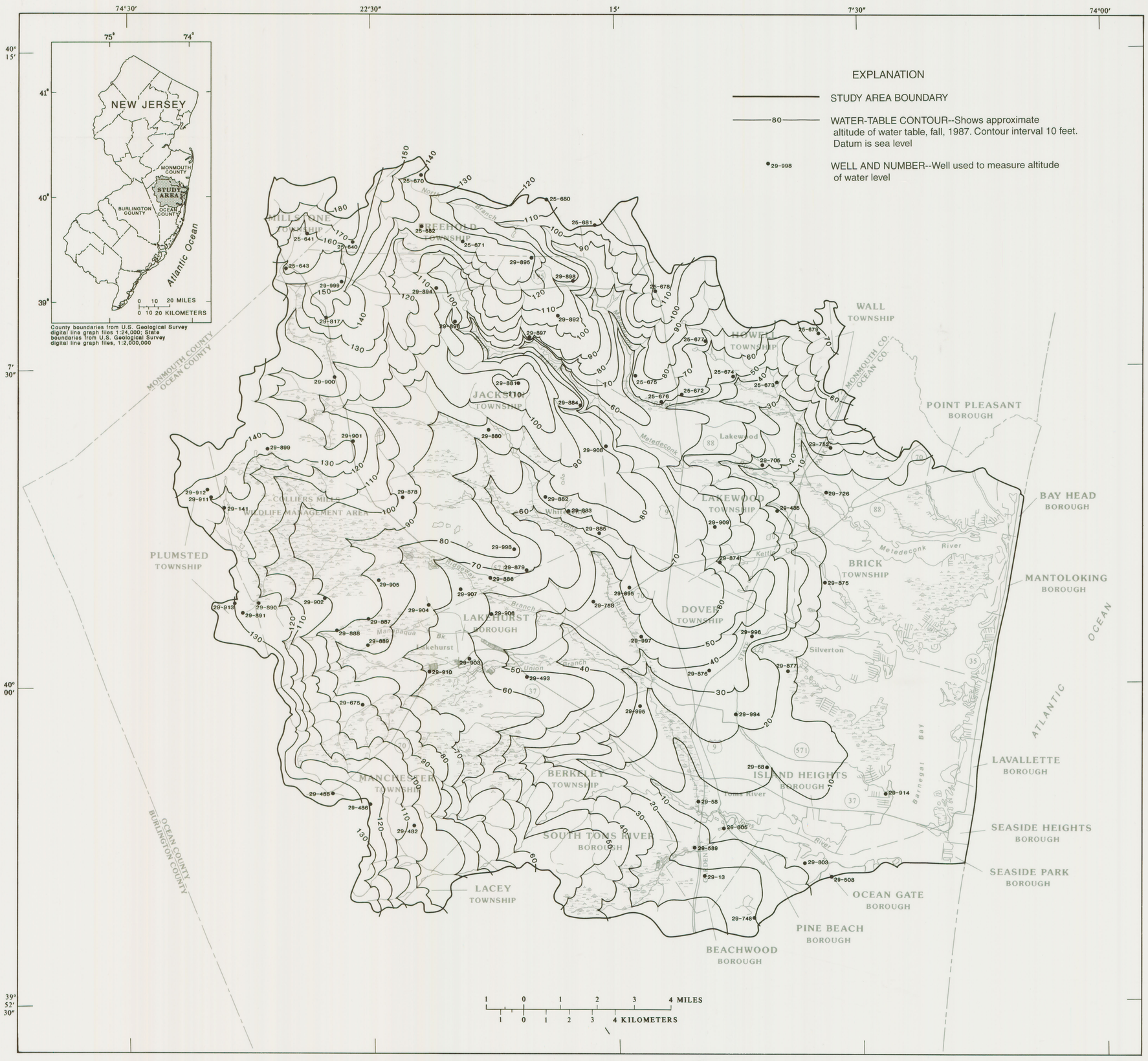

Base from U.S. Geological Survey, 1:24,000, quadrangles, Roosevelt, 1948; Adelphia, 1948; Farmingdale, 1943; Cassville, 1948; Lakehurst, 1948; Lakewood, 1947; Point Pleasand, 1953; Whiting, 1949; Keswick Grove, 1949; Toms River, 1953; Seaside Park, 1953

Figure 2-1.--Map of the study area showing well locations and the altitude of the water level in the Kirkwood-Cohansey aquifer system, October and November, 1987.

