STATE OF NEW JERSEY
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT

DIVISION OF WATER POLICY AND SUPPLY

SPECIAL REPORT NO. 33

GEOLOGY AND GROUND-WATER RESOURCES OF SALEM COUNTY, NEW JERSEY

Prepared in Cooperation With
United States Department of the Interior
Geological Survey

1969

GEOLOGY AND GROUND-WATER RESOURCES OF SALEM COUNTY, NEW JERSEY

By

Jack C. Rosenau

Solomon M. Lang

George S. Hilton

James G. Rooney

U. S. Geological Survey

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ROBERT A. ROE, *Commissioner*

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GEORGE R. SHANKLIN, *Director and Chief Engineer*

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HONORABLE ROBERT A. ROE, *Commissioner*
Department of Conservation and
Economic Development
John Fitch Plaza
Trenton, New Jersey 08625

Dear Sir:

I am transmitting a report entitled "Geology and Ground-Water Resources of Salem County, New Jersey," which was completed under the cooperative agreement with the Water Resources Division, U. S. Geological Survey in cooperation with the Division of Water Policy and Supply, as part of the state-wide program authorized by the 1958 Water Supply Law.

The report summarizes the geology pertinent to the development of the water resources of Salem County. It evaluates the relative importance of the major aquifers as to their present use and suitability for future development. The quality of the ground-water in each aquifer and the salt-water intrusion problem are discussed.

The information in this report is of vital interest and importance to the growth of the County and provides a basis for the protection and safe development of the ground-water resources essential for such growth. I therefore recommend that this report be published as a Special Report of the Division of Water Policy and Supply.

Respectfully submitted,
George R. Shanklin
Director and Chief Engineer

ABSTRACT

Salem County is in southwestern New Jersey in the Atlantic Coastal Plain physiographic province. The county is underlain by coastal-plain deposits of Quaternary, Tertiary, and Cretaceous age which are composed of alternating clay, silt, sand, and gravel. These deposits are underlain by crystalline rocks of Early Paleozoic or Precambrian age. The Coastal-Plain deposits in Salem County range in thickness from about 200 feet in the northwestern part of the county to about 2,400 feet in the extreme southeastern part of the county. The pre-Quaternary deposits dip gently to the southeast.

The important aquifers in Salem County occur in the Potomac Group and Raritan and Magothy Formations, Wenonah Formation and Mount Laurel Sand, Vincentown Formation, Cohansey Sand, and Cape May Formation. Separating these aquifers are aquicludes composed of clayey materials.

The Potomac Group and Raritan and Magothy Formations contain the most productive aquifers in Salem County. These aquifers are hydraulically connected in places and may be considered to form a single hydrologic unit or aquifer system. Reported yields of wells tapping this system range up to 860 gpm (gallons per minute). The highest yields commonly occur where the system has direct hydraulic connection with the overlying Cape May Formation near the Delaware River. A decline in water levels in the aquifer system of the Potomac, Raritan, and Magothy has resulted from heavy pumpage. Movement of water towards centers of pumpage has created the danger of salt-water encroachment into the aquifer from downdip areas where the aquifer already contains saline water. The occurrence of saline water in the aquifer is indicated by local chloride concentrations of up to 2,057 ppm (parts per million).

The aquifer in the Wenonah Formation and Mount Laurel Sand is the second most highly used aquifer in Salem County and is an important source of water for future development. Reported yields of wells tapping this aquifer range up to 507 gpm. Water from this aquifer ranges from soft to very hard (12 to 345 ppm, median 127 ppm) and is commonly high in iron (0.1 to 6.3 ppm). Salt-water intrusion into the aquifer, probably from the overlying Vincentown Formation, in the vicinity of the City of Salem is indicated by chloride concentrations of up to 396 ppm.

The aquifer in the Vincentown Formation is an important aquifer in part of Salem County. It is capable of supplying considerably more water than is now being pumped and hence is important for future ground-water development. Reported yields of wells tapping this aquifer range up to

270 gpm. The water is hard (134 to 270 ppm) and moderate to high in iron content (0.15 to 10 ppm). Salt-water intrusion in the Salem area is indicated by chloride concentrations of up to 2,850 ppm.

The Cohansey Sand is capable of transmitting large quantities of water and is an important source for future ground-water development. Coefficients of transmissibility and storage calculated from a pumping test in Salem County are 30,000 gallons per day per foot and 3×10^{-4}, respectively. Water in the aquifer is generally soft (average 47 ppm) and slightly mineralized. Iron (average 0.3 ppm) and dissolved carbon dioxide are commonly present in objectionable quantities.

The Cape May Formation of Pleistocene age is an important aquifer in the Penns Grove-Deepwater area where it yields up to 1,500 gpm to Ranney (horizontal) collector wells. Where Pleistocene deposits are not thick enough to function as an aquifer, their chief hydrologic function is to absorb precipitation and transmit it to underlying formations.

Use of ground water in Salem County in 1964 averaged 12.28 mgd or nearly 200 gpd per person. Industrial use was 5.33 mgd (million gallons per day) and use for public supply was 2.74 mgd. Irrigation, which has become increasingly important in recent years accounted for 2.14 mgd. Average total summer use of ground water—approximately 17.7 mgd—was considerably higher than the yearly average.

INTRODUCTION

PURPOSE AND SCOPE

The use of ground water in Salem County has increased substantially in recent years and the demand continues to increase. Availability of ground water is vital to the economic growth of the county. The safe and efficient development of the ground-water resources of Salem County requires an adequate knowledge of the geologic and hydrologic characteristics of its water-bearing formations.

This report presents the results of an investigation of the ground-water resources of Salem County. This investigation by the U. S. Geological Survey in cooperation with the New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply, is part of a statewide program of ground-water studies. The investigation was under the immediate supervision of Allen Sinnott, formerly District Geologist.

GEOGRAPHY

Salem County is in the southwestern part of New Jersey and lies roughly between latitudes 39°23′ and 39°48′ N and longitudes 75°04′ and 75°34′ W. (Figure 1.) The countv is bordered on the north by Gloucester County, on the south and east by Cumberland County, and on the west by the Delaware River and the State of Delaware. Salem County has a total area of about 390 square miles, of which about 45 square miles is covered by water.

The relief of Salem County is low and slopes are relatively gentle. A 4-mile strip of tidal marsh bordering the Delaware River has altitudes of generally less than 10 feet. Farther inland, the land surface rises gradually to gently rolling hills. The highest land is in the eastern part of the county where altitudes reach 160 feet.

Salem County is drained by a network of streams, the largest of which, the Salem River, flows into the Salem Canal from which it flows into the Delaware River. The extreme eastern part of the county is drained by the Maurice River, which flows southward through Cumberland County to Delaware Bay. Other major streams discharge directly to the Delaware River.

Salem County is divided into 15 civil divisions, which include 1 city, 11 townships, and 3 boroughs. (See fig. 1.) Approximately 65 percent of the 58,711 people living in Salem County in 1960 resided in the seven municipalities that border the Delaware River and Delaware Bay.

Industry in Salem County is concentrated mostly along the Delaware River. The Chemical manufacturing industry employs about 70 percent of the workers in the county. The second largest industry is the glass manufacturing industry which is concentrated in the City of Salem. The remainder of the county is largely agricultural. In 1964, 110,233 acres or about 49 percent of the land area of the county was used for agricultural purposes. (U. S. Bureau of Census, 1966, Census of Agriculture, 1964, p. 210-211). The largest number of farms are devoted to truck, dairy, and poultry farming.

CLIMATE

The climate of Salem County is generally characterized by mild winters, warm humid summers, and moderate, fairly evenly distributed precipitation. The coldest part of the year is from December through February. January is generally the coldest month; the average minimum January temperature was 25.6°F at Woodstown during the period 1947-59. The hottest month of the year is generally July; the average maximum July temperature was 87.4°F. Snowfall averages about 15 inches annually. The last and first frosts (32°F or colder) occur about April 23 and October 19, respectively.

Rainfall during the growing season is not uniform and prolonged wet and dry periods may occur. Average monthly precipitation at Canton for the period 1946-65 is shown in the table below. Monthly rainfall during the growing season in this period ranged from a low of 0.29 inches in May 1964 to a high of 10.69 inches in May 1948.

Average monthly precipitation, in inches,
at Canton, New Jersey, 1946-65

(Data from U. S. Weather Bureau climatic summaries)

Month	*Precipitation*
January	2.72
February	2.94
March	3.19
April	3.04
May	3.46
June	2.87
July	3.57
August	4.08
September	3.47
October	2.55
November	3.46
December	2.61

METHODS OF INVESTIGATION

An extensive well inventory was made and a network of observation wells was established. Hydrologic and geologic data on these wells are listed in table 6; locations are shown in figure 2. Water-level measurements were used to define the piezometric surface in the aquifers of the county. Aquifer-test data were used to evaluate the hydraulic characteristics of the water-bearing sands. The identification, correlation, and mapping of the subsurface aquifers in the county were done on the basis of well records, drill cuttings, outcrop samples, well drillers' logs, and electric and gamma-ray logs. The Geologic Map of New Jersey (Johnson, 1950) was used for areal identification of the formations.

Samples of water collected from selected wells tapping the various aquifers in the county were analyzed for their chemical content. Partial chemical analyses were made in the field; complete chemical analyses were made in the Philadelphia laboratory of the Water Resources Division of the U. S. Geological Survey. Chemical quality data were obtained also from the files of the New Jersey Department of Health and the following commercial laboratories: Hungerford and Terry; Booth, Garrett, and Blair; and E. I. duPont. Selected chemical analyses of ground water from Salem County are given in table 5. Locations of wells for which quality-of-water data are available are shown in figure 3.

Information on ground-water pumpage was furnished by the New Jersey Division of Water Policy and Supply, the U. S. Department of Agriculture, and by the various industries in the county.

WELL-NUMBERING SYSTEMS

Wells for which data are used in this report have been assigned well numbers which are used in figures, tables, and throughout the text. Well 20, for example, drilled in 1900 at Fort Mott State Park, appears in the tables showing selected wells (table 6), water quality (table 5), and geologic logs (table 7) and on several maps (figures 2, 3, and 12).

Each well has also been assigned a grid number according to a system based upon the New Jersey topographic atlas sheets (see figure 4). Salem County is covered by parts of atlas sheets 30, 31, 34, and 35. The numbering system was described by Kümmel (1913, p. 13 and 14) as follows: "Each atlas sheet is divided into rectangles measuring 6-minutes of latitude and 6-minutes of longitude. Beginning in the upper left-hand corner, these are numbered across the sheet from 1 to 5, inclusive, number 5 being an incomplete rectangle comprising 2-minutes of longitude at the right. Those on the second row are numbered 11 to 15, those on the third 21 to 25, those on the fourth 31 to 35 and on the fifth 41 to

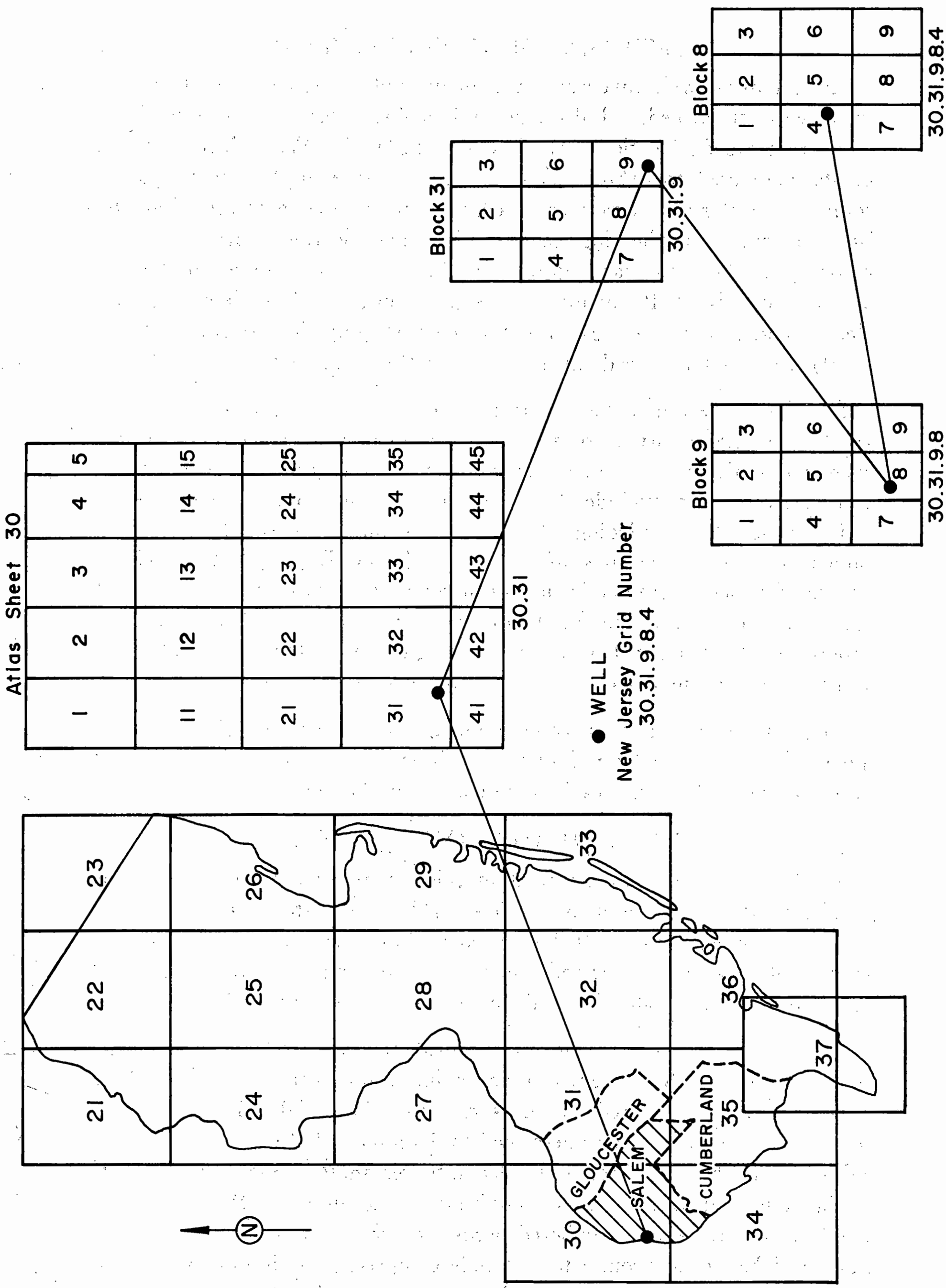

Figure 4.—Method of numbering wells.

45. The rectangles numbered 41 to 44, inclusive, differ from the others in comprising 6-minutes of longitude and 4-minutes of latitude. Number 45 embraces 2-minutes of longitude and 4-minutes of latitude. Each of these rectangles is divided into smaller rectangles measuring 2-minutes of latitude and 2-minutes of longitude by lines already engraved upon the sheet. The 2-minute rectangles in each of the 6-minute rectangles are numbered from 1 to 9 beginning in the upper left-hand corner and numbering to the right, number 4 being on the left under number 1. The subdivisions of the incomplete 6-minute rectangles on the right of the sheet, i.e., those numbered 5, 15, 25, 35, are numbered 1, 4, 7, of those at the bottom, i.e., numbers 41, 42, 43, 44, the subdivisions are numbered 1, 2, 3, 4, 5, 6. The subdivisions of the incomplete rectangle in the lower right-hand corner, number 45, are numbered 1, 4. It is evident that by writing first the number of the atlas sheet; second, the number of the 6-minute rectangle; and third, the number of any 2-minute rectangle, we can form a combination of numbers perculiar to any 2-minute rectangle within the State. In order to locate points more accurately, each of the 2-minute rectangles is divided into nine equal parts, numbered from 1 to 9, beginning in the upper left-hand corner, and each of these is again divided into nine, numbered similarly. The smallest rectangles represent areas about 330 yards from east to west and 440 yards from north to south. By adding the appropriate numbers of these two smaller divisions to the three already written, it is possible to get a combination which represents the exact location of any area 330 x 440 yards."

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of officials of municipalities and companies and many other individuals who have given generously of their time and records.

The New Jersey Bureau of Geology and Topography supplied many well records.

Special acknowledgment is given to the drilling firms of Artesian Well Drilling Co., Fred Capel & Son, D'Agostino Bros., Haines & Moore, Layne-New York Co., Inc., Charles L. Mollitor, John Murtha Co., Rankin Well Drilling Co., and A. C. Schultes and Sons and to their well drillers for their helpful cooperation in furnishing well records and geologic samples.

GROUND-WATER HYDROLOGY

HYDROLOGIC PROPERTIES OF ROCKS

Porosity is the physical property of a rock that defines the degree to which it contains interstices or voids and is expressed as the percentage of the total volume of the rock that is occupied by interstices. When all the voids in a rock are filled with water, the rock is said to be saturated. Therefore, within the zone of saturation, porosity is the percentage of the total volume of the rock that is occupied by water.

Specific yield is the quantity of water yielded by gravity drainage from saturated water-bearing material and is expressed as a percentage of the total volume of the material drained. The specific yield is always less than the porosity because some water is held in the rock by molecular attraction. The quantity of water retained by the material against the pull of gravity is termed specific retention and is expressed as a percentage of the total volume of the material. The sum of the specific yield and the specific retention of a saturated material is equal to its porosity. Although the porosity of a clay may be equal to or greater than that of a well-sorted coarse gravel, the coarse gravel has a much larger specific yield than the clay and hence can yield a much larger quantity of water.

The permeability of a rock determines its capacity to transmit water under a given hydraulic gradient. The field coefficient of permeability is defined as the rate of flow of water under prevailing conditions including water temperature, in gallons per day through a cross-sectional area of 1 square foot (gpd per sq ft) under a hydraulic gradient of 100 percent. Permeability varies with size and degree of sorting of the individual grains in unconsolidated materials. A well-sorted gravel, for example, has a higher permeability than a well-sorted coarse sand. Gravel mixed with a moderate percentage of medium- and fine-grained material, however, may be less permeable than a uniformly sorted coarse sand. In a poorly sorted material, the finer materials fill the pore spaces between the coarser materials thus reducing the permeability.

The hydraulic properties most useful in evaluating aquifers are the coefficients of transmissibility and storage. The coefficient of transmissibility is a measure of the capacity of an aquifer to transmit water. It is the rate of flow of water under prevailing conditions, in gallons per day, through a vertical strip of the aquifer 1 foot wide extending the full saturated height of the aquifer, under a hydraulic gradient of 100 percent. (Theis, 1935). The coefficient of transmissibility of an aquifer is equal to its average coefficient of permeability multiplied by its saturated thickness.

The coefficient of storage of an aquifer is the volume released from or taken into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. For water-table aquifers, the coefficient of storage is approximately equal to the specific yield; this is estimated to average about 21 percent in Salem County. For artesian aquifers, the coefficient of storage is considerably smaller than the specific yield and typically is about 3×10^{-4} in Salem County.

The specific capacity of a well is a measure of its water-yielding capacity and is defined as the yield in gallons per minute per foot of drawdown. High specific capacities generally suggest a high coefficient of transmissibility, and low specific capacities generally suggest a low coefficient of transmissibility. However, specific capacity also is affected by the coefficient of storage, the thickness and boundary conditions of the aquifer penetrated by the well, and construction and development of the well. Specific capacities as high as 37 gpm per foot of drawdown have been reported for wells in Salem County. However, most of the domestic wells have specific capacities of 10 gpm per foot of drawdown or less.

OCCURRENCE OF GROUND WATER

Water beneath the land surface occurs in two zones; the zone of aeration and the zone of saturation. In the zone of saturation, water fills the voids. In the zone of aeration, the voids are occupied partially by air and partially by water. Water in the zone of saturation is called ground water and may occur under water-table or artesian conditions.

Under water-table conditions, ground water is not confined and the surface within the zone of saturation at which the pressure is atmospheric is called the water table. In areas remote from pumping, the water table generally reflects the topography in a subdued manner (see fig. 5). Hence, the water table is at higher altitudes beneath hills than beneath nearby valleys. Where the water table is at the land surface, water will discharge either as a spring or as seepage directly into a stream, pond, or other surface-water body.

Artesian conditions occur where the water is confined under hydrostatic pressure in an aquifer by relatively impermeable overlying and underlying materials. The water level in a well tapping an artesian aquifer is above the top of the aquifer. The piezometric surface of an aquifer is the surface to which the water from a given aquifer will rise under its full head. Where the altitude of the piezometric surface of an artesian aquifer is above that of the land surface, a well screened in that aquifer will flow.

The shape of the piezometric surface (or water table) of an aquifer is determined largely by the location and nature of the areas of natural and artificial recharge and discharge and by the aquifer transmissibility. Mapping of the altitudes of water levels observed in wells tapping an aquifer permits an estimate of the piezometric surface. From the estimated piezometric surface, the ground-water flow pattern in the aquifer can be determined, thus indicating areas of recharge and discharge.

Under natural conditions and over long periods of time, the amount of water that is recharged to an aquifer is balanced by the discharge from it. In an area in which there are artificial withdrawals of ground water, the recharge-discharge balance is disturbed, producing lowering of water levels and a tendency toward a new and different balance. A new balance may be achieved by decreasing the natural discharge by a quantity equal to that being pumped, by increasing the recharge, or by a combination of these two processes. If a new balance is not obtained, water levels will decline until the aquifer is dewatered or until the rate of withdrawal is decreased enough to permit an equilibrium condition.

The aquifers underlying Salem County are recharged by precipitation which enters the aquifers through their outcrop or through overlying permeable material. Because some precipitation is lost by evapotranspiration and some runs off directly to streams, only a part of precipitation is available to infiltrate through the zone of aeration and eventually become ground water in the saturated zone. Water in some aquifers may be derived from underflow from nearby areas and from vertical leakage through adjacent semi-confining units from other aquifers. Recharge to an aquifer can occur also along a stream that is hydraulically connected with the aquifer where the hydraulic gradient is from the stream to the aquifer.

When a well is pumped, the head of water in and around the well is reduced, creating a hydraulic gradient toward the well and causing water to flow into the well. The reduction in head in a water-table aquifer reflects an actual removal of water from storage. The reduction in head in an artesian aquifer, however, reflects mainly a decline in hydrostatic pressure.

Pumping of a well creates a cone of depression which is defined as the geometric solid between the water table or piezometric surface after a well has begun discharging and the water table or piezometric surface if there had been no discharge by the well. The area of diversion of a pumping well is the area in which the ground-water flow in that aquifer is being diverted to the pumping well. After a well begins pumping, the area of diversion of the well will expand until it has captured enough recharge or natural discharge to supply the yield of the well.

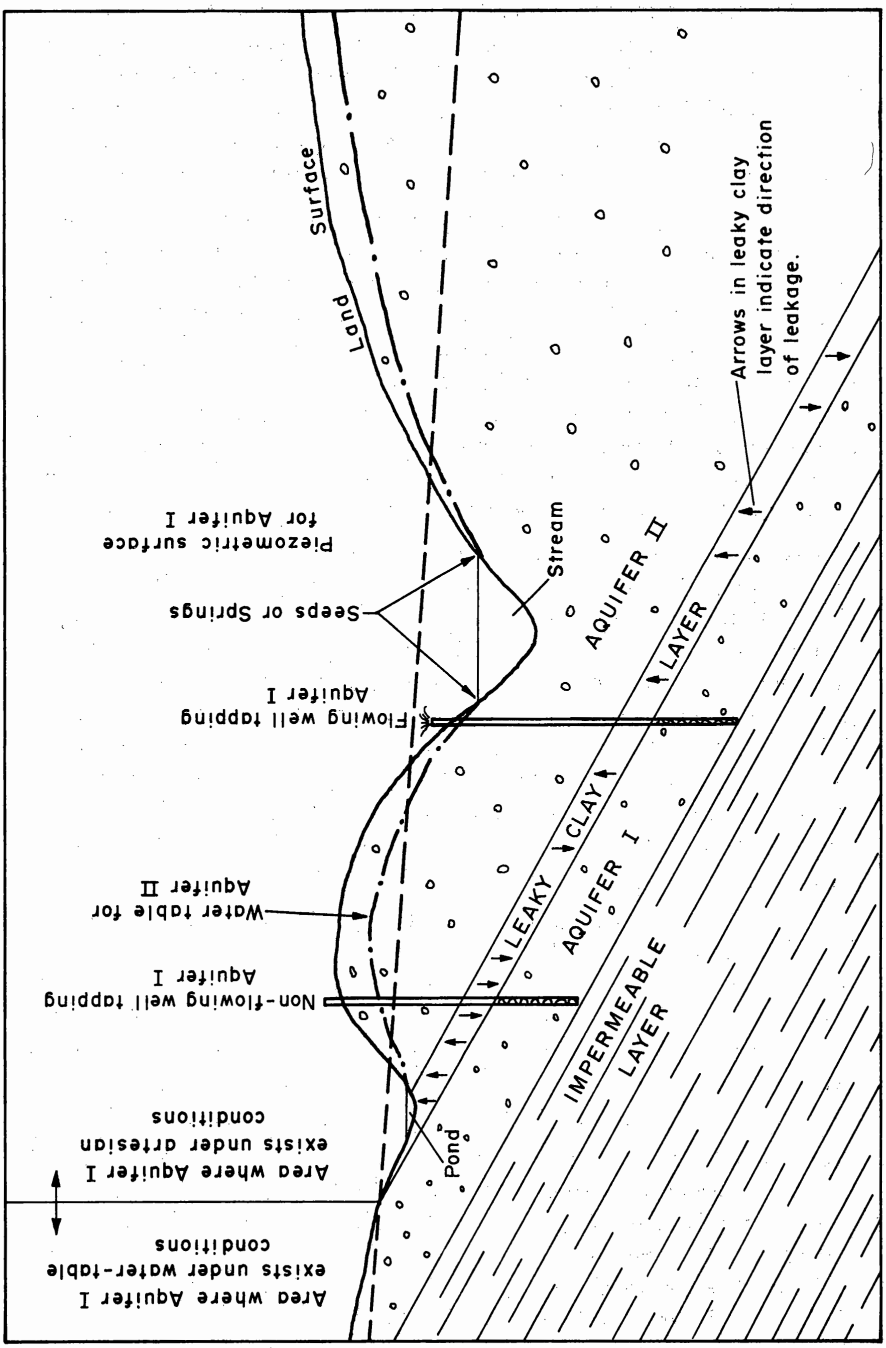

Figure 5.—Generalized section showing the relation between hypothetical aquifers.

In Salem County some aquifers are separated by "leaky" clay layers. Thus, pumping of a well screened in one aquifer could establish areas of diversion in overlying or underlying aquifers. Figure 5 shows a hypothetical relationship between two aquifers separated by a leaky clay layer. It shows that the direction of leakage through the clay layer at any point is from the aquifer with the higher head to the aquifer with the lower head. The direction of leakage at any place can be reversed. If the flowing well shown on figure 5, for example, were pumped sufficiently, the direction of leakage through the clay layer could be reversed in the vicinity of that well.

In Salem County the Delaware River and portions of its tributaries are tidal and for most of the year contain saline water having chloride concentrations of several thousand parts per million. In local areas adjacent to the Delaware River and along the tidal reaches of the smaller streams, the withdrawal of ground water has established a hydraulic gradient from the river to the aquifers. It is in these areas that there is danger of salt-water encroachment.

Ground water is discharged from aquifers in Salem County to streams and wells and by evapotranspiration, leakage to other aquifers, and underflow out of the county. In most of the county, ground water is continually discharging from the water table to streams thus sustaining streamflow during periods lacking precipitation. The discharge of ground water to streams is believed to account for a large part of the aquifer discharge.

Flow characteristics of some streams in Salem County are given in the following table:

Name of station	*Drainage area (square miles)*	*Period of record*	*Minimum daily flow (cfs)*	*Average discharge (cfs)*
Alloway Creek at Alloway	21.9	1952-66	1/	22.5
Maurice River at Norma	113	1932-66	23	164
Oldmans Creek near Woodstown	19.3	1931-40	4.5	29.0
Salem River at Woodstown	14.6	1942-66	1/	18.1

1/Minimum discharge affected by upstream lakes.

WATER-LEVEL FLUCTUATIONS

Ground-water levels fluctuate in response to such factors as recharge from precipitation, evapotranspiration, discharge to streams, pressure changes, and artificial ground-water withdrawals. Long-term records of water levels in an aquifer show the response of the aquifer to development, and thus indicate areas of potential danger because of depletion and contamination, as well as areas in which additional diversions of ground water may be made.

The water table fluctuates as water is added to or removed from storage in the unconfined aquifer. When recharge, which is generally by direct percolation of precipitation, exceeds discharge, water levels rise; conversely, when discharge to surface-water bodies or wells or through evapotranspiration exceeds recharge, water levels decline.

Figure 6 is a hydrograph of water levels from Penns Grove well No. 72 (30.32.5.1.3), a water-table well in the Penns Grove area. The hydrograph shows a fairly regular seasonal fluctuation resulting mainly from seasonal variations in evapotranspiration. The water table is generally highest during winter and early spring and is lowest during late summer and fall. The decline from the high to the low level takes place generally in the period from April through September even though the larger part of the precipitation may fall in the same period. The hydrograph in figure 6 shows also the response of the water table to a period of above average precipitation in 1958-59 and periods of drought in 1953-54, 1957, and 1964-66. The hydrograph shows no long-term downward trend that would suggest that excessive withdrawals of water took place from the water-table aquifer in the Penns Grove area.

Water-level fluctuations in a well tapping an artesian aquifer such as in the Point Airy well 53B (30.34.1.5.7) are generally the result of pressure changes. See figure 7. Water levels in an artesian well do not respond to short-term climatic changes as does a well tapping a water-table aquifer. However, the seasonal variation in the Point Airy well probably reflects in part, water-level trends in the outcrop area of the aquifer. The general decline of about 11 feet in water levels since 1959 results from increased regional pumpage from the Potomac, Raritan, and Magothy aquifer system.

Short-term water-level fluctuations in the Point Airy well are produced by changes in barometric pressure and possibly by the variations in pumping at the Woodstown municipal wells. Figure 8 shows the relationship between the barometric pressure and water levels in the well during November 1961, when pumping at Woodstown was at a relatively uniform rate. The ratio of water-level changes in the well to the inverse

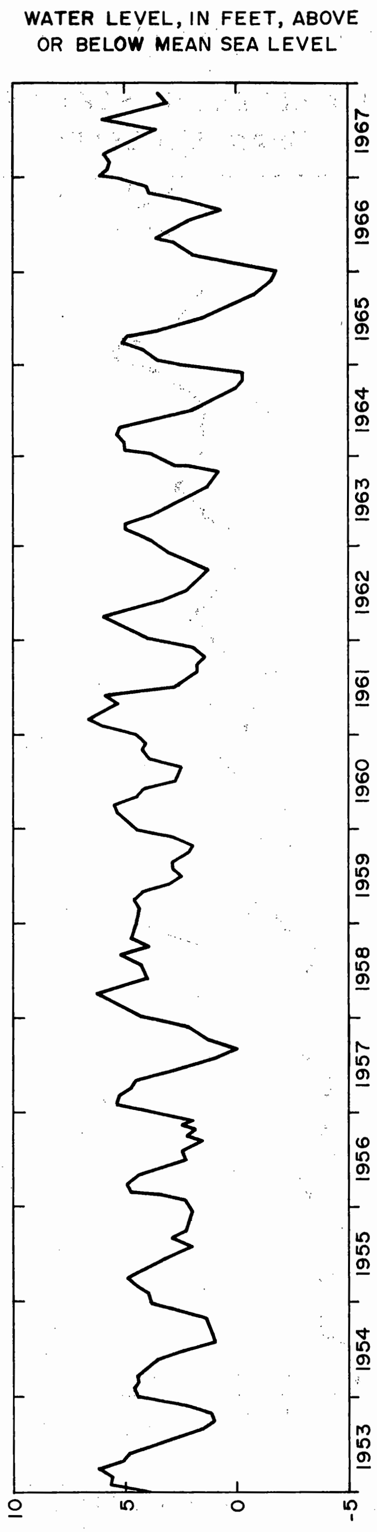

Figure 6.—Water levels in Penns Grove well No. 72 (30.32.5.1.3), 1953-67.

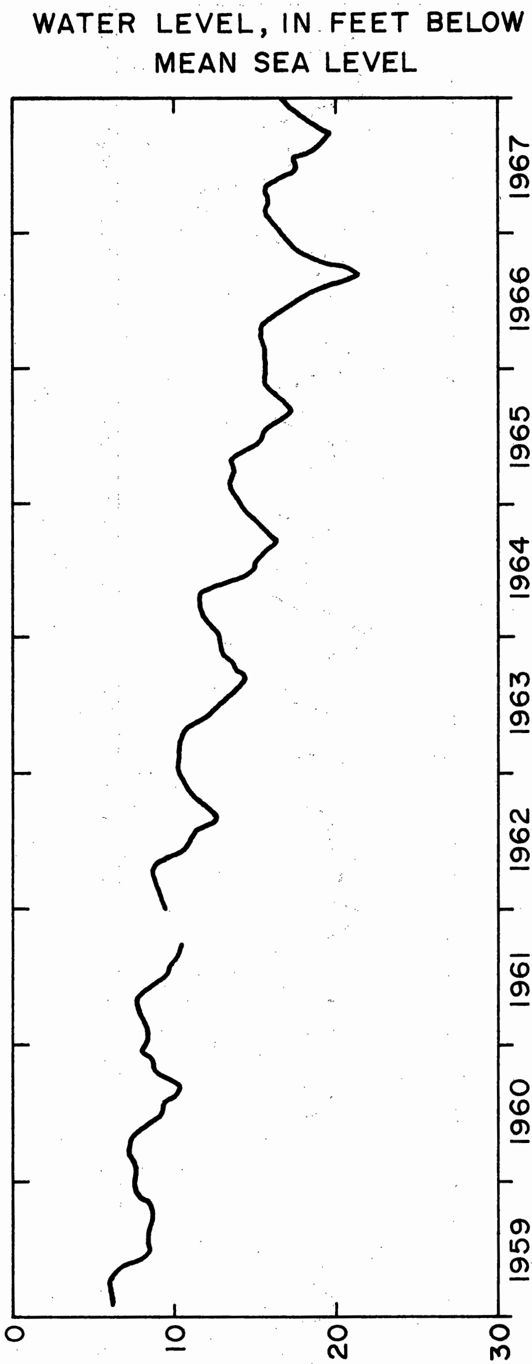

Figure 7.—Water levels in Point Airy well 53B (30.34.1.5.7), 1959-67.

of water-level changes in a water barometer is called the barometric efficiency of the aquifer and is 40 percent for the aquifer tapped by the Point Airy well.

WATER USE

The use of ground water in Salem County in 1964 averaged slightly over 12 mgd (million gallons per day) or nearly 200 gallons per day for each person residing in the county. Industrial use accounted for 43 percent of the total annual ground-water pumpage. Municipal public supply pumpage accounted for 22 percent, irrigation for 17 percent, and rural pumpage for 15 percent. Other uses accounted for the remaining 3 percent.

During the summer months, May through September, the use of ground water increases substantially. In 1964, summer pumpage averaged 17.72 mgd from all the different types of ground-water supply systems in the county and per capita use was 284 gpd (gallons per day) per person. Most of the increase in total ground-water use during the summer is due to the additional water requirements for cooling purposes, including the needs for air conditioning, and for irrigation of farm crops and watering of residential lawns. The annual and seasonal use of ground water in 1964 is given in table 1.

