APPRAISAL OF WATER RESOURCES IN THE HACKENSACK RIVER BASIN, NEW JERSEY

By L. D. Carswell

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CONVERSION FACTORS

Factors for converting English units to metric units are shown to four significant figures. However, in the text the metric equivalents are shown only to the number of significant figures consistent with the values for the English units.

English	Multiply by	Metric
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (l)
gallons per minute (gpm)	.06309	liters per second (l/s)
gallons per minute per foot (gpm/ft)	.2069	liters per second per meter [(l/s)/m]
million gallons per day (mgd)	.04381	cubic meters per second (m^3/s)
inches (in)	25.4	millimeters (mm)
miles (mi)	1.609	kilometers (km)
square miles (sq mi)	2.590	square kilometers (km^2)
acres	.4047	hectares (ha)
cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)

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By Louis D. Carswell

ABSTRACT

The Hackensack River basin, in the northern part of the New Jersey-New York metropolitan area, includes some of the most highly urbanized areas in the United States as well as a largely undeveloped 23.4 square mile area of tidal marsh referred to as the Hackensack Meadows.

Bedrock in the Hackensack River basin, consisting of the Newark Group of Triassic age, is composed of diabase dikes and sills and gently westward dipping sandstone, conglomerate, and shale. The Brunswick Formation of the Newark Group is the only important bedrock aquifer in the basin. Water occurs in this aquifer in joints and fractures. The zone of most abundant and largest water-bearing joints and fractures occurs generally within 200 feet of land surface in lowland areas of major streams and within 400 to 500 feet of land surface in upland areas.

Reported yields of industrial and public-supply wells tapping the Brunswick are as much as 600 gpm (gallons per minute): the median yield is 100 gpm. The formation is anisotropic; the greatest permeability and thus the movement of water in response to pumping are parallel to the strike of bedding. Therefore, wells in well fields alined perpendicular to strike have minimum interference.

The Newark Group is overlain by unconsolidated deposits of till, varved silt and clay, alluvium, and sand and gravel of Quaternary age. Sand and gravel aquifers consist of (1) deltaic deposits formed at the mouths of streams that entered ancient Lake Hackensack in the western part of the basin and (2) valley-fill deposits along the eastern side of the basin. These aquifers locally yield large quantities of water (greater than 300 gpm) to wells.

The chemical quality of water in the Brunswick Formation is generally good, and the water is relatively low in dissolved mineral matter in the upper area of the Hackensack River basin. In the lower area of the basin, water in the Brunswick is highly mineralized: specific conductance ranges from 579 to 3,480 micromhos per centimeter at 25°C; chloride content ranges from 19 to 755 mg/l (milligrams per

liter); and sulfate content ranges from 87 to 966 mg/l. Chemical quality in both the Brunswick Formation and the unconsolidated deposits in the lower area is affected by induced recharge of poor quality surface water from the Hackensack River and Newark Bay. Water quality in these surface water bodies is influenced by tidal flooding and by the disposal of an average of 57 mgd (million gallons per day) of sewage and industrial wastes in the Hackensack Meadows.

Future development of ground-water supplies in the upper area of the basin is restricted, because such development would decrease surface-water supplies which are almost entirely utilized for water supply. Additional development of ground water in the lower area of the basin is limited by the small amount of ground water in the basin and by the intrusion of highly mineralized surface water into the aquifers.

INTRODUCTION

Purpose and Scope

This study is one of a series of investigations of the ground-water resources of New Jersey made as a result of the Water Supply Act of 1958 and its companion Water Bond Act. The purpose of the study was to assemble data on the occurrence, movement, availability, and chemical quality of ground water in the Hackensack River basin in Bergen and Hudson Counties, New Jersey; to evaluate and interpret the data; and to make the results available to the public.

The study was made by the U. S. Geological Survey in cooperation with the New Jersey Department of Environmental Protection, Division of Water Resources. The investigation was partly supported by the U. S. Army Corps of Engineers who requested information on the ground-water resources of the Hackensack River basin, as a part of the Corps' comprehensive reclamation and development study of the Hackensack Meadows area. The Hackensack Meadows area has been the focus of repeated reclamation studies, as it constitutes one of the few remaining large undeveloped areas in the northern New Jersey-New York metropolitan area.

