--	11/17	E
05-823	--	395617.5	745516.4	MOORESTOWN	35	590-640	-48	-62	-75	-64	-50	-50	0	11/17	B
05-1075	31-26130	395633.1	745557	MOORESTOWN	40	528-644	--	--	-63	-61	--	-43	--	11/17	E
07-12	31-02687	395221.8	750635.2	RUNNEMEDE	*31	334-359	-57	-60	-52	-50	-41	-36	5	11/10	B
07-111	31-03456	395724.7	750518.7	CAMDEN	9	139-170	--	--	-26	--	-10	-7	3	11/07	E
07-121	--	395251.3	745936	MOORESTOWN	*76	672-729	-89	-98	-107	--	-59	-73	-16	11/10	E
07-130	31-05077	395353	745707	MOORESTOWN	71	743-748	-67	-75	-80	-79	-52	-59	-7	11/07	E
07-144	31-00684	395441.2	750101	CAMDEN	39	491-527	-60	-64	-67	-65	-49	-42	7	11/07	E
07-157	31-05033	395558.2	750030.2	CAMDEN	45	376-427	--	--	--	--	-43	-37	4	11/07	E
07-163	31-04051	395609.8	750027.5	CAMDEN	39	371-453	-46	-51	-53	-45	-36	-35	1	11/07	E
07-172	31-04799	395428.1	750507.2	CAMDEN	10	218-312	-46	-40	-37	-38	--	-35	--	11/13	E
07-175	31-00079	395515.2	750436.7	CAMDEN	*21	266-306	-55	-52	-51	--	-38	-31	7	11/13	E
07-188	31-05950	394950.1	745857.3	CLEMENTON	65	934-986	--	--	-89	-97	-62	-69	-7	11/12	B
07-221	--	395356.2	750737	PHILADELPHIA	11	162-170	-39	-35	-30	-26	-22	-18	4	11/07	E
07-273	31-04756	395032	750344.4	RUNNEMEDE	*54	612-712	-78	-77	-83	-82	-61	-59	2	11/10	A
07-278	31-02434	395238.1	750314	CAMDEN	65	452-594	-72	-76	-82	--	-50	-56	-6	11/10	--

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down pe-riod
							1978	1983	1988	1993	1998	2003			
07-283	31-04282	395246	750433	CAMDEN	24	445-455	-62	-64	-64	-61	-48	-43	5	11/07	E
07-284	31-05054	395247.3	750434	CAMDEN	*30	-484	--	--	-66	-61	-45	-44	1	11/10	E
07-302	31-02130	395319.2	750138.8	CAMDEN	*21	523-572	-76	-83	-89	-95	-62	-55	7	11/13	B
07-320	31-04642	395650	750310.4	CAMDEN	69	245-285	-33	-36	-34	-32	-26	-18	8	11/12	B
07-335	31-02915	395719.6	750222	CAMDEN	61	243-278	-33	-35	-35	-34	-29	-27	2	11/12	A
07-341	31-01417	395755.2	750408.9	CAMDEN	45	115-145	-22	-20	-19	-21	-10	-7	3	11/12	E
07-350	51-00064	395802.7	750118.8	CAMDEN	12	232-257	--	--	--	--	-23	-18	5	11/12	E
07-368	51-00053	395847	750346.5	CAMDEN	10	106-126	-13	-22	-17	--	--	-12	--	11/17	D
07-372	31-05110	395853.5	750205.9	CAMDEN	68	195-230	--	--	-23	-20	-16	-13	3	11/12	E
07-390	51-00050	395943.2	750211.2	CAMDEN	6	93-118	-9	-8	-11	-9	-8	-6	2	11/17	E
07-412	31-09560	394922	745629	CLEMENTON	149	1082-1092	-62	-72	-78	-80	-58	-58	-0	11/07	E
07-523	31-12315	395151.6	750531.8	RUNNEMEDE	*81	458-557	-56	-58	-61	-58	-43	-38	5	11/10	B
07-528	31-08526	395836.7	750302.2	CAMDEN	20	140-180	-23	-28	-32	-22	-14	-13	1	11/17	E
07-541	31-15720	395611	750545	CAMDEN	20	215-253	--	-34	-31	-26	-19	-14	5	11/12	E
07-547	31-18944	395731.7	750456.3	CAMDEN	35	155-195	--	--	-32	--	-12	-10	2	11/07	E
07-597	31-20270	395718.1	750513	CAMDEN	11	136-176	--	--	-30	--	-11	-8	3	11/07	E
07-723	31-28896	395401.3	750317.4	CAMDEN	64	418-470	--	--	--	--	-49	-43	6	11/13	A
07-932	31-43420	395759.6	750415.3	CAMDEN	29	125-145	--	--	--	--	-11	-7	4	11/12	E
07-933	31-45075	395808	750117	CAMDEN	28	177-182	--	--	--	--	-22	-19	3	10/16	E
07-965	31-26140-0	395936	750200	CAMDEN	19	85-105	--	--	--	--	-12	-7	5	11/14	E
07-1006	31-58576	395755.4	750230.9	CAMDEN	33	250-260	--	--	--	--	--	-16	--	11/14	E
07-1055	31-59303	395817.8	750334.6	CAMDEN	67	210-220	--	--	--	--	--	-9	--	11/14	E
07-1085	39-59128	395406	750337	CAMDEN	51	355-445	--	--	--	--	--	-40	--	11/13	B
15-133	30-01222	394510	752243	MARCUS HOOK	20	317-367	--	--	-2	-4	-4	1	5	11/12	E
15-139	30-01223	394608	752134	BRIDGEPORT	7	301-345	-10	-10	-11	-1	-11	-9	2	11/14	E
15-282	31-07056	394913.2	751103.9	WOODBURY	55	388-450	-30	--	-34	-32	-51	-19	32	12/08	C
15-308	--	395041.4	751237.7	WOODBURY	10	231-271	-14	-15	-19	-41	-26	-13	13	12/03	E