Table 1.—Use of Ground Water in Salem County, N. J. in 1964
(million gallons per day)

Type of Supply	*Annual Average Use*	*Summer Use (May thru Sept.)*
Public Supply	2.74	3.30
Rural[1]	1.77	2.48
Industrial	5.33	6.36
Irrigation[2]	2.14	5.08
Other	.30	.50
County Total	12.28	17.72

[1]Based on estimated population of 22,530 not served by public supply systems, and assuming an average use of 70 (annual) and 110 (summer) gallons per day per person.

[2]Estimated by assuming that one-half (4,715) of the total reported acres (9,430) irrigated in the county received an average of 1½ inches of supplemental irrigation water obtained from wells each time they were irrigated and that each acre was irrigated 4 times in 1964. Requirements are based on irrigation data from the N. J. Division of Water Policy and Supply and the U. S. Bureau of Census, 1966, Census of Agriculture, 1964.

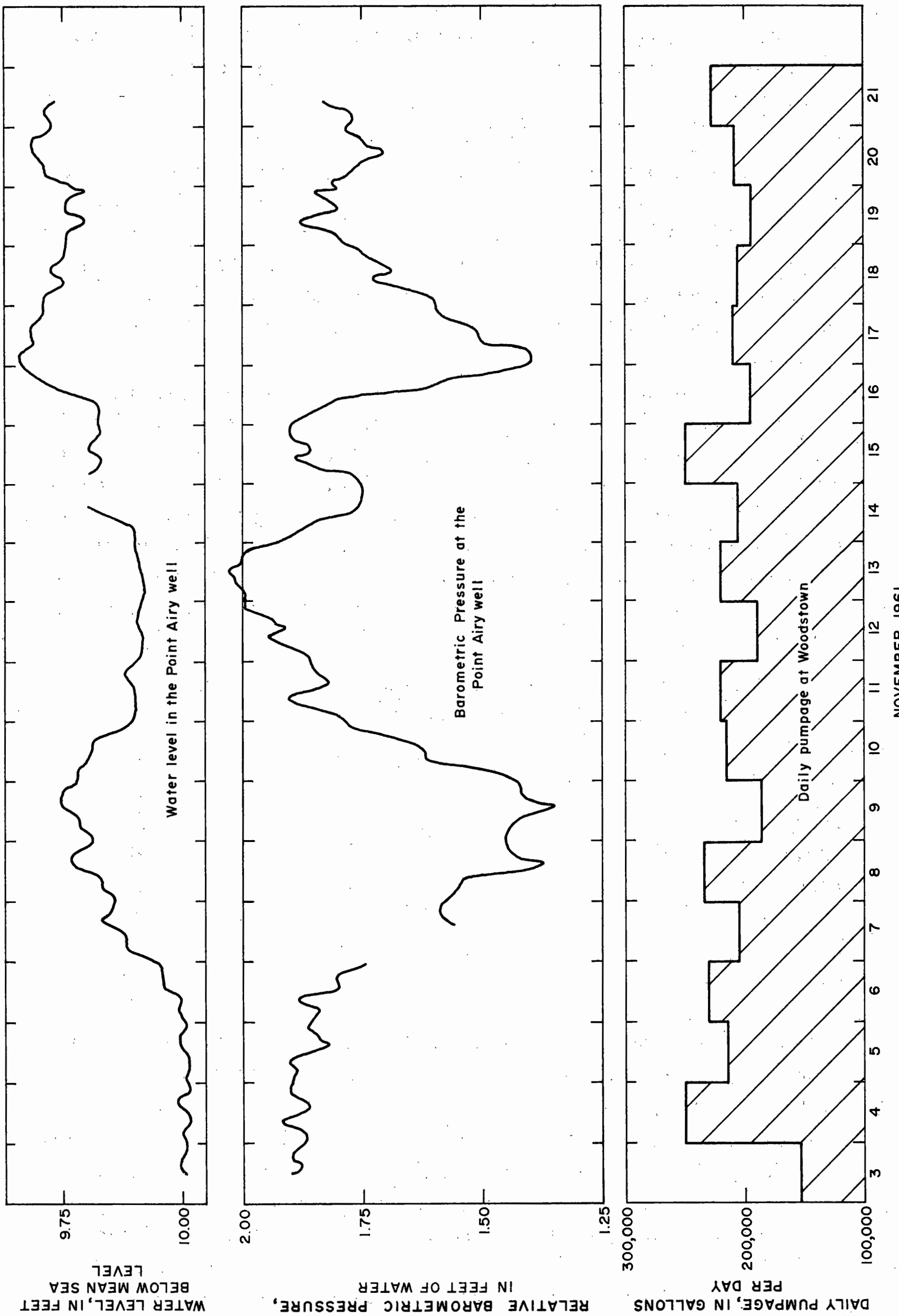

Figure 8.—Water levels and barometric pressure at the Point Airy well 53B (30.34.1.5.7) and pumpage at Woodstown, during November 1961.

The water-use data in table 1 are broken down into the following five classifications according to types of supplies:

1. Public supplies include public and privately owned water systems established mainly to serve a municipality that may include local commercial and industrial establishments.
2. Rural supplies include those residential homes and small business establishments scattered throughout the county that are not served by the municipal public-supply systems.
3. Industrial supplies include those self-supplied water systems established by an industry for cooling, processing, boiler feed, sanitation, or drinking water purposes.
4. Irrigation supplies include those systems that supply supplemental irrigation water to agricultural crops, usually by a sprinkler system; it does not include private residential lawn-watering systems.
5. Other supplies include systems that supply the general water requirements for farms and livestock, schools, hospitals, and other institutions not served by public supply systems.

Five public supply systems in Salem County served about 39,700 of the total county population of 62,230 in 1964. Three of these public systems; Penns Grove Water Supply Co., Pennsville Township Water Department, and the City of Salem Water Department are located along the more densely populated western part of the county near the Delaware River. Together, these three systems served about 35,500 people, or more than half the total county population. They pumped an average of 2.38 mgd in 1964. The public supply systems of Woodstown and Elmer, in the less densely populated interior of the county, serve only about 4,200 people. Together they pumped an average of only 0.36 mgd.

The City of Salem has the only municipal system that utilizes both surface and ground water. In 1964, Salem pumped an average of 0.88 mgd from surface-water sources at their plant in Quinton. Salem's combined surface-water and ground-water use in 1964 averaged 1.59 mgd and their combined seasonal use from May through September averaged 1.79 mgd.

The average monthly and annual pumpage of ground water in 1964 by the five public water supply systems in the county are given in table 2. Also given in table 2 is the population supplied and the average per capita use of water for each municipal system. Annual per capita use ranged from 62 gallons per day per person for the Pennsville Township system to 176 gallons per day for the Salem system. The latter figure includes large quantities of water supplied to several large water-using industries in the city. The annual average per capita use of water for the other

Table 2.—Average monthly and annual pumpage and per-capita use of ground water by public-supply systems in Salem County, N. J. in 1964.

(mgd, million gallons per day)

Month	*Penns Grove Water Supply Co.*	*Pennsville Twp. Water Dept.*	*City of Salem[1] Water Dept.*	*Woodstown Water Dept.*	*Elmer Water Dept.*	*County Total*
January	0.86	0.57	0.52	0.24	0.07	2.26
February	.93	.57	.48	.25	.07	2.30
March	.87	.56	.46	.22	.07	2.18
April	.84	.55	.48	.23	.06	2.17
May	1.03	.77	.82	.27	.11	3.00
June	1.30	.91	.94	.39	.18	3.72
July	1.22	.86	.79	.32	.16	3.35
August	1.04	.76	.94	.30	.15	3.19
September	1.05	.82	.96	.30	.11	3.24
October	.91	.65	.63	.23	.08	2.50
November	.84	.61	.51	.20	.08	2.23
December	.84	.58	1.03	.22	.07	2.71
Annual Average	.98	.68	.71	.26	.10	2.73
Number of Service Connections	3,808	3,020	2,286	925	410	10,449
Population Supplied[2]	15,500	11,000	9,000	2,950	1,250	39,700
Per Capita Annual Average Use (gal/day)	63	62	176[3]	90	79	91[3]

[1] The Salem System also pumped an average of 0.88 mgd from surface-water sources at Quinton, in 1964.

[2] Figures are estimated; they are based on 1964 population estimates by the municipal water departments and the N. J. Research and Statistics Section.

[3] Includes 0.88 mgd of surface water pumped by Salem system.

four systems was about 75 gallons per day per person and summer use averaged 91 gallons per day per person.

About 22,530 people in Salem County obtain water from privately owned wells. Most of these people live in suburban and rural areas away from the Delaware River. It is estimated they used an average of 1.77 mgd of ground water in 1964. Summer use averaged about 2.48 mgd. Most of this water was used for domestic purposes and some was used for watering lawns. In estimating the rural use of ground water it was assumed that their per capita water demand was similar to that of the Elmer and Woodstown public-supply systems which serve no large water-using industries. In 1964 these demands averaged from about 70 gallons per day per person in the winter months to about 110 gallons per day during the summer.

Industrial use of self-supplied ground water in Salem County averaged about 5.33 mgd in 1964. Summer use averaged about 6.36 mgd or nearly twice the amounts used by the public supplies. Ninety percent of the industrial ground-water pumpage is concentrated in the Deepwater-Carneys Point area along the Delaware River.

Irrigation of agricultural crops has increased substantially in Salem County. In 1964 the number of acres irrigated was more than double the acreage irrigated in 1959 and about 64 times greater than the acreage in 1949. The number of acres irrigated in the county since 1949 are given in the following table:

Year	*1949*	*1954*	*1959*	*1964*
Irrigated land in farms (acres)	147	2,639	4,593	9,430

Source: U. S. Bureau of Census, Census of Agriculture.

Ground water from private wells was the source for irrigation water for about one-half of the total acres irrigated in the county. Most of the ground water for irrigation is pumped in the area east of Woodstown and Alloway. However, some pumpage for irrigation takes place west of Woodstown.

The use of ground water for irrigation is important in Salem County, largely because water requirements are seasonal. It varied from zero in the winter months to an average of about 5.1 mgd during the summer months in 1964. Irrigation requirements are generally greatest from about May 1, through September 30 each year. This is also the season of maximum ground-water use for other purposes. During the summer of 1964 irrigation was the second largest type of use of ground water and accounted for nearly one-third the total amount of ground water used in the county. It will undoubtedly increase in the future and, eventually it may become the largest single type of ground-water use in the county.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING CHARACTERISTICS

Salem County is underlain by a southeastward-thickening wedge of generally unconsolidated deposits of Quaternary, Teritary, and Cretaceous age. These deposits are composed of alternating clay, silt, sand, and gravel and are underlain by crystalline metamorphic and igneous rocks of early Paleozoic or Precambrian age.

The Pre-Quaternary deposits strike generally in a northeast-southwest direction and dip gently to the southeast. Pre-Quaternary formations crop out in a series of bands that parallel the Delaware River; the oldest formation occurring along the Delaware River and younger formations cropping out progressively to the southeast (figures 9 and 10).

The thickness of the Coastal-Plain deposits in Salem County as determined by geophysical methods (Wollard, 1941, p. 72) and from borings is 300 feet at Penns Grove, 1,376 feet at Salem, 1,670 feet at Pittsgrove, 2,140 at Elmer, and 2,400 feet at Norma.

The sequence of the Coastal-Plain formations in Salem County and the thickness, lithology, and hydrologic characteristics of each formation are given in table 3. The important aquifers in Salem County occur in the Potomac Group and Raritan and Magothy Formations, Wenonah Formation and Mount Laurel Sand, Vincentown Formation, Cohansey Sand, and Cape May Formation. Separating these aquifers are layers of clayey materials which have lower permeabilities than the aquifer materials. These clay beds are confining or semiconfining units and are referred to as aquicludes. Because some water can flow out of or into an aquifer through these clay layers, they sometimes are referred to as being "leaky."

LATE PRECAMBRIAN(?) ROCKS

Wissahickon Formation

Geology

The Wissahickon Formation is composed of metamorphic rocks—schist and gneiss. These rocks are generally characterized by a preponderance of mica, with quartz, feldspar, garnet, and chlorite; and they are typically medium- to coarsely crystalline, banded in texture and green and gray in color. Joints and other fractures are characteristic structural features of the Wissahickon Formation. It is overlain unconformably by the Potomac Group and Raritan Formation.

The Wissahickon Formation crops out in the vicinity of Wilmington, Delaware, but is overlain by Cretaceous and Quaternary deposits in Salem

County. The top of the Wissahickon Formation is irregular and slopes southeastward at 40 to 140 feet per mile, as shown by the generalized contours of figure 11. The identity and the locations of wells and test borings for which bedrock data are available in and near Salem County are also shown.

Hydrology

Because of the consolidated nature of these rocks, movement of significant quantities of water only can take place through joints and fractures. Salem County has no wells known to be obtaining water from this formation.

CRETACEOUS SYSTEM

Potomac Group and Raritan and Magothy Formations

Geology

The Potomac Group and Raritan Formation are largely continental in origin and are similar in lithology. The Magothy Formation is both continental and marine in origin. Lateral changes in character of individual beds, similar lithologies and sparseness of data make it difficult to differentiate everywhere between these three units in Salem County.

The Potomac Group and Raritan and Magothy Formations in Salem County are considered in this report to include the unconsolidated material that is above the bedrock and below the Merchantville Formation (see columnar section in table 3). The Potomac Group was not recognized in New Jersey on the Geologic Map of New Jersey (Johnson, 1950). According to the U. S. Geological Survey (1967, sheet 2), however, the Potomac Group rather than the Raritan Formation occurs in southwestern New Jersey. Palynological studies (H. E. Gill, oral communication) indicate that both the Potomac Group and the overlying Raritan Formation are present in southwestern New Jersey.

The Potomac Group in Maryland and Delaware consists of interbedded sand, gravelly sand, and clay, and contains abundant coarse lignitic material. The sand is mostly quartz and the gravel is quartz and quartzite. (U. S. Geological Survey, 1967, sheet 7). The Raritan Formation in New Jersey is composed of light-colored quartzose sand and some gravel and variegated clays that vary through shades of white, gray, yellow, brown, and red. Some lignite and pyrite are present. The Magothy Formation, as recognized in Salem County, typically consists of alternating beds of pyritic, lignitic, dark-gray or black clay and white, micaceous, fine to occasionally coarse-grained quartz sand and fine gravel.

Late Precambrian (?)	Cretaceous										Tertiary					Quaternary					System
	Lower Cretaceous	Upper Cretaceous									Paleocene		Eocene	Miocene	Miocene(?) and Pliocene(?)	Pleistocene			Holocene		Series
Wissah (sub	Potom	Rarita	Magot	Merch	Wood	Englis	Marsh	Weno	Moun	Nave	Horn	Vinc	Man (s	Kirk	Coh	Brid	Pens	Cap	Eoli	All	

The Potomac Group and the Raritan and Magothy Formations (fig. 9), crop out in Salem County adjacent to the Delaware River in a 19-square mile triangular area that has a maximum width of 3 miles. These units underlie approximately 24 square miles of the Delaware River and extend southwesterly into the State of Delaware. In New Jersey, they dip to the southeast; the top of the Magothy dips from 36 to 53 feet per mile and the base of the Potomac Group dips about 100 feet per mile. The combined thickness of these formations in Salem County ranges from 200 feet in the outcrop area to about 1,000 feet or more downdip.

Figure 12 shows the areal extent of these units in the outcrop area and in the subsurface in Salem County. Structure contours are drawn on the top of the Magothy Formation.

Hydrology

The Potomac Group and Raritan and Magothy Formations contain some of the most productive aquifers in New Jersey. The sands of the Magothy generally are somewhat finer and less productive than those of the Potomac and Raritan. The aquifers in these units contain a higher percentage of clay in Salem County than in the counties to the north and hence the permeability of these aquifers may be lower in Salem County than in the counties to the north. Because of the extensiveness of the clays in these formations, several distinct aquifers may be present locally. The thicknesses of these aquifers in Salem County range from 5 to 85 feet; in some places the aquifer thickness changes significantly in relatively short distances.

In the outcrop area of the Potomac Group and Raritan and Magothy Formations adjacent to the Delaware River, four aquifers have been identified. One aquifer is between 50 and 120 feet below the land surface and ranges from 6 to 43 feet in thickness. It is tapped by wells at the plants of E. I. duPont de Nemours Co. in Deepwater and Carneys Point, and the Penns Grove Water Supply Co. near Penns Grove. Reported yields of wells tapping this aquifer range up to 860 gpm. The higher yields generally are in areas where local confining clays are absent, and where the aquifer has direct hydraulic connection with the shallow overlying Quaternary deposits—primarily the Cape May Formation—near the Delaware River. Under these conditions, the Quaternary deposits and this aquifer function together as one aquifer.

A second aquifer, from 150 to 250 feet below land surface, in the area near the Delaware River is artesian and varies from 10 to 52 feet in thickness. It has been penetrated by wells of the E. I. duPont de Nemours Co. at Deepwater and at Carneys Point; by wells of the Pennsville Township Water Department at Pennsville; by wells of the Atlantic City Electric Co. at Deepwater; and by wells of the Penns Grove Water Supply Co. at the Layton pumping station. This is the most extensively utilized aquifer in the Penns Grove area, and yields from 356 to 687 gpm to wells. Because the confining clays between this aquifer and the one above do not have large areal extent, the aquifers are hydraulically connected regionally.

A third aquifer in the area near the Delaware River is between 300 and 390 feet below land surface and is 20 to 40 feet thick. Wells of the E. I. duPont de Nemours Co. at Deepwater and probably the Penns Grove Water Supply Co. at the Layton pumping station tap this aquifer and yield from 250 to 600 gpm.

A fourth aquifer occurs between 400 and 500 feet below land surface in the area near the Delaware River and is about 80 feet thick. It yields as much as 600 gpm to wells.

Downdip, where the Magothy Formation is overlain by the Merchantville Clay (see figure 10), three artesian aquifers have been distinguished and are designated as upper, middle, and lower. Any water-bearing zone occurring in the upper 200 feet of the Raritan and Magothy Formations is considered to be part of the upper aquifer, the middle aquifer is in the next lower 200 feet, and the deepest aquifer contains the water-bearing horizons in the next lower 200 to 300 feet. The majority of the wells downdip from the outcrop area are believed to tap the upper aquifer.

Permeabilities of sand samples from the outcrop of the Raritan and Magothy Formations in Middlesex County range from 210 to 3,500 gpd per sq ft and porosities range from 26.5 to 39.5 percent (Barksdale, 1937). Aquifer tests have been made at numerous places outside of Salem County in the Potomac Group and Raritan and Magothy Formations. The two test areas closest to Salem County are at Gibbstown and Westville in Gloucester County. The hydraulic characteristics determined from these tests are probably fairly typical of the characteristics of the materials in Salem County. Computed coefficients of permeability range from about 1,020 to 1,480 gpd per sq ft. The coefficient of storage ranges from 9×10^{-5} to 1.5×10^{-4} at the test areas. Coefficients of storage of this magnitude indicate artesian conditions.

A rather detailed discussion of the hydrology of the aquifers of the Raritan and Magothy Formations was presented by Barksdale and others (1958). Figure 13, taken from their report, shows the theoretical groundwater flow pattern prior to large-scale pumpage for these units considered hydrologically as a single aquifer. As shown, some of the water that recharged these formations in the relatively high-altitude outcrop areas in Mercer and Middlesex Counties to the north and in Delaware to the south travelled many miles through the aquifer before being discharged to streams in distant parts of the outcrop.

The distribution and intensity of pumpage from the aquifers in the Potomac Group and Raritan and Magothy Formations has significantly modified the pattern of ground-water movement shown in figure 13. Pumpage in areas north of Salem County intercept a large part of the flow that otherwise would have been discharged to streams crossing the outcrop area in Salem County. The decline in water levels due to pumping from these aquifers is illustrated by the hydrograph (figure 7) of the Point Airy well (53B). Water levels have declined approximately 11 feet in this well from 1959 to 1967.

Quality of Water

Chemical analyses of waters from the Potomac Group and Raritan and Magothy Formations of Salem County are given in table 5. Locations of wells for which quality-of-water data are available are shown in figure 3. Because of the diversity of factors affecting the quality of these waters, no one analysis can be considered typical of these formations. These analyses indicate that most of the water from parts of the aquifer not contaminated by salt water is of good chemical quality. The water has a median temperature of 58°F, ranging from 54°F for the shallow depths to 62°F for greater depths, such as the 700-foot deep wells at Woodstown.

The location of the interface between fresh water and salt water in the Potomac Group and Raritan and Magothy Formations (see fig. 13) prior to large-scale pumpage was determined on the basis of the distribution of water levels in the outcrop, the difference in density between fresh and salt water, and the estimated location of where ocean water had access to the aquifer. The fresh water and salt water probably are separated by a broad zone of diffusion. For the upper part of the Raritan and Magothy Formations, the salt water is probably farther eastward than the indicated position; whereas, salt water may extend farther westward than the indicated position in the lower part of these formations.

Data obtained from wells in southern New Jersey since 1958 indicate that the interface shown on figure 13 is a reasonably reliable prediction of actual conditions. Chemical analyses of water from wells indicate chloride concentrations in the Woodstown area (wells 50, 55, 56, and 57) range from 13 to 153 ppm and in the Salem area (wells 58, 59, 59A, 59B, and 59C) range from 444 to 2,057 ppm. Chloride concentrations

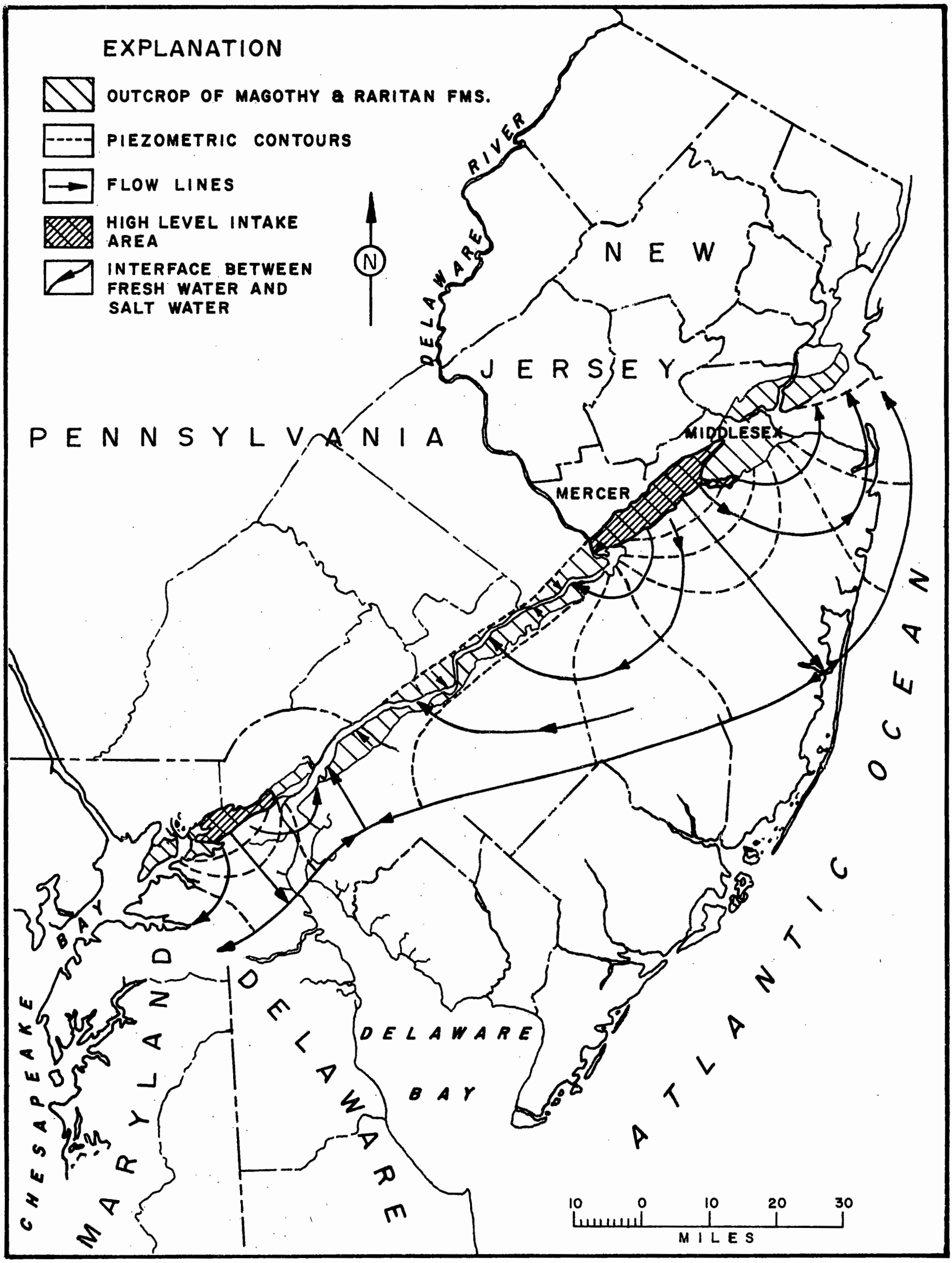

Figure 13.—Theoretical flow pattern and salt water-fresh water interface in the Magothy and Raritan Formations.

in the Salem area increase as depth increases as shown in the following table:

Well No.	*Depth of Well (feet)*	*Chloride Concentration (ppm)*
58	263	444
59C	350	700
59	550	879
59B	709	1,760
59A	714	2,057

In the area adjacent to the Delaware River, from Deepwater to Carneys Point, results of chemical analyses are available for water from four aquifers. Analyses of samples from 2 wells at Carneys Point (table 5, wells 31 and 32) indicate that salt water has penetrated the upper aquifer (50-120 feet below land surface). For example, from 1938 to 1959, chloride content in water from well 31 increased from 25 to 298 ppm, and dissolved solids increased from 132 to 1,040 ppm.

Water from the second aquifer (150-250 feet below land surface) at Carneys Point also shows increased chloride and dissolved solid concentrations (table 5, wells 29 and 30). Other wells in the same aquifer and in the third and fourth aquifers in the area adjacent to the Delaware River do not appear to be contaminated (table 5, wells 35 and 27).

Several small areas of salt-water encroachment from the Delaware River have been developed in the Deepwater area. This does not represent a massive incursion of salt water into the aquifer but indicates that river water has access to the aquifer. The layer of silt and organic muck in the bed of the Delaware River and in the tidal parts of tributaries to the Delaware limits the rate at which salt water can enter an aquifer. Therefore, it is extremely important not to remove significant thicknesses of these protective materials. Future ground-water withdrawals along the Delaware River should proceed with care to avert further expansion of those areas in which salt-water encroachment has taken place and to prevent establishment of new areas of encroachment.

Merchantville Formation

Geology

Black, green, or blue micaceous, glauconitic and sandy clay or clayey silt makes up most of the Merchantville Formation in Salem County. According to Minard (1965) the Merchantville Formation in the Woodstown quadrangle is a strongly silty to clayey sand in which "quartz is the major constituent with about 15 to 20 percent glauconite and some feldspar and mica constituting the remainder." The term "marl" frequently appears in the drillers' descriptions of the Merchantville. An extensive suite of Late Cretaceous marine fossils from this formation has been described (Weller, 1907, p. 43-61) but fossils are seldom reported in drillers' logs.

The Merchantville Formation is as much as 85 feet thick in Salem County. It has a width of outcrop ranging from ½ to 1½ miles and dips southeastward at about 45 feet per mile.

Hydrology

The Merchantville Formation and the overlying Woodbury Clay, function as a confining unit for the Potomac Group and Raritan and Magothy Formations. The permeability of the Merchantville Formation in Salem County is not known. However, four samples of the Merchantville Formation collected from a test hole drilled near New Brooklyn, Camden County, have permeabilities ranging from 0.0009 to 0.003 gpd per square foot and averaging 0.0017 gpd per square foot.

No wells are known to tap this formation in Salem County. A few shallow wells located in the outcrop area of the Merchantville, are screened in the overlying Pleistocene deposits. Hardt and Hilton (1969) found 15 wells in Gloucester County tapping the Merchantville Formation at depths of from 100 to 155 feet. The nearest of these wells to Salem County is at Swedesboro, some 3 miles north of the Salem-Gloucester County line.

Woodbury Clay

Geology

The Woodbury Clay is black, micaceous, and fossiliferous. The formation may be silty and the upper part contains some sand laminae. The lower part contains sufficient glauconitic sand to make the conformable contact with the underlying Merchantville Formation a transition zone. The Woodbury Clay is overlain conformably by the Englishtown Formation, where the latter is present and is overlain unconformably by the Marshalltown Formation where the Englishtown is absent. According to Minard (1965) the Woodbury Clay is absent from the Woodstown quadrangle.

Drillers commonly report the Woodbury Clay in Salem County as a black, blue, or olive-gray clay and occasionally indicate the presence of coarse-grained sand, yellow pebbles, mica, and hard dark clay or hardpan.

Late Cretaceous marine fossils are abundant in the Woodbury Clay. Weller (1907, p. 63-78) described the fossil collections made at six locations in New Jersey.

The width of the Woodbury outcrop ranges from 1 to 2 miles (see fig. 9). The formation has a thickness of as much as 90 feet and it dips southeastward at about 40 feet per mile (see fig. 10).

Hydrology

The Woodbury Clay and the underlying Merchantville Formation serve as the confining layer for the Potomac Group and Raritan and Magothy Formations. The permeability of materials from the Woodbury Clay has been determined at three locations. Bailer samples taken from the 210- to 220-foot depth zone of a test hole at Point Airy have an average coefficient of permeability of 0.9 gpd per sq ft, and an average porosity of 56.2 percent. An outcrop sample collected from a site 1 mile north of Haddonfield, Camden County, Hardt and Hilton (1969) has a coefficient of permeability of 7 gpd per sq ft, and a porosity of 59.6 percent. Samples collected from a test hole near New Brooklyn, Camden County, have an average permeability of 0.018. The permeability of the Woodbury Clay appears to decrease significantly downdip from the outcrop.

No wells in Salem County are known to tap the Woodbury Clay.

Englishtown Formation

Geology

The Englishtown Formation consists of light-colored fine to coarse-grained quartzose sand and may contain lenses and laminae of clay. Subordinate amounts of mica, glauconite, and lignite occur locally. According to Minard (1965) the Englishtown Formation in the Woodstown quadrangle is strongly silty to clayey, very fine grained, poorly to moderately sorted and typically unstratified.

The Englishtown in Salem County is described by well drillers as a white sand with occasional hard streaks, and an olive-gray and pale yellow clay.

The Englishtown Formation was not shown in Salem County on the Geologic Map of New Jersey (Johnson, 1950) but according to Minard (1965) it does crop out in the Woodstown quadrangle. The Englishtown has been identified in the subsurface as far southwestward as Salem. It appears to be variable in thickness (up to 40 feet thick) where recognized in drillers', electric, and gamma-ray logs. The formation dips to the southeast at about 35 feet per mile. The Englishtown Formation is conformably overlain by the Marshalltown Formation and underlain by the Woodbury Clay. In the Woodstown quadrangle (Minard, 1965) the Englishtown Formation unconformably overlies the Merchantville Formation.

Weller (1907, p. 79) found no fossils in Englishtown outcrop areas. H. E. Gill (oral communication) found microfossils in well samples and Minard (1965) reports shells and molds of pelecypods in unweathered sand.

Hydrology

The aquifer in the Englishtown Formation is relatively thin and has been little used in Salem County. Where present, it may be utilized for domestic supplies. Information is available for three wells tapping the Englishtown. Well yields of up to 75 gpm and specific capacities of up to 10 gpm per foot of drawdown have been reported.

A composite sample from the 160- to 170-foot depth zone at a test well at Point Airy consists of very fine-to medium-grained sand having a median particle diameter of 1.5 mm. On the basis of the rate at which water entered the well during the drilling of this depth interval, it is estimated that 10 gpm might be developed from the aquifer in the vicinity of Point Airy.

According to Seaber (1965) the highest water levels in the Englishtown aquifer in New Jersey occur downdip from the outcrop area. This indicates that the water in the Englishtown Formation downdip from the outcrop was obtained from vertical leakage from other aquifers.

Quality of water

Chemical analyses of water from two wells (wells 61 and 63) tapping the Englishtown Formation in Salem County are given in table 5. The water is low in dissolved solids (157 ppm), moderately hard, (68 and 117 ppm) slightly alkaline (pH 7.2 and 7.3), and high in iron (3.4 and 10 ppm). Hardt and Hilton (1969) report similar quality of Englishtown water in Gloucester County. However, the occurrence of salt water in the Salem area is indicated by a chloride concentration of 316 ppm in 1964 in well 64A.

Marshalltown Formation

Geology

The Marshalltown Formation is a dark green or brown, glauconitic, micaceous, occasionally lignitic clay or sandy (quartz) clay. According to Minard (1965) in the Woodstown quadrangle "quartz and glauconite, in nearly equal proportions, constitute the bulk of the formation: feldspar, mica, pyrite, phosphatic fragments, and calcareous shells are minor constituents." It is abundantly fossiliferous (Weller, 1907, p. 81-89). Megafossils include *Exogyra ponderosa,* and *Ostrea falcata;* microfauna include a large foraminiferal assemblage (Mello, Minard, and Owens, 1964, p. 61-63).

Drillers describe the Marshalltown as green, light olive, black or gray; as a marl, clay, sand, tough clay, or sandy clay; or as having mica, shells (including sharks' teeth) or a "hardpan" at the top of the formation.

The outcrop of the Marshalltown has a width from one-half to one mile. The formation is as much as 45 feet thick and it dips to the southeast at about 35 feet per mile. The Marshalltown Formation makes a conformable transitional contact with the overlying Wenonah Formation.

Exposures of Marshalltown may be found along small tributaries of Oldmans Creek near Auburn. An excellent exposure is located at the northern end of the Boy Scouts of America property known as Camp Kimble (fig. 1). At this location, between altitudes 35 feet and 15 feet, on the north face of a 50-foot bluff, is a greenish-brown, clayey, fossiliferous, and highly glauconitic, quartz sand.

Hydrology

The Marshalltown Formation functions as a leaky confining layer above the Englishtown Formation in northern New Jersey. The permeability of the Marshalltown Formation collected from a test hole drilled near New Brooklyn, Camden County, have permeabilities of 0.01 and 0.001 gpd per square foot.

A few domestic wells tap the Marshalltown Formation. These wells reportedly yield from 15 to 75 gpm and have specific capacities from 2 to 3 gpm per foot of drawdown. Additional domestic supplies may be developed from this formation.

Drillers' reports indicate that the quality of the water from the Marshalltown may be fair to poor; the water containing undesirable iron content, odor, and turbidity.

Wenonah Formation and Mount Laurel Sand

Geology

The Wenonah Formation and overlying Mount Laurel Sand are often difficult to separate in subsurface geologic logs and are mapped as a unit on the Geologic Map of New Jersey (Johnson, 1950). They also constitute a single hydrologic entity and therefore are discussed as one unit.