The investigation was begun by John Vecchioli and continued by the author under the general supervision of Allen Sinnott, former District Geologist of the Ground Water Branch, and John E. McCall and Harold Meisler, consecutive District Chiefs, Water Resources Division.

Location and Extent of Area

The Hackensack River basin is mainly in Hudson and Bergen Counties in northeastern New Jersey, but the headwaters extend northward into Rockland County, N. Y. (fig. 1). The basin is in the northern half of the New York-New Jersey metropolitan area. This report describes the hydrologic conditions in the part of the basin that is in New Jersey (fig. 1). Political subdivisions, the drainage network, and the location of selected wells in the basin are shown on figure 2. The basin is 4 to 7 miles wide and approximately 34 miles long. The total drainage area of the Hackensack River basin is 202 square miles. The New Jersey part of the basin has an area of 139 square miles, including about 23 square miles of tidal marsh, commonly referred to as the Hackensack Meadows, which extends 10 miles upstream from Newark Bay.

Previous Investigations

Previous investigations of the ground-water conditions in the Hackensack River basin include a study by Perlmutter (1959) of the upper third of the basin in Rockland County, New York; a report on the present and future water supply of Bergen County, New Jersey

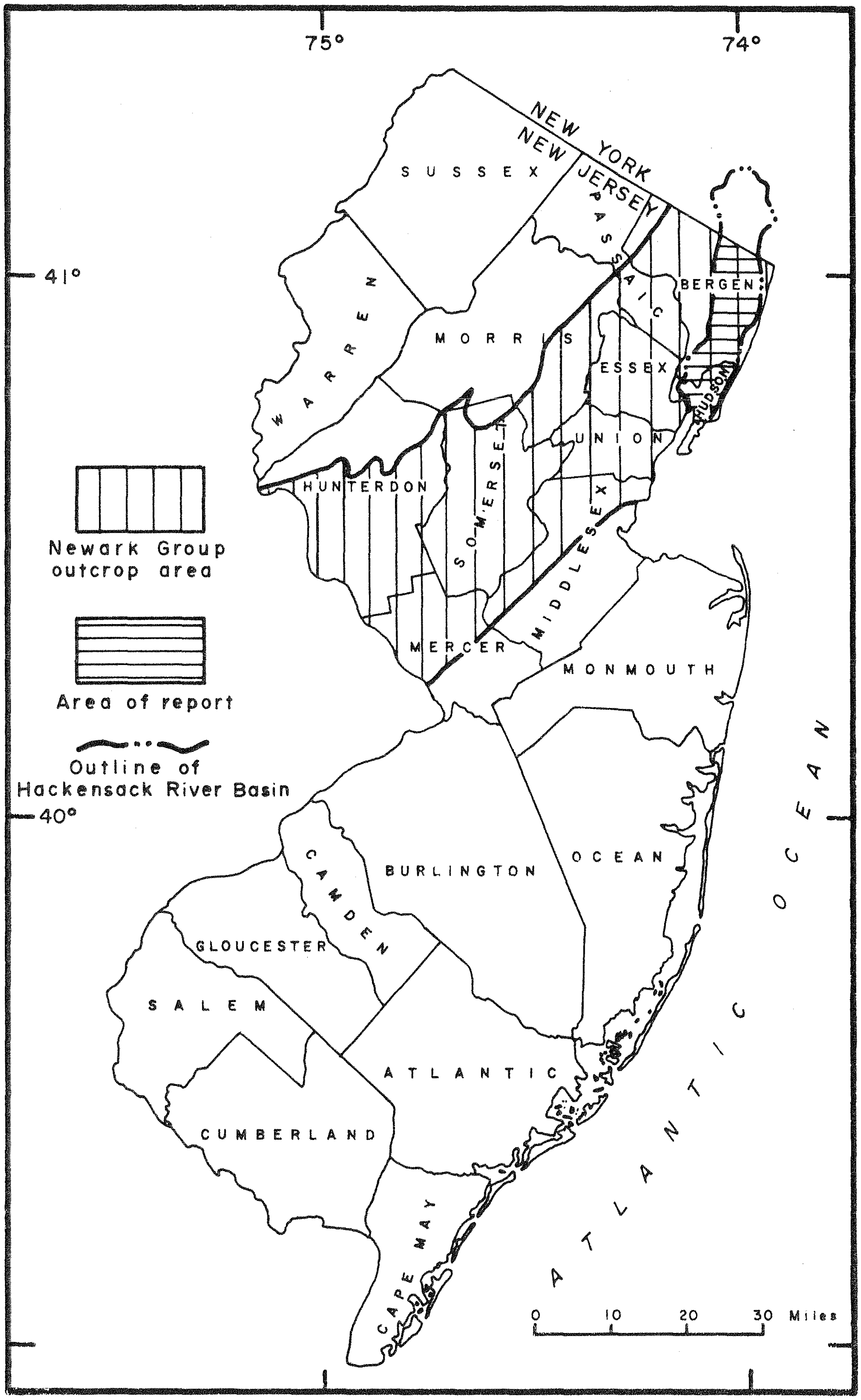

Figure 1.--Map of New Jersey showing location of the Hackensack River basin and area covered by this report.

(Bergen County Water Study Committee, 1957); and a preliminary report on the geology and ground-water supply of the Newark, N. J. area (Herpers and Barksdale, 1951). The surface-water resources of the Hackensack River basin in Rockland County, New York, were described by Ayer and Pauszek (1963).

Previous investigations of the geology of the area include reports by Kümmel (1898 and 1899), Merrill and others (1902), Darton and others (1908), Salisbury (1902), and Reeds (1933). Excellent summaries of recent geological investigations of the Brunswick Formation in the area are given by Savage (1968) and Van Houten and Savage (1968). The thickness and composition of the deposits underlying the Hackensack Meadows were determined by Parrillo (1959).

Acknowledgments

It is a pleasure to acknowledge the cooperation and assistance of the Hackensack and Park Ridge Water Companies for providing information on wells, chemical analyses, and access to wells for making geophysical and borehole-velocity measurements.