GROUND WATER

This sheet includes a water-level map for the study area, constructed from water-level data collected in October and November 1987. Two long-term water-level hydrographs and the results of aquifer tests conducted in the Kirkwood-Cohansey aquifer system in and near the study area also are presented.

Water Table

Ground water in unconfined aquifers flows from recharge areas to discharge areas. Recharge generally occurs at outcrop areas or at topographic highs, whereas discharge occurs at topographic lows, such as wetlands, rivers, streams, and springs. The shape of the water table is controlled principally by topography; therefore, the water table tends to be a subdued replica of the topography. Streams also affect the shape of the water table. Where the water table intersects a stream channel, the water-table contour has a "v" shape. For a gaining stream--one that receives ground-water discharge--the "v" points upstream because ground water is flowing into the stream. All of the streams in the study area are gaining streams.

Water-Level Map

The water-level map of the Kirkwood-Cohansey aquifer system was constructed from water levels measured in 83 wells throughout the study area in October and November 1987 (fig. 2-1). Well locations also are shown in figure 2-1; well-construction data for these wells are listed in table 2-1. Elevations of streams, lakes, and wetlands (all considered to be part of the water table) were taken from USGS 7-1/2-minute topographic maps to supplement well measurements. Some of the surface-water features that affect the shape of the water table could not be shown in figure 2-1 at the 1:100,000 scale. All water levels were measured with respect to land surface at each measuring site. The elevation of the land surface then was used to determine the water-level altitude with respect to sea level. Water-level altitudes in the study area range from sea level in the eastern part of the basin to about 180 ft above sea level in the northwestern part of the basin.

Water-Level Monitoring

The USGS has collected long-term water-level data for two wells in the study area that are screened in the Kirkwood-Cohansey aquifer system. These wells are located in the upper reaches of the Toms River Basin (fig. 2-2). Colliers Mills Test Well 4 is near the center of the western boundary of the study area between the border of Jackson and Plumsted Townships; the Crammer Observation Well, at the Whiting Bible Church in Manchester Township, is in the southern part of the study area. Water-level hydrographs for these two wells for the period of record are shown in figures 2-3 and 2-4, respectively; figure 2-4 also shows annual precipitation at the Toms River weather station (fig. 2-2). The period of record for the Colliers Mills well is from March 1964 through March 1990. Water levels in this well were measured hourly from March 1964 through April 1975 with an automatic continuous recorder. The lowest monthly values during this time period are shown on the water-level hydrograph. No water-level data were collected between April 1975 and October 1976, but from October 1976 through March 1990, site visits were conducted several times a year to measure the water levels manually. Hourly water-level data obtained with an automatic continuous recorder are available for the Crammer Observation Well from May 1952 through March 1990. The lowest monthly values are shown on the water-level hydrograph (fig. 2-4).

Table 2-1.--Well-construction data for, and water levels measured in, the Kirkwood-Cohansey aquifer system, October and November 1987

[Data reported to maximum number of significant figures available in Ground-Water Site Inventory data base on file at the U.S. Geological Survey office in West Trenton, N.J.; --, missing data; St, Saint; Inc, Incorporated; Co, Company; WD, Water Department; WC, Water Company; US, United States; Vil, Village; L, Lake; T PK, Trailer Park; Boro, Borough; PKG, Packaging; Tech, Technical; Twp, Township; MUA, Municipal Utility Authority; Util Auth, Utility Authority; Irr, Irrigation; Assoc, Association; DEP, Department of Environmental Protection; DWM, Division of Waste Management; NJ, New Jersey; Corp, Corporation]