The Wenonah Formation is characterized by a fine-grained quartz sand that is micaceous, occasionally lignitic and glauconitic, and colored from black and brown to red and yellow. Iron-cemented sand layers (ironstone) may be seen in outcrop and a brown silty clay has been observed at the base of the formation. According to Minard (1965), in the Woodstown quadrangle, "the major sand constituents in order of decreasing abundance are quartz, feldspar, mica, and carbonaceous matter. Mica and carbonaceous matter are particularly diagnostic of this unit."

In drillers' logs, the Wenonah is described as a fine-grained sand or sandy clay with occasional hard layers (iron-cemented sand) or "Jersey stone."

The Mount Laurel consists of medium- to coarse-grained quartz and glauconitic sands. It is much less micaceous and lignitic than the Wenonah. The major constituents, in order of decreasing abundance, are quartz, feldspar, and glauconite (Minard, 1965). The Mount Laurel has a distinctive "salt and pepper" appearance, owing to its light-gray and dark-green sands, but may also be reddish or yellow in color. It is noticeably fossiliferous (Weller, 1907, p. 103-136, and Richards and others, 1957, p. 196) in outcrop and frequently in subsurface. In the Woodstown quadrangle Minard, 1965) shell fragments are moderately abundant but identifiable fossils are rare.

In drillers' logs a "salt and pepper sand" or "Belemnite strata" (Belemnitella americana) distinguishes the Mount Laurel Sand. Shells, marl, or green sand are terms that are also used along with the colors black and white, gray, green, red, and yellow. A pebbly zone often marks the top of the Mount Laurel or the base of the conformably overlying Navesink Formation. The Wenonah Formation conformably overlies the Marshalltown Formation.

The combined breadth of outcrop for the two formations varies from 1 to 3 miles in Salem County, and their total thickness is not believed to exceed 120 feet, and is generally between 80 and 100 feet.

Figure 14 shows contours drawn on the top of the Mount Laurel Sand and indicates that the top of the formation has a uniform dip throughout the county of 35 feet per mile to the southeast and an average strike of N. 55° E.

Hydrology

The Wenonah Formation and Mount Laurel Sand function as one aquifer and in 1964 yielded 0.81 mgd to public-supply wells in Salem and Elmer. Private homes, farms, industries, and schools utilize this aquifer to the extent that it is the second most utilized aquifer in the county. The Wenonah and Mount Laurel is an important source of water for future development in Salem County except in the vicinity of Salem.

More than 100 wells are known to tap this aquifer downdip from the outcrop. Most of them have 4-inch or smaller sized casings and many do not have screens. The larger-diameter wells (greater than 6 inch) are usually screened. Specific capacities of 39 wells listed in table 6 range from 0.7 to 9.4 gpm per foot of drawdown, and the average is 3.8. Reported yields of larger-diameter wells range from 125 to 507 gpm.

The permeability and porosity of a sample from the aquifer of the Wenonah and Mount Laurel at Point Airy are 73 gpd per square foot and 44.1 percent, respectively.

The water-bearing characteristics of the Wenonah and Mount Laurel aquifer were determined from two pumping tests conducted in cooperation with the Salem Water Department in order to determine: (1) the mutual interference between two wells, (2) the extent of the cone of depression or area of influence under normal operating conditions, (3) the hydraulic connection between the nearby tidal stream and the screened aquifer, and (4) the cause of increasing chloride concentrations in water samples from the wells at this site and other nearby areas. The tests were conducted at the City of Salem's well field which is located on the southeast side of town, adjacent to a tidal tributary of Keasbeys Creek. (See figure 15.)

Figure 15 shows also a generalized geologic section through the Salem well field. The test site is in the outcrop area of the Vincentown Formation which here is mantled by approximately 10 feet of Quaternary material and is under water-table conditions. Hydraulic connection exists between the tidal stream adjacent to the well field and the Vincentown aquifer which extends to a depth of about 52 feet below land surface at the test site. Clayey and semiconfining Hornerstown Sand and Navesink Formation underlie the water-table aquifer and have a combined thickness of about 32 feet. The top of the Wenonah and Mount Laurel aquifer which underlies the Hornerstown and Navesink Formations occurs at about 84 feet below land surface. At the test site this aquifer is about 90 feet thick and is underlain by the confining Marshalltown and older formations.

The first pumping test was conducted in October 1960 prior to any salt-water intrusion into the Wenonah and Mount Laurel aquifer. This test showed the effects of a recharge boundary soon after pumping began; drawdowns approached maximum levels within 30 to 45 minutes in the one observation well available. Analysis of the test data indicated that the recharge boundary represents vertical leakage, probably from the shallow water-table aquifer in the Vincentown, through the semiconfining Hornerstown and Navesink, to the Wenonah and Mount Laurel aquifer. However, the limitation of having only one observation well in this test

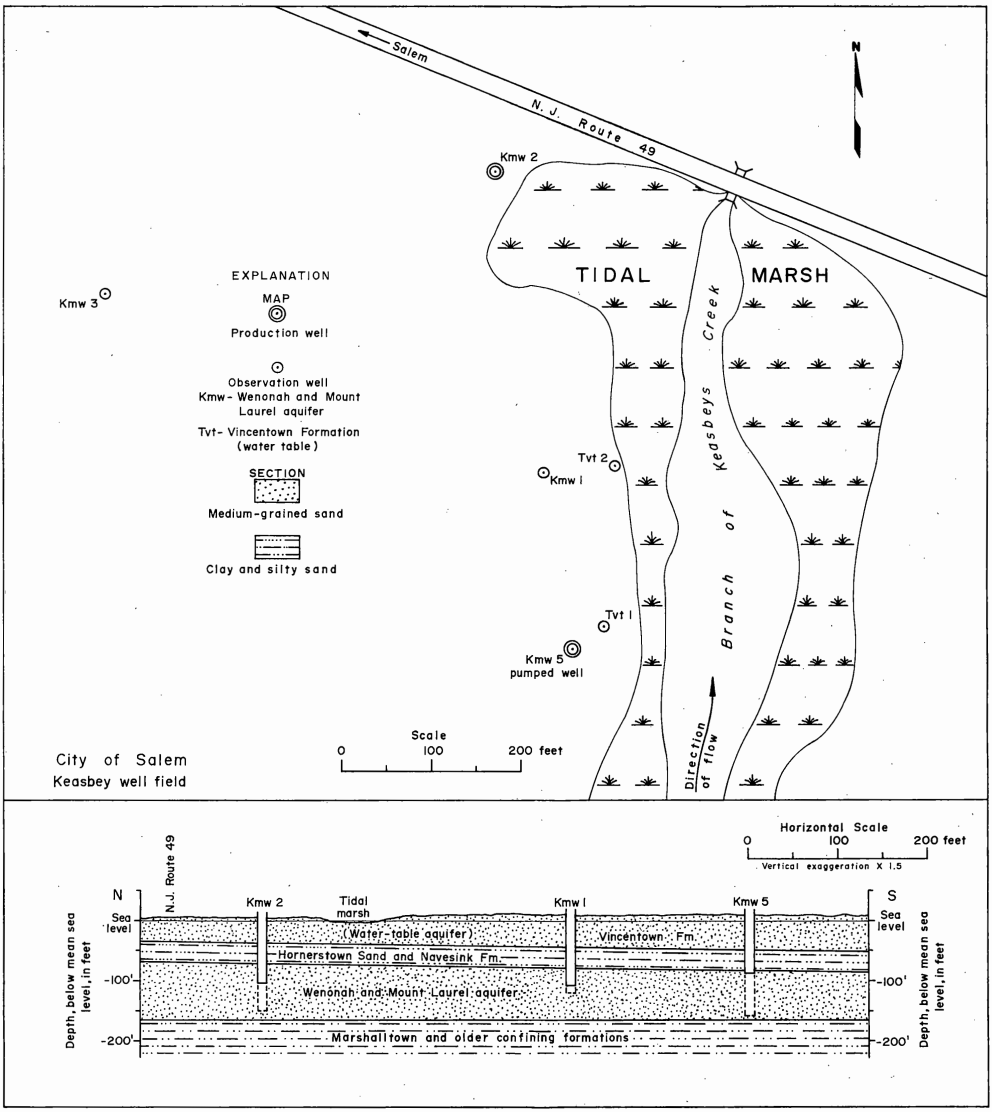

Figure 15.—Location of and generalized geologic section of the Salem well field.

precluded obtaining reliable aquifer characteristics and properly evaluating the effects of leakage and distance-drawdown relations.

A second pumping test of the Wenonah and Mount Laurel aquifer was conducted in March, 1965. In this test five observation wells were available; three are screened in the Wenonah and Mount Laurel aquifer and two are screened in the shallow water-table aquifer in the Vincentown Formation. (See table 4.) Salem's production well (Well 110) screened from 96 to 168 ft in the Wenonah and Mount Laurel, was pumped at 500 gpm, and water levels were measured in the observation wells. The drawdowns after 24 hours of pumping are given in table 4. The test data were analyzed by steady, and non-steady leaky artesian aquifer methods and equations developed by Jacob (1946), Hantush and Jacob (1955), Cooper (1963), and modifications of these by Walton (1962). The development of these equations is based on the assumption that water levels in the material overlying the semiconfining unit are not lowered significantly in comparison with drawdowns in the pumped artesian aquifer, and, that sufficient time has elapsed for the hydraulic gradient through the confining bed to adjust to the drawdowns. Under steady state conditions the water pumped is balanced by vertical leakage rather than withdrawn from storage in the artesian aquifer.

Table 4.—Distance-drawdown data for observation wells used in a pumping test of the Wenonah and Mount Laurel aquifer near Salem, N. J.

(March 1965; pumping rate, 500 gpm)

Observation Well[1]	*Screen setting (Depth in feet, below land surface)*	*Distance from pumped well (ft)*	*Drawdown after pumping 24 hours (ft)*	*Altitude of water surface after 24 hours pumping (ft below MSL)*
Water-table wells				
142A (Tvt 1)	23- 26	50	6.8	-13.8
142B (Tvt 2)	21- 24	214	1.9	- 8.4
Mount Laurel-Wenonah wells				
110 (Kmw 5)	96-168	pumped well	—	—
110A (Kmw 1)	104-114	200	20.8	-24.9
108 (Kmw 2)	110-150	535	9.2	-15.2
110B (Kmw 3)	135-140	650	8.0	-12.0

[1]Number indicates well number in this report; abbreviations and number in parentheses is the local number used in the field.

From the analyses of data from the observation wells, it was determined that the average transmissibility of the Wenonah and Mount Laurel aquifer at the test site is about 9,000 gpd per ft (gallons per day per foot); the permeability is about 100 gpd per sq ft; and the storage coefficient is about .35 x 10^{-4}. The vertical permeability of the leaky, semiconfining Hornerstown and Navesink Formations is approximately 0.42 gpd per sq ft.

The effect of vertical leakage from the overlying Hornerstown and Navesink Formations to the Wenonah and Mount Laurel aquifer becomes apparent by examining the distance-drawdown curves in figure 16. They show that without leakage the drawdown at 1,000 feet from the pumped well would be about 13.5 feet at the end of 24 hours of pumping at 500 gpm; with leakage, the drawdown would be only about 4.5 feet. Also, without leakage the cone of influence or area of diversion would extend to about 6,000 feet from the pumped well; with leakage it extends to about 3,000 feet.

An estimate of the quantity of water derived from leakage through the Hornerstown and Navesink was made from data obtained in the Salem test. Theoretically, the rate of leakage is proportional to drawdown in the pumped aquifer or to the head difference established between the aquifer and the overlying, semiconfining unit. The average head difference throughout the cone of diversion was about 2.0 feet between the shallow water-table aquifer in the Vincentown and the leaky artesian aquifer in the Wenonah and Mount Laurel aquifer. The amount of leakage can be computed by the following form of Darcy's equation:

$$Q = P\, I \pi r^2$$

where:

Q = rate of leakage
P = vertical permeability of semiconfining unit
I = hydraulic gradient
r = radial distance from the discharging well
π = 3.14 (constant)

Therefore, when: $P = 0.42$ gpd/sq ft; $I = \frac{2 \text{ ft}}{32 \text{ ft}}$ and $r = 3{,}000$ ft

then, $Q = 0.42 \times \frac{2}{32} \times 3.14 \times (3{,}000)^2 = 740{,}000$ gpd

or $Q = 514$ gpm

The computed rate of leakage from the theoretical area of diversion (3,000 ft) agrees closely with the actual test pumping rate of 500 gpm.

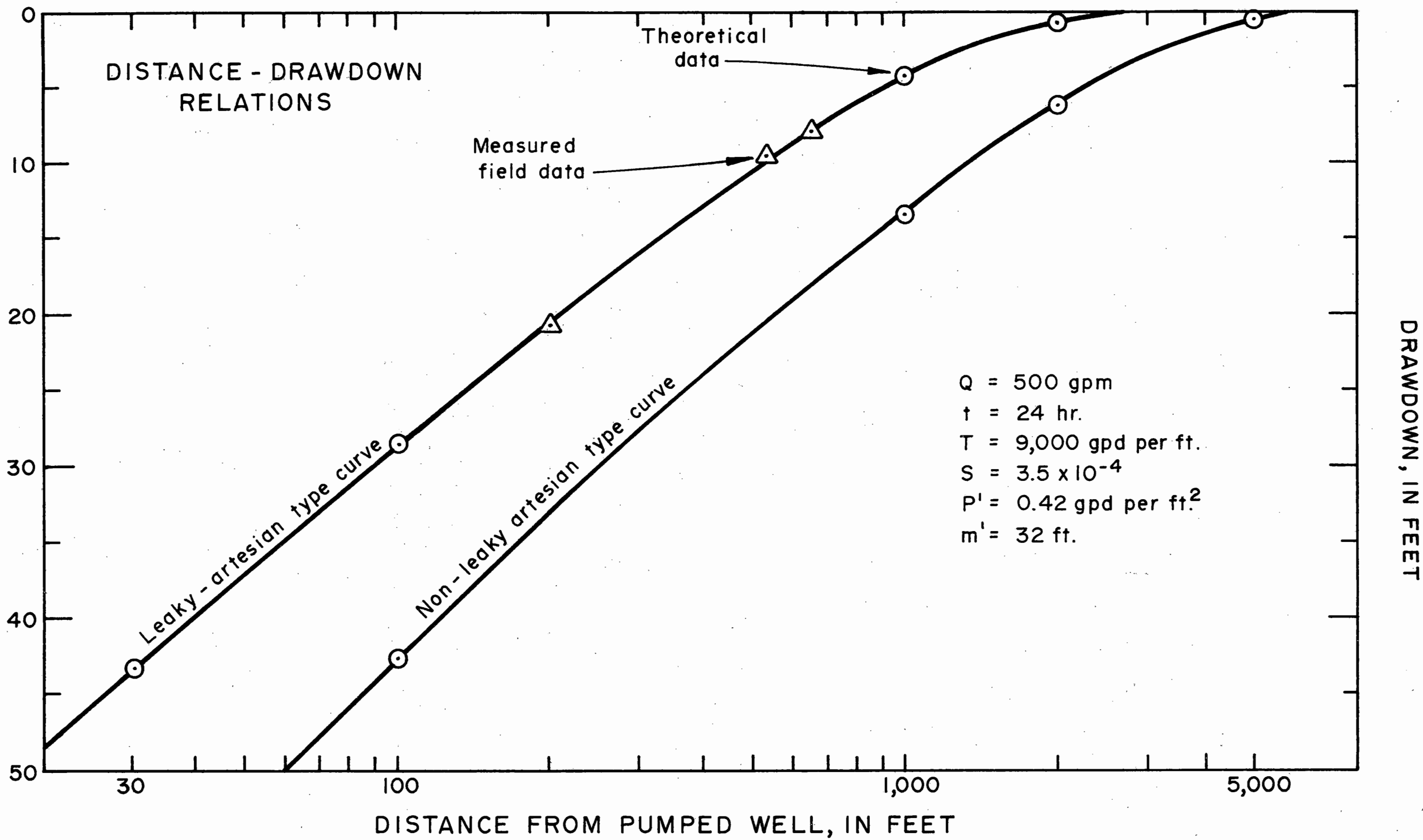

Figure 16.—Theoretical distance—drawdown relations for leaky aquifer and non-leaky aquifer conditions determined from a pumping test at Salem.

Leakage rates of vertical flow through the semiconfining Hornerstown Sand and Navesink Formation will vary widely depending on actual pumpage rates and the resulting drawdowns in the pumped aquifer. Computed leakage in the Salem test within a radius of 100 feet from the pumped well, where the average drawdown was about 34 feet, was less than 10 gpm; within 1,000 feet where the average drawdown was 8 feet it was 230 gpm. If pumpage from the aquifer is increased, drawdowns will increase and the cone of depression will expand. Even though the permeability of the semiconfining Hornerstown and Navesink Formations is very small near Salem, considerable vertical leakage may occur over large areas from small head differences between aquifers.

Ground-water recharge to the Wenonah and Mount Laurel aquifer in Salem County, downdip from the outcrop, is derived mainly from vertical leakage from overlying aquifers. In the outcrop area some recharge occurs as well as discharge to local streams draining the area. Figure 17, a generalized piezometric map of the aquifer in the county, indicates the pattern of ground-water movement. Some water may flow into Salem County from neighboring Gloucester County near the headwaters of Oldmans Creek. Vertical leakage into the aquifer is indicated by the two piezometric highs just north and south of Woodstown. The generalized horizontal pattern of flow is from the higher levels to the lower lying areas near the outcrop along Oldmans Creek and along Salem River near Woodstown. Some ground water flows toward the outcrop area in Mannington Township and some flows toward Salem and to Lower Alloway Creek Township. Near the outcrop in the southern part of the county, hydraulic gradients are small and general altitudes of the piezometric surface are near sea level. Here, the horizontal movement of ground water is limited by low gradients and vertical leakage probably occurs from the Wenonah and Mount Laurel aquifer to shallower aquifers.

Quality of water

Analyses of 32 water samples from 24 wells tapping this aquifer are given in table 5. The hydrogen-ion concentration (pH) ranges from 5.2 to 8.3 in the 32 samples. Five samples taken from 3 wells in the outcrop of the formation have a pH of 5.8 or less. Each of the other samples has a pH above 7.0. The average pH of the 32 samples is 7.3 and the average pH of the 27 samples having pH's above 7.0 is 7.6.

Iron concentrations are not uniform. In 31 samples from 24 wells, the range was from 0.1 to 6.3 ppm and 23 samples had more than 0.3 ppm. Water from this aquifer generally requires treatment for use in domestic and most industrial supplies. Treatment for the removal of hardness is also common. Samples analyzed ranged from soft to very hard (12 to 345 ppm, median 127 ppm). Samples collected from wells in the outcrop of the formation were generally soft (12 to 34 ppm except for one sample containing 124 ppm).

Total dissolved solids and specific conductance also show the difference between the chemistry of water in the outcrop and in downdip parts of this formation. In two of the three wells (wells 67 and 70) in the outcrop area, total dissolved solids (38 and 55 ppm) and specific conductance (57 and 75 micromhos) are low. Water from the third well (well 76) is not representative of water from the outcrop area of the Wenonah and Mount Laurel; this well is shallow and appears to tap a source of contaminated water; the sample has high nitrates (97 ppm) and relatively high chlorides (33 ppm), dissolved solids (266 ppm), and specific conductance (367 micromhos). Samples taken from the downdip parts of the formation are generally moderate to high in dissolved solids (130 to 686 ppm) and specific conductance (217 to 1,180 micromhos).

Salt-water intrusion by vertical leakage from the overlying water-table aquifer in the Vincentown and Cape May Formations into the aquifer of the Wenonah and Mount Laurel in the Salem area is indicated by chloride concentrations ranging from 4.8 to 396 ppm (tables 5 and 6, wells 98A, 108, 110, 110A, 110B, 117A, and 118A). An increase in chloride concentration in the City of Salem well no. 2 (well 108) from 1952 to 1964 is shown in figure 18. Salt water in the water-table aquifer was derived from tidal flooding during the drought period of 1961-66. During this period water levels in the water-table aquifer were quite low—as much as 7 feet below mean sea level in March 1965, and fresh-water discharge to tidal streams declined or ceased.

Chloride concentrations in tidal streams at Salem lie somewhere between those in the Delaware River at Reedy Island and those at Delaware Memorial Bridge. Chloride concentration as computed from specific conductance at Reedy Island ranged from 25 ppm to 11,000 ppm during the period 1963-66. Chloride concentration at Delaware Memorial Bridge ranged from less than 10 ppm to 4,500 ppm during the period 1955-66.

As the drought ends, water levels in the water-table aquifer rise, ground-water discharge into the tidal streams increases and the salt-water content in the aquifer decreases. However, it may take several years before salt water in the Wenonah and Mount Laurel aquifer can be flushed upward through the Hornerstown Sand, Navesink Formation, and water-table aquifer into the tidal streams.

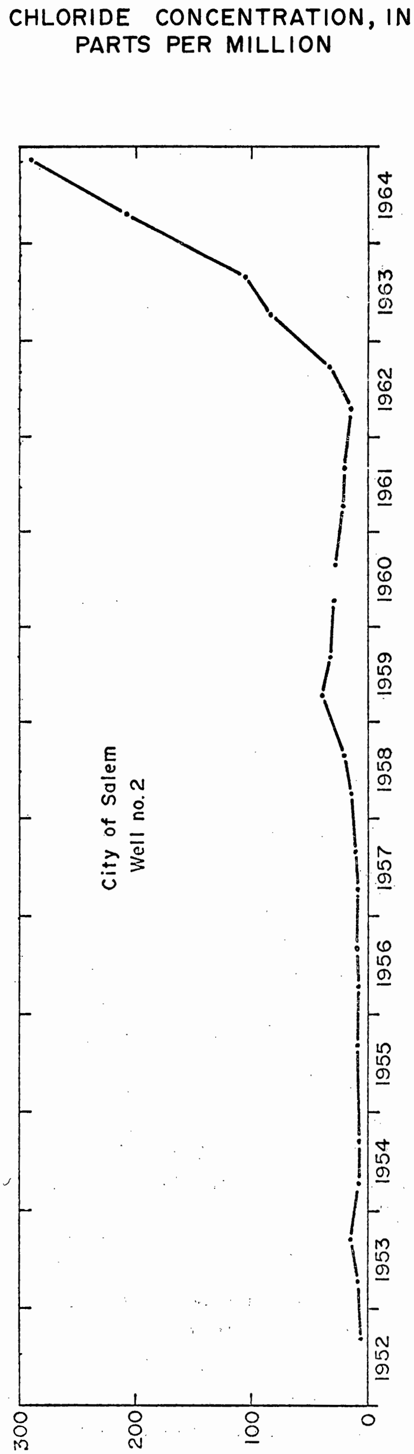

Figure 18.—Chloride concentration in water from City of Salem well no. 2 (well 108) 1952-64.

Navesink Formation

Geology

The Navesink Formation is characteristically a glauconitic sand with varying amounts of silt and clay. It is brown or dark green to blue-black and has a shell bed at its base. The upper part of the formation is less glauconitic, more clayey, more micaceous, and lighter in color than the lower. In the Woodstown quadrangle (Minard, 1965) the sand is "mostly medium grained but coarse to very coarse quartz grains and granules are common in the basal few feet." This formation conformably overlies the Mount Laurel Sand. The contact with the overlying Hornerstown Sand is gradational, the transition taking place within a few feet (Minard, 1965).

The Navesink Formation and the overlying Hornerstown Sand are commonly described by drillers as "marl" or "greensand," although they may also indicate the presence of clay, silt, sand, shells, or pebbles. Color descriptions range from white through gray, light green or blue, very dark green, brown and black. The combined thickness of the Navesink and Hornerstown Sand ranges from 30 to 52 feet. The formations dip southeasterly at approximately 35 feet per mile.

Weller (1907, p. 103-136), describing the Cretaceous marine fossils of the "Mount Laurel-Navesink Formations," indicates a conspicuous 1-foot layer of shells of the Pelecypoda, *Gryphaea convexa* occurring 10 feet above the base of the Navesink.

A good exposure of the Navesink Formation in contact with the overlying Hornerstown Sand is visible in a roadside cut on the east side of the Woodstown-Swedesboro Road, 1 mile north of the Salem-Gloucester County line, Gloucester County (N. J. grid no. 30.24.7.8.5). Several feet of green highly glauconitic Hornerstown Sand overlies brown and less glauconitic Sand of the Navesink Formation.

Gamma-ray logs of wells in Salem County show the presence of two relatively high radioactive layers spread 20 to 25 feet apart. They appear to coincide in position with high concentrations of glauconitic sand in well 53 (Point Airy) or with reported shell layers near the top of the Hornerstown Sand and the bottom of the Navesink Formation, thus spanning the Tertiary-Cretaceous (Hornerstown Sand-Navesink Formation) contact zone in Salem County. This feature was used as a marker in correlating well logs as shown in figure 19.

Hydrology

The Navesink Formation and overlying Hornerstown Sand function largely as a leaky confining unit for the Wenonah and Mount Laurel aquifer. Hardt (Hardt and Hilton, 1969) collected samples of the Navesink Formation and Hornerstown Sand from a pit located 1 mile southeast of Sewell in Gloucester County. Porosities of the Navesink Formation sample and the Hornerstown Sand sample are 54.3 and 52.2 percent, respectively, and the permeabilities are 65 and 30 gpd/sq ft, respectively. Analysis of the previously described pumping test of the Wenonah Formation and Mount Laurel Sand at Salem indicates that the coefficient of vertical permeability of the Navesink and Hornerstown aquiclude in that area is 0.42 gpd/sq ft.

No wells are known to tap either the Navesink Formation or the Hornerstown Sand in Salem County. It is possible that small supplies might be developed from either of these formations where they are sandy.

TERTIARY SYSTEM

Paleocene Series

Hornerstown Sand

Geology.—The Hornerstown Sand is a highly glauconitic, clayey, dark-green sand that contains small percentages of quartz grains and apatite pellets. When a sample of the Hornerstown material is washed, a characteristic pea green clayey glauconitic residue is obtained (Owens and Minard, 1960, p. 24) which differentiates this formation from underlying Cretaceous formations. The Hornerstown Sand unconformably overlies the Navesink Formation and is unconformably overlain by the Vincentown Formation.

Although not plentiful, some fossils have been found in the Hornerstown Sand. The sponge *Peronidella dichotoma* (Gabb), the coral *Flabellum mortonic* (Vaughan), the pelecypod *Cucculaea antrosa* (Morton) and the gastropod *Turritella* are reported (Richards and others, 1957, p. 17) in samples from a pit in Gloucester County.

The Hornerstown Sand crops out in at least three locations in Salem County: (1) N. J. Grid 30.34.1.5.1, on the west side of the Woodstown-Swedesboro Road, 0.7 mile north of Point Airy; (2) N. J. Grid 30.33.3.8.2, on the north side of Featherbed Lane, 0.15 mile west of Kings Highway; and (3) N. J. Grid 30.34.1.6.9, in the north bank of a branch of Oldmans Creek, about 175 feet west of State Route 45, 0.67 mile north of the Point Airy Station Road.

As the Hornerstown Sand and the Navesink Formation are considered a single hydrologic unit in this report, the hydrology of the Hornerstown Sand has been discussed in the section on the Navesink Formation.

Vincentown Formation

Geology.—The Vincentown Formation is a slightly clayey, medium-grained sand. Quartz and feldspar are the major constituents; glauconite, mica, and pyrite are minor constituents (Minard, 1965). The Vincentown aquifer consists of highly fossiliferous beds, limesand, limestone, sandstone, and slightly glauconitic and micaceous quartz sand. Predominant colors are gray, green, light brown, or yellow. Nonwaterbearing beds are composed of green, clayey, glauconitic sand. The Vincentown has an estimated maximum thickness of about 160 feet in the southeastern part of the county.

The Vincentown Formation is described by drillers as sand, clay, clay with pepper, marl, marl with shells and clay, limesand, limerock, limestone, rock layers, shell layer, or sea-shell formation. Colors indicated are gray, green, yellow, and light brown.

The aquifer is highly fossiliferous. Fossils have been described by Weller (1907, p. 161-171), Greacen (1941), and Richards and others (1957, p. 199-203), and Minard (1965).

The Vincentown Formation is difficult to separate in places from the overlying Manasquan or Kirkwood Formations. In the outcrop area, the Vincentown is overlain unconformably by the Kirkwood Formation.

Few exposures of the Vincentown Formation occur in Salem County. One outcrop has been described in the discussion of the Hornerstown Sand. Another exposure, of light brown glauconitic quartz sand, occurs about 300 feet south of Oldmans Creek and 200 feet west of the Eldridge Hill-Harrisonville Road (N. J. grid 30.34.2.5.4).

Hydrology.—The aquifer of the Vincentown Formation is an important source of ground water in a 90 square mile area of Salem County that includes the outcrop zone and the area underlain by the highly permeable section downdip from the outcrop.

The thickness of the aquifer in the Vincentown Formation in Salem County ranges from 10 feet or less in the outcrop area near Woodstown (well 55) to 92 feet at Quinton (well 111). The extent of the aquifer in the Vincentown Formation is shown on the structure contour map in figure 20. The aquifer probably extends no more than five miles downdip from the outcrop. However, it probably extends southwestward to at least the Delaware River although not shown by the contours on figure 20.

Wells tapping the aquifer of the Vincentown Formation yield moderate supplies of water, up to 270 gallons per minute. Well 156, located at

Quinton and supplying water for the city of Salem, is the only public-supply well known to tap the Vincentown aquifer. The Vincentown water-bearing zone is capable of supplying considerably more water than is now being pumped and is an important source for future ground-water development. Data for 45 wells in the Vincentown water-bearing zone are given in table 6. Most of the wells are 4 inches in diameter and only a few have screens. Specific capacities range from 0.5 to 8.3 and average 4.0 gpm/ft of drawdown.

Water-table conditions exist in the outcrop area. Here, local recharge occurs and discharge is to local streams such as Oldmans Creek and Alloway Creek. Movement of water in the artesian aquifer downdip from the outcrop is from Gloucester County southwestward through Salem County. Although the permeabilities of the overlying and underlying aquicludes are low, leakage can occur into or out of the Vincentown Formation through these materials where there is a vertical head gradient.

Quality of water.—The chemical quality of water in the Vincentown aquifer may limit its use. The water is hard and has a moderate to high iron content. Hardness ranges from 134 to 270 ppm and the average hardness of 13 samples from the aquifer is 208 ppm. Total iron content ranges from 0.15 to 10 ppm and the median total iron content of 13 samples is 2.1 ppm.

The occurrence of salt water in the Vincentown Formation in the Salem area is indicated by chloride concentrations in four wells (tables 5 and 6—wells 142A, 142B, 142C, and 144) ranging from 10 to 2,850 ppm in 1964-66.

Eocene Series

Manasquan Formation

Geology.—The Manasquan Formation is not known to crop out in Salem County. Figure 10 depicts the formation in subsurface where it has a maximum thickness of 150 feet. It is a sandy glauconitic clay and appears to have primarily a grayish or dusky-green color. The glauconite constitutes from 50 to 80 percent of the sand and the remaining percentage consists of quartz grains, pyrite, mica, and a few foraminifera.

The Manasquan is described by well drillers as: marl or clay, clay with pepper or shells, clay or sandy marl, and marl with shells and clay. Colors used by drillers to describe the formation are: black, gray, green, chartreuse, and white.

The Manasquan Formation overlies conformably the Vincentown Formation and underlies unconformably the Kirkwood Formation but it is difficult to differentiate from these formations in most drillers' logs. The formation dips southeastward, from 22 to 32 feet per mile. Weller (1907, p. 173-175) indicates that Manasquan fossils are not abundant but represent a modified recurrence of the Hornerstown suite.

Hydrology.—Well 164, which yields 10 gpm, is the only well known to tap the Manasquan Formation in Salem County. Although a few other wells may be taking some water from the Manasquan, they primarily tap the Vincentown Formation. The Manasquan is clayey and impermeable enough to be considered a confining bed. Although it has a few thin sandy sections that may contribute minor quantities of water to wells, it is probably more accurately classified as a leaky aquiclude.

Miocene Series

Kirkwood Formation

Geology.—Thick beds of dark-colored clays, some silt, and layers of fine-grained micaceous quartz sand are typical of the Kirkwood Formation in Salem County. In the Woodstown quadrangle (Minard, 1965) the lower part of the formation is mostly thick-bedded, very fine- to fine-grained sand and is typically micaceous. Beds of pebbly coarse-grained sand containing abundant glauconite occur in the basal 2 to 4 feet. The upper part of the formation is interbedded poorly sorted silt and clay (Minard, 1965).

Drillers' logs indicate that the Kirkwood Formation is primarily a clay that contains occasional fine-grained sand or shells. Colors described are gray, brownish yellow, black, green, brown, and orange. It is also described as a fine-grained yellow sand or medium-grained sand with shells. The log of 160 feet of samples from well 176 (table 7) indicates that the formation is highly variable, consisting of about 60 percent clay or silt and about 40 percent medium-grained quartz sand.

The Kirkwood unconformably overlies the Manasquan and Vincentown Formations and dips southeastward at approximately 18 feet per mile. Its outcrop area is approximately 100 square miles. (See figures 9 and 10). Figure 10 shows the stratigraphic position of the Kirkwood and indicates that it has a maximum thickness of about 275 feet in Salem County. This estimate of thickness is questionable, however, because the Kirkwood is difficult to separate from the overlying and underlying formations and because of the sparseness of wells for which geologic or drillers' logs are available.

Exposures of the Kirkwood Formation may be seen at numerous locations east of Woodstown: a light buff-colored, silty, and micaceous clay crops out on the east side of the Woodstown-Mullica Hill Road (State

Highway 45) at N. J. Grid 30.34.1.9.3; and a buff-colored, silty, and micaceous clay containing fine quartz grains has been collected from a roadside cut on the west side of the Eldridge Hill-Harrisonville Road and about 300 feet south of Oldmans Creek at N. J. Grid 30.34.2.5.7.

Hydrology.—The Kirkwood Formation in Salem County has been developed for domestic and farm supplies. Reported yields to wells range from 5 to 175 gpm and the average is 50 gpm.

The Kirkwood in Salem County is recharged by precipitation in its outcrop area and in areas where it is overlain by permeable sections of the Cohansey Sand or materials of Quaternary age. Much of the water that recharges the aquifer in and near the outcrop is discharged locally to nearby streams.

Few data on the chemical quality of Kirkwood water are available. Iron concentrations range from 0.2 to 6.4 ppm but are generally less than 1.5 ppm. Hardness is known to be as high as 160 ppm. In general, the available data suggest that the water may be used for most purposes with little or no treatment.

Miocene(?) and Pliocene(?) Series

Cohansey Sand

Geology.—The Cohansey Sand underlies approximately 25 percent of Salem County. It is a white or light-colored, medium- to coarse-grained stratified quartzose sand containing occasional lenses of gravel. It contains locally, clay laminae and lenses of light-colored clay that may be as much as 25 feet thick. In the Woodstown quadrangle (Minard, 1965) "quartz and feldspar are the principal sand constituents: small amounts of muscovite are present in the basal part of the formation. Rock fragments in the gravel are mainly quartz, quartzite, and sandstone; chert is subordinate."

Individual layers or beds within the formation generally dip to the southeast at about 10 feet per mile but the dip ranges from 6 to 16 feet per mile. The formation ranges in thickness from less than 1 foot near the western edge of its outcrop area to a known 82 feet and a possible 200 feet in the extreme eastern part of the county.