The cooperation of the firm of Leggette, Brashears and Graham, consulting ground-water geologists; Artesian Well and Equipment Co.; Rinbrand Well Drilling Company; Burrows Well Drilling Company; and the New Jersey Bureau of Geology and Topography, which provided many of the well records used in compiling this report, is gratefully acknowledged.

Lawrence J. Mansue collected and tabulated well records during the summer of 1964, and Harold E. Gill and William C. Roth assisted in making some of the borehole-velocity measurements.

GEOGRAPHY

Topography and Drainage

The Hackensack River basin lies within the glaciated section of the Piedmont Province of the Appalachian Highlands. The bedrock in most of the basin is composed of sedimentary rocks, predominantly sandstone, mudstone, and conglomerate. The more resistant beds of sandstone and conglomerate form low, elongate, northward-trending hills. The sedimentary rocks were intruded by molten rocks forming dikes and sills of diabase. The diabase forms the steeply sloping Laurel Hill near Secaucus and the Palisades on the east of the basin. Most of the bedrock in the basin is covered by unconsolidated deposits of boulders, gravel, sand, and clay of Pleistocene age, largely products of the last (Wisconsin) advance of the continental ice sheets across the basin. The bedrock surface is highly irregular, as it was formed by preglacial and interglacial streams and was modified further by glacial scour.

The principal tributaries to the Hackensack River are Pascack Brook and Berrys, Overpeck, Saw Mill, and Penhorn Creeks. The river is tidal and navigable as far north as a dam at New Milford, N. J., about 20 miles north of Newark Bay. The tidal part of the river basin, includes the Hackensack Meadows which cover an area 10 miles long and as much as 4 miles wide, comprising 15,000 acres of marsh that is only a few inches above high tide.

The eastern and northern boundaries of the Hackensack River basin, with the exception of a small area near Sparkill, New York, follow the crest of the Palisades ridge. This ridge rises abruptly from and parallels the Hudson River from Jersey City north to Haverstraw, New York. Altitudes of the crest of the ridge in New Jersey are as much as 500 feet above sea level. Several small narrow valleys are partly cut through the ridge, giving the divide an undulating character.