New Jersey well number	Lati-tude	Long-itude	Owner	Local well name	Year drilled	Elevation of land surface (feet above sea level)[1]	Depth of well (feet below land surface)	Screened interval (feet below land surface)	Water level (feet below land surface)	Altitude of water level (feet above sea level)
25-640	401030	742303	ZDANCEWIC, LEON	ZDANCEWIC HAND	--	190	26	--	20.49	169.51
25-641	401042	742427	TATERS	TATERS HAND	--	173	15	--	10.11	162.89
25-643	400953	742507	IVANS, ROSE	IVANS HAND	1930	162	14	3 - 14	9.56	152.44
25-670	401205	742056	MORRIS, JOHN	MORRIS HAND	1964	149	22	0 - 22	13.02	135.98
25-671	401030	741940	LAWRENCE, DOROTHY	LAWRENCE HAND	1941	159	36	0 - 36	22.51	136.49
25-672	400652	741257	ST ALEXANDER NEVSKY	NEVSKY HOME	--	72	70	65 - 70	9.82	62.18
25-673	400711	741001	WASTE MANAGEMENT INC	WM OW6	1984	42	30	25 - 30	7.43	34.57
25-674	400717	741122	GYIRASZI	GYIRASZI HOUSE	1987	61	65	60 - 65	5.56	55.44
25-675	400719	741423	FOLEY, HERB	FOLEY HOUSE	1985	95	50	45 - 50	17.25	77.75
25-676	400642	741335	KRUPNICK, MARK	KRUPNICK HOUSE	1986	76	80	74 - 80	14.94	61.06
25-677	400807	741213	BRENIAK	BRENIAK HOUSE	1986	78	85	80 - 85	6.08	71.92
25-678	400918	741345	HOWELL GULF	GULF MONITOR	1987	122	11	0 - 11	9.73	112.27
25-679	400817	740844	BOWNE	BOWNE HOUSE	1981	77	50	45 - 50	11.81	65.19
25-680	401129	741705	SCHWARTZMAN	SCHWARTZMAN HAND	1940	132	22	0 - 22	15.58	116.42
25-681	401052	741536	SCHUG CONSTRUCTION CO	SCHUG	1987	121	28	18 - 28	7.63	113.37
25-682	401052	742056	WORTH, DORIS	WORTH HAND	1957	144	15	- 0.6 - 15	6.60	137.40
29-13	395530	741220	BEACHWOOD WD	BWD 4	1963	60	99	67 - 99	37.53	22.47
29-58	395715	741231	TOMS RIVER WC	TRWC 21	1968	10	56	46 - 56	7.0	3.0
29-68	395803	741024	TOMS RIVER WC	TRWC 15	1958	25	230	195 - 225	14.25	10.75
29-141	400414	742702	US GEOLOGICAL SURVEY	COLLIERS MILLS 4 OBS	1964	135.31	71	46 - 71	5.25	130.05
29-435	400406	741002	MANCHESTER TMUA	1	1969	30	78	63 - 78	6.27	23.73
29-482	395643	742114	CRESTWOD VIL WC	CRESTWOD VIL 2	1969	115	159	129 -159	12.72	107.28
29-486	395714	742234	WHITING BIBLE CHURCH	CRAMMER OBS	--	179.05	69	0 - 69	55.03	124.02
29-488	395729	742343	CEDAR GLEN L WC	1	1970	150	143	123 -143	17.38	132.62
29-493	400013	741746	PINE ACRES T PK	2-1971	1971	82	101	77 -101	25.40	56.60
29-508	395528	740826	OCEAN GATE BORO WD	OGWD 3	1959	10	153	133 -153	3.40	6.60
29-589	395610	741238	TOMS RIVER WC	TRWC 32	1979	20	49	34 - 44	4.00	16.0
29-675	395935	742248	NEW BEGINNINGS SCHOOL	1	1976	102	58	50 - 56	7.58	94.42
29-695	400219	741436	SESCO BAY MACHINES	1	1980	90	76	72 - 76	34.85	55.15
29-705	400511	741029	FAIRWAY VILLAGE	GOLF CLUB	1980	30	110	90 -110	8.91	21.09
29-726	400432	740831	BRICK TWP MUA	FORGE POND 5	1970	20	67	42.58- 67	17.63	2.37
29-748	395430	741049	OCEAN CO UTIL AUTH	CWPCF 2	1978	40	117	107 -117	20.10	19.9
29-752	400535	740823	GREENBRIAR-IRR-SALES	BRYANT RD	1981	46	60	50 - 60	18.23	27.77
29-758	400159	741543	MANCHESTER TWP MUA	HOLLY OAKS 2	1978	80	83	68.5 - 83	32.85	47.15
29-803	395547	740915	OCEAN CO UTIL AUTH	OCUA 14-1W	1978	15	65	55 - 65	8.68	6.32
29-805	395637	741144	OCEAN CO UTIL AUTH	OCUA 9-2E	1978	12	60	50 - 60	4.95	7.50
29-817	400843	742353	GOVERNALE	GOVERNALE NO 1	1977	155	45	--	5.45	149.55
29-874	400254	741149	BUDELMAN	BUDELMAN HOUSE	1986	63	68	63 - 68	14.38	48.62
29-875	400224	740835	BP GAS CO	BP MONITOR SE	1987	12	13	0 - 13	4.80	7.2
29-876	400021	741210	MACKIEWICZ	MACKIEWICZ 1	1986	78	120	110 -120	44.03	33.97