The Cohansey Sand is the uppermost Tertiary formation in the New Jersey Coastal Plain. It overlies the Kirkwood Formation unconformably. Within Salem County, it is overlain unconformably by a veneer of deposits of Pleistocene age. The Cohansey is generally considered to be a river or estuarine-type deposit, although some of its materials may have been deposited under near-shore or marine conditions (Barksdale and others, 1958).

Hydrology.—The Cohansey Sand is generally a water-table unit although it may contain more than one distinct water-bearing bed and local thin semiconfining beds. It is recharged by precipitation on its outcrop area.

Because it is composed predominately of highly permeable materials, the Cohansey is able to transmit large quantities of water. An aquifer test made at the Paulaitis farm (31.41.5.3.9) 3¼ miles southeast of Elmer, indicated an average coefficient of transmissibility of about 30,000 gallons per day per foot, a permeability of 1,200 gpd (gallons per day) per square foot, and a coefficient of storage of 3 x 10^{-4}. Well logs and hydrologic data from the test indicate that a clay that is about 10 feet thick and of small areal extent acts as a partially confining layer to the aquifer. Vertical permeability of the confining layer is approximately 0.2 gallons per day per square foot. As water from the overlying shallow water table was able to percolate through and around the confining bed in response to head differentials established by pumping, the Cohansey Sand may be considered a single hydrologic unit, regardless of numerous and distinct water-bearing beds.

The Cohansey Sand has an estimated average specific yield of about 21 percent (Rhodehamel, 1966, p. 44). Thus, where sufficiently thick, the Cohansey Sand can store and release substantial quantities of water.

From the standpoint of total availability of water, the Cohansey Sand ranks behind the aquifer of the Wenonah Formation and Mount Laurel Sand. Where sufficiently thick, it compares favorably in ability to yield water with aquifers of the Potomac Group and Raritan and Magothy Formations. Because the water demand in areas underlain by the Cohansey has been small, the pumpage from this aquifer does not reflect its yielding ability: the Cohansey Sand is an important source of future ground-water development.

Quality of water.—Water from the Cohansey Sand is generally slightly mineralized and soft. Dissolved-solids content of two samples are 18 and 105 ppm. Hardness of 12 samples ranges from 3 to 102 ppm and averages 47 ppm. Iron and dissolved carbon dioxide are commonly present in objectionable quantities. Iron concentrations of 12 samples range from 0.07 to 1.2 ppm and average 0.3 ppm. High concentrations of nitrate, probably resulting from leaching of fertilizers or animal excrement, are occasionally found in water samples collected from agricultural areas. Nitrate concentrations of two samples are 1.3 and 44 ppm. The removal of iron and the adjustment of pH may be required before Cohansey waters can be used in certain industrial processes. The results of the analyses of water from the Cohansey Sand are presented in table 5.

QUATERNARY SYSTEM

Pleistocene Series

The Pleistocene Series comprising the Bridgeton, Pensauken, and Cape May Formations have similar geohydrologic characteristics. These formations, shown on figure 21, mantle the older sediments and are known to be as much as 96 feet thick in the southeastern part of the county. Their chief hydrologic function, where they are not thick enough to function as an aquifer, is to absorb precipitation and transmit it to underlying formations. In the Woodstown quadrangle, Minard (1965) divides the Pleistocene deposits into a gravelly alluvium and a glauconitic alluvium. This subdivision has not been followed in this report.

Bridgeton Formation

The Bridgeton Formation crops out in an area of about 60 square miles in the eastern half of Salem County (fig. 21). The exposures are irregular and are at altitudes ranging from 100 to 160 feet above sea level. The formation is as much as 50 feet thick in the county.

The Bridgeton Formation is composed of fine- to very coarse-grained quartzose sand and gravel that may be iron stained and cemented. A sieve analysis of a sample collected at a location 2 miles notheast of Mullica Hill in Gloucester County, shows more than 95 percent medium- to very coarse-grained sand. The sands are white, yellow, and brown, generally fairly well sorted, subangular, and occasionally crossbedded.

The Bridgeton Formation yields from 10 to 50 gpm of water to wells for domestic use and stock supplies. In the eastern part of the county it is probably hydraulically connected to the underlying Cohansey Sand and, locally, to the Kirkwood Formation.

Pensauken Formation

The Pensauken Formation crops out in irregular and isolated patches in central Salem County. It underlies a total area of about 5 square miles in Salem County (fig. 21) and occurs at altitudes of 40 to 120 feet above sea level. The Pensauken is as much as 30 feet thick in the county and consists of medium- to coarse-grained quartzose sand, some gravel, and clay. The sand grains are usually poorly sorted and dirty; they are subangular and may be yellow, red, or brown in color. In some areas, the sand and gravel are iron stained and cemented. Because of similar lithologies, the Pensauken may be difficult to distinguish from the older Bridgeton or the younger Cape May. However, the presence of glauconite, and the occurrence of iron stained and cemented sands are indicative of the Pensauken.

The hydrology of the Pensauken Formation is similar to that of the Bridgeton. Well yield is from 10 to 25 gpm of water for domestic use.

Cape May Formation

The Cape May Formation crops out adjacent to the Delaware River and its tributary streams (fig. 21) and underlies about 85 square miles of Salem County. It is found at altitudes as high as 90 feet but usually not higher than 70 feet above sea level. The formation is as much as 150 feet thick in the southwest and about 30 feet thick along streams in the interior of the county.

In some areas, it may be difficult to distinguish the Cape May Formation from the Pensauken Formation because of their similar lithologies. The Cape May Formation is composed of medium- to coarse-grained quartzose sand with abundant gravel and minor amounts of clay. The sand and gravel are usually yellow or brown, but sometimes gray in color. The clays are yellow, brown, gray, and black. The materials are usually poorly sorted and the sand grains are subangular. The Cape May sediments are not cemented or iron stained, as are the older Pleistocene deposits, but do contain some glauconite and may be ilmenitic (Owens, Minard, Wiesnet, and Markewicz, 1960).

The Cape May Formation is an important aquifer in the Penns Grove-Deepwater area where it yields up to 1,500 gpm of water to Ranney (horizontal) collector wells. The outcrop area is flat and recharge from precipitation infiltrates easily to underlying older formations. The Cape May probably has a higher permeability than either the Bridgeton or the Pensauken Formations.

Salt water may intrude the Cape May Formation along the Delaware River and along tidal reaches of its tributary streams if the fresh-water head in the aquifer is lowered sufficiently near places where the Delaware River and the Cape May Formation are hydraulically connected. Because water from the Cape May Formation recharges the older formations, water of poor quality entering the Cape May Formation could harm the underlying productive aquifers.

Holocene Series

Alluvium of Holocene age in Salem County is a mixture of silt, clay, organic material, sand, and gravel deposited in tidal flats and along the stream channels (figure 21). Most of this material is fine silt and clay having low permeability. Along the Delaware River where the alluvium is 10 to 40 or more feet thick, it retards the movement of brackish water from the Delaware River into the water-bearing sands of the underlying formations.

Available geologic data indicate that windblown deposits occur locally and are generally thin in Salem County. They are light-gray well-sorted sands of rounded quartz grains. The eolian deposits are not of hydrologic importance except to allow water to percolate through them into other formations.

SALT WATER IN THE CITY OF SALEM

Salt water occurs in several aquifers in the vicinity of the city of Salem. Chloride concentrations in wells tapping the Vincentown ranged from 10 to 2,850 ppm in 1964-66. The high chloride concentrations are the result of infiltration of salt water directly into the aquifer from tidal flooding, especially during the drought period of 1961-66. Chloride concentrations in tidal streams that virtually surround Salem were not measured. However, measurements at sites on the Delaware River suggest chloride concentrations at Salem during this period probably ranged up to about 8,000 ppm.

Vertical leakage of salt water has taken place from the Vincentown and Cape May Formations into the aquifer of the Wenonah and Mount Laurel. Chloride concentrations in this aquifer in the vicinity of Salem range from 4.8 to 396 ppm. Chloride concentrations in one well increased from 20 ppm in 1962 to 290 ppm in 1964.

The occurrence of salt water in the Englishtown Formation in the Salem area is indicated by a chloride concentration in one well of 316 ppm in 1964 and is also probably the result of downward leakage through overlying aquifers.

Chloride concentrations in the Potomac, Raritan, and Magothy aquifer system in the vicinity of Salem range from 444 to 2,057 ppm and increase as depth increases. These chlorides are probably not from intrusion of salt water derived from tidal streams but rather are from the zone of diffusion between fresh water and salt water which occurs downdip in the aquifer system.

SUMMARY AND CONCLUSIONS

The most important aquifers in the Coastal Plain of Salem County are in the (1) Potomac Group and Raritan and Magothy Formations; (2) Wenonah Formation and Mount Laurel Sand; (3) Vincentown Formation; (4) Cohansey Sand; and (5) Cape May Formation. Aquicludes composed of layers of clayey materials separate the aquifers.

The Potomac Group and Raritan and Magothy Formations contain the most productive aquifers in Salem County. The greatest concentration of population and industry in the county occurs along the Delaware River where these are virtually the only aquifers available for development. Reported yields of wells tapping these aquifers range up to 860 gpm. The higher yields in the uppermost of three aquifers in the Potomac Group and Raritan and Magothy Formations generally occur where the aquifer has direct hydraulic connection with the overlying Cape May Formation. Coefficients of permeability of sand samples from these formations range from 210 to 3,500 gpd per sq ft.

A decline in water levels in the aquifers of the Potomac, Raritan, and Magothy has resulted from heavy pumpage from this aquifer system. This pumpage has significantly modified the natural pattern of ground-water movement in the system. Whereas ground-water discharge was originally to the Delaware River and its tributary streams, it is now to centers of pumpage.

Movement of water toward centers of pumpage has created the danger of salt-water encroachment into the aquifer from the Delaware River and its tributaries as well as from downdip areas where the aquifer already contains saline water. The occurrence of saline water in the aquifer is indicated by chloride concentrations of 444 to 2,057 ppm in the Salem Area. Chloride concentration in one well at Carneys Point increased from 132 ppm in 1938 to 1,040 ppm in 1959.

The aquifer in the Wenonah Formation and Mount Laurel Sand is available in approximately 80 percent of Salem County and is the second most highly used aquifer in the county. It is an important source of water for future development. Reported yields of wells range up to 507 gpm. Analysis of a pumping test in Salem indicates coefficients of transmissibility, permeability, and storage are 9,000 gpd per foot, 100 gpd per square foot, and 3.5 x 10^{-4} respectively. Water from this aquifer is soft to very hard (12 to 345 ppm, median 127 ppm) and is commonly high in iron (0.1 to 6.3 ppm). Salt-water intrusion into the aquifer, probably from the overlying Vincentown Formation, in the vicinity of Salem is indicated by chloride concentrations of up to 396 ppm. The high chlorides were derived ultimately from flooding of tidal streams during drought periods when ground-water levels were abnormally low.

The aquifer in the Vincentown Formation is an important aquifer in part of Salem County. It is capable of supplying considerably more water than is now being pumped and hence is an important source for future ground-water development. Reported yields of wells tapping this aquifer range up to 270 gpm. The water is hard and is moderate to high in iron content. Salt-water intrusion in the Salem area is indicated by chloride concentrations of up to 2,850 ppm.

The Cohansey Sand, which underlies about 25 percent of Salem County is composed of highly permeable materials and hence is capable of transmitting large quantities of water. Coefficients of transmissibility and storage calculated from a pumping test in Salem County are 30,000 gpd per foot and 3 x 10^{-4} respectively. The Cohansey Sand is an important source for future ground-water development. Water in the aquifer is generally soft and slightly mineralized. However, iron and dissolved carbon dioxide are commonly present in objectionable quantities.

The Cape May Formation of Pleistocene age is an important aquifer in the Penns Grove-Deepwater area where it yields up to 1,500 gpm to Ranney collector wells. Where Pleistocene deposits are not thick enough to function as an aquifer their chief hydrologic function is to absorb precipitation and transmit it to underlying formations.

Fine silt and clay of Holocene age occur in tidal flats and stream channels in Salem County. Along the Delaware River and its tributaries these relatively impermeable materials retard the movement of saline surface water into the water-bearing sands of the underlying materials.

Use of ground water in Salem County in 1964 averaged 12.28 mgd or nearly 200 gpd per person. Industrial use accounted for 5.33 mgd—about 43 percent of the total. Use for public supply was 2.74 mgd—22 percent of the total. Irrigation, which has become increasingly important in recent years accounted for 2.14 mgd—17 percent of the total. Rural use of ground water was 1.77 mgd—15 percent of the total. Other uses accounted for the remaining 3 percent. Average total summer use of ground water—approximately 17.7 mgd—was considerably higher than the yearly average.

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APPENDIX

TABLE 5.—CHEMICAL ANALYSES OF WATER FROM WELLS IN THE AQUIFERS OF SALEM COUNTY

(Results in parts per million except as indicated)

Well No.	N. J. Grid number	Date of collection	Temperature (°F)	Silica (SiO_2)	Total Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids Sum	Hardness as $CaCO_3$ Calcium, magnesium	Hardness as $CaCO_3$ Noncarbonate	Specific conductance (micromhos at 25°C)	pH
								POTOMAC GROUP AND RARITAN AND MAGOTHY FORMATIONS											
3	30.22.8.8.6	5-15-56	---	9.8	12.5	9.6	3.8	----	----	----	32	12	----	----	----	36	---	--	7.7
4	30.22.8.8.8	2-17-59	---	33.7	20	8	5.8	----	----	----	6.8	12	----	1.2	220	44	---	--	6.4
5	30.22.8.8.8	2-17-59	---	13.8	16	17	6.2	----	----	----	59	44	----	1.6	258	70	---	--	6.4
6	30.22.8.9.1	4- 2-56	---	16	6.8	6.4	1.0	----	----	----	20	2.5	----	----	64	20	---	--	6.1
9	30.22.9.8.8	1-11-51	48	8.2	1.5	9.5	1.9	225	3.7	177	9.0	256	0.8	1.1	593	32	0	1,130	7.9
13	30.23.4.6.3	8- 8-58	58	----	.4	----	----	----	----	----	----	4	----	----	---	17	---	80	5.5
14	30.23.4.8.1	4- 9-51	---	14	.47	9.2	4.3	6.5	1.6	15	22	9.8	.1	10	96	41	28	131	6.3
17	30.23.8.6.6	11- 5-58	56	12	4	13	3.2	21	4.2	109	0	2	.2	.6	117	46	0	185	7.3
19	30.31.9.4.9	11-19-59	59	8.7	4.6	14	3.3	179	.6	121	7.5	238	.2	.9	529	49	0	972	7.1
20	30.31.9.8.4	4-26-56	---	5.4	2.1	12	1.4	116	4.9	129	1.8	131	.3	.0	346	36	0	654	7.6
	30.31.9.8.4	12-15-59	56	7.7	3.6	9.8	1.1	104	4	126	5.9	103	1.6	.6	302	29	0	548	7.4
22	30.32.1.6.2	10-21-44	---	9	.25	15	8	35		---	18	50	----	----	160	20	---	250	7.4
	30.32.1.6.2	9-15-52	59	----	.84	6.4		77		151	17	30	----	.3	---	16	0	386	7.5
	30.32.1.6.2	11 - 1-54	---	----	.9	10	0	----	----	*168	95	*42	----	----	190	10	---	---	7.7
23	30.32.1.6.5	6-29-53	---	----	2.5	---	---	----	----	*154	----	46	----	----	219	33	---	365	6.9
24	30.32.1.6.7	11- 7-29	58	24.9	----	2.9	.8	62	----	143	13.4	13.1	----	.4	188	11	---	---	7.6
25	30.32.1.6.8	11-19-29	55	24	----	7.7	1.9	69	----	136	.2	48	----	.7	222	27	---	---	7
	30.32.1.6.8	5-21-52	---	11.7	----	----	----	----	----	144	----	46	----	----	222	27	---	370	7
26	30.32.1.6.9	7- 1-29	55	35.8	----	6.8	3.6	83	----	154	3	56	----	.4	270	32	---	---	7.5
	30.32.1.6.9	5-16-52	---	12.6	----	----	----	----	----	152	----	50	----	----	234	23	---	390	6.8

*Calculated

TABLE 5.—CHEMICAL ANALYSES OF WATER FROM WELLS IN THE AQUIFERS OF SALEM COUNTY —Continued

(Results in parts per million except as indicated)

Well No.	N. J. Grid number	Date of collection	Temperature (°F)	Silica (SiO_2)	Total Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids Sum	Hardness as $CaCO_3$ Calcium, magnesium	Hardness as $CaCO_3$ Noncarbonate	Specific conductance (micromhos at 25°C)	pH
						POTOMAC GROUP AND RARITAN AND MAGOTHY FORMATIONS (CONTINUED)													
27	30.32.1.8.9	1-11-51	55	9.7	4.8	14	2.3	90	4	131	25	74	.5	.8	244	44	0	466	6.5
	30.32.1.8.9	9-15-54	---	----	9	----	----	----	----	---	----	79	----	.24	---	---	---	---	---
28	30.32.1.9.3	10-13-29	---	27.6	----	3.4	trace	92.7	----	174	7.8	51.2	----	.4	270	8.5	---	---	7.5
	30.32.1.9.3	5-20-52	---	7.7	----	----	----	----	----	161	----	46	----	----	219	33	---	365	6.9
29	30.32.2.1.3	3-28-38	---	----	*2.7	*13	*3			*76	*48	*54	----	----	229	60	---	---	7
	30.32.2.1.3	10-18-54	---	16.6	24.6	32	10	----	----	*48	96	104	----	.01	400	122	---	---	5.7
	30.32.2.1.3	2-17-59	---	16.8	32	36	15	----	----	---	82	140	----	.08	310	152	---	---	6.4
30	30.32.2.1.3	3-28-38	---	----	*1.6	*5	*1	----	----	*117	*.8	*33	----	----	161	20	---	---	7.6
	30.32.2.1.3	10-18-54	---	14.3	*25.1	32	10	----	----	*56	104	114	----	.36	414	122	---	---	5.9
	30.32.2.1.3	2-17-59	---	16.3	56	52	22	----	----	---	119	206	----	12	700	220	---	---	6.15
31	30.32.2.1.3	3-28-38	---	----	*16.3	*6	*3	----	----	*43	*16.4	*25	----	----	132	50	---	---	6.8
	30.32.2.1.3	10-18-54	---	30	44.7	25	13	----	----	0	88	96	----	.015	174	116	---	---	3.5
	30.32.2.1.3	2-17-59	---	30.5	114	80	17	----	----	---	253	298	----	.8	1,040	270	---	---	6.1
32	30.32.2.1.3	10-18-55	---	35.2	30	12	8.5	----	----	63	40	50	----	.015	214	64	---	---	5.6
	30.32.2.1.3	9-18-56	---	30	88	30	18	*126	----	---	150	195	----	----	---	150	---	---	4.6
	30.32.2.1.3	2-17-59	---	33	100	52	34	----	----	---	212	262	----	.05	992	270	---	---	6.3
33	30.32.2.1.4	10-15-41	---	----	3.6	----	----	----	----	129	2	39	----	----	---	45	---	---	---
34	30.32.2.1.7	10-15-41	---	----	4.2	----	----	----	----	127	3	33	----	----	---	39	---	---	---
35	30.32.2.5.4	12-21-55	---	----	1	24	16	----	----	*146	91	*108	----	----	*330	40	---	550	7.2
38	30.32.4.2.3	9-15-54	---	----	3.5	----	----	----	----	---	----	56	----	1	---	---	---	---	---
41	30.32.4.3.3	11- 4-59	---	----	0	----	----	----	----	---	----	20	----	.03	---	---	---	---	9.1

*Calculated

TABLE 6.—RECORDS OF SELECTED WELLS IN SALEM COUNTY, N. J. —Continued

Well number: Numbers correspond with number in figure 2.
New Jersey grid number: See figure 4 for description of the New Jersey grid numbering system.
Use: D, domestic; F, farm, I, industrial; In, institutional and commercial; Ir, irrigation; PS, public supply; T, test well.

Other data available: BR, drilling penetrated bedrock; DL, drillers log available in Trenton office of USGS; EL, electric log available in Trenton office of USGS; GL, gamma-ray log available in Trenton office of USGS; QW, quality-of-water data in table 5; SL, selected log available in table 7.

Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
				POTOMAC GROUP AND RARITAN AND MAGOTHY FORMATIONS														
1	30.22.6.3.6	Bruce Bridge	D'Agostino Bros.	1957	12	T	205	6	---	---	---	---	---	0	1957	DL	----	Driller reported good sands but no water
2	30.22.8.3.5	Penns Grove Water Supply Co., 1901	J. W. Pratt and Haines Bros.	1901	5	T	350	6	---	---	---	---	---	-	----	BR, DL, SL		
3	30.22.8.8.6	E.I. duPont, Layne test well No. 3	Layne-New York Co., Inc.	1956	5	T	162	-	152	140	35	6	29	254	1956	BR, DL, EL, QW	11	Total depth drilled = 246 ft.
4	30.22.8.8.8	E.I. duPont, well No. 5	C.W. Lauman and Co., Inc.	1957	5	I	81	12	51	51	29	10	47	483	1957	DL, QW	13	
5	30.22.8.8.8	E.I. duPont, well No. 6	C.W. Lauman and Co., Inc.	1957	5	I	185	12	157	157	24	41	---	609	1957	DL, QW	----	
6	30.22.8.9.1	E.I. duPont, Layne test well No. 1	Layne-New York Co., Inc.	1956	5	T	180	8	160	160	20	50	91	180	1956	EL, QW	4.4	T.D. = 228 ft.
7	30.22.9.5.7	Penns Grove Water Supply Co., Layne No. 1	Layne-New York Co., Inc.	1956	19	PS	357	8	317	279	87	28	73	530	1956	DL, SL, EL	11.8	T.D. = 371 ft.
8	30.22.9.8.8	Penns Grove Water Supply Co., Layton No. 6	Layne-New York Co., Inc.	1918	14	PS	190	8	174	174	16	---	---	---	----	GL	----	Also screened between 43 and 53 ft. Gamma logged 1959 and found to be filled in to 115 ft depth.
9	30.22.9.8.8	Penns Grove Water Supply Co., Layton No. 11	Layne-New York Co., Inc.	1944	14	PS	394	8	351	351	43	20	59	310	1944	DL, QW, SL	8	Total depth drilled = 404 ft.
10	30.23.1.7.9	Pan American Refining Corp., FT-5	Layne-New York Co., Inc.	1953	10	T	240	5	---	136	33+	---	---	---	----	DL, BR	----	
11	30.23.1.8.1	Pan American Refining Corp., PT-1	Layne-New York Co., Inc.	1953	6	T	217	6	217	---	---	---	---	---	----	DL, BR, SL	----	Numerous sand and gravel lenses of limited thickness.
12	30.23.1.8.8	Pan American Refining Corp., PT-2	Layne-New York Co., Inc.	1953	5	T	234	6	224	219	16+	8	74	85	1953	DL, SL	1.3	
13	30.23.4.6.3	Walter Freed	Gus Hauser	1955	15	F	145	4	---	---	---	11	---	---	1955	QW	----	
14	30.23.4.8.1	Penns Grove Water Supply Co., Pedricktown No. 11	Artesian Well Drilling Co.	1931	10	PS	152	8	116	113	39	4	32	650	1931	DL, QW	----	
15	30.23.7.2.9	H. W. Dawson	Haines and Moore	1957	27	D	124	4	118	100	24+	22	27	15	1957	DL	3	
16	30.23.7.9.3	Robert Funk	Haines and Moore	1950	25	D	122	4	115	108	14+	18	20	20	1950	DL	10	Water not potable owing to iron content
17	30.23.8.6.6	Boy Scouts of America, Camp Kimble	Unknown	----	17	In	134	6	129	---	---	17	---	18	1958	QW	----	
18	30.23.9.4.4	Boy Scouts of America, Camp Kimble	Lee Roberts	1939	70	In	172	3	130	165	13+	70	---	2	1939	SL, DL	----	Screen blocked after 3 weeks' use; well abandoned.
19	30.31.9.4.9	Dept. of the Army, Finns Point National Cemetery	Ed. Roberts, Sr.	1951	7	In	319	4	282	302	18	15	---	60	1958	QW, GL	----	
20	30.31.9.8.4	Fort Mott State Park	P. H. and J. Conlan	1900	8	In	320	8	300	300	20+	2	36	142	1946	DL, GL, SL, QW	4.2	Static w. l. at 8-ft depth, obstruction at 118-ft depth 1/21/60 when gamma-logged. Low chlorides and possible break in casing suggest this may now be a Magothy well. Compare quality-of-water data to Finns Point well.
21	30.32.1.3.8	E.I. duPont, Layne No. 1	Layne-New York Co., Inc.	1938	6	I	360	12	330	325	25	100	240	600	1938	DL	4.3	Total depth drilled = 441 ft.

TABLE 6.—RECORDS OF SELECTED WELLS IN SALEM COUNTY, N. J. —Continued

Well number: Numbers correspond with number in figure 2.
New Jersey grid number: See figure 4 for description of the New Jersey grid numbering system.
Use: D, domestic; F, farm, I, industrial; In, institutional and commercial; Ir, irrigation; PS, public supply; T, test well.

Other data available: BR, drilling penetrated bedrock; DL, drillers log available in Trenton office of USGS; EL, electric log available in Trenton office of USGS; GL, gamma-ray log available in Trenton office of USGS; QW, quality-of-water data in table 5; SL, selected log available in table 7.

Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
			POTOMAC GROUP AND RARITAN AND MAGOTHY FORMATIONS (CONTINUED)															
22	30.32.1.6.2	E.I duPont, Drinkwater No. 8	Layne-New York Co., Inc.	1943	6	I	347	10	317	306	40	120	140	400	1943	DL,QW	20.0	Total depth = 361 ft.
23	30.32.1.6.5	Deepwater Operating Co., No. 5	Layne-New York Co., Inc.	1953	10	I	219	10	150	147	72	60	109	626	1953	DL,QW	12.8	T.D. = 224 ft. Also screened 149-169 ft.
24	30.32.1.6.7	Deepwater Operating Co., No. 1	Ridpath and Potter	1928	13	I	380	8	351	348	32	43	119	250	1928	DL,QW	3.3	
25	30.32.1.6.8	Deepwater Operating Co., No. 2	Layne-New York Co., Inc.	1929	13	I	250	15	---	---	---	---	---	600	1929	QW		
26	30.32.1.6.9	Deepwater Operating Co., No. 3	Layne-New York Co., Inc.	1929	12	I	250	15	---	---	---	---	---	529	1929	QW	----	
27	30.32.1.8.9	Pennsville Township Water Dept. No. 2	Layne-New York Co., Inc.	1949	7	PS	232	10	210	197	35	36	93	402	1949	DL,QW, SL	7	
28	30.32.1.9.3	Deepwater Operating Co., No. 4	Layne-New York Co., Inc.	1929	15	I	430	15	---	356	64	---	---	370	1929	DL,QW	----	
29	30.32.2.1.3	E.I. duPont, No. 1	Layne-New York Co., Inc.	1929	5	I	200	18	170	167	28	52	153	450	1929	DL,QW	4.2	T.D. = 215 ft.
30	30.32.2.1.3	E.I. duPont, No. 2	Layne-New York Co., Inc.	1933	5	I	219	12	169	167	52	50	138	445	1953	DL,QW	5.1	
31	30.32.2.1.3	E.I. duPont, No. 3	Layne-New York Co., Inc.	1933	5	I	102	18	71	40	62	9	32	860	1953	DL,QW	37.4	
32	30.32.2.1.3	E.I. duPont, No. 4	Layne-New York Co., Inc.	1955	5	I	86	16	71	74	12	9	55	745	1955	DL,QW	16.2	
33	30.32.2.1.4	E.I. duPont, Layne No. 3	Layne-New York Co., Inc.	1939	5	I	190	12	170	169	21	84	---	687	1939	DL,QW	----	T.D. = 210 ft.
34	30.32.2.1.7	E.I. duPont, Layne No. 2	Layne-New York Co., Inc.	1939	5	I	159	12	138	134	26	80	139	366	1939	DL,QW	6.2	T.D. = 172 ft.
35	30.32.2.5.4	E.I. duPont, Elastomers well	A. C. Schultes and Sons	1955	8	I	480	8	465	459	35	24	215	600	1955	DL,EL,QW	3.1	T.D. = 520 ft. Also screened at 396-421 and 438-448-ft depths.
36	30.32.2.5.4	Pennsville Township Water Dept. TW-2	Layne-New York Co., Inc.	1945	9	T	598	8	---	---	--	---	---	---	----			
37	30.32.2.6.8	New Jersey Turnpike Aurhority Exit 1, Toll Plaza	Gus Hauser	1952	12	In	160	6	140	104	56	20	140	60	1952	DL, GL	.5	Well abandoned owing to poor quality water.
38	30.32.4.2.3	Pennsville Township Water Dept. Well 1	Layne-New York Co., Inc.	1946	8	PS	238	10	213	212	26	20	153	357	1945	DL,QW	2.7	T.D. drilled = 248 feet.
39	30.32.4.2.3	Pennsville Township Water Dept. TW-1	Layne-New York Co., Inc.	1945	9	T	242	10	200	200	42	22	99	100	1945	BR, DL	1.3	T.D. drilled = 601 ft--bedrock.
40	30.32.4.2.9	Pennsville Township Water Dept. TW-1/3	Layne-New York Co., Inc.	1955	7	T	312	8	---	195	20	44	---	---	1955	EL, DL	----	
41	30.32.4.3.3.	Pennsville Township Water Dept. Well 3	Layne-New York Co., Inc.	1956	7	PS	102	12	87	84	21	6	29	700	1956	EL, DL, QW	30	Total depth drilled = 330 ft.
42	30.32.4.5.5	Pennsville Township Water Dept. TW-2/3	Layne-New York Co., Inc.	1955	6	T	354	8	---	---	---	---	---	---	----	EL, DL, SL	----	
43	30.33.2.1.1	New Jersey Turnpike Authority, No. 1-1	Wm. Stothoff Co., Inc.	1953	40	In	368	6	342	332	36+	34	150	230	1953	DL, GL, QW	2.0	
43A	30.33.2.1.1	New Jersey Turnpike Authority, No. 1-1	Gus Hauser	1951	40	In	170	8	148	140	34+	43	123	135	1951	DL	1.1	This well deepened and replaced by No. 43.

TABLE 6.—RECORDS OF SELECTED WELLS IN SALEM COUNTY, N. J. —Continued

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Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
				POTOMAC GROUP AND RARITAN AND MAGOTHY FORMATIONS (CONTINUED)														
44	30.33.2.1.1	New Jersey Turnpike Authority, No. 2-1S	Wm. Stothoff Co., Inc.	1953	35	In	344	8	324	310	35+	50	150	300	1953	DL, SL, QW	3.0	
45	30.33.2.1.4	New Jersey Turnpike Authority, No. 1-1N	Wm. Stothoff Co., Inc.	1953	40	In	333	8	313	310	23+	46	86	350	1953	DL, GL	8.8	
46	30.33.3.2.5	Benjamin Cheesman	J. Haines and Bro.	1896	110	D	301	3	290	267	33	100	---	---	1898	SL	----	Data from USGS Bull. 727, p. 38.
47	30.33.6.1.7	Richmond Ice Cream Co., No. 1	A. C. Schultes and Sons	1940	25	I	283	10	266	256	17	31	150	150	1940	SL, DL, QW	1.3	
47A	30.33.6.1.7	Richmond Ice Cream Co., No. 1	A. C. Schultes and Sons	1948	25	I	475	8	418(?)	418	47	42	122	300	1948	SL, DL	3.7	
48	30.33.6.1.7	Richmond Ice Cream Co., No. 2	A. C. Schultes and Sons	1946	20	I	446	10	418	413	47	45	145	175	1946	SL, DL	1.8	Total depth, 465 ft.
49	30.33.6.5.1	A. R. Gemberling, Jr.	A. C. Schultes and Sons	1950	43	D, In	291	6	279	271	20	35	50	100	1950	DL, SL	6.7	Small veterinary hospital supplied.
50	30.33.6.6.9	American Stores, Inc.	G. H. Rankin, Jr.	1960	57	In	575	6	562	540	30	66	196	40	1960	DL, GL, QW, SL	.3	
51	30.33.9.1.1	Salem County Home, No. 3	Haines and Moore	1958	40	In	368	4	361	350	18+	50	68	50	1958	DL, SL	2.8	
52	30.34.1.4.5	W. F. Kelly	Haines and Moore	1960	90	D	510	3	500	485	25	96	---	---	1960	DL, GL, QW	----	
53	30.34.1.5.7	USGS Point Airy Observation Well	C. L. Mollitor	1958	71	T	314	6	305	296	45	85	160	100	1958	GL, DL, SL, QW	1.3	Total depth drilled, 718 ft.
53A	30.34.1.5.7	USGS Point Airy Observation Well	C. L. Mollitor	1958	71	T	530	6	522	512	30	81	184	70	1958	GL, DL, QW	.7	Total depth drilled, 718 ft.
53B	30.34.1.5.7	USGS Point Airy Observation Well	C. L. Mollitor	1958	71	T	672	4	665	658	17	88	153	8	1958	GL, DL, QW	.1	Total depth drilled, 718 ft.
53C	30.34.1.5.7	USGS Point Airy Observation Well	C. L. Mollitor	1958	71	T	718	4	685	695	23+	78	---	10	1958	DL, QW	----	No. screen.
54	30.34.1.8.1	Allen Davis	John Murtha	1959	86	D	335	4	323	314	36+	89	124	60	1959	DL, GL, QW	1.7	Well deepened to 350-ft depth in 1961
55	30.34.4.4.3	Woodstown Ice and Coal Co., No. 1	Artesian Well Drilling Co.	1927	58	I	360	8	340	330	30+	62	107	140	1958	SL, DL, QW	3.1	Log is for well No. 1 modified from USGS Bulletin 727, p. 37.
56	30.34.4.4.4	Woodstown Water Dept. No. 1	Layne-New York Co., Inc.	1928	45	PS	700	6	660	627	76	50	82	360	1955	SL, DL, QW	10.1	Static water levels for 1928 and 1935 reported as 39 and 40 ft, respectively.
57	30.34.4.4.4	Woodstown Water Dept. No. 2	Layne-New York Co., Inc.	1946	45	PS	700	8	670	632	74	45	85	440	1955	DL, QW	11	T.D. drilled, 716 ft.
58	30.42.2.4.5	J. R. Dilworth	Haines and Moore	1950	5	D	263	4	256	256	7+	11	34	25	1950	DL, QW	1.1	Well abandoned 1960 owing to high chlorides.
59	30.42.3.7.4	City of Salem Water Dept., Layne Test 1935	Layne-New York Co., Inc.	1935	17	T	550	11	---	483	85	--	---	---	1935	SL, QW, BR	----	T.D. drilled 1440 ft. High chloride water.
59A	30.42.3.7.4	City of Salem Water Dept., Layne Test 1935	Layne-New York Co., Inc.	1935	17	T	714	11	667	667	69	8	---	---	1935	QW	----	High-chloride water.
59B	30.42.6.1.1	USGS Salem Observation Well 1	Kaye Well Drilling	1965	3	T	709	6	699	660	50	18	---	---	1965	QW	----	Screen 699-709'

TABLE 6.—RECORDS OF SELECTED WELLS IN SALEM COUNTY, N. J. —Continued

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Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
			POTOMAC GROUP AND RARITAN AND MAGOTHY FORMATIONS (CONTINUED)															
59C	30.42.6.1.1	USGS Salem Observation Well 3	Kaye Well Drilling	1965	3	T	350	6	340	310	52	10	---	---	1965	QW	----	Screen 340-350'
			ENGLISHTOWN FORMATION															
60	30.32.6.3.6	Benny Spina	Gaines and Moore	1952	20	D	35	4	27	27	8+	5	13	20	1952	DL	2.5	
61	30.33.3.3.1	William H. Miller	Gus Hauser	1954	85	D	126	4	92	97	29+	42	---	75	1954	DL, QW	----	May also tap the Marshalltown Formation.
62	30.33.3.3.8	Humphrey Wolfe	Gus Hauser	1954	70	D	112	4	92	109	7+	37	45	15	1954	DL	2	May also tap the Marshalltown Formation. Hole abandoned owing to poor quality of water. Casing and screen reset to become Well 68.
63	30.33.5.3.4	Harris Sales Co.	A. C. Schultes and Sons	1949	40	I	124	6	113	107	19+	26	32	60	1949	QW	10	Car washing for State Police.
64	30.33.7.3.6	Melvin Sharp, Jr.	P. H. Coleman	1956	55	D	188	3	---	161	26	45	---	---	1956	SL, DL	----	
64A	30.42.2.7.4	Clement Powell	Geo. Rankin, Sr.	----	5	D	132	2	---	---	---	12	---	---	reported	QW	----	
			WENONAH FORMATION AND MOUNT LAUREL SAND															
65	30.33.2.6.5	Genevieve DuBois	Gus Hauser	1954	70	T	59	6	---	8	47	--	---	---	1954	DL	----	Top of Kmt at 55-ft depth.
66	30.33.3.2.5	J. J. McNally, Jr.	Haines and Moore	1957	117	D	82	4	76	45	37	59	75	20	1957	DL	1.2	
67	30.33.3.3.2	Eugene T. Pashuck	Haines and Moore	1959	58	D	57	4	49	0	56	34	38	22	1959	DL, QW	5.5	
68	30.33.3.3.8	Humphrey Wolfe	Gus Hauser	1955	70	D	65	6	54	0	65	28	36	40	1955	DL	5	See well No. 62
69	30.33.3.4.4	Kelly Bros. No. 2	Haines and Moore	1954	60	Ir	65	10	45	0	65	6	26	125	1954	DL	6.2	
70	30.33.3.6.1	R. O. Kettner	Haines and Moore	1951	90	D	72	4	---	40	32+	49	---	---	1951	DL, QW	----	
71	30.33.3.6.5	M. W. Henthorn	Unknown	-----	80	D, F	82	6	---	---	---	26	---	---	1958			
72	30.33.6.1.3	G. E. Lohymer No. 1	Haines and Moore	1953	56	D	70	4	63	35	35+	26	31	15	1953	DL	3	
73	30.33.6.2.4	R. J. Gessner	Haines and Moore	1954	55	D	56	4	49	42	14+	30	37	20	1954	DL	2.9	
74	30.33.6.6.9	Louis Bader	Haines and Moore	1959	65	I	158	6	112	95	63+	30	60	98	1959	DL	3.2	Automatic laundry.
75	30.33.7.6.6	Colonial Nurseries No. 2	Haines and Moore	1956	15	D	62	4	43	36	26+	12	24	25	1956	DL	2	No screen.
76	30.33.7.7.7	Edward F. Harris	Haines and Moore	1951	27	D	38	4	31	20	18+	24	28	20	1951	DL, QW	5	
77	30.33.7.7.9	Mannington Twp. Elementary School	Haines and Moore	1959	25	In	93	6	51	45	47	17	29	75	1959	DL, SL	6.2	No screen.