The western boundary of the Hackensack River basin, the divide between the Hackensack River basin and the Passaic and Saddle River basins, follows the crest of a series of northward-trending ridges, whose summits range in altitude from about 100 feet at North Arlington to 600 feet above sea level in Rockland County, New York.

Climate

Winters are controlled by polar continental air masses and summers by tropical air masses which, although of marine origin, pass over very warm land masses before reaching New Jersey (Biel, 1958, p. 66).

The Hackensack River basin is near enough to the paths of the storms which move from west to east across the Great Lakes region and down the St. Lawrence Valley to receive some precipitation from that source. However, the heaviest general rains are produced by coastal storms of tropical origin (U. S. Weather Bureau, 1959).

The average annual precipitation in the Hackensack River basin is 45 inches. Recorded extremes in annual precipitation are a low of 26 inches and a high of 61 inches.

The mean annual temperature in the basin is 53°F with a monthly mean low of 31.5°F in January and a monthly mean high of 75.8°F in July. The growing season averages 185 days with the mean date of the first and last killing frosts October 21 and April 19, respectively. Prevailing winds are from the northwest from October to April and from the southwest for the other months.

GEOLOGY

General Features

During the Late Triassic Epoch downfaulting produced a series of northeastward-trending basins in the Piedmont Plateau from North Carolina to Nova Scotia. Sedimentary and associated igneous rocks of Triassic age occupy the downfaulted basins and are known as the Newark Group. In New Jersey the Newark Group crops out in a band 16 to 30 miles wide trending southwestward from the Hudson River to the Delaware River (fig. 1). In the vicinity of the Delaware River the Newark Group is about 12,000 feet thick (Johnson and McLaughlin, 1957, p. 32). The bedrock in the Hackensack River basin is a part of the Newark Group of Late Triassic age.

The sedimentary rocks of the Newark Group in New Jersey are composed of reddish brown arkosic sandstone, mudstone, siltstone, and conglomerate, and dark-gray argillite. The sediments were derived largely from rocks of Paleozoic and Precambrian age to the southeast and were deposited in a nonmarine intermontane basin (Van Houten, 1965). In Triassic time the sedimentary rocks were intruded by diabase sills (intrusions which parallel the enclosing beds) and dikes (intrusions which cut across the bedding). The diabase is more resistant to erosion than other rocks of the Newark Group and generally forms ridges such as the Palisades.

The Newark Group has been divided into three formations on the basis of distinctive lithology: a lower unit, the Stockton Formation; a middle unit, the Lockatong Formation; and an upper unit, the Brunswick Formation. The Lockatong interfingers with both the underlying Stockton and overlying Brunswick; its presence has been reported at only one locality in the Hackensack River basin (Van Houten, 1964, p. 500). The distribution of the units of the Newark Group in the Hackensack River basin is shown in figure 3.

The beds of the Newark Group generally strike north to northeast in the Hackensack River basin and dip west to northwest at approximately 10 degrees. A prominent set of steeply dipping joints parallels the strike of the beds. A less prominent set of nearly-vertical joints parallels approximately the direction of dip of the beds. In the cliffs along the Hudson River the diabase has well developed columnar jointing which inspired the name "Palisades" for the vertical columns of rock. The faults that cut and displace the Triassic rocks typically strike northeastward and are parallel to or intersect the strike of the beds at a low angle.

Surficial deposits cover most of the bedrock in the Hackensack River basin and are largely a result of several major advances of the continental glaciers across the area during the Pleistocene Epoch. Younger deposits of Holocene age, consisting largely of alluvium deposited by present-day streams, overlie the glacial deposits. The alluvium is restricted to the flood plains of the streams.

During Pleistocene time glaciers which advanced across the basin probably removed an unknown thickness of weathered or easily eroded rock and soil. Part of this material was ground to clay size and the mixture later redeposited on the bedrock. Deposits of the latest (Wisconsin) ice advances now are exposed at the land surface. They consist of unsorted deposits of boulders, pebbles, sand, and rock flour which cover the hills and partly fill the valleys. A few miles south of the Hackensack River basin, frontal deposits from the melting ice sheet accumulated as a terminal moraine.

