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WITHDRAWALS OF GROUND WATER AND SURFACE WATER IN NEW JERSEY, 1993

INTRODUCTION

Throughout the past century, New Jersey has responded to the effects of population and industrial growth on the State's water resources by developing comprehensive water management programs. Regulations are in place for monitoring the withdrawals of surface water for public supply (enacted in 1907) and the withdrawals of ground water for public supply (1910); registering the drilling of new wells and permitting the withdrawals of 100,000 gallons or greater during a 24-hour period (1947); regulating the withdrawals of surface water by self-supplied users (1963); and regulating the withdrawals of ground water by irrigation users (1981).

The amount and frequency of precipitation and above normal summer temperatures can affect the use of water, especially withdrawals for irrigation, public supply, and thermoelectric power (Clawges and Titus, 1993; Nawyn and Clawges, 1995). In 1993, normal climatological conditions were reported for New Jersey. Annual precipitation was 44 in. (inches), and the average annual temperature was 53° Fahrenheit. Both values were the average annual values reported by the National Climatic Data Center (1994) for 1961-90. Precipitation was above average throughout the State in March and September. In the Coastal Plain (fig. 1), average precipitation during the growing season (June-September) was almost 1 in. less than the average precipitation for this period (National Climatic Data Center, 1994).

Data on withdrawals of ground water and surface water in New Jersey in 1993 were compiled from monthly reports submitted to the New Jersey Department of Environmental Protection by water users with pumping equipment capable of producing 100,000 gallons per day or greater. Estimated data are noted in the text. In 1993, withdrawals totaled 2,171 Mgal/d (million gallons per day)--578 Mgal/d of ground water and 1,593 Mgal/d of surface water (table 1).

GROUND-WATER WITHDRAWALS

About 63 percent of ground-water withdrawals in New Jersey are from aquifers in the Coastal Plain. Withdrawals from aquifers in the Piedmont, Highlands, and Valley and Ridge Physiographic Provinces totaled about 37 percent of all ground-water withdrawals (table 2d).

Base from U.S. Geological Survey digital data, 1:100,000, 1983, Universal Transverse Mercator projection, Zone 18

Figure 1. Counties and physiographic provinces in New Jersey.

Coastal Plain

Withdrawals from aquifers in the Coastal Plain (fig. 1) totaled 366 Mgal/d. Withdrawals from the Potomac-Raritan-Magothy aquifer system, the primary source of ground water for public supply in New Jersey, totaled 188 Mgal/d. Withdrawals from the Upper, Middle, Lower, and undifferentiated aquifers of the Potomac-Raritan-Magothy aquifer system were 62 Mgal/d, 51 Mgal/d, 49 Mgal/d, and 26 Mgal/d, respectively. Withdrawals totaled 89 Mgal/d from the Kirkwood-Cohansey aquifer system and 26 Mgal/d from the Atlantic City 800-foot sand. Withdrawals from unclassified aquifers in the Coastal Plain totaled 47 Mgal/d for self supply, such as domestic and irrigation use (table 2).

Table 1. Withdrawals of water in New Jersey, by county and type of water, 1993

[Withdrawals in million gallons per day; --, not reported]

County	Type of water	
	Ground water	Surface water
Atlantic	43	3
Bergen	33	89
Burlington	41	125
Camden	68	3
Cape May	18	6
Cumberland	34	46
Essex	22	5
Gloucester	31	45
Hudson	1	--
Hunterdon	14	114
Mercer	14	555
Middlesex	49	3
Monmouth	23	51
Morris	55	54
Ocean	50	9
Passaic	8	286
Salem	11	22
Somerset	17	101
Sussex	12	6
Union	15	12
Warren	19	58
State	578	1,593

Non-Coastal Plain

The Piedmont, Highlands, and Valley and Ridge Physiographic Provinces (fig. 1) are the non-Coastal Plain provinces; withdrawals of ground water there totaled 212 Mgal/d, including 146 Mgal/d for public supply and 66 Mgal/d for self supply. Withdrawals from glacial-deposit aquifers totaled 69 Mgal/d, including 64 Mgal/d for public supply and 5 Mgal/d for self supply. Withdrawals from aquifers of the Brunswick Group totaled 74 Mgal/d--56 Mgal/d for public supply and 18 Mgal/d

for self supply. Withdrawals from aquifers of the Kittatinny Supergroup, Franklin Limestone, and Precambrian crystalline-rock aquifers totaled 18 Mgal/d, including 15 Mgal/d for public supply and 3 Mgal/d for self supply. Withdrawals from unclassified aquifers in the non-Coastal Plain provinces of New Jersey totaled 51 Mgal/d and included 11 Mgal/d for public supply and 40 Mgal/d for self supply (table 2).