29-877	400019	740944	OCEAN COUNTY COLLEGE	OCC ARBORITUM	1984	24	100	--	7.84	16.16
29-878	400428	742133	FORGUS, STEVEN	FORGUS DRIVE	1960	106	28	24 - 28	11.80	94.20
29-879	400244	741746	SCOTT, ROBERT L	SCOTT HOME	1987	85	69	64 - 69	13.35	71.65
29-880	400603	741854	HEUBLEIN, WALTER	HEUBLEIN CHICK	1940	114	30	25 - 30	25.87	88.13
29-881	400709	741758	DIMAKIDES, DIMITRIUS	DIMAKIDES HAND	1955	123	19	17 - 19	11.98	111.02
29-882	400428	741710	JOHNSTON, GREG	JOHNSTON	1973	85	28	23 - 28	9.62	75.38
29-883	400408	741627	BEUTTEL	BEUTTEL HOUSE	1985	102	65	55 - 65	28.99	73.01
29-884	400637	741604	ZENGEL	ZENGEL HOUSE	1947	108	40	30 - 40	27.11	80.89
29-885	400336	741531	STYLE CRAFT PRODUCTS	STYLE 1	1986	75	75	70 - 75	10.84	64.16
29-886	400234	741852	ADDIS, WAYNE	ADDIS	1985	78	65	60 - 65	13.54	64.46
29-887	400136	742236	LAKEHURST NAVAL AIR	LNAS-DR	1985	100.9	22	7 - 22	10.9	90.0
29-888	400120	742335	LAKEHURST NAVAL AIR	LNAS-DI	1985	95.9	20	5 - 20	5.67	90.23
29-889	400059	742338	LAKEHURST NAVAL AIR	LNAS-DK	1985	95.5	20	5 - 20	9.96	85.54
29-890	400159	742559	LAKEHURST NAVAL AIR	LNAS-EJ	1985	126.1	18	3 - 18	2.55	123.55
29-891	400145	742628	US AIR FORCE	USAF MW SOUTH	--	139	25	20 - 25	13.27	125.73
29-892	400844	741645	DUBOWSKY, THOMAS	DUBOWSKY 1	1979	124	70	65 - 70	18.79	105.21
29-894	400924	742029	VISTA CENTERS ASSOC	VISTA B	1960	153	100	90 -100	45.78	107.22
29-895	401006	741734	HINE, WILLIAM	HINE HAND	1950	150	27	0 - 27	17.19	132.81
29-896	400837	741955	CROMER, CHARLES	CROMER HAND	1955	118	18	0 - 18	10.89	107.11
29-897	400814	741738	RIGGLEMAN, CHARLES	RIGGLEMAN HAND	1941	105	15	0 - 15	13.08	91.92
29-898	400933	741617	BUTLER	BUTLER HAND	1942	118	20	0 - 20	7.51	110.49
29-899	400538	742542	CARSON, ROBERT	CARSON BARN	1953	145	30	25 - 30	9.80	135.20
29-900	400719	742338	LAPICALLO, V	NAPOLI UNUSED	1986	150	85	75 - 85	22.38	127.62
29-901	400548	742304	NISSLEY	NISSLEY HOUSE	1957	157	39	34 - 39	27.26	129.74
29-902	400206	742357	LAKEHURST NAVAL AIR	LNAS-AS 27	1981	112	14.3	2.3 - 14.3	9.05	102.95
29-903	400039	741931	LAKEHURST WD	LAKEHURST WD 3	1985	73	35	30 - 35	11.27	61.73
29-904	400156	742046	LAKEHURST NAVAL AIR	LNAS-DT	1985	79.83	25	6 - 25	5.42	74.41
29-905	400231	742217	LAKEHURST NAVAL AIR	LNAS-DY	1985	104.5	27	12 - 27	17.15	87.35
29-906	400142	741850	LAKEHURST NAVAL AIR	LNAS-EA	1985	94.95	45	30 - 45	36.49	58.55
29-907	400218	741947	LAKEHURST NAVAL AIR	LNAS-DU MW	1985	98.99	45	25 - 45	31.62	67.37
29-908	400539	741518	THOMPSON, PAUL	THOMPSON HOUSE	1987	142	106	100 -106	63.46	78.54
29-909	400344	741157	KNELL	KNELL HOUSE	1986	75	80	76 - 80	22.84	52.16
29-910	400021	742045	STAKES, BONNIE	STAKES DRIVE	1970	78	16.4	12 - 16.4	9.81	68.19
29-911	400429	742726	NJDEP	DEP-E1	--	135	10.5	5.5 - 10.5	4.55	130.45
29-912	400440	742733	NJDEP	DEP-E7	--	143	21	16 - 21	8.33	134.67
29-913	400159	742643	US AIR FORCE	USAF MW WEST	--	168	48	43 - 48	38.16	129.84
29-914	395725	740646	VERNACCHIO, OTTO M	VERNACCHIO	1986	5	95	90 - 95	4.10	0.90
29-994	395919	741121	BEY LEA GOLF COURSE	BEY LEA GOLF COURSE	1969	38	65	48 - 60	11.98	26.02
29-995	395931	741418	CIBA-GEIGY CORP	CIBA-GEIGY 744-1106	1986	63.44	102	92 -102	40.95	22.49
29-996	400109	741051	DOVER TWP	DOVER LF 5 MW	1983	51	21.5	1.5 - 21.5	18.54	32.46
29-997	390109	741415	CATENELLA	CATENELLA DOM	1986	65	76	71 - 76	16.84	48.16
29-998	400314	741808	BARLETTA, JOSEPH	BARLETTA DOM 1	1986	122	68	64 - 68	38.53	83.47
29-999	400934	742324	STATE OF NJ-DEP DWM	NJDEP MW-2S	1986	165	23	13.2 - 23	11.14	153.8