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USGS well number	New Jersey permit number	Latitude	Longi-tude	USGS quadrangle	Altitude of land surface (ft)	Screened interval (ft)	Water-level altitude (ft)						1998-2003 water-level change (ft)	2003 mea-surement date	Shut-down pe-riod
							1978	1983	1988	1993	1998	2003			
15-312	51-00063	395106.8	750944.7	WOODBURY	20	322-372	-58	-55	-56	-45	-52	-29	23	12/04	D
15-321	31-00028	395220.1	750851.6	WOODBURY	13	237-277	--	-57	-61	--	--	-34	--	11/17	B
15-331	31-04259	394954.3	750908.1	WOODBURY	35	405-457	-44	-47	-53	-49	-42	-34	8	11/21	B
15-349	--	394650	752315	MARCUS HOOK	6	170-220	-5	-5	-8	-5	-6	-4	2	11/12	E
15-357	--	394957	751736	BRIDGEPORT	4	-105	-4	-4	--	--	--	-6	--	11/25	E
15-398	30-02016	394935	751937	BRIDGEPORT	1	50-60	--	--	-2	-1	-2	-0	2	11/23	E
15-430	31-17788	395154.5	750942	WOODBURY	15	256-328	--	-49	-53	--	--	-19	--	11/13	D
15-615	30-03530-9	394637	751915	BRIDGEPORT	29	378-388	--	--	-15	-16	-15	-12	3	11/25	E
15-618	30-03531-7	394804	751932	BRIDGEPORT	7	230-240	--	--	-7	-7	-8	-5	3	11/23	E
15-671	--	394957	750529	RUNNEMEDE	35	650-670	--	--	-69	-69	-53	-47	6	11/18	E
15-678	30-03625	394946	751611	BRIDGEPORT	9	194-204	--	--	-8	-5	-8	-5	3	12/04	E
15-680	30-03602	395038	751604	BRIDGEPORT	9	186-196	--	--	-5	-6	-5	-2	3	12/04	E
15-712	30-04347	394808	751723	BRIDGEPORT	7	275-290	--	--	-11	-11	-11	-8	3	11/17	E
15-738	30-03612-7	394948	751523	BRIDGEPORT	5	188-198	--	--	-9	-9	-9	-6	3	12/04	E
15-742	31-25266-4	394652	751003	WOODBURY	84	757-777	--	--	-37	-37	-32	-26	6	11/17	E
15-770	31-26237-6	395202	751114	WOODBURY	10	204-224	--	--	-25	-21	-17	-12	5	11/17	E
15-772	31-26242	395206	751117	WOODBURY	10	196-216	--	--	--	--	--	-12	--	11/17	E
15-778	31-26245	395222	751118.8	WOODBURY	5	170-190	--	--	--	--	-17	-13	4	11/17	E
15-1004	--	394421	750603	PITMAN EAST	80	1038-1206	--	--	--	-63	-55	-49	6	11/17	E
15-1125	30-04112	394937	751727	BRIDGEPORT	15	186-196	--	--	--	-3	-4	-3	1	11/25	E
15-1201	30-11328	395024	751449	WOODBURY	12	235-245	--	--	--	--	--	-5	--	12/04	E
15-1487	30-12609	394433	752011	WOODSTOWN	104	495-525	--	--	--	--	-15	-16	-1	11/10	A
33-86	30-01139	394557	752522	MARCUS HOOK	13	169-189	-10	-12	-11	-17	-14	-12	2	11/12	E
33-330	50-00098	394205	752658.1	PENNS GROVE	16	-394	-38	-15	-23	-40	-34	-34	-0	11/24	B
33-335	30-01133	394211.3	752743.3	PENNS GROVE	*13	270-430	--	-30	-33	--	--	-32	--	11/24	E
33-458	--	392751	753209.2	TAYLORS BRIDGE	*11	1112-1132	--	-33	--	-41	-42	-45	-3	11/21	E
P10103	--	395314	751009	PHILADELPHIA	9	242-247	-27	--	-22	-18	-16	-10	6	11/07	E