Table 2. Withdrawals of ground water from the Coastal Plain and non-Coastal Plain physiographic provinces in New Jersey, by aquifer and type of supply, 1993

[Withdrawals in million gallons per day, Mgal/d; --, not reported; **, value less than 1 Mgal/d]

Aquifer	Type of supply: Public supply	Type of supply: Self supply
Coastal Plain Aquifers		
Kirkwood-Cohansey aquifer system	60	29
Rio Grande water-bearing zone	2	--
Atlantic City 800-foot sand	24	2
Piney Point aquifer	1	**
Vincentown aquifer	1	**
Wenonah-Mount Laurel aquifer	5	**
Englishtown aquifer system	6	1
Potomac-Raritan-Magothy aquifer system		
Upper aquifer	52	10
Middle Aquifer	41	10
Lower aquifer	45	4
Undifferentiated	17	9
Unclassified aquifers	--	47
Coastal Plain total	254	112
Non-Coastal Plain Aquifers		
Glacial-deposit aquifers	64	5
Aquifers of the Brunswick Group	56	18
Aquifers of the Kittatinny Supergroup, Franklin Limestone, and Precambrian crystalline-rock aquifers	15	3
Unclassified aquifers	11	40
Non-Coastal Plain total	146	66
State total	400	178

SURFACE -WATER WITHDRAWALS

Withdrawals of surface water totaled 1,593 Mgal/d (table 1). The largest surface-water withdrawals were in Mercer (555 Mgal/d), Passaic (286 Mgal/d), Hunterdon (114 Mgal/d), Burlington (125 Mgal/d), Somerset (101 Mgal/d), and Bergen Counties (89 Mgal/d) (table 1). Surface water was withdrawn chiefly by public suppliers (711 Mgal/d) and thermoelectric-power facilities (558 Mgal/d). Withdrawals of surface water by industrial, mining, irrigation, and commercial users totaled 154 Mgal/d, 73 Mgal/d, 96 Mgal/d, and 1 Mgal/d, respectively. The Delaware River is the chief source of surface water for thermoelectric-power and industrial use. About 85 Mgal/d of surface water was transferred by public suppliers from the Delaware River at Hunterdon County to Somerset County through the Delaware and Raritan Canal (fig. 2).

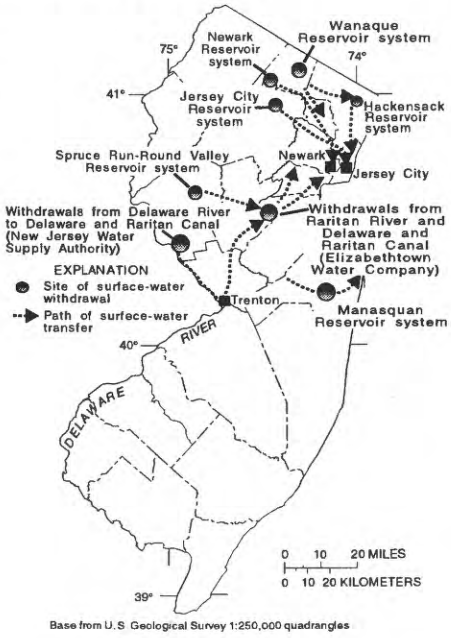

Figure 2. Transfers of surface water among public-supply systems in New Jersey.

Withdrawals of surface water for public supply in one county can be widely distributed among several counties through interconnected water systems (fig. 2). Water from the Wanaque Reservoir system (Passaic County), one of the largest water-supply reservoirs in the State, is distributed to communities throughout northeastern New Jersey. Water from reservoirs in Morris County is distributed to water users in Essex (City of Newark) and Hudson (Jersey City) Counties. Water users in Middlesex County receive water from reservoirs in Monmouth County.