Streams of melt water issuing from the stagnating and retreating glacier formed stratified deposits of gravel, sand, silt, and clay. As the glacier retreated, crustal downwarping beneath the glacier, as a result of its weight, combined with blockage of drainage by the terminal moraine to the south ponded the melt water forming a lake known as Lake Hackensack in the area of the present Newark Bay and Hackensack Meadows and extending northward into Rockland County, N. Y. Subsequently, this lake was partly filled with deposits of varved silts, and clay prior to the establishment of outlets which drained the lake. The lake beds were eventually veneered with alluvium and a mat of decayed plant material.

Pre-Quaternary Rock Units

Stockton Formation

The Stockton Formation in the Hackensack River basin occurs in a narrow belt, as much as two miles wide, on the western slope of the Palisades from West New York, N. J., northward into Rockland County, New York. The Stockton underlies the Lockatong Formation in the southern part of the basin and intertongues with the Lockatong in the northern part of the basin. The Stockton is locally cut by the Palisades sill.

The Stockton is composed of light-colored arkosic sandstone and some thin beds of red sandstone and shale. The arkosic sandstone contains 50 to 70 percent quartz and 15 to 40 percent feldspar and is atypical in that the content of sodium feldspar exceeds that of potassium feldspar according to Van Houten (1965, p. 832-833). Silica cement is common. Also present are minor amounts of calcite and rarely dolomite cement as well as authigenic feldspar overgrowths and void fillings. In the past some arkosic sandstone has been quarried locally for building stone.

The exact thickness of the Stockton in northeastern New Jersey is unknown (Merrill and others, 1902, p. 6), but it is much less than the 5,000 feet along the Delaware River reported by Johnson and McLaughlin (1957, p. 40).

Lockatong Formation

The Lockatong Formation has been identified at only one location, North Bergen, in the Hackensack River basin. Here it consists of argillite that has been altered to hornsfels during the emplacement of the adjacent diabase sill (Van Houten, 1964, p. 500).

The Lockatong overlies the Stockton Formation and is overlain by the Brunswick Formation. Laterally it intertongues with both the Brunswick and the Stockton Formations.

The Lockatong Formation is composed of cyclic units of chemical and detrital origin that average 15 feet in thickness. The detrital deposits are mudstones composed of abundant sodium feldspar, calcite, illite, and chlorite with very little quartz and potassium feldspar. In the chemical deposits the mudstone contains abundant analcime, albite, dolomite, calcite, illite, and chlorite. Dolomite and analcime casts of skeletal glauberite (and possibly anhydrite) crystals are common in some of the chemical deposits (Van Houten, 1965).

The formation is 90 feet thick at North Bergen. It thins northward and is entirely missing at the New York-New Jersey State line. It presumably thickens south of North Bergen and is 3,750 feet thick in western New Jersey and adjacent Pennsylvania.

Brunswick Formation

The Brunswick Formation overlies the Stockton Formation and forms the bedrock throughout most of the Hackensack River basin. It is reddish-brown and composed of mudstone, siltstone, sandstone, and conglomerate. In the southern part of the basin mudstone is the dominant lithology. The deposits gradually become coarser grained northward (Kümmel 1898, p. 43 and Savage, 1968) so that in the northern part of the basin in New York the Brunswick consists largely of sandstone and commonly contains beds of conglomerate.

Gypsum and glauberite are reported to occur in the Brunswick Formation. Herpers and Barksdale (1951, p. 37) have reported the presence of gypsum from well borings in the Newark area just south of the Hackensack River basin. Glauberite has long been known to be present locally in the Brunswick Formation. Van Houten (1965, p. 834) reports that some beds enclose large complete molds of glauberite, as well as rosettes of elongate calcite casts. The coarser deposits are fledspathic and are commonly cemented by calcite (Van Houten, 1965, p. 834).

The thickness of the Brunswick Formation in the Hackensack River basin is unknown. Herpers and Barksdale (1951, p. 23) estimated the Brunswick to be about 6,000 to 7,000 feet thick in the Newark area just south of the Hackensack River basin.