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Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
				WENONAH FORMATION AND MOUNT LAUREL SANDS (CONTINUED)														
78	30.33.8.3.6	Edward F. Jill	Haines and Moore	1954	55	D	125	4	101	90	35+	21	31	20	1954	DL	2	No screen.
79	30.33.8.4.9	John Ruhl	Gus Hauser	1954	37	D	123	4	75	76	33+	23	---	60	1954	DL	-----	No screen.
80	30.33.9.1.1	County Home No. 2	Haines and Moore	1950	40	In	115	4	88	75	40+	13	23	25	1950	DL	2.5	No screen.
81	30.33.9.1.2	County Maintenance Garage	Haines and Moore	1952	55	In	125	4	103	74	55+	13	18	25	1952	DL, QW	5	No screen.
82	30.34.1.5.7	USGS Point Airy Observation Well	J. C. Rosenau	1958	71	T	65	6	55	58	57	17	21	25	1958	DL, GL	0.7	T.D. = 718 ft. No screen.
83	30.34.1.8.4	F. H. Ridgeway, Jr.	R. B. Stafford, Jr.	1955	82	D	118	4	---	---	---	10	---	--	1955	QW	----	
84	30.34.1.9.2	A. E. Longstreth	Gus Hauser	1954	85	D	140	4	118	99	51+	38	---	80	1954	DL	----	No screen.
85	30.34.1.9.3	Clarence Smith	Haines and Moore	1948	70	D	104	4	96	85	19+	25	29	20	1948	DL	5	
86	30.34.2.4.9	Robert E. Fast	Haines and Moore	1959	92	D	125	4	108	104	21+	42	48	20	1959	DL	3.3	No screen.
87	30.34.2.7.7	L. C. Bromell	Haines and Moore	1933	80	D, F	125	4	---	---	---	--	---	--	----	QW	----	
88	30.34.2.8.2	T. W. Davis	Haines and Moore	1930	85	D, F	80	4	---	---	---	--	---	--	----	QW	----	
89	30.34.3.7.8	W. C. A. Costilla No. 2	Haines and Moore	1949	132	F	252	4	231	192	59+	75	---	60	1949	DL, SL	----	
90	30.34.4.2.1	E. A. Combs	Gus Hauser	1957	75	Ir	145	6	---	---	---	6	---	--	1958		----	
91	30.34.4.4.5	G. L. Petsas, Woodstown Diner	Haines and Moore	1956	48	In	125	6	80	82	43+	13	32	40	1956	DL, QW	2.1	No screen.
92	30.34.4.5.6	J. M. Wordsworth	Haines and Moore	1959	60	D	136	4	117	116	20+	12	17	22	1959	DL, QW	4	No screen.
93	30.34.4.7.1	J. S. Pritchett	Haines and Moore	1948	42	D	115	3	---	---	---	11	16	20	1948		5	No screen.
94	30.34.5.7.1	Lewis Duble	Haines and Moore	1959	63	D	170	4	160	144	26+	19	24	25	1959	DL	5	No screen.
95	30.34.8.6.5	C. C. Seabrook	Haines and Moore	1950	144	D	332	6	303	300	36+	103	113	50	1950	DL, SL	5	No screen. Total depth drilled, 336 ft.
96	30.34.9.6.4	Quinton Hackett	Haines and Moore	1955	130	F	340	4	324	315	25+	80	84	20	1955	DL	5	No screen.
97	30.34.9.7.6	Henry Garrison	Unknown	1922	120	I	425	8	---	---	---	75	---	20	1959	GL, QW	----	Observation well. Casing reduces to 2-inch.
98	30.34.9.8.1	Daretown Public School	Gus Hauser	1954	133	In	437	6	377	358	82	85	---	--	1959	GL, SL, DL, QW	----	T.D. = 441 ft. Casing reduces to 4-inch.
98A	30.42.2.9.9	City of Salem Well 4	A. C. Schultes and Sons	----	10	PS	124	12	94	90	---	9	80	350	----	QW	----	
99	30.42.3.2.6	Salem County Memorial Hospital No. 1	A. C. Schultes and Sons	1950	23	In	97	6	73	70	23+	15	60	35	1959	DL, QW	0.8	T.D. = 101 ft.
100	30.42.3.2.6	Salem County Memorial Hospital No. 2	A. C. Schultes and Sons	1954	20	In	112	6	82	70	52+	18	60	35	1959	DL	.7	T.D. = 116 ft.

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Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
				WENONAH FORMATION AND MOUNT LAUREL SAND (CONTINUED)														
101	30.42.3.2.6	H. S. Smith	Haines and Moore	1953	23	D	64	4	47	38	26+	19	24	25	1953	DL	5	
102	30.42.3.5.4	Mannington Mills, Schultes No. 2	A. C. Schultes and Sons	1947	20	I	130	10	90	51	80	15	---	225	1947	DL, QW	----	
103	30.42.3.5.4	Mannington Mills, Schultes No. 3	A. C. Schultes and Sones	1959	10	I	127	10	96	44	83	22	91	200	1959	DL	2.9	T.D. drilled = 132 ft.
104	30.42.3.7.4	City of Salem Water Dept. No. 1	Layne-New York Co., Inc.	1936	17	PS	136	10	86	60	76	9	108	209	1935	DL, QW	2	T.D. = 166 ft.
105	30.42.3.7.6	City of Salem Water Dept. TW-2	Delmarva Drilling Co.	1960	8	T	185	4	165	53	102	9	29	120	1960	GL, EL, DL	5	Screened from: 60-65, 80-105, and 145-155 ft.
106	30.42.4.2.7	Herbert Dilks	P. H. Coleman	----	5	D	124	2	118	118	6+	8	--	17	----	DL	----	
107	30.42.5.2.2	City of Salem Water Dept., TW-1	Delmarva Drilling Co.	1960	7	T	140	4	50	41	109	3	105	100	1960	GL, EL, DL, SL	1.0	Total depth = 215 ft and into the Kwb. Screened from: 50-90 and 130-140 ft.
107A	30.42.6.1.1	USGS Salem Observation Well 2	Kaye Well Drilling	1965	3	T	96	4	91	80	85	7	---	---	1965	--------	----	85 foot thickness of bed based on data from adjacent 709 foot test hole.
108	30.42.6.2.4	City of Salem Water Dept., Well 2	Layne-New York Co., Inc.	1936	5	PS	157	12	110	82	86	15	71	400	1960	DL, QW	5.7	T.D. drilled = 165 ft.
109	30.42.6.2.4	City of Salem Water Dept., TW-3	Delmarva Drilling Co.	1960	10	T	147	4	102	98	57+	10	28	170	1960	GL, EL, DL, QW	9.4	T.D. = 155 ft.
110	30.42.6.2.4	City of Salem Water Dept., Well 5	Delmarva Drilling Co.	1961	10	PS	168	17	96	82	86	11	86	507	1961	QW, DL	5.9	Concrete casing "Kelly well" chloride 130 ppm on 4-19-65
110A	30.42.6.2.4	USGS Observation Well KMW 1	Geo. Rankin, Jr.	1965	8	T	115	3-2	105	82	---	13	---	---	March 1965	QW	----	Chloride 396 ppm 4-19-65
110B	30.42.6.2.4	USGS Observation Well KMW 3	Geo. Rankin, Jr.	1965	11	T	140	3	135	82	---	17	---	---	March 1965	----	----	Chloride 5.0 ppm 4-19-65
111	30.43.4.6.4	USGS Observation Well Quinton 1892	Kisner and Bennett	1892	10	PS	248	6	----	166	82	1	---	55	1892	DL, GL, SL	----	Well open to 140 ft, original depth, 248 ft.
112	30.44.1.5.4	David Blacklock	G. H. Rankin, Jr.	1953	68	D	315	3	252	250	65	37	---	25	1953	DL	----	No screen.
113	30.44.2.1.4	Ephraim P. Horner	C. C. Holladay	1926	77	In	305+	4	---	255	25+	41	47	10	1958	GL, QW	1.7	Observation well. Gamma-ray logged to 280 ft.
114	30.44.2.8.1	Camp Roosevelt B.S.A.	Haines Bros.	1928	69	In	305	3	---	280	25+	30	33	20	1928	DL, SL	6.7	No. screen.
115	30.44.4.2.2	Lewis Masker	Haines and Moore	1959	57	D	305	4	287	275	30+	37	41	21	1959	DL, QW	5.2	No screen.
116	30.44.4.3.5	Arnold Strang	Haines and Moore	1949	70	D	345	4	322	305	40+	52	57	25	1949	DL	5	No screen. Casing reduces to 3-inch.
117	30.44.4.3.9	Paul Alger	D'Agostino Bros.	1960	70	T	380	7	---	320	55+	--	--	--	----	GL, EL, DL	----	No screen.
117A	31.41.1.3.8	Elmer Water Co. No. 3	Layne-New York Co., Inc.	1963	105	PS	574	10	460	420	100	53	253	400	1964	EL, QW	2.0	
118	34.3.6.3.5	Louis deWilde	Haines and Moore	1954	45	D	400	4	388	380	20+	45	--	12	1954	DL	----	No screen. Casing reduces to 3-inch

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Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
				WENONAH FORMATION AND MOUNT LAUREL SAND (CONTINUED)														
118A	34.3.7.2.3	Lower Alloway Creek Twp. Elem. School	D'Agostino Bros.	1964	--	PS	340	4	325	310	70	11	25	10	1964	EL, QW	.7	
119	34.4.1.1.6	Warren Cobb	D'Agostino Bros.	1950	60	D	380	4	361	356	24+	41	46	25	1950	SL, QW, DL	5	No screen.
				VINCENTOWN FORMATION														
120	30.33.6.9.9	A. R. Hackett	D'Agostino Bros.	1957	50	F	62	4	48	26	36+	15	20	20	1957	DL	4	No screen.
121	30.33.8.9.9	E. C. Bell	D'Agostino Bros.	1956	40	D	58	4	46	37	21+	16	20	20	1956	DL, QW	5	No screen.
122	30.33.9.3.6	Eugene Eldridge	D'Agostino Bros.	1953	55	D	50	3	45	41	9+	14	19	20	1953	DL	4	No screen.
123	30.33.9.3.8	Leon Wilson	D'Agostino Bros.	1950	60	D	52	4	47	---	---	17	--	--	1950	QW	----	No screen.
124	30.33.9.5.3	Maurice Tilghman	D'Agostino Bros.	1959	70	D	64	4	51	45	19+	24	30	20	1959	DL	3.67	No screen.
125	30.33.9.5.7	J. W. Porter	P. H. Coleman	1955	70	D	110	3	---	---	---	35	--	--	1953		----	
126	30.33.9.9.2	George MacKinder	Gus Hauser	1953	70	D	111	4	87	81	30+	40	--	50	1953	QW	----	
127	30.34.2.9.8	Jean Angelo	Gus Hauser	1953	130	D	132	4	104	100	32+	60	--	70	1953	DL	----	No screen.
128	30.34.4.3.2	Howard Sims	Haines and Moore	1949	135	D	116	4	93	92	24+	74	94	12	1949	DL	.6	No screen.
129	30.34.4.5.6	H. E. Carlson	Haines and Moore	1955	63	In	63	3	46	37	26+	15	20	20	1955	DL	4	No screen.
130	30.34.4.6.8	S and C Welding and Machine Shop	Haines and Moore	1955	65	D	60	3	46	44	16+	18	24	15	1955	DL	1.9	No screen.
131	30.34.5.4.9	M. H. Leap	Haines and Moore	1954	78	D	85	4	69	64	21+	26	30	25	1954	DL	6.2	No screen.
132	30.34.5.8.2	Wm. Lautenbach	Haines and Moore	1960	130	D	135	4	120	112	23+	70	--	20	1960	DL, GL	----	No screen.
133	30.34.5.8.2	R. P. Sheenan	Haines and Moore	1951	130	D	158	4	138	119	39+	75	80	20	1951	DL, QW	4	No screen.
134	30.34.5.9.5	D. C. Coles	Haines and Moore	1957	100	D	128	4	108	95	33+	46	56	20	1957	DL	2	No screen.
135	30.34.6.2.2	S. D. Gensemer	Haines and Moore	1952	90	F	107	4	81	80	27+	30	35	20	1952	DL	4	No screen
136	30.34.6.8.4	R. M. Sickler	Haines and Moore	1954	142	F	218	4	197	194	24+	95	120	15	1954	DL, SL	.6	No screen.
137	30.34.7.2.3	Gordon McBride	Haines and Moore	1956	70	D	73	4	59	54	19+	24	30	20	1956	DL, GL	3.7	No screen. Observation well
138	30.34.7.7.5	R. Dunkelberger	Gus Hauser	1953	75	F	144	4	81	80	64+	43	--	110	1953	SL, DL, QW	----	No screen.
139	30.34.8.1.1	H. H. Kirby	Haines and Moore	1958	140	D	147	4	130	128	19+	86	94	20	1958	SL, DL, QW	2.8	No screen.
140	30.34.8.1.3	YMCA Camp Karney	Haines and Moore	1949	65	In	106	4	92	80	26+	31	41	20	1949	DL	2	No screen.

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Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
					VINCENTOWN FORMATION (CONTINUED)													
141	30.34.8.2.4	P. F. Gross	Haines and Moore	1949	105	D	157	4	147	145	12	57	67	25	1949	DL, SL	2.5	No screen.
142	30.34.9.1.2	Walter Tarpine	Haines and Moore	1947	125	F	216	4	197	185	31+	78	98	10	1947	DL	.5	No screen.
142A	30.42.6.2.4	Salem City Obs. No. 1	City of Salem	1965	4	T	26	1.5	23	14	36	8.0	--	--	March 1965	----	----	Chloride 435 ppm 4-19-65 2,850 ppm 3-22-66
142B	30.42.6.2.4	Salem City Obs. No. 2	City of Salem	1965	.8	T	24	1.5	21	14	36	8.0	--	--	March 1965	QW	----	Chloride 1,650 ppm 3-22-66
142C	30.42.6.2.4	Salem City Obs. No. 3	City of Salem	1965	11	T	45	2	40	---	---	20	--	--	March 1965	----	----	Chloride 10 ppm 4-19-65
143	30.42.6.3.7	H. J. McCracken	G. H. Rankin, Jr.	1954	10	D	74	3	36	31	43+	9	--	50	1954	DL	----	Chloride 10 ppm 4-19-65
144	30.42.6.7.1	Anthony Hamidy	P. H. Coleman	1955	10	D	80	2	75	18	57	7	--	8	1956	DL, SL, QW	----	Chloride 10 ppm 4-19-65. Well finished in Hornerstown Sand.
145	30.43.1.6.6	Ira Jackson	G. H. Rankin, Jr.	1952	19	D	45	1-1/2	42	32	13+	4	7	25	1952	DL	8.3	
146	30.43.2.9.8	E. T. Garrison, Jr.	G. H. Rankin, Jr.	1952	37	D	115	3	77	62	53+	29	--	20	1952	DL	----	
147	30.43.3.2.9	J. L. Evans	Haines and Moore	1957	50	Ir	94	6	74	70	24+	24	28	40	1957	DL	10	No screen.
148	30.43.3.4.8	W. C. Mills, III	Haines and Moore	1957	40	D	82	4	66	65	17+	28	32	25	1959	DL	6.2	No screen.
149	30.43.3.5.3	George Freeman	G. H. Rankin, Jr.	1952	63	D	135	3	66	---	---	37	--	--	1952	QW	----	No screen.
150	30.43.3.5.9	Steven Moncrief	G. H. Rankin, Jr.	1953	33	D	125	3	105	58	67+	18	--	20	1953	DL, QW	----	No screen.
151	30.43.3.7.1	Clyde Clingerman	Unknown	1953	33	D	97	--	---	---	---	18	--	--	1953	QW	----	
152	30.43.3.8.1	J. R. Seligman	Haines and Moore	1960	30	D	90	4	68	60	31+	13	--	20	1960	DL, GL	----	No screen.
153	30.43.3.9.5	J. F. Vetrovec	Haines and Moore	1952	45	F	170	4	155	151	19+	27	50	15	1952	DL	.6	No screen.
154	30.43.4.5.9	H. F. Smith	G. H. Rankin, Jr.	1958	17	D	90	2	82	64	26+	16	19	25	1952	DL	8.3	
155	30.43.4.5.9	Quinton Fire Company, No. 1	G. H. Rankin, Jr.	1954	23	D	101	2	61	40	60+	18	--	50	1954	DL	----	No screen.
156	30.43.4.6.5	City of Salem Water Dept. No. 3 Quinton	Ridpath and Potter	1900	7	PS	140	8	130	26	75+	9	59	270	1946	DL, QW	5.4	Original depth, 248 feet (Kmw).
157	30.43.4.9.1	G. M. Scull	G. H. Rankin	1952	25	D	105	2	97	51	53+	18	22	10	1952	DL	2.5	
158	30.43.6.1.1	B. L. Seabrook No. 4	Haines and Moore	1951	30	D	95	3	76	74	21+	24	27	15	1951	DL	5	No screen.
159	30.43.6.1.5	Williams General Store	Unknown	1954	40	D	156	2	---	120	36	26	--	25	1954	QW	----	
160	30.43.6.1.9	C. C. Porch	G. H. Rankin, Jr.	1954	40	D	178	2	150	115	63	34	--	30	1954	DL	----	No screen.

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Well No.	New Jersey Grid number	Owner or name	Driller	Date completed	Altitude above mean sea level (ft)	Use	Depth of well (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Depth to top of bed (feet)	Thickness (feet)	Water level (depth below surface) static (feet)	Water level (depth below surface) pumping (feet)	Yield (gpm)	Date of measurement	Other data available	Specific capacity	Remarks
			VINCENTOWN FORMATION (CONTINUED)															
161	30.43.6.2.5	W. L. Holmes	G. H. Rankin, Jr.	1954	37	D	178	2	150	114	64	24	--	22	1954	SL	----	No screen.
162	34.2.3.7.2	R. E. Drummond	G. H. Rankin, Jr.	1951	10	D	80	2	72	---	---	8	12	30	1951		7.5	No screen.
163	34.2.3.9.5	Everett Burrell	C. C. Holladay	----	10	D, F	167	4	114	110	57	15	--	--	1959	GL	----	
			MANASQUAN FORMATION															
164	34.3.3.9.8	Calls Trailer Camp	D'Agostino Bros.	1959	60	PS	180	2	160	160	35	45	85	10	1959	DL, EL	.25	Total depth drilled, 330 ft.
			KIRKWOOD FORMATION															
165	30.44.2.3.9	M. Wilson No. 1	Delmarva Drilling Co.	1959	143	Ir, T	80	36	---	29	31	--	--	175	1959	DL	----	Yield estimated by driller as less than 175 gpm. Hole abandoned.
166	30.44.2.6.3	M. Wilson No. 2	Delmarva Drilling Co.	1959	142	Ir, T	75	36	---	29	25	40	--	175	1959	DL	----	Yield estimated by driller as less than 175 gpm. Hole abandoned.
167	31.41.2.2.3	Edward Glass	Gus Hauser	1950	135	D, F	105	4	96	95	10+	18	21	5	1950	DL	1.8	
168	31.41.4.5.2	Fred Cooper	Haines and Moore	1949	110	D, F	101	4	84	90	11+	18	28	30	1949	SL, DL, QW	3	
169	31.41.6.4.1	Pierce Van Keuren	Gus Hauser	1955	117	D	125	4	---	90	24	17	--	50	1959	GL, QW		
170	34.2.3.7.2	Edwin Ridgway	P. H. Coleman	----	3	D, I	64	2	---	28	---	5	--	--	----	DL, QW	----	Geographic position and driller's log indicate this well taps Qcm, Tkw, and Tvt.
171	34.3.3.9.3	William Brown	Gus Hauser	1953	120	D	94	4	84	79	11	37	--	28	1953	DL, QW	----	
172	34.3.4.3.2	Wallace Bradway	G. H. Rankin, Jr.	1952	25	D	85	2	81	82	4+	10	14	20	1952	DL	5	
173	34.3.5.6.7	Stephen Framer	G. H. Rankin, Jr.	1953	40	D	80	2	72	72	8+	9	13	15	1960	SL	3.9	
174	34.3.7.3.2	Walter E. Hill	G. H. Rankin, Jr.	1952	4	D	65	1-1/2	---	---	---	6	10	18	1952		4	
175	35.1.2.9.6	Parvin State Park, PW-A	Wm. Stothoff Co., Inc.	1945	73	In	80	6	70	67	15	13	67	29	1945	DL, QW	.5	Total depth drilled, 105 ft.
176	35.1.2.9.6	Parvin State Park, PW-B	Vance Skinner	1960	75	In	154	6	138	128	25	5	22	26	1960	DL, GL, EL, SL, QW	1.5	Total depth drilled, 210 ft.
177	35.1.3.3.4	N. W. Yoseph	Frank Kobelo	1948	95	D	145	4	134	---	---	26	29	25	1948		8	
			COHANSEY SAND															
178	30.34.6.9.5	W. H. Coates, No. 2	Haines and Moore	1952	140	F	36	4	29	0	35+	13	23	15	1952	DL, QW	1.5	
179	30.44.2.7.9	Wm. B. Reeves	Haines and Moore	1954	135	D	68	4	61	8	61+	42	46	20	1954	DL, QW	5.0	
180	30.44.2.9.7	A. C. Crispin	Haines and Moore	1957	125	D	47	4	41	15	32	35	40	20	1957	DL	4.0	

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				COHANSEY SAND (CONTINUED)														
181	30.44.5.7.2	Wm. Beal	Gus Hauser	1953	105	Ir	47	4	23	20	27+	2	--	40	1953	DL	----	
182	30.44.5.7.5	B. P. Moore	Haines and Moore	1956	110	F	51	4	45	39	12+	19	41	10	1956	DL	.4	
183	30.45.1.8.1	J. C. Garrison, Sr. No. 2	Haines and Moore	1957	136	F	57	4	50	26	32	16	46	10	1957	DL, QW	.3	
184	30.45.4.3.4	Ellsworth Harris	Gus Hauser	1956	120	D	69	4	59	42	15	15	27	20	1956	DL	1.7	
185	31.31.7.4.1	Wm. B. Irell	Gus Hauser	1954	130	F	59	4	36	6	53	4	--	100	1954	DL	----	Total depth drilled, 60 feet.
186	31.31.8.6.3	Ed. Schober	Haines and Moore	1954	130	F	38	4	31	10	28+	16	20	20	1954	DL, QW	5.0	
187	31.31.8.6.9	H. Nadel	Gus Hauser	1954	133	F	77	4	67	58	19+	15	--	100	1954	DL	----	
188	31.41.1.2.8	Elmer Community Hospital	Haines and Moore	1947	135	In	58	8	38	---	58+	20	--	100	1947	DL, QW		
189	31.41.1.3.6	Pfeffer's Bakery	Haines and Moore	1949	110	D	24	4	---	---	---	--	--	--	----	QW		
190	31.41.1.3.8	Elmer Water Co. No. 4	Ridpath and Potter	1935	107	PS	62	8	42	37	23	3	38	60	1935	DL, QW	1.8	
191	31.41.1.5.4	Delbert Robinson	Haines and Moore	1960	135	D	67	4	62	51	16+	21	29	16	1960	DL, QW	2.0	
192	31.41.3.9.7	James Hart	Haines and Moore	1956	125	D	45	4	39	0	45+	24	38	15	1956	DL, QW	1.0	
193	31.41.5.3.9	Charles Paulaitis	Owner	1958	120	Ir	53	4	37	35	25	17	--	125	1959	DL,SL,GL,QW	----	Selected log from auger boring by USGS and located 75 ft from irrigation well cited.
194	31.41.5.6.3	Adam Paulaitis	Gus Hauser	1953	115	Ir	60	6	36	28	28	11	27	220	1953	DL, GL	13.8	
195	31.41.6.4.4	Lloyd Yeagle	Lloyd Yeagle	1948	120	D	36	1-1/4	31	---	---	14	--	6	1958	QW		
196	31.42.4.4.6	Peter Mavroff	Rudy Skypala	1954	96	D	40	2	34	7	33+	12	16	40	1954	DL, QW	10.0	
197	35.1.1.3.3	Alfred Fromm	Gus Hauser	1954	105	D, F	55	4	41	40	14	22	--	85	1954	DL		
198	35.2.1.1.5	R. Garcia	Gus Hauser	1954	92	D, F	53	4	43	2	51	19	--	45	1954	DL		
199	35.2.1.7.8	Paul Weininger	Gus Hauser	1953	105	F, In	82	6	58	43	33	43	--	160	1953	DL, QW, SL	----	
200	35.2.4.4.3	Samuel Lamnin	Gus Hauser	1953	83	D, F	65	4	55	45	20	29	--	40	1953	DL		
				QUATERNARY														
201	30.22.9.3.8	H. Larrson, No. 3	Haines and Moore	1955	22	D	32	4	26	---	---	7	15	20	1955	DL	2.5	
202	30.22.9.4.9	Penns Grove Water Supply Co., Ranney	Ranney Water Collector Corp.	1939	17	PS	34	192	--	---	---	--	--	629	1939	QW	----	Seven radial 8-inch screens extend from the central collector.

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						QUATERNARY (CONTINUED)												
203	30.22.9.5.7	Penns Grove Water Supply Co., 2 B	Artesian Well and Equipment Co., Inc.	1944	19	PS	58	12	45	---	---	18	51	306	1944	DL	9.3	Pumps into the Ranney collector, well 202.
204	30.22.9.5.7	N.J. State Water Policy and Supply Comm., No. 24	A. C. Schultes and Sons	1941	18	T	51	6	46	---	---	18	23	9	1941	DL, GL	1.8	USGS observation well.
205	30.22.9.7.6	E. I. duPont, Ranney	Ranney Water Collector Corp.	1939	15	I	49	156	45	---	---	4	29	1500	1939	QW	----	
206	30.32.2.3.6	N.J. State Water Policy and Supply Comm., No. 41	A. C. Schultes and Sons	1941	11	T	25	6	20	---	---	2	10	4	1941	DL	0.5	USGS observation well.
207	30.32.7.3.3	H. N. Stanton	Haines and Moore	1957	15	D	24	4	18	---	---	8	20	12	1957	DL	1.0	
208	30.33.1.2.5	E. D. Tomlinson	Haines and Moore	1953	32	F	20	3	13	---	---	12	13	6	1953	DL	6.0	
209	30.35.4.7.2	Leslie Newkirk	Haines and Moore	1954	145	F	37	4	30	---	---	17	30	18	1954	DL	1.4	Well probably obtains some water from the Cohansey Sand.
210	30.35.7.4.5	E. A. Foster	Haines and Moore	1953	140	I	36	4	29	---	---	11	15	20	1953	DL	5.0	Well probably obtains some water from the Cohansey Sand.
211	30.35.7.8.3	Seabrook Farms	Haines and Moore	1951	142	D	47	4	40	---	---	14	19	25	1951	DL	5.0	Well probably obtains some water from the Cohansey Sand.
212	31.41.1.9.3	S. F. Ruhl	Haines and Moore	1955	110	Ir	48	4	34	---	---	8	20	40	1955	DL	3.3	Well probably obtains some water from the Cohansey Sand.
213	31.41.4.9.3	Rebecca McClintock	Gus Hauser	1951	95	--	49	4	39	---	---	30	36	18	1951	DL	3.0	Well probably obtains some water from the Cohansey Sand.
214	31.41.6.7.9	H. Landauer	Rudy Skypala	1955	115	D	46	2	40	---	---	28	--	10	1955	DL	----	Well probably obtains some water from the Cohansey Sand.
215	31.42.1.7.6	Richard Walsh	Rudy Skypala	1954	95	F,D	30	2	24	---	---	6	13	10	1954	DL	1.4	Well probably obtains some water from the Cohansey Sand.
216	35.1.6.2.4	Elliott Shull	Gus Hauser	1953	70	D	46	4	36	---	---	11	--	80	1953	DL	----	Well probably obtains some water from the Cohansey Sand.

TABLE 7.—LOGS OF SELECTED WELLS IN SALEM COUNTY

The logs enable the reader to determine the geology at specific sites and to interpret what type materials might be encountered in drilling nearby. Drillers' logs and geologic logs based on samples obtained from drillers are included. They were obtained from numerous sources; the files of the New Jersey State Geologist, the New Jersey Department of Health, various publications, drillers, property owners, and through the collection of samples from wells during their construction.

Unless otherwise noted, the geologic correlation of these logs has been made by the authors. Owing to sparse well coverage and lack of detail in many of the logs, the correlations are tentative.

Each well log is numbered; the well can be located on figure 2. Detailed physical and hydrologic data are available in table 6. Quality-of-water data are available for some of the wells and are given in table 5. For an explanation of the well-numbering and location systems, see the Introduction and figure 4.

Table 7.—Logs of selected wells in Salem County.

Well 2: Penns Grove Water Supply Company, 1901.

Location: Penns Grove.

Remarks: Land surface altitude about 5 feet. Log adapted from New Jersey Geological Survey Annual Report for 1901, p. 92. Drilling stopped in bedrock, hole abandoned because of insufficient supply (35 gpm reported at the 100 foot depth).

	Thickness (feet)	*Depth (feet)*
Quaternary:		
Cape May Formation:		
Sand, orange-yellow	15	15
Clay, loamy, yellow	7	22
Gravel, coarse; large pebbles and boulders; water bearing	8	30
Clay, gray	18	48
Boulder (sandstone, coarse-grained, white)	1	49
Clay, black	37	86
Gravel, heavy; large pebbles	1	87
Clay, black	7	94

Table 7.—Logs of selected wells in Salem County—Continued.

Well 2—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous:		
Magothy Formation:		
Gravel, coarse; with pebbles, cobbles, and boulders	8	102
Sand, coarse, clean	4	106
Raritan Formation:		
Clay, plastic, red	26	132
Sand and thin clay	24	156
Sand, fine, white	5	161
Clay, lead-colored	11	172
Sand, fine, white	21	193
Clay, plastic, red	9	202
Sand, coarse, gray, clean	5	207
Clay, plastic, red	3	210
Sand, fine, and red clay	24	234
Sand, very fine, gray	4	238
Sand, coarse, red	12	250
Sand, fine, yellow	10	260
Clay, red, and sand	10	270
Late Precambrian(?):		
Wissahickon Formation(?):		
Rock, micaceous, soft	5	275
Rock, micaceous, hard	75	350

Well 7: Penns Grove Water Supply Company, Layne 1.
Location: Upper Penns Neck Township, 1.3 miles E. of Carneys Point.
Remarks: Land surface altitude, 19 feet.

Quaternary:		
Cape May Formation:		
Sand, yellow, and soil	3	3
Cretaceous:		
Magothy Formation:		
Clay, white and sandy	5	8
Sand, coarse, white	12	20
Sand, coarse, and gravel	10	30
Sand, coarse	15	45

Table 7.—Logs of selected wells in Salem County—Continued.

Well 7—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Raritan Formation:		
Clay, blue	20	65
Clay, red and white	30	95
Sand, coarse, and gravel	2	97
Clay, blue	5	102
Sand, coarse, and gravel	19	121
Clay, red, white, and blue	19	140
Sand, coarse; gravel, and red and white clay	47	187
Sand, coarse; gravel, wood, and red and white clay	20	207
Sand, and red, white, and blue clay streaks	29	236
Sand, coarse, and gravel	29	265
Clay, red and white	14	279
Sand, coarse, white	87	366
Clay, red and white	5	371

Well 9: Penns Grove Water Supply Company, Layton 11.

Location: Upper Penns Neck Township, 1.6 miles SE. of Carneys Point and 4.6 miles W. of Auburn.

Remarks: Land surface altitude, 14 feet. Well originally known as the E. I. duPont de Nemours and Company, Layton 11.