[1] Values for elevation of land surface listed to the whole number were determined by either altimeter or visual inspection of a map. Values listed to the tenth or hundreth place were determined by level.

Seasonal water-level fluctuations in the Colliers Mills well, located on the shore of Colliers Mills Pond, generally are less than 1 ft. Water levels in this well during the first 12 years of record (1964-75) appear to be fairly stable because the lowest monthly values were derived from a large number of regular measurements. The water levels during 1976-90 appear to be more variable as a result of the smaller number and increased randomness of measurements made during the later time period (fig. 2-3). This hydrograph also shows a large water-level decline during the 1985 water year[2], which resulted from a change in the pond level rather than from climatological factors. Although precipitation in 1985 was the lowest in 55 years of record, Colliers Mills pond was drained that year (W.D. Jones, U.S. Geological Survey, oral commun., 1991). Water levels in the Crammer Observation Well also declined, but not as much as the water levels in the Colliers Mills well. Typical seasonal water-level fluctuations in the Crammer well, unlike those in the Colliers Mills well, ranged from 2 to 5 ft. During 1974-90 water levels in this well declined about 2 ft.

The relation between precipitation and water levels is evident in figure 2-4, which illustrates the sensitivity of the unconfined aquifer system to inputs to the system. The addition of precipitation to the system coincides with the rise in water level, whereas a decrease in rainfall causes an immediate decline in the water level.

[2] A water year, typically used in hydrologic analyses, is the 12-month period from October 1 through September 30. It is designated by the calendar year in which it ends. In this study, all data are reported for the calendar year unless otherwise noted.