Diabase

Sills and dikes of diabase (commonly called traprock) intruded the strata of the Newark Group. They are relatively resistant to erosion and form the Palisades ridge, Laurel Hill, and Little Snake Hill. Minor intrusive bodies of diabase are found at North Arlington and Bogota. The diabase dikes at Laurel Hill, Little Snake Hill, and Bogota cut the Brunswick Formation at high angles. The diabase at North Arlington is a sill, and that which forms the Palisades is a semiconcordant sill. The latter sill was fed by dikes and the upper and lower contacts of the sill locally cut across the bedding of the Stockton Formation. The Palisades diabase is 1,200 feet thick north of Englewood and thins southward to Jersey City (Darton, in Merrill and others, 1902, p. 9).

Diabase is a black, hard, dense rock composed of about equal amounts of plagioclase fledspar and augite. The texture ranges from finely crystalline in small dikes or chilled border zones of large intrusions to coarsely crystalline in the center of large intrusions where the rock solidified slowly thus giving the crystals a longer time to grow. Diabase is extensively quarried for road metal, particularly the dike at Laurel Hill and along the west flank of the ridge formed by the Palisades sill.

Quaternary Deposits

Pleistocene Deposits

Unconsolidated deposits overlying the Newark Group consist of sand, gravel, silt, and clay, that were deposited largely during the last (Wisconsin) glaciation of the Pleistocene Epoch. These deposits are generally thickest in the valleys and are thin or absent on hill crests. The deposits can be broadly subdivided into till and stratified drift. Till is an unsorted mixture of sand, gravel, silt, and clay deposited directly from the ice. It covers almost all the bedrock in the Hackensack River basin. The thickness of the till is variable; it averages 25 feet and is known to exceed 165 feet locally in the meadows area. Stratified drift consists of sand, gravel, silt, and clay which has been transported by water; it is poorly to well sorted. The stratified drift was deposited in contact with the ice or as outwash in flood plains, deltas, and as fine sediment in lakes during and after the retreat of the ice.

Stratified drift deposits of varved silt and clay, as much as 300 feet thick in the meadows, occur in two troughs (fig. 4) which roughly parallel the sides of the basin and probably connect a few miles south of the New York State line. Perlmutter (1959, p. 25) has reported similar deposits of laminated clay continuous with those of New Jersey in southern Rockland County, New York. Because of their varved character and lack of marine fossils, the silt and clay are presumed