WITHDRAWALS BY CATEGORY OF USE

The categories of water use are public supply, domestic, commercial, irrigation, industrial, mining, and thermoelectric power. Water users can be self-supplied or publicly supplied. Public suppliers deliver water to domestic, commercial, industrial, thermoelectric-power, and public water users. Irrigation and mining users are entirely self-supplied.

Public Supply

Public-supply withdrawals totaled 1,116 Mgal/d (table 3), including 405 Mgal/d of ground water and 711 Mgal/d of surface water. About 80 percent (893 Mgal/d) of the public-supply withdrawals are metered deliveries; the remaining 20 percent (223 Mgal/d) are attributed to distribution-system maintenance, public water use, or unaccounted-for water. Metered deliveries included domestic (570 Mgal/d), commercial (196 Mgal/d), industrial (103 Mgal/d), and thermoelectric-power (24 Mgal/d) (fig. 3). Distribution-system maintenance (11 Mgal/d) includes the backwashing of filters and well screens (fig. 3). Unaccounted-for water use was estimated to be about 155 Mgal/d, including distribution losses, such as water leaks, improperly registering meters, and unauthorized connections (fig. 3). Public water use for municipal facilities, such as offices, parks, and schools, was estimated to be about 57 Mgal/d (fig. 3).

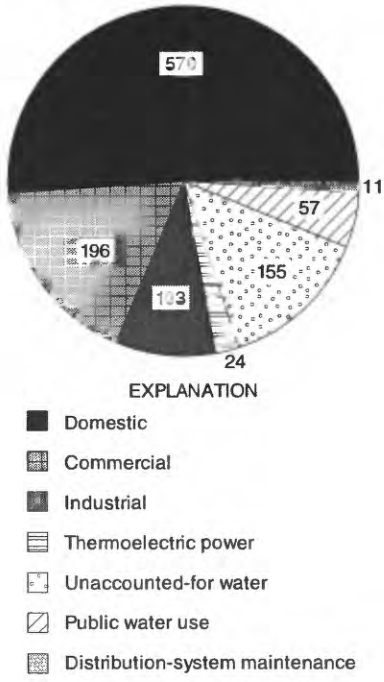

Figure 3. Estimated water deliveries of public suppliers in New Jersey, by category of use; estimated distribution-system-maintenance usage; and estimated distribution losses, 1993. (Values are in million gallons per day.)

Withdrawals by County

More than one-quarter of all the publicly supplied water in New Jersey is withdrawn in Passaic County; withdrawals for public supply in the county totaled 290 Mgal/d (table 3), including about 61 Mgal/d pumped to the Wanaque Reservoir. Withdrawals for public supply were 112 Mgal/d in Somerset County, 108 Mgal/d in Bergen County, 95 Mgal/d in Morris County, and 94 Mgal/d in Hunterdon County (table 3).

Per Capita Use

About 6.9 million persons or 88 percent of the residents of New Jersey are estimated to be served by public-supply systems (U.S. Bureau of the Census, 1992). In 1993, domestic deliveries in the State were estimated to be 570 Mgal/d (fig. 3), and the per capita use of publicly supplied domestic users was estimated to be 83 gal/d (gallons per day). In 1993, the smallest monthly domestic deliveries were in February and totaled 473 Mgal/d (per capita use, 69 gal/d). This volume is assumed to be almost all indoor water use. The largest monthly domestic deliveries were in July and totaled 645 Mgal/d (per capita use, 93 gal/d). This volume is assumed to include the largest amount of outdoor water use.

Domestic

Withdrawals for domestic use in 1993 were estimated to be 650 Mgal/d. Self-supplied domestic use was estimated to be 80 Mgal/d; deliveries of publicly supplied water were estimated to be 570 Mgal/d. Domestic deliveries of publicly supplied water were estimated to be 51 percent of total public-supply withdrawals. Self-supplied withdrawals were estimated by multiplying the number of users (U.S. Bureau of the Census, 1992, 1994) by the per capita coefficient of 83 gal/d. This per capita coefficient was estimated on the basis of per capita use of publicly supplied residents.