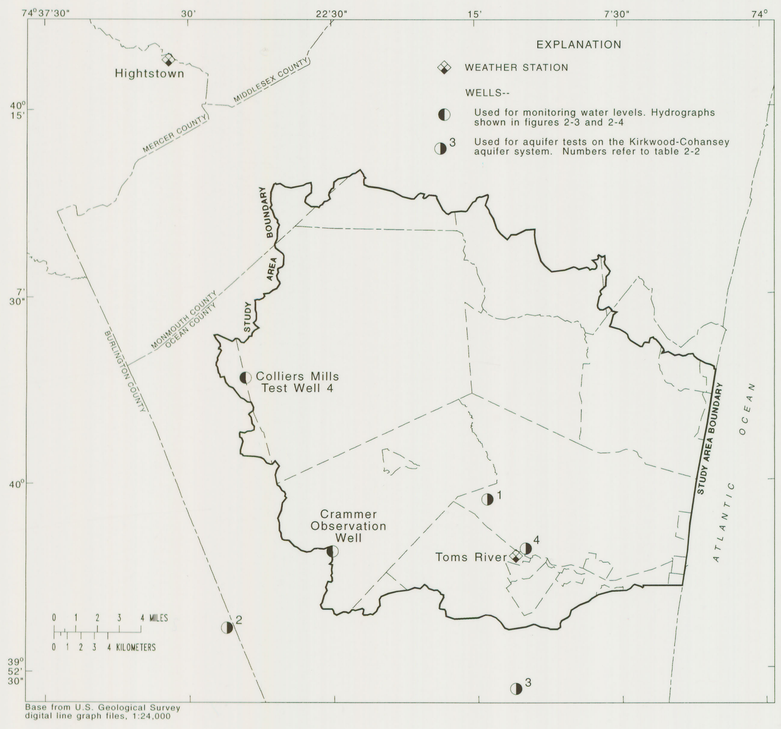

Figure 2-2.--Locations of weather stations, observation well for which water levels are shown in figures 2-3 and 2-4, and locations of aquifer-test sites listed in table 2-2.

Aquifer Properties

Hydraulic properties of the Kirkwood-Cohansey aquifer system can be determined from the results of aquifer tests. During an aquifer test, a well is pumped for a period of time and water-level measurements are made in surrounding wells to observe the change in water level in the aquifer. The values of certain hydraulic properties of the aquifer can be calculated from the data collected in such a test. Some of the properties that were calculated from tests conducted in the Kirkwood-Cohansey aquifer system are listed in table 2-2. Four tests were conducted between 1955 and 1988 in the vicinity of the study area. The locations of the test sites are shown in figure 2-2.

Three properties calculated from the results of these four tests are horizontal hydraulic conductivity, transmissivity, and storage coefficient (table 2-2). Horizontal hydraulic conductivity, the ability of the aquifer material to transmit water in a horizontal direction, ranges from 9.0 to 140 ft/d, which is typical of well-sorted sand. Transmissivity, which is equal to the horizontal hydraulic conductivity multiplied by the thickness of the aquifer, ranges from 1,900 to 25,000 ft^2/d for the Kirkwood-Cohansey aquifer system in the vicinity of the study area. The storage coefficient (virtually equal to the specific yield in an unconfined aquifer) is a dimensionless value that quantifies the volume of water an aquifer will release or absorb into storage per unit surface area of the aquifer per unit change in water level. This value was calculated for only one of the four tests (table 2-2). Toms River Water Company calculated a value of 0.024 (L.L. Murphy, Toms River Water Company, written commun., 1989), which is within the range of values typical of an unconfined aquifer.

Equations used to calculate hydraulic properties take into account conditions such as the length of the aquifer test, distance between the pumped well and the observation wells, boundary conditions, and effects of local clay layers, all of which can affect the test results. Some of these specialized equations had not yet been developed by the 1950's, when two of the aquifer tests were conducted; therefore, the effects of physical conditions at the site were not fully accounted for in the analyses. For example, an aquifer test in an unconfined aquifer should be conducted for about 72 hours in order to ensure that the effects of any boundary conditions, local clay layers, or delayed yield are observed (Driscoll, 1986, p. 223). The length of the first two tests is unknown, but most aquifer tests conducted in the 1950's were not sufficiently long to show such effects. Special conditions that might have been present during the four aquifer tests are not discussed in the literature, except as noted in table 2-2.