Quaternary:		
Cape May Formation:		
Sand and gravel	20	20
Cretaceous:		
Merchantville Formation:		
Sand, hard	12	32
Magothy Formation:		
Sand, coarse	28	60
Raritan Formation:		
Clay, tough	7	67
Clay, sandy	16	83
Clay	66	149
Clay, sandy	11	160
Clay, tough	12	172
Sand, medium-coarse	18	190

Table 7.—Logs of selected wells in Salem County—Continued.

Well 9—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Raritan Formation—continued		
Clay, tough	18	208
Clay, sandy, white	13	221
Clay, tough	10	231
Sand, coarse	6	237
Clay	61	298
Clay, blue	18	316
Sand, hard	8	324
Clay, very tough	27	351
Sand, fine, gray	18	369
Sand, medium-coarse	25	394
Clay, tough	10	404

Well 11: Pan American Refining Corporation Pump Test Well 1.

Location: Oldmans Township, 3.7 miles NE. of Penns Grove and 5.2 miles NW. of Auburn.

Remarks: Land surface altitude, 6 feet.

Quaternary:		
Cape May Formation:		
Sand	10	10
Sand and gravel	19	29
Clay, dark-gray	2	31
Gravel, large	8	39
Cretaceous:		
Raritan Formation:		
Clay, red	4	43
Clay, white and dark-gray	16	59
Sand, medium, white	3	62
Sand and clay	1	63
Sand, coarse	3	66
Clay, sandy; bits of decomposed wood	10	76
Sand, fine, brown	4	80
Sand, coarse	6	86
Sand, coarse, and clay	7	93
Clay, red and gray	13	106
Clay, sandy, light-brown	10	116

Table 7.—Logs of selected wells in Salem County—Continued.

Well 11—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Raritan Formation—continued		
Sand, dirty to clean, medium	6	122
Sand, pinkish-gray, medium	7	129
Sand and gravel, clean	2	131
Sand and white clay balls	5	136
Sand and clay, white	3	139
Sand, fairly clean	11	150
Clay, red	4	154
Clay, gray and brown	33	187
Gravel and clay, mixed	30	217
Gravel, large, and mica rock	below	217

Well 18: Camp Kimble, Boy Scouts of America.

Location: Oldmans Township at Auburn.

Remarks: Land surface altitude, 70 feet.

Quaternary:		
Pensauken Formation:		
Gravelly	20	20
Cretaceous:		
Undifferentiated:		
Marl, blue	145	165
Magothy Formation:		
Sand, white	13	178

Well 20: Fort Mott State Park, State of New Jersey.

Location: Lower Penns Neck Township at Finns Point.

Remarks: Land surface altitude, 8 feet. Well reported to have flowed at 50 gpm in 1900. Log adapted from New Jersey Geological Survey Annual Report for 1900, p. 131.

Quaternary:		
Cape May Formation:		
Sand, yellow, and gravel	25	25

Table 7.—Logs of selected wells in Salem County—Continued.

Well 20—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous:		
Woodbury Clay and Merchantville Formation:		
Clay, sandy, black	25	50
Sand, coarse	15	65
Clay, dark, hard	40	105
Magothy Formation:		
Clay, whitish, dirty	17	122
Clay, whitish; lighter than above	8	130
Sand, medium-coarse, bluish-gray	18	148
Sand, fine, white	6	154
Raritan Formation:		
Sand and clay, red	36	190
Sand, medium-coarse, red	20	210
Clay, sandy, fine, yellowish	10	220
Clay, sandy, red	65	285
Clay, plastic, red	15	300
Sand, medium-coarse, white	9	309
Gravel, coarse, whitish-gray; last 20 feet water bearing	11	320

Well 36: Pennsville Township Water Department, Test Well 2.
Location: Upper Penns Neck Township on Pine Street, Deepwater.
Remarks: Land surface altitude, 9 feet. Log adapted from data prepared by M. E. Johnson, former New Jersey State Geologist.

Quaternary:		
Cape May Formation:		
Clay, gray	7	7
Sand, fine to medium, yellow; few chlorite grains	16	23
Sand, fine to coarse, variegated; rounded grains of red argillaceous sandstone (Triassic)	21	44
Cretaceous:		
Magothy and Raritan Formations:		
Clay, gray, and some sand	9	53
Sand, variegated gravel, and streaks of clay	24	77
Clay, gray, and some sand	10	87

Table 7.—Logs of selected wells in Salem County—Continued.

Well 36—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Magothy and Raritan Formations—continued		
Sand, fine to medium, yellow-gray, speckled	23	110
Sand, fine to medium, gray, speckled; a little muscovite	6	116
Sand, fine to mostly coarse, speckled	18	134
Clay, gray	39	173
Sand, fine to medium, hard, light-reddish yellow	6	179
Clay, gray	16	195
Sand, fine to very coarse, yellow-gray	22	217
Clay, red; hardpan at 227-228 ft.	151	368
Sand, fine to coarse, gray	6	374
Clay, red, and fine sand	94	468
Sand, fine to coarse, light-gray	9	477
Clay, red, and little sand and gravel	18	495
Sand, fine to medium, light-red; and a few coarse grains	8	503
Clay, gray and red; and little gravel	95	598

Well 42: Pennsville Township Water Department, Test Well 2/3.
Location: Pennsville Township at East Pittsfield Avenue and West Penn Street, Pennsville.
Remarks: Land surface altitude, 6 feet.

Quaternary:		
Cape May Formation:		
Soil	1	1
Clay, sandy, gray	7	8
Sand, gray	14	22
Cretaceous:		
Merchantville Formation:		
Clay, gray, and gravel	23	45
Magothy Formation:		
Clay, sandy, hard	15	60
Sandstone	5	65
Clay, gray	13	78
Sandstone	2	80

Table 7.—Logs of selected wells in Salem County—Continued.

Well 42—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Raritan Formation:		
Clay, tough, red and white	25	105
Clay, red and white; streaks of sandstone	46	151
Clay, tough, red and blue; streaks of sandstone	12	163
Clay, sandy, gray	30	193
Sand, fine, white; and lignite	13	206
Clay	3	209
Sand, coarse, white	5	214
Clay, red and white; streaks of sandstone	29	243
Clay, sandy, red and white	6	249
Clay, tough, red and white	21	270
Clay, sandy, red and blue	20	290
Clay, tough, blue	15	305
Clay, sandy, red and white	24	329
Clay, tough, red and white	26	355

Well 44: N. J. Turnpike Authority, No. 2-1 South.

Location: Oldmans Township, 2 miles SW. of Auburn.

Remarks: Land surface altitude, about 35 feet. Log adapted from data prepared by F. J. Markewicz, N. J. Geological Survey.

Quaternary:		
Cape May Formation:		
Sand, fine to coarse, quartz; silt and soft nodules of glauconite; light-olive gray	10	10
Cretaceous:		
Marshalltown Formation:		
Silt, sandy, micaceous, fossiliferous, glauconitic, dark-gray	20	30
Englishtown Formation:		
Sand, silty, clayey, micaceous, slightly glauconitic, fossiliferous, dark-gray; few pebbles	10	40
Silt, clayey, sparsely micaceous, dark gray	10	50
Woodbury Clay:		
Clay, silty, micaceous, very dark-gray	10	60
Silt, clayey, micaceous, dark-gray	30	90
Silt, clayey, micaceous; marcasite nodules to ½ inch in top 10 feet; dark-gray	20	110

Table 7.—Logs of selected wells in Salem County—Continued.

Well 44—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Merchantville Formation:		
Silt, slightly micaceous, moderately glauconitic, dark-gray	10	120
Silt, gritty, slightly micaceous, and glauconitic; little clay; dark-olive-gray	30	150
Magothy Formation:		
Silt, gritty, slightly micaceous, glauconitic, dark-olive-gray. Scattered coarse grains of quartz and fossil fragment resembling annelid	10	160
Sand, fine to coarse and angular to sub-round, medium-olive-gray	2	162
Silt, slightly clayey; with coarse-sand grains; medium-olive-gray	18	180
Silt, slightly clayey; some glauconite and whitish silt; medium gray	5	185
Raritan Formation:		
Clay, silty; few coarse grains and charred wood; seeds and some siderite ooliths; pale yellowish brown	5	190
Silt, gritty; few coarse grains, some glauconite, pebbles up to ¼ inch, siderite ooliths; yellowish gray and somewhat variegated	10	200
Silt, gritty; few coarse angular grains, little glauconite, siderite ooliths; yellowish gray	20	220
Silt, gritty, light-olive-gray	10	230
Silt, clayey; many coarse grains; variegated reddish brown	10	240
Silt, sandy; with medium coarse quartz grains; reddish brown	10	250
Silt, sandy, few coarse grains, light-olive-gray	10	260
Clay, silty; very few sand grains	5	265
No report	10	275
Silt, clayey; few coarse sand grains; medium gray	10	285
Claystone, silty; few coarse sand grains, pyritized and carbonized wood fragments; light-olive-gray	2	287
Clay, silty; carbonized wood fragments, yellowish red, variegated	13	300

Table 7.—Logs of selected wells in Salem County—Continued.

Well 44—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Raritan Formation—continued		
Claystone, silty, variegated	10	310
Silt and fine sand, quartz, sparsely glauconitic; few carbonized wood fragments; medium-olive-gray	3	313
Sand, medium-coarse; sub-angular to sub-rounded quartz grains; few pebbles to ¼ inch; brownish gray	4	317
Sand, coarse to medium, reddish-brown, variegated	8	325
Sand, fine, slightly micaceous, yellowish-gray	3	328
Sand, medium to coarse and up to ¼ inch, olive gray	3	331
Sand, fine to medium; few coarse grains of sub-angular to sub-rounded quartz; some carbonized wood; light colored	4	335
Sand, coarse; with few pebbles to $\frac{3}{16}$ inch, and much charred wood; light colored	10	345
Sand, fine to medium and silty clay; light-olive-gray		below 345

Well 46: Benjamin Cheesman

Location: Oldmans Township, 1.5 miles SE. of Auburn and 2.6 miles NNW. of Sharptown.

Remarks: Land surface altitude, 110 feet. Log adapted from USGS Bulletin 727, p. 38 and Plate I, and New Jersey Geological Survey Annual Report 1896, p. 127.

Quaternary and Tertiary:		
Undifferentiated:		
Soil	2	2
Clay and gravel	4	6
Sand, ("molding"), orange	8	14
Boulder (Bullhead) in green clay marl (reworked Hornerstown marl?)	1	15
Tertiary:		
Hornerstown Sand:		
Greensand marl, light-olive	10	25

Table 7.—Logs of selected wells in Salem County—Continued.

Well 46—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous:		
Navesink Formation:		
Clay, gravel, and greensand mixed; dark olive	10	35
Mount Laurel Sand and Wenonah Formation:		
Greensand, light-olive; consisting of whitish quartz and glauconite grains	10	45
Sand, quartzose, reddish-yellow; with a few greensand grains	50	95
Clay, sandy and marly; a few greensand grains	20	115
Sand, reddish-yellow; same as above	10	125
Marshalltown Formation:		
Clay and sand, olive-green; white and red-stained quartz and some glauconite grains	20	145
Gravelly conglomeratic mixture of whitish quartz and dark-blue mineral grains (vivianite); teeth and vertebra of shark	10	155
Englishtown Formation:		
Sand, white, and running black mud	25	180
Woodbury Clay and Merchantville Formation:		
Marl, clay, micaceous, dark	87	267
Magothy Formation:		
Sand, medium, very slightly olive	23	290
Sand, coarse, bluish-white; contains water	10	300
Raritan Formation:		
Clay, red and white, mottled	1	301

Table 7.—Logs of selected wells in Salem County—Continued.

Well 47 and 48: Richmond Ice Cream Company, composite of wells 1 and 2.

Location: Pilesgrove Township at Sharptown.

Remarks: Land surface altitude, 25 feet for well 1 and 20 feet for well 2. The log to the Raritan Formation was adapted from well 1, furnished by the N. J. State Geologist, M. E. Johnson.

Well 1, located near the plant, was drilled to 284 feet in April 1940. It had 17 feet of screen set between 262 and 283 feet. In June 1948, the well was deepened to 475 feet and 20 feet of screen was set in the sand between 418 and 465 feet.

Well 2, located near a pond about 300 feet SE. of no. 1, was drilled to 465 feet and screened from 418 to 446 feet in May 1946.

	Thickness (feet)	*Depth (feet)*
Quaternary:		
Undifferentiated:		
Gravel, ironstone, yellow	43	43
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Sand and marl, gray	13	56
Clay and little sand, blue	34	90
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Clay, blue	18	108
Clay, and streaks of blue and white sand; water bearing	27	135
Undifferentiated:		
Clay, blue	10	145
Clay, blue and black, medium-hard	111	256
Magothy Formation:		
Sand, coarse, light-gray; lignite	4	260
Sand, gray, and ¼-inch gravel; water bearing	13	273
Sand, clayey, fine, gray	11	284
Raritan Formation:		
Clay, gray and pink	16	300
Clay, blue, and 1 to 2 foot sand lenses	100	400
Clay and sand	18	418
Sand, white	47	465

Table 7.—Logs of selected wells in Salem County—Continued.

Well 49: Arthur R. Gemberling, Jr.

Location: Pilesgrove Township, 0.9 mile SE. of Sharptown.

Remarks: Land surface altitude, 43 feet. The well is listed as a "domestic" supply in Table 6 but Dr. Gemberling (veterinarian) uses considerable water in conjunction with his small animal hospital.

	Thickness (feet)	*Depth (feet)*
Quaternary:		
Topsoil	6	6
Tertiary:		
Vincentown Formation:		
Clay, brown	3	9
Hornerstown Sand:		
Clay, green, and marl	15	24
Cretaceous:		
Navesink Formation:		
Marl, black	34	58
Mount Laurel Sand and Wenonah Formation:		
Clay, sandy, and shells	7	65
Sand, fine, gray, and shells	14	79
Clay, sandy, and shells	6	85
Sand, medium, gray, and marl	23	108
Marshalltown Formation:		
Clay, blue and marl	7	115
Clay, blue	17	132
Marl, black	9	141
Englishtown Formation:		
Sand, in streaks, hard	8	149
Woodbury Clay:		
Clay, blue	2	151
Hardpan	3	154
Clay, blue	7	161
Hardpan	1	162
Clay, blue	61	223
Clay, sandy	13	236
Clay, blue	4	240
Merchantville Formation:		
Marl, green	16	256
Clay, hard, dry	4	260
Clay, sandy, black	6	266

Table 7.—Logs of selected wells in Salem County—Continued.

Well 49—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Magothy Formation:		
Clay, tough	5	271
Sand, gray	10	281
Sand, hardpan	3	284
Clay, sandy, gray	7	291

Well 50: American Stores Inc.

Location: Pilesgrove Township, 0.4 mile SW. of Woodstown.

Remarks: Land surface altitude, 57 feet. Log adapted from data prepared by F. J. Markewicz, N. J. Geological Survey, drillers' notes and USGS gamma-ray log. Samples below 345 feet were contaminated owing to a broken well casing.

Tertiary:		
Kirkwood Formation:		
Silt, finely micaceous, slightly clayey, light-yellowish-orange	10	10
Silt, finely micaceous, gray, very slightly lignitic	10	20
Vincentown Formation:		
Sand, mostly fine to medium, slightly glauconitic and micaceous, gray	23	43
Hornerstown Sand:		
Sand, silty, olive-gray, glauconitic, slightly fossiliferous	7	50
Sand, glauconitic, green, fossiliferous. Few very small, immature or deformed forams, mostly coiled. Few broken fragments of Dentalina or Nodosaria	10	60
Cretaceous:		
Navesink Formation:		
Sand, glauconitic, sea-green, with a minor clay binder	10	70
Sand, clayey, olive-gray; mostly fine-grained quartz with scattered very coarse grains; glauconitic, and fossiliferous. A few coiled and several globular forams	10	80

Table 7.—Logs of selected wells in Salem County—Continued.

Well 50—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Navesink Formation—continued		
Sand, clayey, light-gray, fine- to medium-grained, slightly glauconitic, and fossiliferous	10	90
Mount Laurel Sand and Wenonah Formation:		
Sand, fine- to medium-grained quartz with very fine grains of glauconite. Few fossil fragments	10	100
Sand, fine-grained quartz, clayey; little glauconite	20	120
Sand, fine- to medium-grained quartz, grayish-green; little glauconite; few fossil fragments	10	130
Sand, fine- to medium-grained quartz, clayey; little glauconite; few coiled forams; Cibicides or Anomalina; several Belemnitella fragments	10	140
Sand, fine-grained quartz, clayey, lightly glauconitic, light-olive	20	160
Marshalltown Formation:		
Sand, fine-grained quartz; some clay; olive-gray; slightly glauconitic	25	185
Sand, fine-grained quartz, glauconitic, slightly micaceous, silty, olive-gray; few fossil fragments ..	7	192
Englishtown Formation:		
Sand, fine, silty, moderately glauconitic, dark-olive-gray	18	210
Englishtown and Woodbury Formations (undifferentiated):		
Silt, clayey, fine-grained quartz, finely micaceous, very slightly lignitic and glauconitic, slightly fossiliferous. Contains flat brown sideritic or shaly pebbles	25	235
Woodbury Formation:		
Silt, clayey, finely micaceous, slightly lignitic; many flat shaly pebbles and few small green clots of glauconite	5	240
Silt, finely micaceous, moderately lignitic, very slightly glauconitic, dark-gray. Forams include: globorotalia, gumbelina, and numerous small coiled forams. Driller reported hard layers between 250 feet and 258 feet	18	258

Table 7.—Logs of selected wells in Salem County—Continued.

Well 50—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Woodbury Formation—continued		
Silt, clayey, finely micaceous, slightly lignitic, dark-gray; few fine sand streaks; arenaceous; agglutinated forams. Aputure noted on many specimens	23	281
Merchantville Formation:		
Hard layer	1	282
Silt, clayey, finely micaceous, slightly lignitic, dark-gray	8	290
Clay, sandy, micaceous, greenish-black; some rock fragments	20	310
Clay, sandy, greenish-black	10	320
Clay, sandy, micaceous, greenish-black; some brown clay	15	335
Magothy Formation:		
Clay, variegated pinkish-white and brownish-orange; some medium sand; small percent of siderite spherulites	10	345
Sand, fine- to coarse-quartz grains and some quartz pebbles, gray	13	358
Raritan Formation:		
Clay, generally tough, mottled, red, white, and gray; occasional sand lenses of from 2 to 10 feet in thickness	182	540
Sand, fine- to medium-grained quartz, light-gray	30	570
Clay	8	578

Well 51: Salem County Home, No. 3.

Location: Mannington Township, 2.4 miles SW. of Woodstown and 1.8 miles S. of Sharptown.

Remarks: Land surface altitude, 40 feet.

Tertiary:		
Kirkwood Formation:		
Clay, gray and brownish-yellow	12	12
Vincentown Formation:		
Sand, fine to medium; limestone layers and some clay	36	48

Table 7.—Logs of selected wells in Salem County—Continued.

Well 51—continued

	Thickness (feet)	*Depth (feet)*
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Sand, glauconitic; shell fragments and some green and brown clay	12	60
Sand, glauconitic, greenish-black	10	70
Sand, glauconitic, greenish-black; shell fragments	10	80
Sand, green; some brown clay and shells	11	91
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Sand, medium to coarse; shell fragments	29	120
Sand, fine to medium; with some brown clay and shell fragments	10	130
Sand, fine to medium; fine-grained glauconite and shell fragments	10	140
Sand, fine to medium, glauconitic; gray clay and shell fragments	20	160
Sand, mostly medium-grained, slightly glauconitic; shell fragments	15	175
Marshalltown Formation:		
Sand, clayey and glauconitic	15	190
Marshalltown and Englishtown Formations (undifferentiated):		
Clay, sandy, micaceous; pebbles and shell fragments	30	220
Englishtown Formation:		
Sand, clayey, micaceous and glauconitic	20	240
Woodbury Clay:		
Clay, sandy, black to gray; small pebbles; highly micaceous; shell fragments	20	260
Clay, dark-gray, micaceous	20	280
Merchantville Formation:		
Clay, sandy, black to greenish gray, micaceous; shell fragments	45	325
Magothy Formation:		
Clay, gray with streaks of pink and white	5	330
Clay, gray, with streaks of fine sand	10	340
Sand, fine to coarse-grained, highly lignitic	30	370

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53: USGS, Point Airy.

Location: Pilesgrove Township, 1 mile N. of Woodstown.

Remarks: Land surface altitude, 71 feet. Log developed from drillers log, "cable-tool" samples, and gamma-ray log. Mineralogy by J. P. Minard and J. P. Owens.

	Thickness (feet)	*Depth (feet)*
Tertiary:		
Kirkwood Formation:		
Clay, sandy, and top soil	5	5
Clay, sticky, buff to variegated in color, and tan fine to medium glauconitic quartz sand. Lignite and little mica; some silt-size black opaques	5	10
Manasquan(?) and Vincentown Formations (undifferentiated):		
Gravel (up to 1½ inch) and fine- to very fine-quartz sand with few coarse grains; mica, considerable bright green glauconite and silt-size black opaques. Grayish yellow (5 Y 8/4) color	1	11
Sand, medium to coarse quartz and 10 percent glauconite, and clay with pebbles up to ¼ inch; gray-green color	7	18
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation (undifferentiated):		
Sand and clay, glauconite and quartz, medium- to coarse-grained with some quartz granules, grayish olive green (5GY 3/2) color	0.5	18.5
Clay, sandy, botryoidal, glauconite, medium- to coarse-grained; with quartz 1-3 percent; grayish olive green color	4.5	23
Clay, sandy, glauconitic, gray; with dark-green grains, 3-5 percent quartz; medium- to coarse-grained, botryoidal; grayish olive green color. Water at 27 feet	4	27
Clay, sandy, glauconitic; with 3-5 percent quartz; medium size elongate botryoidal dark-green grains; greenish-gray clay; ovoid apatite pellets; grayish-olive-green color	4	32

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

Tertiary and Cretaceous—continued Hornerstown Sand and Navesink Formation (undifferentiated)—continued	*Thickness (feet)*	*Depth (feet)*
Clay, sandy, glauconitic, medium grained; 1-2 percent coarse-quartz grains; a few dark-green and many fragmental grains; grayish-olive-green color	8	40
Clay, sandy, glauconitic, medium- to coarse-grained; 2-3 percent quartz; light- and dark-green glauconite grains in a gray-clay matrix; ovoid apatite pellets; grayish-olive-green color	5	45
Clay, sandy; quartz and glauconite; very poorly sorted; medium to very coarse grained with many quartz granules and pyrite clusters; possible reworked bryozoa fragments and occasional apatite pellets; grayish-olive green	5	50
Clay, sandy; quartz and glauconite (15 percent); medium grain size with some coarse and very coarse; gray; considerable angular and tabular quartz grains; dark brown ovoid apatite pellets; grayish-olive-green color	5	55
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Sand, glauconite (5-8 percent) and medium grained quartz; occasional coarse grains to granule size. One piece of iron oxide cemented sandstone, plates of siderite, and one rock fragment that looks like gneissic mica schist (driller reported hard drilling from 58 to 61 feet). Dusky yellow green (5 GY 5/2) color. Water at 58 feet	5	60
Sand, glauconitic (5-8 percent); quartz with occasional white medium mica plates and green chloritized mica plates; subangular and some angular medium- to coarse-grained quartz; dusky-yellow-green	5	65
Sand, glauconitic (3 percent); quartz; iron oxide cemented sandstone and little green mica; clay; dusky-yellow-green color	5	70

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Mount Laurel Sand and Wenonah Formation—continued		
Sand, glauconitic (1-2 percent); quartz, fine to medium and occasionally coarse grained. Glauconite is fine to medium grained; dark brown apatite pellets; dusky-yellow-green color	5	75
Sand, glauconitic (3-4 percent); quartz, many granules, mica, apatite, ironstone fragments, clay; dusky-yellow-green color	15	90
Sand, glauconitic (4-5 percent); quartz, medium and little coarse grained and some granules; mica, apatite, ironstone, piece of shark tooth, some clay; dusky-yellow-green color	5	95
Sand, clayey; becoming very calcareous at bottom; glauconitic (10 percent), fine grained quartz, considerable apatite pellets, rounded accordian glauconite, little mica and flat ironstone fragments; grayish-olive green (5 GY 3/2) color	20	115
Same as above plus calcareous shell material, micro fossils and pyrite	5	120
Sand, clayey, very calcareous, glauconitic (5-8 percent); fine to medium grained quartz, calcareous microfossils, shell fragments, considerable pyrite and mica; greenish black (5 G 2/1) color	5	125
Sand, glauconitic (5 percent), quartz, fine to medium; with shell fragments and many microfossils (Cristellaria, Frondicularia, Turritetla); some pyrite; greenish black color	5	130
Clay, calcareous, sandy, glauconitic (15 percent), fine to medium quartz; large thick calcareous shell fragments (Gryphanea or Oleneothyria, not Astrea) and many microfossils; greenish black color	5	135
Marshalltown Formation:		
Clay, sandy, glauconitic (20-25 percent); quartz, fine-grained; some shell fragments and microfossils; some green mica; slightly calcareous matrix; greenish-black color	5	140

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Marshalltown Formation—continued		
Clay, sticky, sandy, glauconitic (30 percent); fine- to medium-grained angular to subangular quartz; pyrite and white to bronze mica; some microfossil fragments; slightly calcareous matrix; greenish-black color	5	145
Clay, slightly calcareous, sticky, sandy; glauconite and quartz (50 percent), fine to medium grained with some granules; many calcareous coated microfossil fragments; some pyrite clusters and occasional calcareous shell fragments; greenish-black color	5	150
Clay, very calcareous, sticky, sandy; glauconite (30-35 percent) and quartz, medium grained and some very coarse grains; pyrite, apatite pellets, shell fragments, and considerable microfossil fragments included; greenish black color	5	155
Clay, sandy, glauconitic (30 percent); quartz, fine to coarse grained and poorly sorted; some angular quartz and rounded accordian forms of glauconite; little green mica; occasional poorly preserved microfossil fragment; essentially non-calcareous; greenish black color	5	160
Hard pan	1	161
Englishtown Formation:		
Sand, quartz, glauconitic (5-10 percent), slightly calcareous, medium- to coarse-grained; pyrite, a little white mica, and numerous apatite pellets; flat bottomed calcareous shell valve like Gryphaea or Exogyra—¼ x 1½ x 2 inches; some clay and pebbles and water; greenish black color	4	165
Clay, sandy, fine quartz grains, micaceous, and pyritic; apatite pellets, one ribbed shell fragment, and one glauconite grain (rounded curved accordian type); dark greenish gray (5GY 4/1) color	10	175

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Englishtown Formation—continued		
Clay, sandy, very fine quartz grains, micaceous; apatite pellets, pyrite, few shell fragments and 5 to 10 percent glauconite (tabular and accordian types). Microfossils include the Cristellaria, Frondicalaria, Flabellina, and Vagulina types. Dark greenish-gray color	10	185
Clay, sandy, fine to medium grained quartz, micaceous; pyrite, lignite, and tabular and accordian forms of glauconite; some coarse quartz grains; thin rock seams; non-calcareous; dark greenish-gray color	5	190
Woodbury Clay:		
Clay, sandy, fine grained glauconitic (2-3 percent) quartz; very micaceous—most clear little green; pyrite encased lignite; small calcareous shell fragment; thin rock seams. Sand is not calcareous. Dark greenish-gray color	10	200
Clay, sandy to silty, glauconitic (3-5 percent) quartz; very micaceous—green, bronze, and clear; dark green and olive glauconite suites; piece of shark tooth at 206 ft; thin rock seams. Glauconite decreasing to 1-2 percent in last 11 ft. Small thin calcareous shell fragments between 215 and 220 feet. Dark greenish-gray color ...	26	226
Rock, very hard	1	227
Clay, glauconitic (1-2 percent); with green mica, and very fine-grained quartz sand and silt; quartz granules and pebbles to ¼ inch; some pyrite, lignite and some of the glauconite as large as coarse grain size; some slender needlelike pieces of Frondicalaria; dark greenish-gray color	13	240
Clay, micaceous and glauconitic (2 to 5 percent increasing to 10 percent in last 5 feet); lignitic dark-brown apatite pellets; little fine to medium grained quartz sand; dark greenish gray becoming olive-gray (5Y 3/2) color at 250 feet	20	260

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Merchantville Formation:		
Clay, glauconitic (fine to medium grained) quartz sand with some coarse grains; slightly micaceous (green); glauconite in curved accordian forms—20 percent increasing to 30 percent of sample, with depth; pebbles and rock fragments; few apatite pellets and a trace of pyrite; greenish-black (5G 2/1) color	15	275
Clay, glauconitic (fine to medium grained) quartz sand with some quartz granules and pebbles up to $\frac{3}{16}$ inch; micaceous. Glauconite increased to 50 percent of sample; some accordian forms; iron oxide fragments, apatite pellets, and one piece of lignite; greenish-black color	10	285
Clay, finely micaceous, with fine- to medium-grained glauconite-quartz sand; many grains to very coarse; glauconite includes some accordian forms; pyrite and iron oxide; greenish black to dark greenish gray	10	295
Magothy Formation:		
Hardpan and clay (ironstone fragments); coarse to very coarse glauconitic (15 percent) quartz sand; tabular form of glauconite; little mica, apatite pellets, pyrite, and shells; olive-gray (5Y 4/1) color	1	296
Sand, medium to very coarse quartz and glauconite (15 percent) grains; pyrite, apatite, some mica and little ironstone; few rounded tabular forms of glauconite and some needle-like clear crystals (gypsum?); water	1	297
Sand, fine to medium quartz with few coarse grains; slightly micaceous and pyritic; glauconitic (3-4 percent decreasing to 1 percent at 300 feet), olive to dark green; weathered apatite pellet; cemented quartz sand clusters; dark greenish-gray (5GY 4/1) color	8	305

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Magothy Formation—continued		
Sand, fine to coarse grained quartz with a few grains of glauconite and little lignite; medium dark (N-4) to very light- (N-8) gray color . . .	15	320
Sand, fine to very coarse quartz grains—little rose; a few grains of feldspar and of an opaque heavy mineral; very lignitic; very light-gray color	5	325
Sand, medium to very coarse quartz grains—little blue and red; many small pebbles; a little lignite; hard layer at 332 feet; very light-gray color . . .	8	333
Clay, and fine to coarse grained quartz sand; some very coarse quartz and some glauconite grains; pyrite and a little lignite; medium dark-gray (N-4) color	8	341
Raritan Formation:		
Clay, silty, red and gray to 345 feet and gray below; dry and firm; medium to coarse, red-brown siderite grains with pyrite nodules; some lignite; grayish red (10 R 4/2) to 345 feet and light-olive-gray (5Y 6/1) color below	19	360
Clay, silty, light-pinkish-gray, firm; some quartz and siderite (red-brown) grains; lignite, pyrite, and 3/8 inch piece of pyrite replaced lignite; pinkish-gray (5YR 8/1) color	5	365
Clay, light-gray, and occasional thin sand layers of very fine to coarse-grained quartz; pyrite granules, siderite (oolites); light-gray (N-7) to medium light gray (N-6) color	30	395
Clay, black and gray, and layers of fine to medium sand; siderite; medium-light-gray (N-6) color	11	406
Sand, fine to medium grained quartz and some stained yellowish; siderite; light brownish-gray (5 YR 6/1) color	2	408
Clay, red, white, and brown, tough; few thin stringers of fine to medium-quartz sand and up to 30 percent siderite; medium orange-pink (10 R 7/4) color	18	426

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Raritan Formation—continued		
Clay, gray, brown and red; as much as 30 percent siderite; dark yellowish-brown (10 YR 4/2) color	11	437
Sand, fine-grained quartz; very hard; moderate-brown (5 YR 3/4) color	1	438
Sand, and variegated clay, gray, red, white, and brown; thin cemented sand layers of medium grained quartz, broken weathered rock fragments, pyrite or marcasite concretions and siderite; moderate brown becoming pale yellowish brown (10 YR 6/2) with depth	37	475
Clay, silty, very fine to medium grained siderite sand; pale yellowish brown	10	485
Clay, gray, and very fine grained sand; slightly micaceous; moderate yellowish brown to light olive gray (5 Y 6/1)	15	500
Sand, very fine grained quartz, and clay layers; much lignite; olive gray (5 Y 4/1); hardpan at 512-513 feet and water below	15	515
Sand, very fine-grained through medium sized gravel; slightly micaceous; some heavy minerals, lignite and clay balls; light brownish-gray (5 YR 6/1) color; water bearing	27	542
Clay, red, brown, and gray, and layers of fine sideritic sand; slightly micaceous; pale reddish brown (10 R 5/4) to moderate-reddish-orange (10 R 6/6) color	10	552
Sand, fine to coarse grained quartz, cemented; slightly micaceous; moderate reddish orange	3	555
Silt, lignitic and slightly micaceous; dark gray (N-3)	5	560
Sand, very fine, and silt; some very coarse-quartz grains; pale reddish-brown color	10	570
Clay, variegated, white, gray, red, and brown; tough and highly sideritic; few thin sand stringers; pale reddish brown color	39	609

Table 7.—Logs of selected wells in Salem County—Continued.

Well 53—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous—continued		
Raritan Formation—continued		
Sand, fine grained quartz to fine grained gravel; little siderite; pale yellowish brown (10 YR 6/2) color—probably owing to the overlying clay ...	9	618
Sand, fine to very coarse grained quartz, and gravel up to ¼ inch; slightly sideritic; very light-gray (N-8) color; water bearing	17	635
Silt and brown and gray clay; pale yellowish-brown (10 YR 6/2) color	10	645
Clay, sticky, red, white, brown, and black; some very fine micaceous sand; lignite; grayish red (10 R 4/2) through pale reddish brown and pale brown (10 YR 5/2) color	13	658
Sand, fine to medium grained quartz; clay balls and lignite; slightly micaceous; some heavy minerals; light brownish gray (5 YR 6/1) to pale brown color; water bearing	9	667
Sand, fine to very coarse-grained quartz; fine size gravel, clay balls, and lignite; heavy minerals; pale reddish brown (10 R 5/4) color	8	675
Clay, sideritic, silty, and tough; variegated red, white, gray, and brown; heavy minerals in lower half; pale reddish brown color	20	695
Sand, fine to coarse-grained quartz; red and gray clay in thin layers; slightly micaceous and lignitic; pale reddish brown color; water bearing	23	718

Well 55: Woodstown Ice and Coal Company, No. 1.

Location: East Grant Street, Woodstown. Situated about 15 feet from the present supply well.

Remarks: Land surface altitude, 58 feet. Total depth 302 feet below mean sea level. Log adapted from M. W. Twitchell as cited in Mansfield, 1922, p. 37.

Quaternary:		
Cape May Formation:		
Gravel and clay, yellow	25	25

Table 7.—Logs of selected wells in Salem County—Continued.