In the past, self-supplied residents used more water than publicly supplied residents chiefly because of the cost of water. Although there are electrical and maintenance costs associated with a self-supply system, the cost of water for self-supplied residents of single-family housing units is minimal. Another factor that can affect water use is the type of water fixtures, such as toilets. This factor is not clearly differentiated between publicly supplied and self-supplied users. Since the early 1980's, water-conserving fixtures have been installed in all new publicly supplied and self-supplied housing units. In addition, water-conserving toilets are the only type of replacement toilets available. When the replacement of existing water fixtures in older housing units is completed, the difference in water use between publicly supplied and self-supplied water users may change; however, for this report, the per capita use of publicly supplied residents are estimated to be the same as self-supplied residents.

Commercial

Withdrawals for commercial use were estimated to be 210 Mgal/d. Self-supplied withdrawals for commercial use were 14 Mgal/d (table 3), and publicly supplied deliveries were estimated to be 196 Mgal/d (fig. 3), or about 18 percent of total public-supply withdrawals. Self-supplied withdrawals of ground water and surface water for commercial use were about 13 Mgal/d and 1 Mgal/d, respectively. The largest self-supplied commercial withdrawals were 8 Mgal/d in Warren County (table 3) where the Pequest (State-operated) fish hatcheries are located.

Table 3. Withdrawals of ground water and surface water in New Jersey for public supply and self supply, by county and category of use, 1993

[Figures may not add to totals because of independent rounding. Withdrawal data are metered values, except as noted. All values in million gallons per day; **, withdrawals less than 1 million gallons per day; --, not reported.]

		Self supply						
County	Public supply	Domestic[1]	Commercial	Irrigation[2]	Industrial	Mining	Thermo-electric power	County total[2,3]
Atlantic	27	6	1	11	1	--	--	46
Bergen	108	2	1	**	10	--	--	122
Burlington	28	7	1	83	4	5	38	166
Camden	63	3	1	1	1	2	--	71
Cape May	13	4	**	1	**	6	**	24
Cumberland	16	4	**	10	5	45	--	80
Essex	26	**	**	**	1	--	--	27
Gloucester	20	4	**	5	46	1	--	76
Hudson	--	--	--	--	1	--	--	1
Hunterdon	[4]94	6	**	**	8	--	20	128
Mercer	43	2	**	**	24	--	500	569
Middlesex	39	2	**	1	8	2	--	52
Monmouth	67	4	**	2	1	--	--	74
Morris	95	7	**	**	4	3	--	109
Ocean	42	9	1	2	1	4	--	59
Passaic	290	3	**	**	**	--	--	294
Salem	5	2	**	7	18	--	1	33
Somerset	112	5	**	**	1	**	--	118
Sussex	5	7	**	**	--	6	--	18
Union	16	**	1	**	10	**	--	27
Warren	7	3	8	1	58	--	--	77
State	1,116	80	14	125	202	[3]75	559	2,171

[1] Estimated water-use values.
[2] Includes withdrawal values estimated by water user.
[3] Value may not equal total due to rounding.
[4] Includes water transfer from Delaware River in Hunterdon County to Raritan River in Somerset County.

Irrigation

Withdrawals for irrigation use were 125 Mgal/d (table 3)--29 Mgal/d of ground water and 96 Mgal/d of surface water. Withdrawals in Burlington County, chiefly surface water for cranberry production, were 80 Mgal/d, accounting for about 64 percent of withdrawals for irrigation use in the State. Consumptive use of water used for cranberry irrigation was estimated to be about 12 Mgal/d (Clawges and Titus, 1993). The largest ground-water withdrawals were 9 Mgal/d in Atlantic County. Withdrawals for irrigation use totaled 10 Mgal/d in Cumberland County, 7 Mgal/d in Salem County, and 5 Mgal/d in Gloucester County (table 3).

New Jersey, the Garden State, supports a viable agricultural trade because of the State's productive soils, proximity to major markets, and abundant water resources. In 1993, about 9,000 farms occupied 17 percent (848,000 acres or 1,330 mi^2) of the land area of the State (U.S. Bureau of the Census, 1994). Vegetables, tree fruits (peaches), small fruit (blueberries) or nut crops, and sod (turf) are the chief irrigated crops.

Industrial

Withdrawals for industrial use totaled 305 Mgal/d. Self-supplied withdrawals totaled 202 Mgal/d (table 3)--48 Mgal/d of ground water and 154 Mgal/d of surface water. Publicly supplied withdrawals for industrial use were estimated to be 103 Mgal/d (fig. 3) or 9 percent of total public-supply withdrawals. Self-supplied withdrawals for industrial use, consisting mostly of surface water, were 58 Mgal/d in Warren County and 46 Mgal/d in Gloucester County (table 3). The largest self-supplied withdrawals of ground water for industrial use were 11 Mgal/d in Middlesex County and 5 Mgal/d in Gloucester County.