Table 2-2.--Hydraulic properties of the Kirkwood-Cohansey aquifer system in and near the study area

[fig., figure; ft/d, feet per day; $(gal/d)/ft^2$, gallons per day per foot squared; ft^2/d, feet squared per day; (gal/d)/ft, gallons per day per foot; --, missing data]

Well number (fig. 2-2)	Site location	Date of test	Length of test (hours)	Method of evaluation[1]	Horizontal hydraulic conductivity (ft/d)	Horizontal hydraulic conductivity $[(gal/d)/ft^2]$	Transmissivity (ft^2/d)	Transmissivity [(gal/d)/ft]	Storage coefficient	Reference
1	Toms River Chemical Company	1/56	--	Theis	140	1,050	3,800	28,400	--	Rhodehamel, 1973, p.55
2	Lebanon State Forest 18-V [2]	8/04/58	--	Thiem	120	880	12,000	88,000	--	Rhodehamel, 1973, p.55
3	Lacey Township Municipal Utilities Authority well #1 [3]	7/14/87 to 7/17/87	48+	Cooper and Jacob	[4]110	[4]810	25,000	186,000	--	Remington and Vernick Engineers, 1987
4	Toms River Water Company well #36 [5]	12/07/87 to 12/08/87	24	Cooper and Jacob	[4]9.0	[4]67	1,900	14,000	0.024	L.L. Murphy, Toms River Water Company, written commun., 1989

[1] Methods explained in Driscoll, 1986.
[2] Values of horizontal hydraulic conductivity and transmissivity represent an average of 20 values.
[3] Value of transmissivity is an average of four values.
[4] Values of horizontal hydraulic conductivity were estimated by the authors from reported transmissivity values.
[5] Interference may have occured during the test from pumping from local wells screened in the same aquifer.

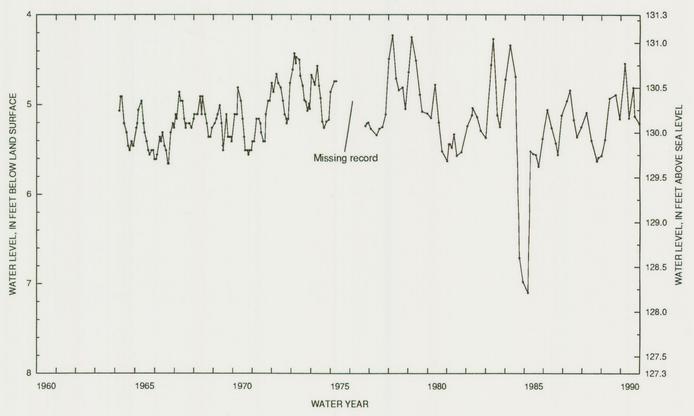

Figure 2-3.--Water levels in Colliers Mills Test Well 4, mid-1964 through mid-1990.

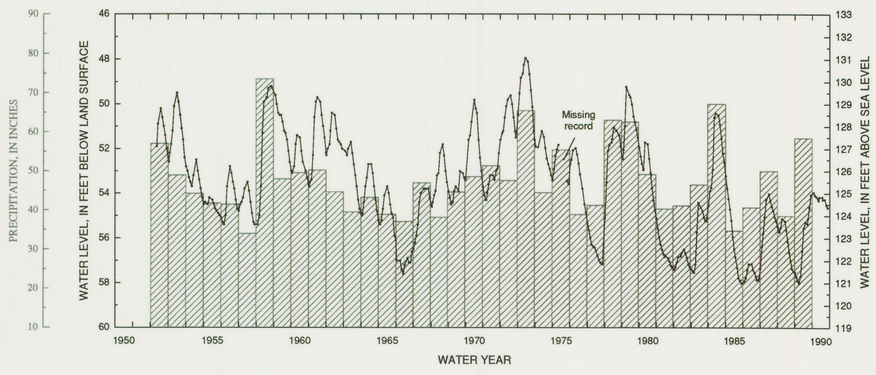

Figure 2-4.--Water levels in Crammer Observation Well at Whiting Bible Church, 1952 through mid-1990, and annual precipitation at the Toms River weather station, 1952-89 (National Oceanic and Atmospheric Administration, 1928-89).

Watt, M.K., Johnson, M.L., and Lacombe, P.J., 1994, Hydrology of the unconfined aquifer system, Toms River, Metedeconk River, and Kettle Creek Basins, New Jersey, 1987-90: U.S. Geological Survey Water-Resources Investigations Report 93-4110

HYDROLOGY OF THE UNCONFINED AQUIFER SYSTEM, TOMS RIVER, METEDECONK RIVER, AND KETTLE CREEK BASINS, NEW JERSEY, 1987-90

By
Martha K. Watt, Melissa L. Johnson, and Pierre J. Lacombe

1994