Well 55—continued

	Thickness (feet)	Depth (feet)
Tertiary:		
Kirkwood Formation:		
Clay, black	5	30
Vincentown Formation:		
Limesand and foraminifera	10	40
Shell layer of Gryphaea, Terebratula, and other fossils	10	50
Hornerstown Sand:		
Greensand, marl, pure, very dark	30	80
Cretaceous:		
Navesink Formation:		
Marl, greensand; lighter green than above; mixed with light-gray clay; belemnites at about 90 feet	10	90
Mount Laurel Sand and Wenonah Formation:		
Sand, slightly clayey, yellowish-gray; 1/3 greensand and 2/3 white quartz; containing belemnites and molluscan fossils; water-bearing	45	135
Sand, black and white, clear; with belemnitella, Terebratula and other fossils; water-bearing	25	160
Marshalltown Formation:		
Greensand, clayey, and molluscan fossils	10	170
Clay, sandy, dark; admixture of white quartz and some greensand; contains mollusks, foraminifera and other fossils	20	190
Englishtown Formation:		
Sand, mixture of white quartz and some greensand, greenish gray; fossiliferous as above and slightly water bearing	20	210
Woodbury Clay:		
Clay, micaceous, dark, very slightly greenish; containing Gryphaea and belemnitella(?) 240-250 feet	40	250
Clay, micaceous, almost black; yellow pebbles between 270-290; no fossils observed	40	290
Merchantville Formation:		
Clay, greenish; with molluscan fossils from 290-300 feet and nodules from 290-310 feet	40	330
Magothy Formation:		
Sand, medium-coarse, gray or bluish-white, water-bearing	30	360

Table 7.—Logs of selected wells in Salem County—Continued.

Well 56: Woodstown Water Department, No. 1.

Location: West Avenue, Woodstown.

Remarks: Land surface altitude, 45 feet.

	Thickness (feet)	Depth (feet)
Undifferentiated:		
Surface to 353 feet (308 feet below mean sea level), similar to well 55	353	353
Cretaceous:		
Raritan Formation:		
Sand, and red clay, mixed	113	466
Sand, shell, and fine gravel	9	475
Clay, red	15	490
Gravel, sand, and clay, mixed	27	517
Boulders	4	521
Sand, gravel, clay, and boulders, mixed	13	534
Clay, red	3	537
Sand and gravel streaks	24	561
Sand, coarse, gravel, and boulders	27	588
Clay	38	626
Sand, coarse, and gravel	21	647
Sand, gravel, and clay	20	667
Sand, coarse, and gravel	39	706

Well 59: City of Salem Water Department, Layne Test 1935.

Location: Salem at Market and Broadway.

Remarks: Land surface altitude, 17 feet. Drilled by rotary method. Log adapted from data supplied by the driller and M. E. Johnson, the former New Jersey State Geologist.

Quaternary:		
Cape May Formation:		
Gravel, medium to coarse, and yellow sand	21	21
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Glauconite, with little quartz	39	60

Table 7.—Logs of selected wells in Salem County—Continued.

Well 59—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Glauconite and medium to coarse quartz sand	11	71
Glauconite and medium to coarse grained quartz; some shell fragments	11	82
Glauconite and quartz (40-60 ratio), fine to medium grained; shell fragments	21	103
Glauconite and quartz (25-75 ratio), fine to medium grained; shell fragments	22	125
Sand, fine to coarse, quartz, and some fine glauconite	30	155
Marshalltown Formation:		
Sand, clayey, fine, glauconitic	31	186
Woodbury Clay:		
Clay, gray	80	266
Merchantville Formation:		
Sand, fine and coarse, slightly clayey, glauconitic ..	5	271
Clay, sandy, glauconitic, micaceous, dark gray ...	21	292
Clay, gray, and fine glauconitic sand	43	335
Magothy Formation:		
Gravel, fine to coarse, light-gray; slightly glauconitic sand	26	361
Clay, micaceous, dark-gray	17	378
Raritan Formation(?):		
Sand, fine to coarse, light-gray, and slightly glauconitic; small pebbles	49	427
Raritan Formation:		
Clay, pink and gray, and some medium sand	56	483
Sand, fine to medium, light-gray and slightly glauconitic; a few small pebbles	86	569
Clay, pink and gray	21	590
Sand, fine and coarse, light gray	47	637
Clay, pink and gray, and sand, mixed	22	659
Sand, fine to coarse, white	4	663
Clay, sandy, pink and gray	4	667
Sand, fine to coarse, light-gray; small pebbles (water bearing, salty, static water level ± 15′).	69	736

Table 7.—Logs of selected wells in Salem County—Continued.

Well 59—continued

	Thickness (feet)	Depth (feet)
Cretaceous—continued		
Raritan Formation—continued		
Clay, red and gray	268	1,004
Sand, fine to medium, pink; scattered black and red grains; little pyrite	21	1,025
Clay, red and gray, and some sand	33	1,058
Sand, medium to coarse, light-gray	15	1,073
Clay, white, red, and gray	119	1,192
Sand, muddy, fine to medium	41	1,233
Sand, well rounded quartz, fine; a little pyrite; some red and brown grains	22	1,255
Sand, muddy, fine to medium	43	1,298
Sand, fine to medium, pink (Driller first noted bits of "shale" at 1,300 feet)	27	1,325
Sand, fine to medium-grained, light pink	38	1,363
Sand, slightly muddy, medium-grained quartz, light-pink; few grains hard gray clay or soft shale	13	1,376
Late Precambrian(?):		
Wissahickon Formation:		
Quartz grains, angular, and large red and light gray talcose fragments	34	1,410
Same as above, but harder	30	1,440

Well 64: Melvin Sharp, Jr.

Location: Mannington Township, 2.7 miles SW. of Sharptown.

Remarks: Land surface altitude, 55 feet.

Quaternary:		
Cape May Formation:		
Clay	4	4
Iron sand	1	5
Sand, cream, and small stones	3	8
Iron sand	7	15
Tertiary and Cretaceous (undifferentiated):		
Hornerstown Sand and Navesink Formation:		
Marl clay, medium-green	25	40

Table 7.—Logs of selected wells in Salem County—Continued.

Well 64—continued

	Thickness (feet)	*Depth (feet)*
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Buckshot stone and yellow clay	1	41
Clay, yellow, and fine sand	23	64
Sand, cream	3	67
Sand, burnt-orange, and some clay	11	78
Sand, medium	7	85
Sand, cream	5	90
Sand, medium-coarse, gray-black; irony water	2	92
Sand, light-gray, and gray clay	50	142
Marshalltown Formation:		
Sand, clayey, gray	19	161
Rock layer	1	162
Marshalltown and Englishtown Formations (undifferentiated):		
Clay, black; mixed with dark sand; water bearing	25	187
Englishtown Formation:		
Sand	1	188
Woodbury Clay:		
Clay, dark	16	204

Well 77: Mannington Township Elementary School No. 2.
Location: Mannington Township, 3.0 miles NE. of the City of Salem.
Remarks: Land surface altitude, 25 feet.

Quaternary:		
Cape May Formation:		
Sand	18	18
Sand and gravel	15	33
Tertiary(?) and Cretaceous:		
Hornerstown Sand(?) and Navesink Formation:		
Clay, brown and black sand	10	43
Shells	2	45
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Belemnite sand	47	92
Clay and sand	1	93

Table 7.—Logs of selected wells in Salem County—Continued.

Well 89: W.C.A. Costillo, No. 2.

Location: Pilesgrove Township, 3.9 miles NNE. of Pittsgrove.

Remarks: Land surface altitude, 132 feet.

	Thickness (feet)	*Depth (feet)*
Quaternary and Tertiary(?):		
No record, open well	15	15
Tertiary:		
Kirkwood Formation:		
Clay	87	102
Vincentown Formation:		
Limestone and limesand	44	146
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Marl	46	192
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Sand, belemnite, and marl	33	225
Sand, belemnite strata	27	252

Well 95: C. Courtney Seabrook.

Location: Upper Pittsgrove Township, 1 mile NW. of Daretown.

Remarks: Land surface altitude, 144 feet. Top 35 feet was an open well.

Quaternary and Tertiary(?):		
No record	35	35
Tertiary:		
Kirkwood Formation:		
Sand, fine, yellow	17	52
Clay, black	111	163
Manasquan and Vincentown Formations (undifferentiated):		
Marl and clay	67	230
Vincentown Formation:		
Limestone and limesand	30	260
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Marl and shells	40	300
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Belemnite strata	36	336

Table 7.—Logs of selected wells in Salem County—Continued.

Well 98: Daretown Public School.

Location: Upper Pittsgrove Township at Daretown.

Remarks: Land surface altitude, 133 feet. Log adapted from the driller's record and gamma-ray log.

	Thickness (feet)	*Depth (feet)*
Quaternary and Tertiary:		
Undifferentiated:		
Gravel, orange	8	8
Sand, fine to medium, orange	17	25
Mud, orange	23	48
Tertiary:		
Kirkwood Formation:		
Clay, black to gray	60	108
Clay, grayish-green to brown	8	116
Clay, light-gray	18	134
Clay, khaki colored; seashells	3	137
Clay, dark brown	32	169
Manasquan Formation:		
Clay, chartruese; some shells	22	191
Manasquan and Vincentown Formations (undifferentiated):		
Clay, dull green, pepper	25	216
Vincentown Formation:		
Clay, light gray, some pepper	31	247
Clay, dark gray, lots of pepper	32	279
Seashells and pepper	14	293
Tertiary and Cretaceous:		
Hornerstown Sand, Navesink Formation, and Mount Laurel Sand (undifferentiated):		
Marl, black	65	358
Cretaceous:		
Mount Laurel Sand, Wenonah and Marshalltown Formations (undifferentiated):		
Sand, grayish-green, with black marl	82	440
Marshalltown Formation:		
Clay, black	1	441

Table 7.—Logs of selected wells in Salem County—Continued.

Well 107: City of Salem Water Department, Test well 1, 1960.

Location: Salem, on Oak Street near city limits.

Remarks: Land surface altitude, 7 feet.

	Thickness (feet)	*Depth (feet)*
Quaternary and Tertiary:		
Undifferentiated:		
Clay, brown	2	2
Clay, sandy, gray	4	6
Sand, fine to coarse, brown	11	17
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Pepper sand, black and brown, fine to coarse	1	18
Pepper sand	13	31
Pepper sand and stringers of white sand	10	41
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Pepper sand and seashells	5	46
Pepper sand, and fine white sand	7	53
Sand, fine to coarse, gray	5	58
Sand, very silty; some coarse and fine sand mixed, gray; gray clay and seashells	47	105
Sand, very silty, cemented, gray and green; very hard at 144 feet	45	150
Marshalltown Formation and Woodbury Clay (undifferentiated):		
Clay, blue, and some small sand stringers	40	190
Woodbury Clay:		
Clay, blue	25	215

Well 111: City of Salem Water Department, Quinton 1892.

Location: Quinton Township at pumping station, NW. part of Laurel Lake, Quinton.

Remarks: Land surface altitude, 10 feet. Well not in use, filled in to 140 foot depth. Log adapted from New Jersey Geological Survey Annual Report for 1893, p. 415-416.

Quaternary:		
Undifferentiated:		
Soil	1	1
Gravel	3	4

Table 7.—Logs of selected wells in Salem County—Continued.

Well 111—continued

	Thickness (feet)	Depth (feet)
Tertiary:		
Kirkwood Formation:		
Clay and shells *(Lucina contracta, Yoldia limatula, Corbula elevata, Astaste undulata, Turritella pleibeia)*	26	30
Manasquan Formation:		
Marl, clayey and sandy, green and white; includes a considerable mixture of foraminifera	8	38
Vincentown Formation:		
Limesand and limerock, alternating; contains Bryozoa, foraminifera and coral	108	146
Clay (with Globegerina and Terrebratula(?))	2	148
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Greensand marl and shell	14	162
Clay	4	166
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Sand, quartz, gray; water bearing	82	248

Well 114: Camp Roosevelt, Boy Scouts of America.

Location: Alloway Township, 2.5 miles SW. of Daretown at Watson's Mills.

Remarks: Land surface altitude, 69 feet.

Undifferentiated:		
Unreported	3	3
Tertiary:		
Kirkwood Formation:		
Clay, gray, and some fine sand	17	20
Clay, light-gray	10	30
Clay, light-gray with pink streaks	40	70
Clay, gray	20	90
Clay, little glauconite and slightly greenish	20	110
Manasquan Formation:		
Clay, more glauconite and greenish	20	130
Clay, little less glauconite	20	150
Clay, little less glauconite, light gray and greenish	20	170

Table 7.—Logs of selected wells in Salem County—Continued.

Well 114—continued

	Thickness (feet)	Depth (feet)
Tertiary—continued		
Vincentown Formation:		
Clay, glauconitic, gray and slightly greenish	20	190
Sand, clay, glauconite and little mica	40	230
Sand, quartz, clayey and glauconite	10	240
Tertiary and Cretaceous:		
Hornerstown Sand and Navesink Formation:		
Glauconite, some quartz and clay	40	280
Cretaceous:		
Mount Laurel Sand and Wenonah Formation:		
Sand, medium to coarse, quartz and glauconite, yellow and green	10	290
Sand, fine to coarse, quartz and glauconite, yellow and green	15	305

Well 119: Warren Cobb.

Location: Alloway Township, 3 miles SE. of Alloway at Cobbs Mill Lake.

Remarks: Land surface altitude, 60 feet.

Quaternary:		
Cape May Formation:		
Sand and gravel	4	4
Tertiary:		
Kirkwood Formation:		
Clay, black	44	48
Clay, gray	38	86
Clay, black	62	148
Manasquan and Vincentown Formations (undifferentiated):		
Marl, shells and clay, black	52	200
Vincentown Formation:		
Clay, gray, and some marl	96	296
Tertiary and Cretaceous:		
Vincentown, Hornerstown Sand and Navesink Formations (undifferentiated):		
Marl, shells, and clay	60	356
Cretaceous:		
Mount Laurel Sand:		
Belemnite strata	24	380

Table 7.—Logs of selected wells in Salem County—Continued.

Well 136: Raymond M. Sickler.
Location: Upper Pittsgrove Township, 4.0 miles E. of Woodstown.
Remarks: Land surface altitude, 145 feet.

	Thickness (feet)	*Depth (feet)*
Quaternary:		
Bridgeton Formation:		
Sand	25	25
Tertiary:		
Kirkwood Formation:		
Sand and clay	23	48
Kirkwood and Manasquan Formations:		
Clay	138	186
Vincentown Formation:		
Marl	8	194
Limestone and limesand	24	218

Well 138: Roy Dunkelberger.
Location: Alloway Township, 3.2 miles S. of Woodstown.
Remarks: Land surface altitude, 75 feet.

Tertiary:		
Kirkwood Formation:		
Clay, orange, some shells	10	10
Clay, gray, some shells	34	44
Clay, brown, some shells	29	73
Manasquan Formation:		
Clay, grayish-green, some shells	7	80
Vincentown Formation:		
Sand, and seashell formation, gray	64	144

Table 7.—Logs of selected wells in Salem County—Continued.

Well 139: Howard H. Kirby.

Location: Pilesgrove Township, 2.9 miles NW. of Daretown and 6.0 miles NE. of Alloway.

Remarks: Land surface altitude, 140 feet. Log adapted from sample analyses by R. Mayer, Geologist, New Jersey Geological Survey, and driller's log.

	Thickness (feet)	*Depth (feet)*
Quaternary:		
Bridgeton Formation:		
Sand and gravel	10	10
Clay, yellow	1	11
Sand, quartz, rounded to sub-rounded; few quartz pebbles; ironstained	15	26
Quaternary and Tertiary:		
Bridgeton and Kirkwood Formations:		
Sand, quartz, coarse-grained, rounded to sub-rounded, yellowish-white; rounded quartz pebbles; mica and heavy minerals; some brown clay; brownish-orange color	22	48
Tertiary:		
Kirkwood Formation:		
Clay, hard, light-gray; some shell fragments; finely micaceous and lignitic	27	75
Clay, dark-brown, lignitic, finely micaceous; numerous shell fragments (pelecypods, gastropods, and foraminifera)	53	128
Vincentown Formation:		
Limestone and limesand, calcareous, light-gray; coarse to medium-grained sand; bryozoa, echinoidea, foraminifera and coral	19	147

Table 7.—Logs of selected wells in Salem County—Continued.

Well 141: Peter F. Gross.

Location: Pilesgrove Township, 2 miles NW. of Daretown and 3 miles WNW. of Pittsgrove.

Remarks: Land surface altitude, 105 feet.

	Thickness (feet)	*Depth (feet)*
Quaternary and Tertiary:		
Undifferentiated:		
Sand and gravel	26	26
Tertiary:		
Kirkwood Formation:		
Clay, gray	54	80
Clay, black	34	114
Manasquan Formation:		
Shells, sand, and marl	31	145
Vincentown Formation:		
Limestone layers, sand, and shells	12	157

Well 161: William L. Holmes.

Location: Alloway Township, 0.8 mile ESE. of Alloway.

Remarks: Land surface altitude approximately 37 feet. Log adapted from data supplied by the New Jersey Geological Survey and the driller.

Tertiary:		
Kirkwood Formation:		
Clay, tough, grayish-yellow (5 Y 8/4); scattered subangular quartz pebbles up to 10mm in diameter	12	12
Clay, silty, tough; color changes from pale greenish yellow (10 Y 8/2) through light gray (N-7) and medium-light gray (N-6). Driller reported it as blue	20	32
Clay, silty, and slightly micaceous; with lignite, subangular quartz and few forams; medium-dark gray (N-4)	8	40
Clay, silty, and slightly micaceous; lignite, subangular quartz and red iron oxide grains, few glauconite grains, foraminifera; medium dark gray (N-4). Driller reported color as dark brown to black	20	60

Table 7.—Logs of selected wells in Salem County—Continued.

Well 161—continued

	Thickness (feet)	Depth (feet)
Tertiary—continued		
Manasquan Formation:		
Sand, glauconitic (60 percent); fine to 5mm but mostly medium to coarse grained, subangular quartz; forams, pyrite, muscovite, and a black vitreous nonmagnetic mineral. Color is a mottled light-olive gray (5 Y 6/1) and dusky green (5 G 3/2)	10	70
Sand, glauconitic (80 percent); fine to 2mm but mostly medium grained, subangular green stained quartz; few forams, tourmaline, and muscovite. Color is dusky green (5 G 3/2)	20	90
Sand, glauconitic (50 percent); fine to 4mm mostly medium to coarse, subangular, quartz grains; pyrite, muscovite, and a few large forams. Color is grayish green (5 GY 6/1) to a mottled dusky green (5 G 3/2) and yellowish gray (5 Y 8/1)	24	114
Vincentown Formation:		
Sand, glauconitic (25 percent to 15 percent at 130 feet); very fine to 5mm, mostly medium to coarse, subangular quartz grains; lime nodules, forams, echinoid spines, and pyrite. Color of sand is greenish gray (5 GY 6/1); nodules are light-greenish gray (5 GY 8/1) but weather to grayish yellow (5 Y 8/4)	38	152
Marl, composed of 90 percent shell fragments, bryozoa, echinoid spines, and forams, with fine grained quartz sand, subangular and clean; glauconite and limestone layers as thick as 6 inches; yellowish-gray (5 Y 8/1) color	18	170
Sand, very fine to 3mm, mostly medium to coarse, subangular, quartz grains; marly with glauconite (20 percent); abundant forams, bryozoa, echinoid spines and pelecypod fragments (30 percent); rock layers as thick as 5 inches mottled with yellowish gray (5 Y 8/1) and dusky-green (5 G 3/2) color	8	178

Table 7.—Logs of selected wells in Salem County—Continued.

Well 168: Fred Cooper.

Location: Pittsgrove Township, 2.1 miles NNW. of Centerton.

Remarks: Land surface altitude, 110 feet. Well formerly known as Cooper's Dairy No. 3.

	Thickness (feet)	*Depth (feet)*
Quaternary:		
Bridgeton Formation:		
Sand and gravel	30	30
Tertiary:		
Cohansey Sand and Kirkwood Formation:		
Sand, fine, yellow, and clay	50	80
Kirkwood Formation:		
Clay, black, and sand	10	90
Sand, medium, and shells	11	101

Well 173: Stephen Framer.

Location: Lower Alloways Creek Township, 2.4 miles ENE. of Canton.

Remarks: Land surface altitude, 40 feet.

Quaternary:		
Pleistocene (undifferentiated):		
Sand, quartz, fine to very coarse-grained; some granules and pebbles, dirty and subangular, variegated color. Driller reported gravel and clay	5	5
Tertiary:		
Kirkwood Formation(?):		
Sand, quartz, medium to very coarse-grained, dirty and subangular, dark yellowish orange (10 YR 6/6); becoming clayey, dark yellowish brown (10 YR 4/2) and lignitic at 25 feet	25	30
Kirkwood Formation:		
Clay, light olive gray (5 Y 6/1)	42	72
Sand, clayey; fine to medium quartz grains, dirty and subangular, limonitic stained, light olive gray. Driller reported clay, sand, and shells	8	80

Table 7.—Logs of selected wells in Salem County—Continued.

Well 176: Parvin State Park, PW-B.

Location: Pittsgrove Township, 2.2 miles SE. of Centerton.

Remarks: Land surface altitude, 75 feet. Log adapted from data prepared by N. J. Geological Survey, driller's log and USGS gamma-ray and electric logs.

	Thickness (feet)	*Depth (feet)*
Quaternary:		
Cape May Formation:		
Sand, fine- to very coarse-grained clean quartz, and rounded gravel, yellowish-buff color	6	6
Tertiary:		
Cohansey Sand:		
Sand, medium- to very coarse-grained clean quartz, buff colored, and rounded gravel	11	17
Sand, very fine- to very coarse-grained sand, tan colored; rounded gravel—pebbles as large as 1.5 inches in diameter	8	25
Sand, medium-coarse-grained, round to sub-round quartz, reddish orange color	11	36
Ironstone layer (Jersey stone)	4	40
Clay, buff	2	42
Kirkwood Formation(?):		
Clay, black and reddish brown; dirty fine sand and silt	8	50
Kirkwood Formation:		
Sand, medium-grained, clean, well sorted, subrounded, quartz, light gray	6	56
Clay, silty, gray	4	60
Sand, medium-grained, subrounded quartz; light-gray color	10	70
Hardpan and seams of fine sand consisting of well sorted, subrounded, quartz grains with many pink garnets; slightly lignitic, gray	5	75
Clay, silty, gray	6	81
Sand, medium grained, well sorted; becoming fine grained to silty at 90 feet; gray color	14	95
Clay, silty, gray; much lignite and plant matter	3	98
Clay, reddish-brown, silty; becoming gray below 107 feet; containing up to ¼ inch pebbles near 100 and 110 foot depths	13	111

Table 7.—Logs of selected wells in Salem County—Continued.

Well 176—continued

Tertiary—continued Kirkwood Formation—continued	*Thickness (feet)*	*Depth (feet)*
Sand, medium-grained clean, well sorted, subrounded quartz, light-gray	11	122
Clay, sandy, gray	5	127
Sand, medium-grained, clean, fairly well-sorted; round to subround quartz; red garnets and some lignite; gray color	5	132
Clay, sandy, gray, lignitic	5	137
Sand, medium to very coarse-grained; subrounded to subangular quartz; considerable lignite; little glauconite; red garnets to 148 feet; gray color	17	154
Clay, glauconitic, reddish-brown; some coarse grained sand and gravel	5	159
Clay, silty, finely micaceous, reddish-gray	31	190
Clay, finely micaceous, light gray (green)	20	210

Well 193: Charles Paulaitis No. 4.

Location: Pittsgrove Township, 3 miles SE. of Elmer.

Remarks: Land surface altitude, 120 feet. Drilled with power auger.

Quaternary:		
Bridgeton Formation:		
Sand, medium- to coarse-grained, and gravel, dark-yellowish orange	5	5
Sand, medium-grained, clayey, and gravel, dark-yellowish orange; water at 12.5 feet	10	15
Sand, medium- to coarse-grained, clayey, yellowish-orange	12	27
Clay, white	1	28
Sand, gravel, and cobbles	7	35
No recovery (cobbles?)	5	40
Tertiary:		
Cohansey Sand:		
Sand, medium- to coarse-grained, clayey, dark-yellowish-orange	19	59
Kirkwood Formation:		
Clay, gray	11	70
Clay, tough, dark-gray	7	77

Table 7.—Logs of selected wells in Salem County—Continued.

Well 199: Paul Weininger

Location: Pittsgrove Township, 0.5 mile WNW. of Norma.

Remarks: Land surface altitude, 105 feet.

	Thickness (feet)	*Depth (feet)*
Tertiary:		
Cohansey Sand:		
Sand, coarse-grained, loamy, orange	8	8
Sand, medium-grained, loamy, yellow	18	26
Sand, fine-grained, loamy, yellow	17	43
Sand, medium-grained, yellow	8	51
Sand, coarse-grained, pink	8	59
Sand, coarse-grained, brown and orange; some Jersey stone	17	76
Sand, coarse-grained, orange; becoming loamy	6	82

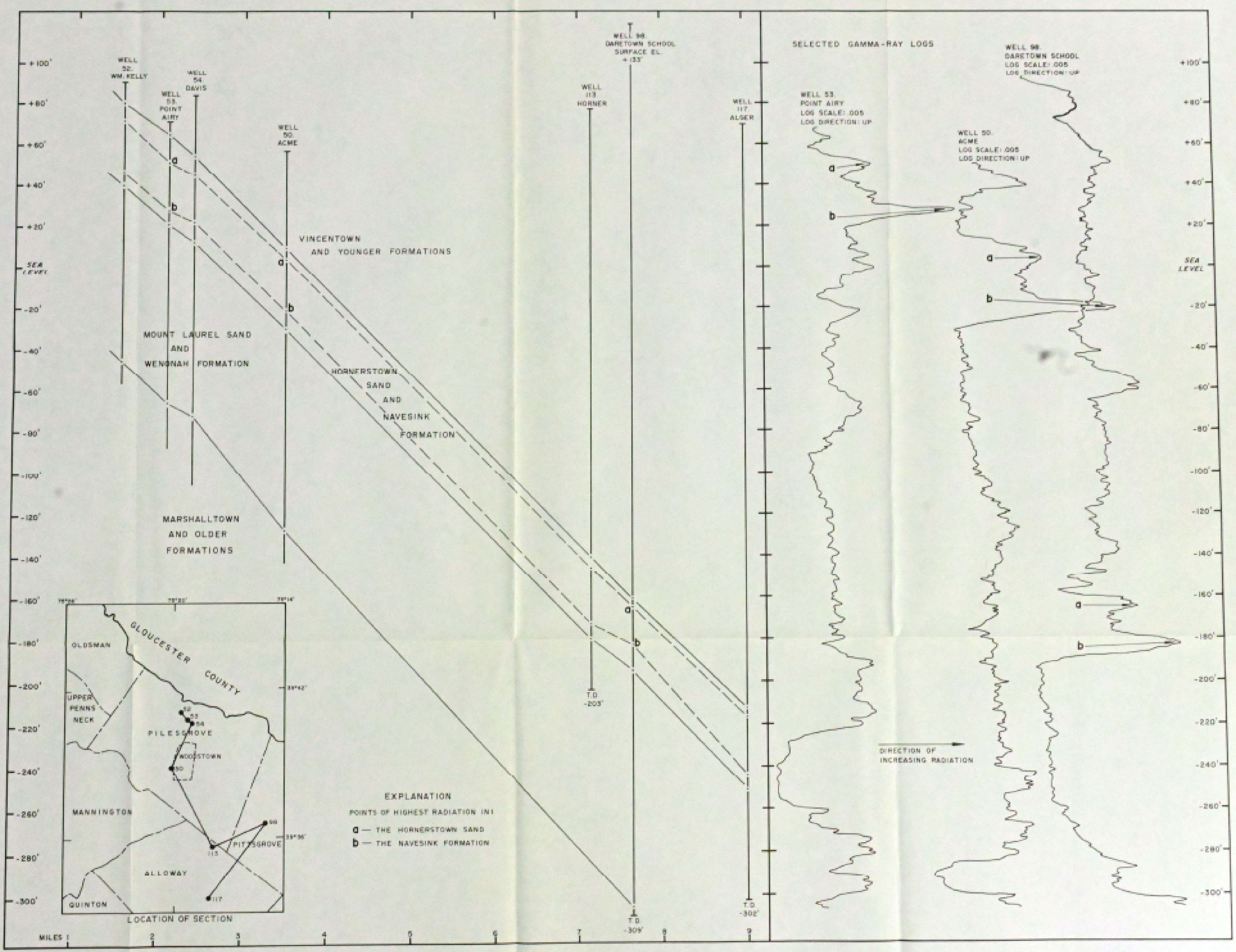
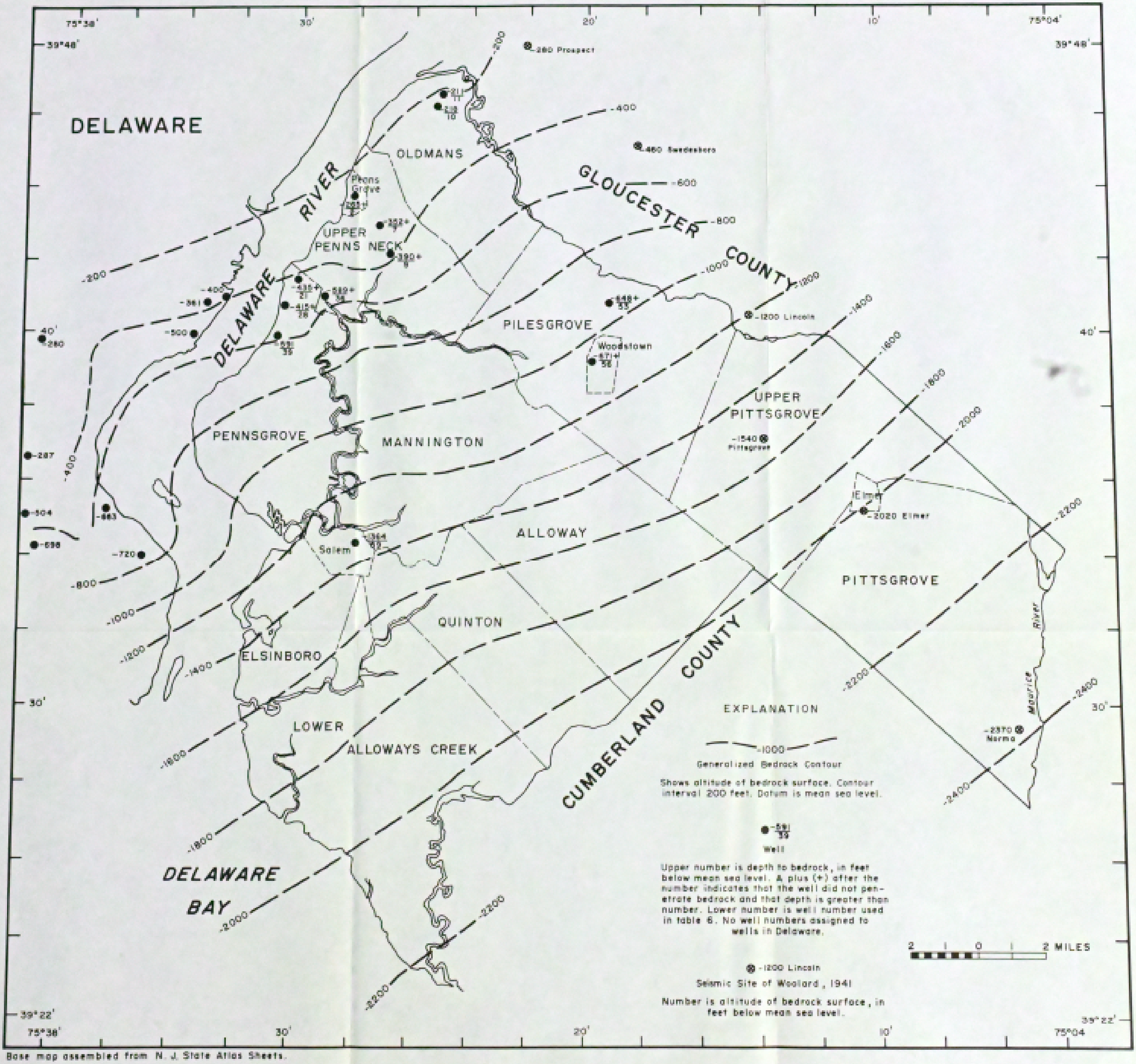


Figure 19.—Geologic section based on gamma-ray logs and selected gamma-ray logs.



Base map assembled from N. J. State Atlas Sheets.

Figure 11.—Configuration of the bedrock surface.

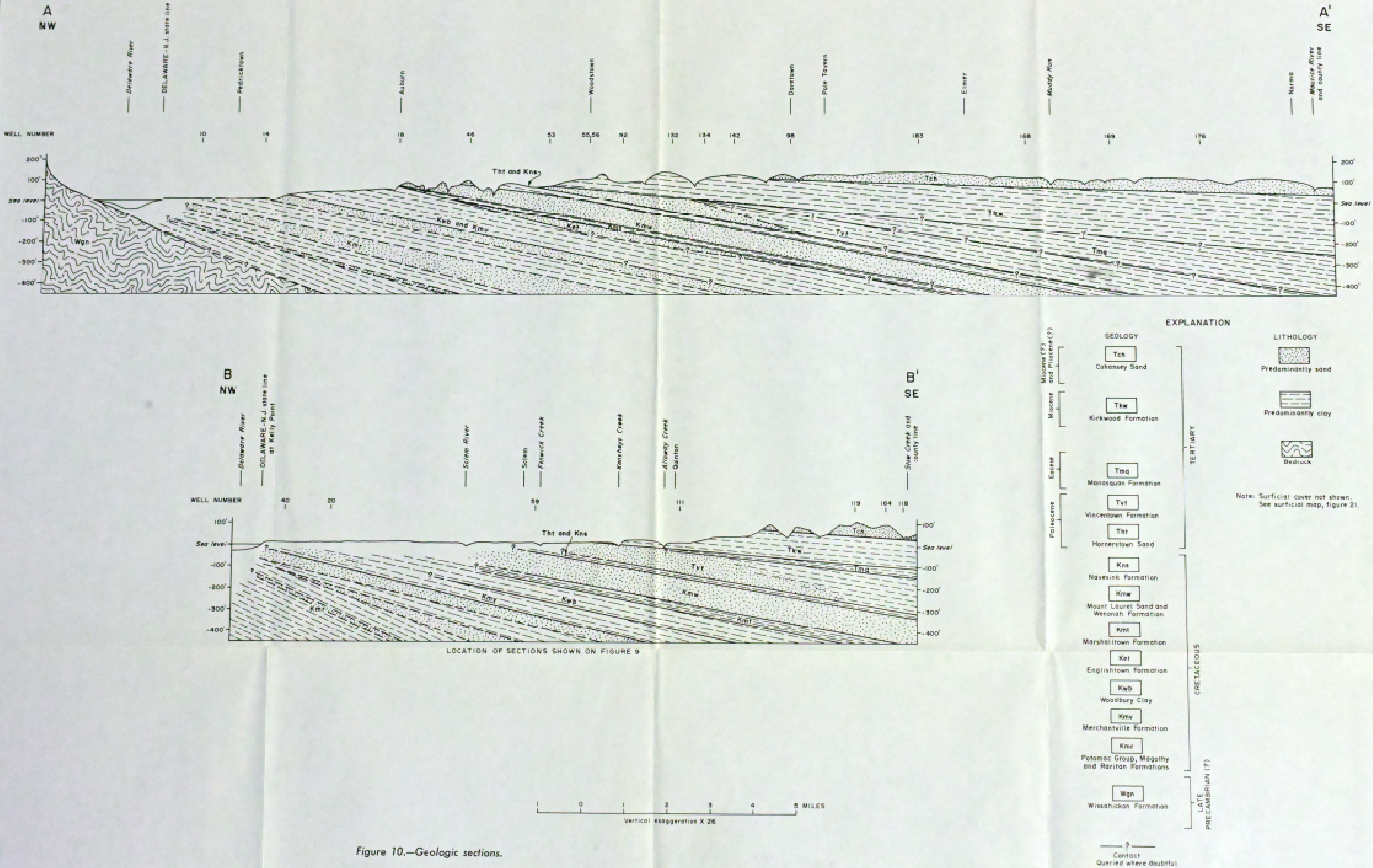


Figure 10.—Geologic sections.