The number of self-supplied industrial facilities in New Jersey totaled about 300, including chemical, petroleum, and paper-manufacturing facilities that require large volumes of water for cooling or production processes. In 1993, self-supplied industrial users accounted for about 2 percent of all industrial facilities in New Jersey (Bureau of the Census, 1994). The most recent (1983) data on water use in manufacturing from the U.S. Bureau of the Census (1986) indicates that 85 percent of total withdrawals for industrial purposes were made by self-supplied water users. In 1993, self-supplied industrial withdrawals were estimated to be 66 percent of total industrial water use in New Jersey. Many self-supplied industrial facilities are purchasing supplemental water from local public suppliers, and the water requirements of self-supplied water users have decreased as a result of water conservation practices (Ploeser and others, 1992).

Mining

Withdrawals for mining use were 75 Mgal/d (table 3). Surface-water withdrawals totaled 73 Mgal/d; the balance was ground water. The largest withdrawals for mining use were 45 Mgal/d in Cumberland County and 6 Mgal/d each in Cape May and Sussex Counties (table 3). Withdrawals for mining use in 1993 were 134 percent of the average withdrawals during 1991-92 (32 Mgal/d) as a result of increased production at a sand-glass facility in Cumberland County.

Mining facilities in the Coastal Plain produce sand and gravel for housing and road construction, industrial sand for glass making, and fire clay for furnaces and ceramics. Crushed stone, consisting of basalt and granite, is extracted throughout the Piedmont, Highlands, and Valley and Ridge Physiographic Provinces. Shale is quarried in the Piedmont Physiographic Province. Among the states, New Jersey ranks third in the production of industrial sand and gravel (U.S. Bureau of Mines, 1995). New Jersey is the only state to produce greensand, a water softening, filtration medium used to remove soluble iron and manganese from ground water and as an organic conditioner for soils. (Harrison, 1988; U.S. Bureau of Mines, 1995).

Thermoelectric Power

Thermoelectric-power use in New Jersey totaled 583 Mgal/d, including self-supplied withdrawals of 559 Mgal/d (table 3) and public-supply deliveries of about 24 Mgal/d (fig. 3). About 2 Mgal/d of ground water were withdrawn for thermoelectric-power use. Withdrawals from the Delaware River in Mercer, Burlington, and Hunterdon Counties were 500 Mgal/d, 38 Mgal/d, and 20 Mgal/d, respectively (table 3). Annual withdrawals for thermoelectric-power use can vary widely. Thermoelectric-power use is related to climatological conditions that affect energy demands of New Jersey customers; non-utility sources of generation, such as cogeneration facilities; and plant maintenance schedules. Withdrawals of saline water for thermoelectric-power use in New Jersey were not included.

NONCONSUMPTIVE USE

Consumptive use is defined as that part of withdrawals that is evaporated, transpired, or incorporated into crops or products (Solley and others, 1993). For example, the use of water for a lawn, a backyard garden, or field crops is consumptive use because the water is transpired or incorporated into the plants. Conversely, nonconsumptive use is the use of water for toilet flushing because the water can be available (after treatment at a wastewater treatment facility) for other uses, such as public supply or irrigation, or as process water for industrial users. Irrigation use for cranberry production (estimated 68 Mgal/d) (Clawges and Titus, 1993), as well as, industrial (U.S. Bureau of the Census, 1986), mining (Quan, 1988), and thermoelectric power use (Solley and others, 1993) are chiefly nonconsumptive use. Withdrawals for these uses was estimated to be 1,031 Mgal/d or 47 percent of total withdrawals in the State. Nonconsumptive use was estimated to be 92 percent (949 Mgal/d) and consumptive use to be 8 percent (82 Mgal/d) of these uses.

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—John P. Nawyn

Information on New Jersey water-use data can be obtained from:

U.S. Geological Survey
Mountain View Office Park
810 Bear Tavern Road, Suite 210
West Trenton, New Jersey 08628
(609) 771-3964 or jnawyn@usgs.gov

Fact Sheet FS-119-97
July 1997