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							1978	1983	1988	1993	1998	2003			
P10113	--	395408	751039	PHILADELPHIA	6	--	-7	--	-5	-4	-3	-3	0	11/07	E
P10114	--	395445	750830	PHILADELPHIA	10	122-167	--	--	-8	-6	-6	-5	1	11/07	E
Delaware wells															
Cc45-01	10029	394110	753542	WILMINGTON SOUTH	70	187-197	--	--	--	--	--	-8	--	12/22	--
Cc45-02	10030	394059	753533	WILMINGTON SOUTH	65	211-221	--	--	--	--	--	-8	--	12/22	--
Cc45-27	159723	394114	753545	WILMINGTON SOUTH	70	295-305	--	--	--	--	-29	-11	18	12/22	E
Cd51-26	190390	394020	753448	WILMINGTON SOUTH	15	182-242	--	--	--	--	--	-38	--	12/22	E
Da43-02	42911	393608	754703	ELKTON	70	228-247	--	--	--	--	-16	6	22	12/22	E
Da43-03	50306	393607	754659	ELKTON	69	222-250	--	--	--	--	--	6	--	12/22	--
Db15-05	8006	393917	754016	NEWARK EAST	20	215-306	--	--	--	--	-1	0	1	12/15	--
Dc31-67	190145	393746	753939	WILMINGTON SOUTH	65	415-435	--	--	--	--	--	-67	--	12/23	E
Db33-17	10398	393734	753711	NEWARK EAST	48	185-189	--	--	--	--	-40	-51	-11	12/12	E
Dc33-18	190389	393752	753754	NEWARK EAST	42	610-720	--	--	--	--	--	-77	--	01/06	E
Dc34-05	Dc3405	393755	753648	WILMINGTON SOUTH	28	574-599	--	--	-68	-65	-64	-74	-10	12/12	E
Ea14-33	95617	393422	754648	ELKTON	70	322-372	--	--	--	--	--	-53	--	12/29	E
Ea24-07	96500	393314	754649	ELKTON	*40	332-352	--	--	--	--	-51	-42	9	12/22	E
Ea25-07	48857	393314	754529	ELKTON	58	324-412	--	--	--	--	--	-40	--	12/22	--
Ea35-31	193104	393248	754551	ELKTON	60	830-870	--	--	--	--	--	-34	--	12/22	--
Eb23-25	10405	393309	754215	ST GEORGES	60	600-604	--	--	-49	-52	-63	-36	27	12/12	E
Ec15-27	36504	393428	753538	DELAWARE CITY	13	692-722	--	--	--	--	-179	-178	1	12/22	--
Ec15-28	37981	393445	753509	DELAWARE CITY	11	707-737	--	--	--	--	--	-187	--	12/22	E
Ec32-07	Ec32-07	393209	754920	ST GEORGES	9	586-596	--	--	-93	-87	-101	-102	-1	01/12	E
Fb33-25	39676	392708	754257	MIDDLETOWN	60	800-846	--	--	--	--	-37	-42	-5	12/23	--
Fb11-09	157658	392924	754418	MIDDLETOWN	70	830-870	--	--	--	--	--	-37	--	12/23	--
Maryland wells															
CE Bf 82	Zz63151	393537	754920	ELKTON	70	120-125	--	--	--	--	6	7	1	12/30	E
CE Ce 55	Zz63155	393241	755002	ELKTON	55	370-375	--	--	--	--	-13	-9	4	12/30	E

For additional information, write to:
Director
U.S. Geological Survey
New Jersey Water Science Center
Mountain View Office Park
810 Bear Tavern Rd., Suite 206
West Trenton, NJ 08628

or visit our Web site at:
http://nj.usgs.gov/

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