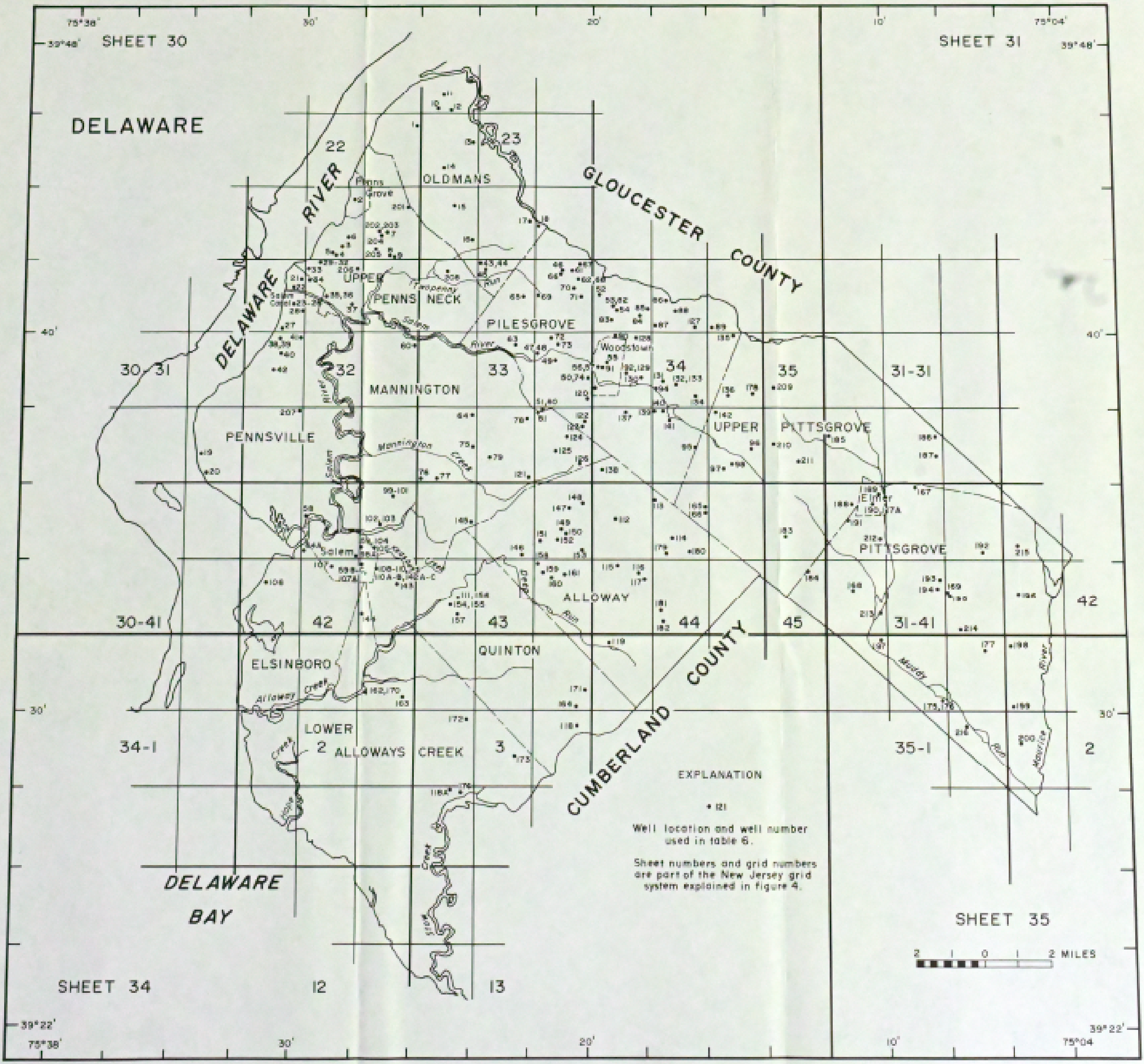


Figure 2.—Location of wells.

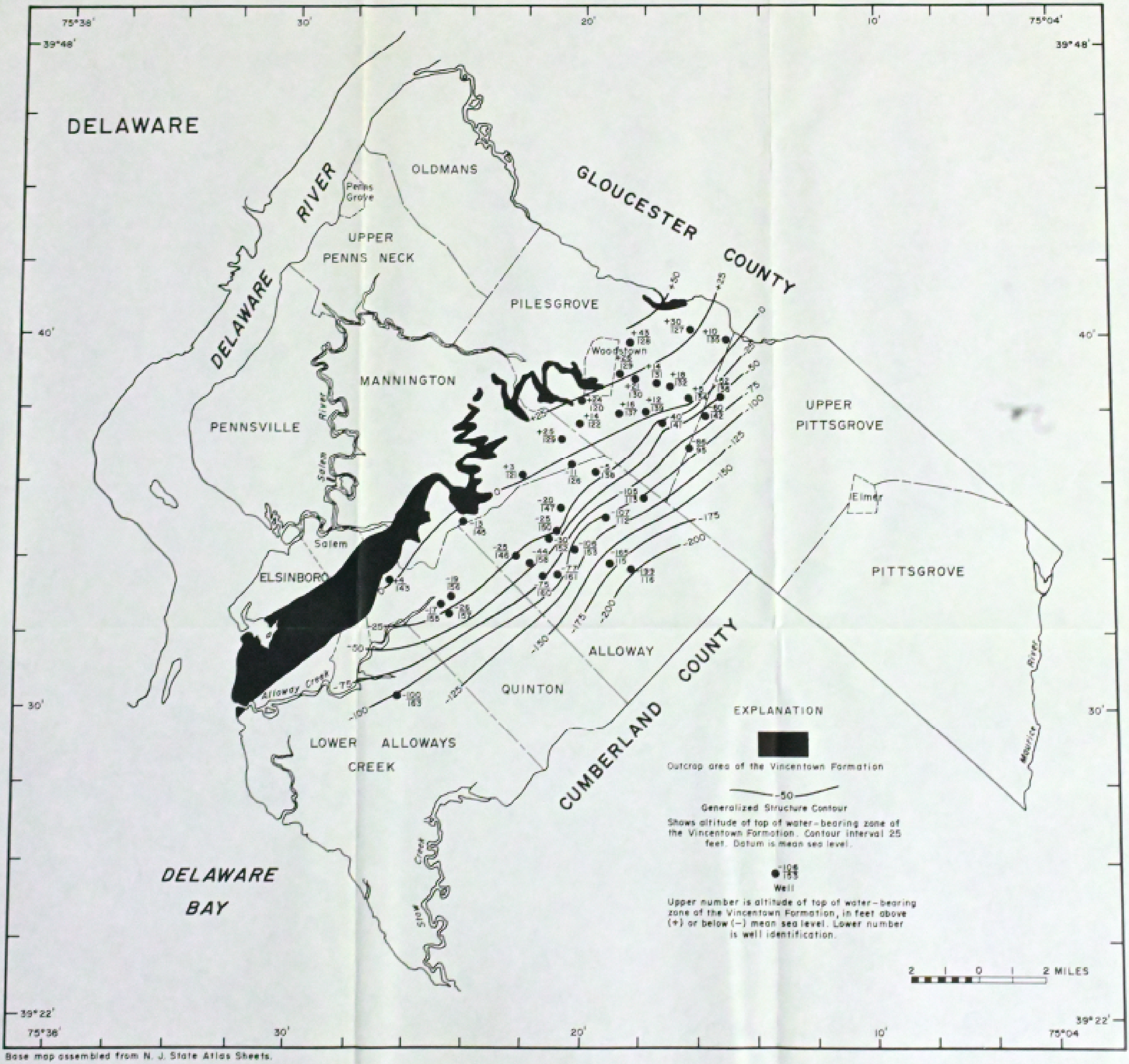


Figure 20.—Structure contours on top of the aquifer of the Vincentown Formation.

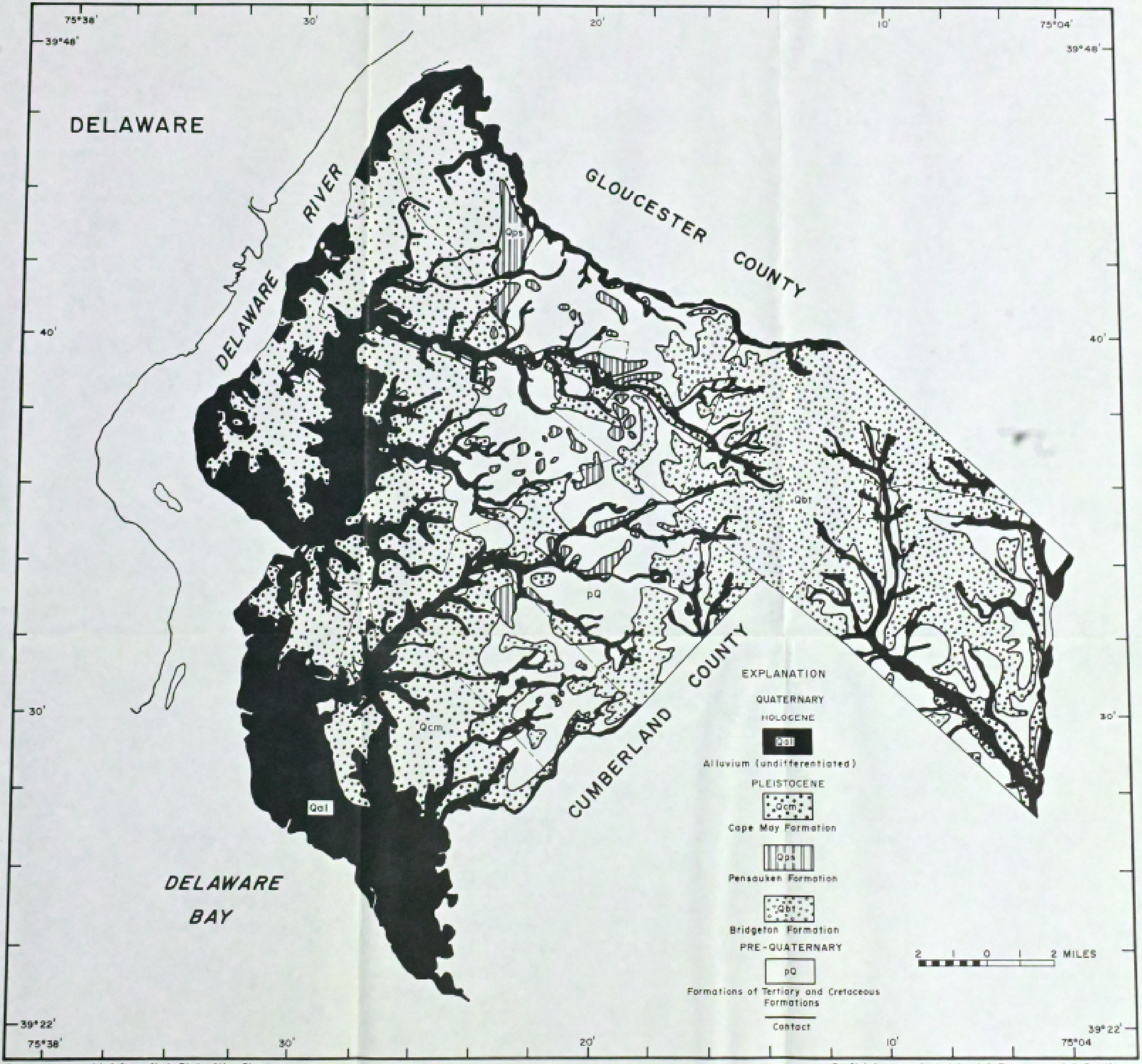


Figure 21.—Generalized surficial geologic map of Salem County.

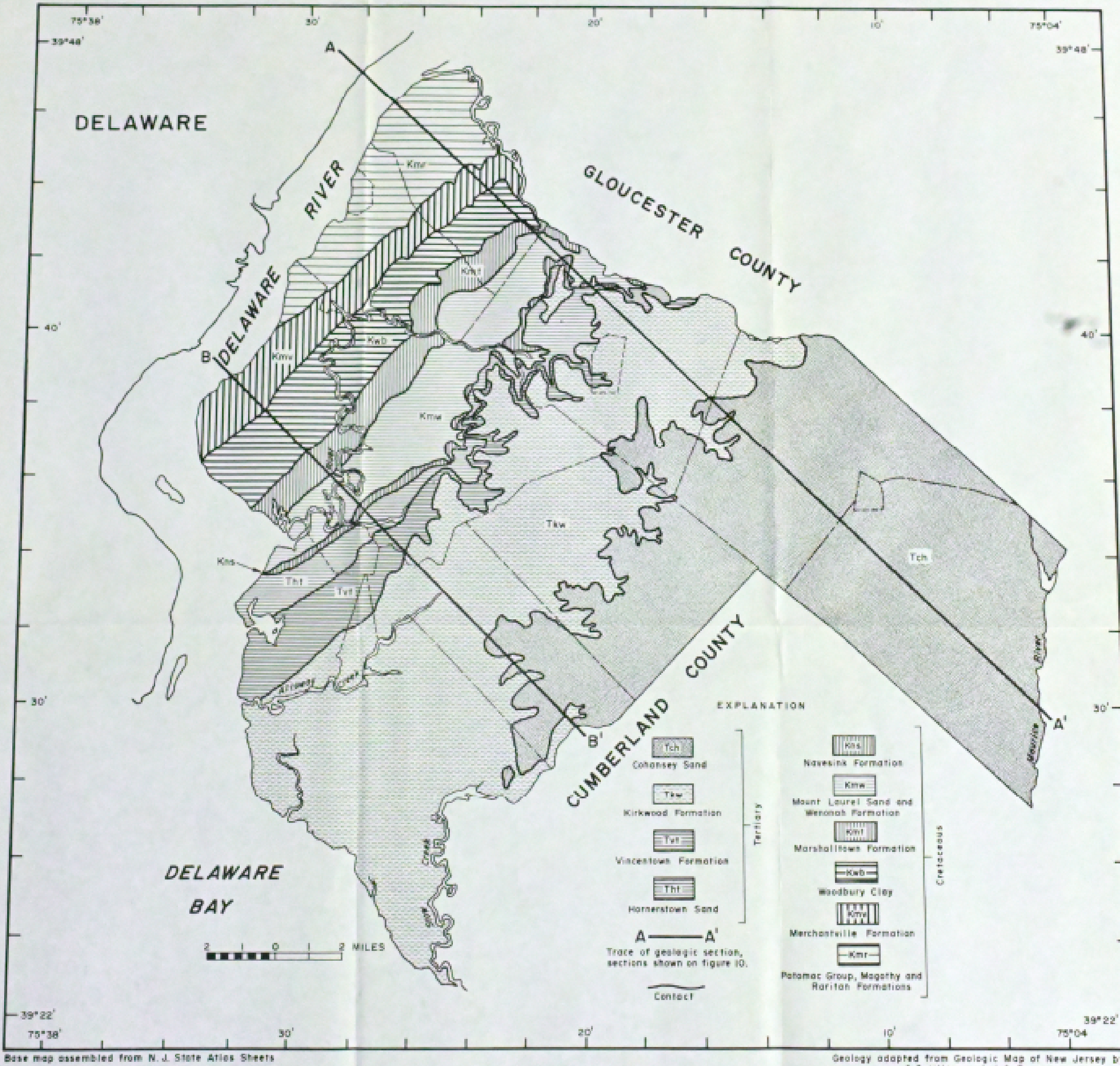


Figure 9.—Pre-Quaternary geology.

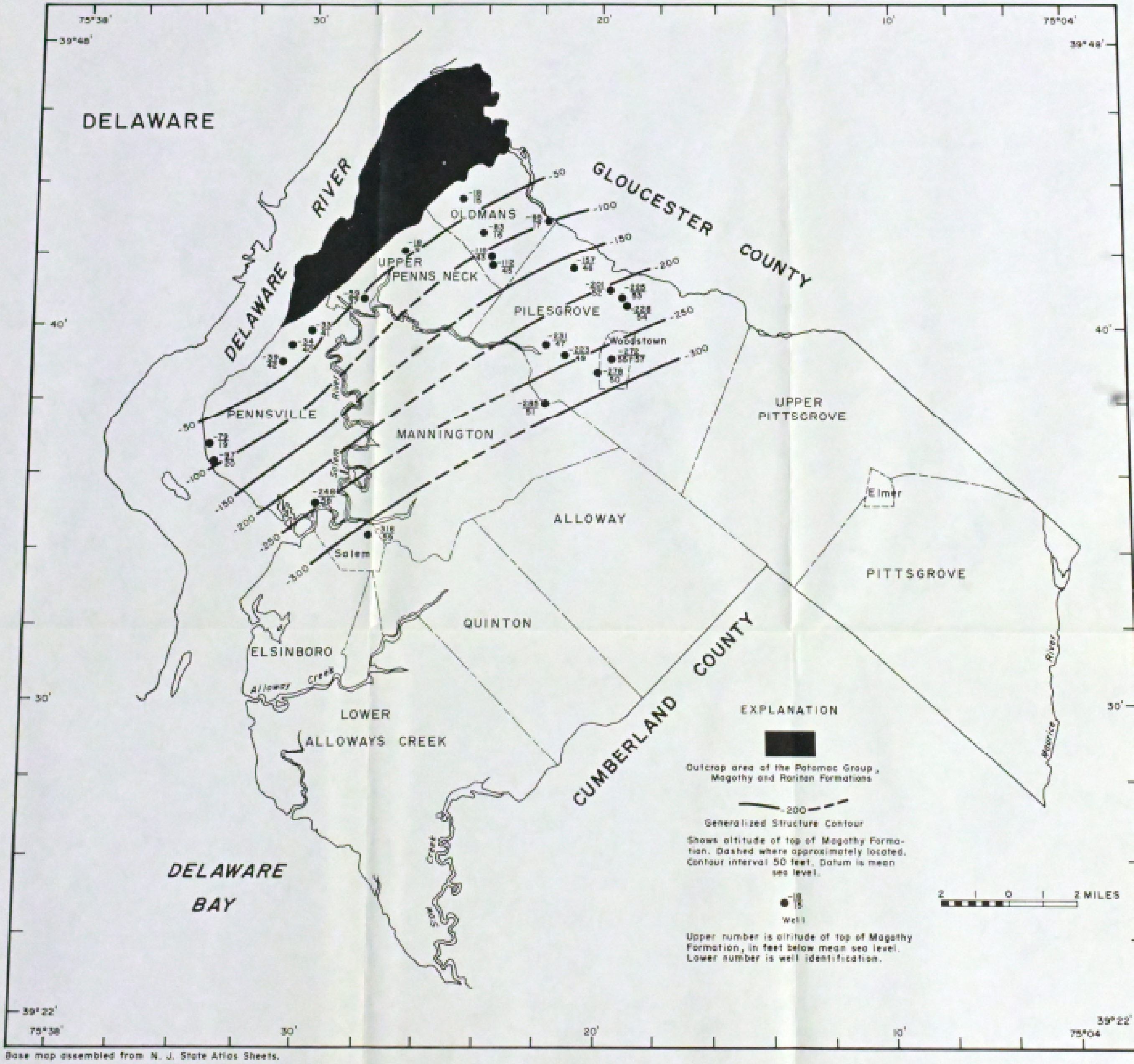
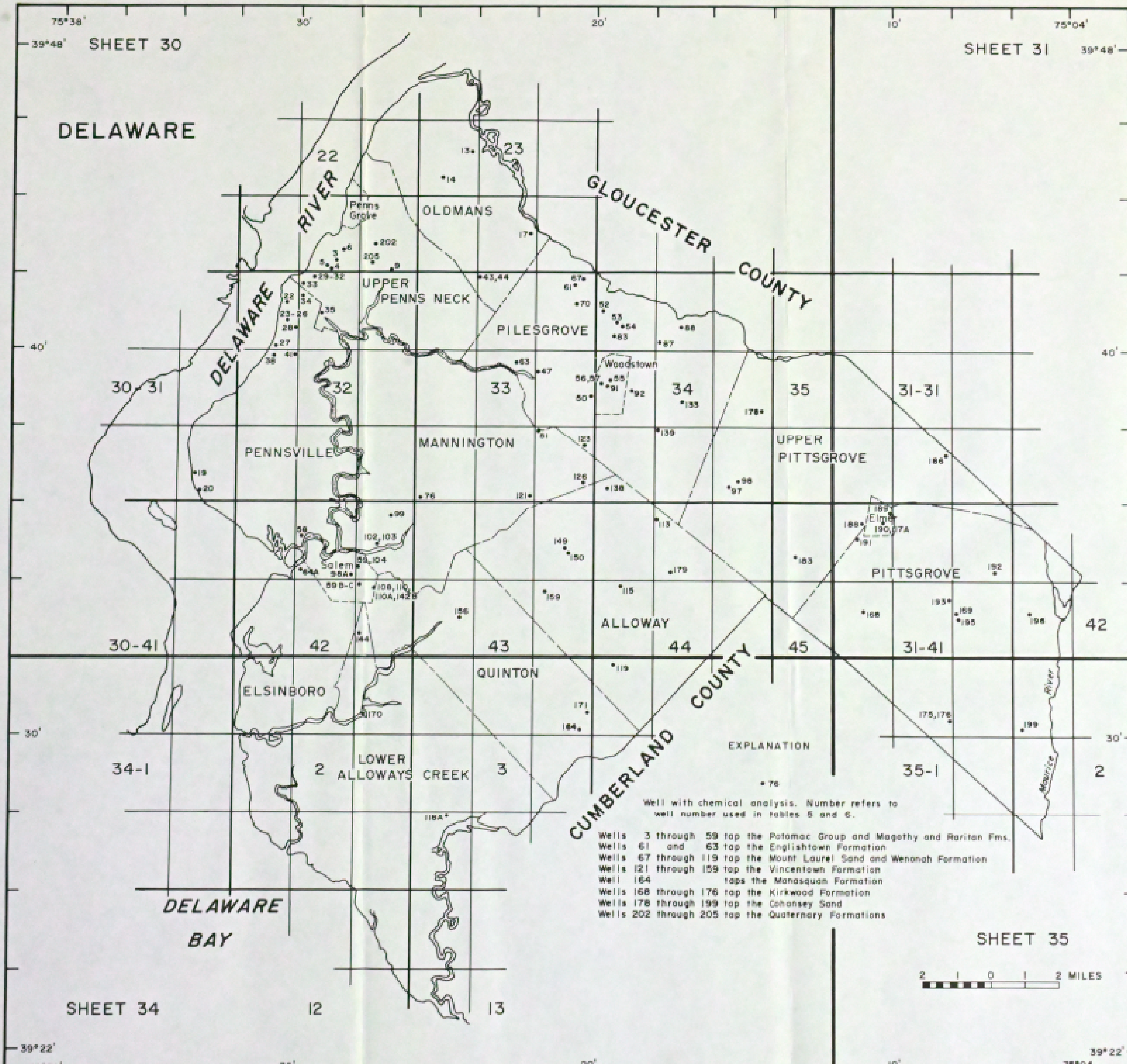


Figure 12.—Structure contours on top of the Magothy Formation.



Base map assembled from N. J. State Atlas Sheets

Figure 3.—Location of wells for which quality of water data are available.

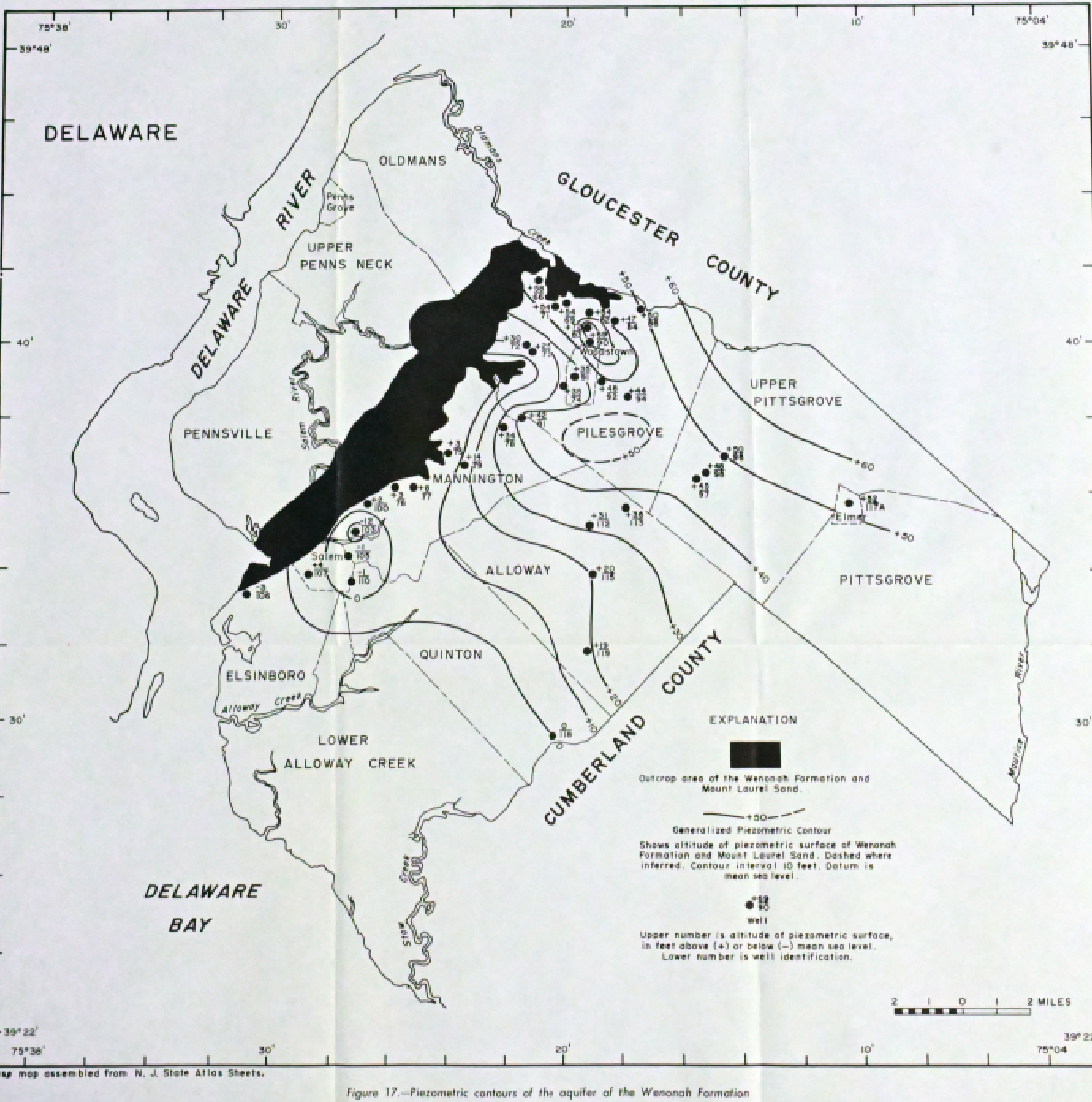
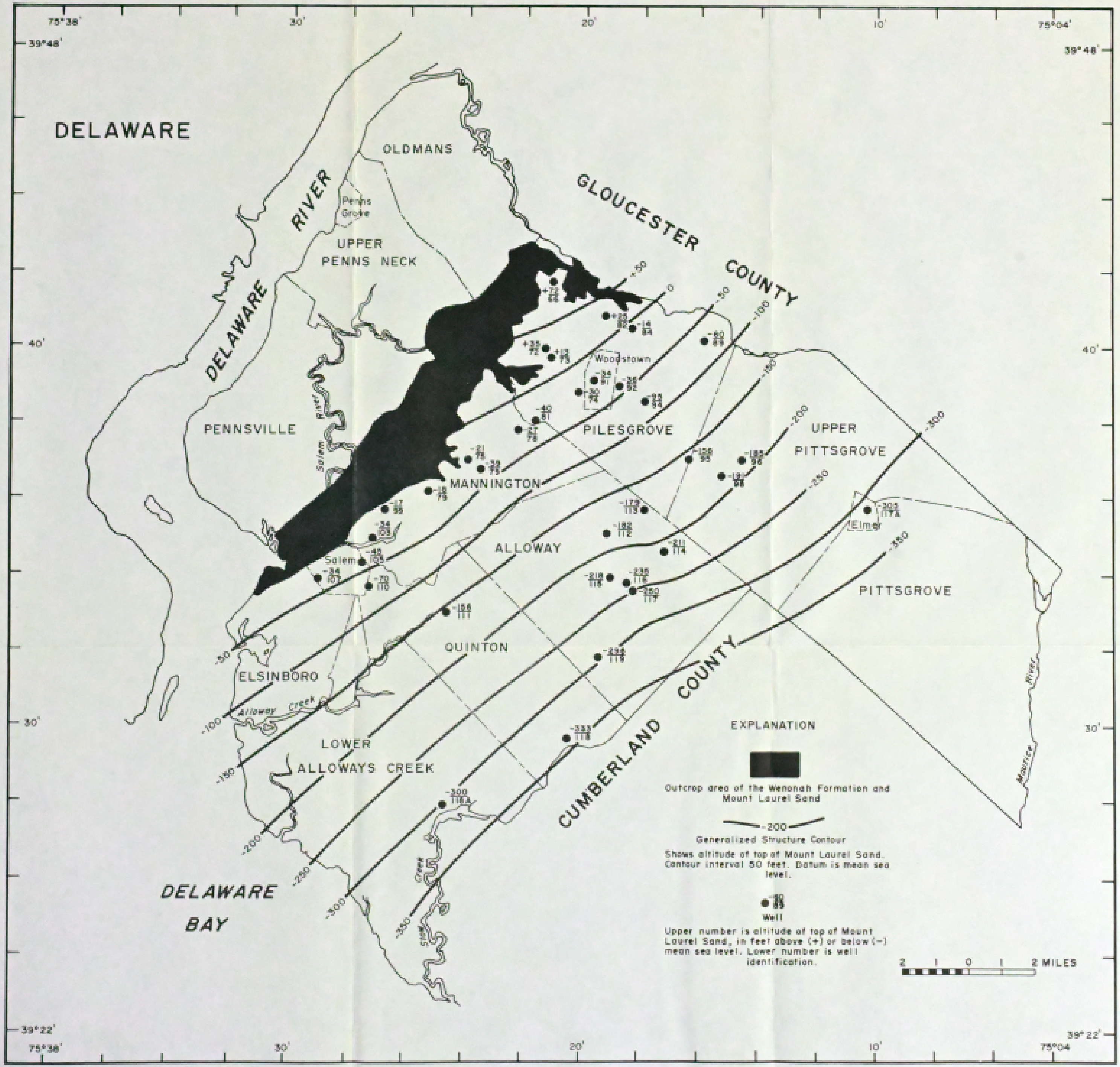
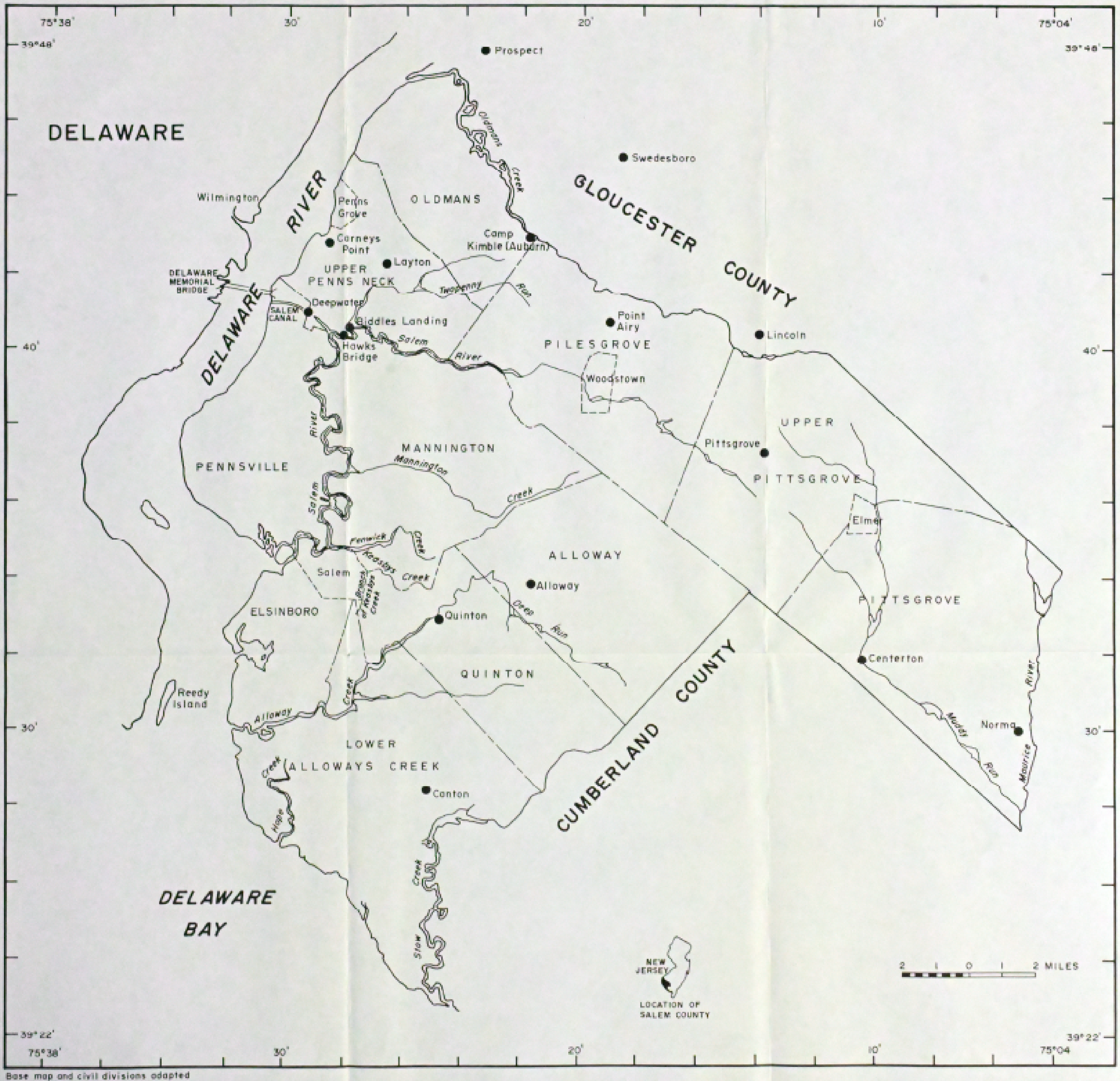


Figure 17.—Piezometric contours of the aquifer of the Wenonah Formation and Mount Laurel Sand.



Base map assembled from N. J. State Atlas Sheets.

Figure 14.—Structure contours on top of the Mount Laurel Sand.



Base map and civil divisions adapted from N.J. State Atlas Sheets.

Figure 1.—Civil divisions and important place names.