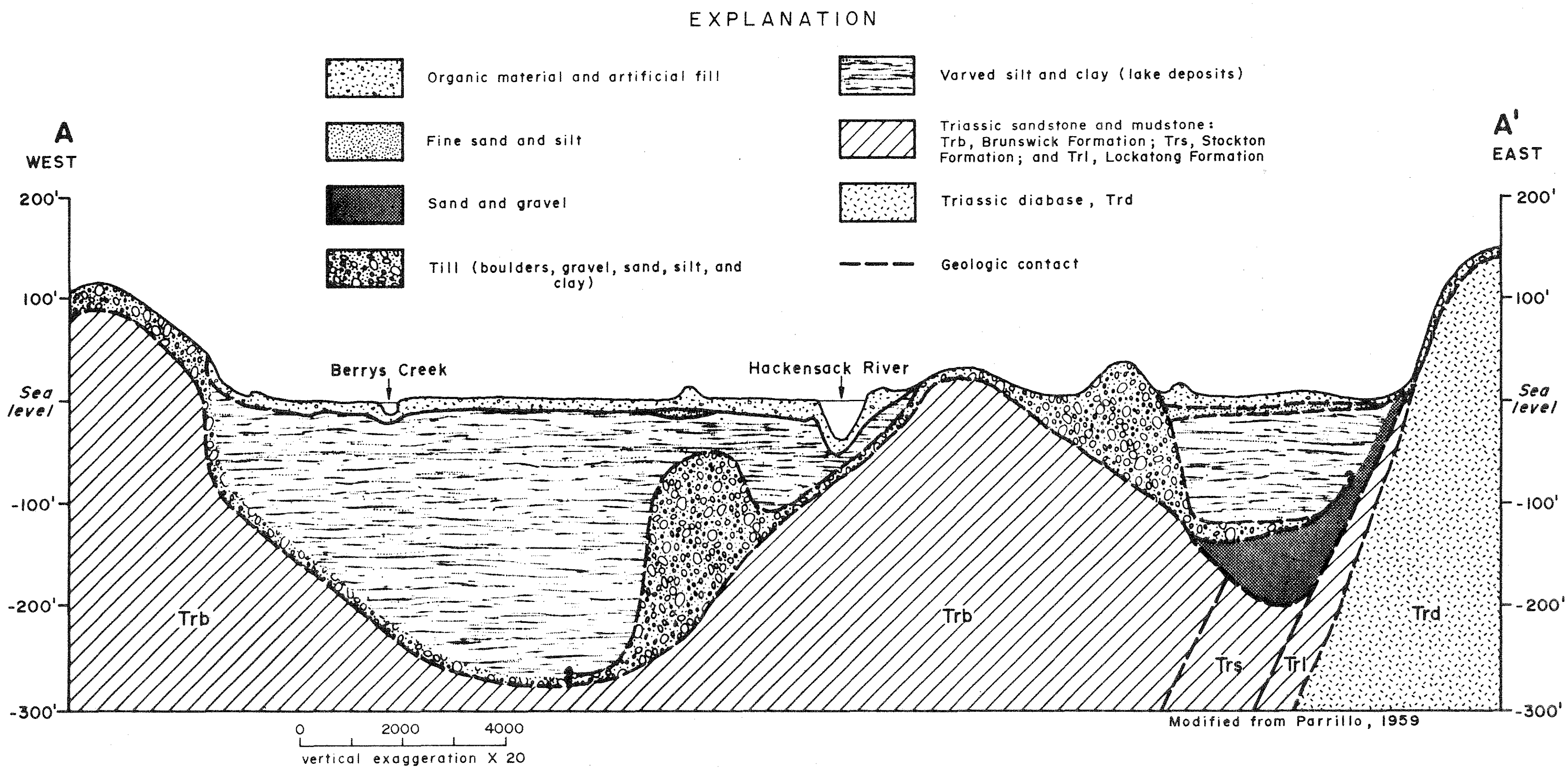

Figure 4.--Geologic section across the Hackensack Meadows area.

to have been deposited in fresh-water lakes (Lake Hackensack) which formed as the ice retreated. The varved silt and clay overlie till or bedrock and underlie Holocene deposits. In the eastern trough, from Jersey City northward to Ridgefield Park, however, the varved silt and clay overlies coarse sand and gravel also.

Coarse sand and gravel in the eastern trough underlie both till and lakebeds and are as much as 50 feet thick. They are fluvial deposits formed prior to the last glacial advance across the area. They were probably more extensive in the eastern trough and were deposited also in the western trough, but most of the materials have been removed by glacial scour. Thin deposits of stratified coarse sand and gravel underlie terraces along the sides of the valleys north of the Hackensack Meadows. Also several small hills of coarse sand and gravel, called kames, were formed in contact with the retreating ice north of the meadows.

In seven small areas (shown on figure 5), a part of the interval normally containing lakebeds is composed of beds of sand and gravel deposited as small deltas. The streams that built these deltas flowed eastward either in contact with the ice as the glaciers retreated or in Lake Hackensack. The valleys formed by these streams probably represent successively more southerly routes of the Passaic and Saddle River prior to the establishment of their present course.

Holocene Deposits

In the upper part of the basin, Holocene deposits are thin and of small areal extent. In the lower part of the basin, deposits of sand, gravel, silt, clay, peat, and root mat (decayed vegetation) of Holocene age directly underlie the Hackensack Meadows. Here fine-grained sand and silt overlie till and varved silt and clay of Pleistocene age. The sand deposits are lenticular and thicken to 50 feet downstream. Root mat overlies the sand and silt in most of the meadowland and is about 10 feet thick, but locally is 50 feet thick. Artificial fill consisting largely of trash and rubbish overlies the natural deposits in parts of the Hackensack Meadows.

HYDROLOGY

Surface Water

The Hackensack River basin can be divided into two areas which differ markedly in their hydrologic characteristics. The division arbitrarily set at the north edge of New Milford, New Jersey, separates the basin into an upper (northern) 113-square mile area and a lower (southern) 84-square mile area.

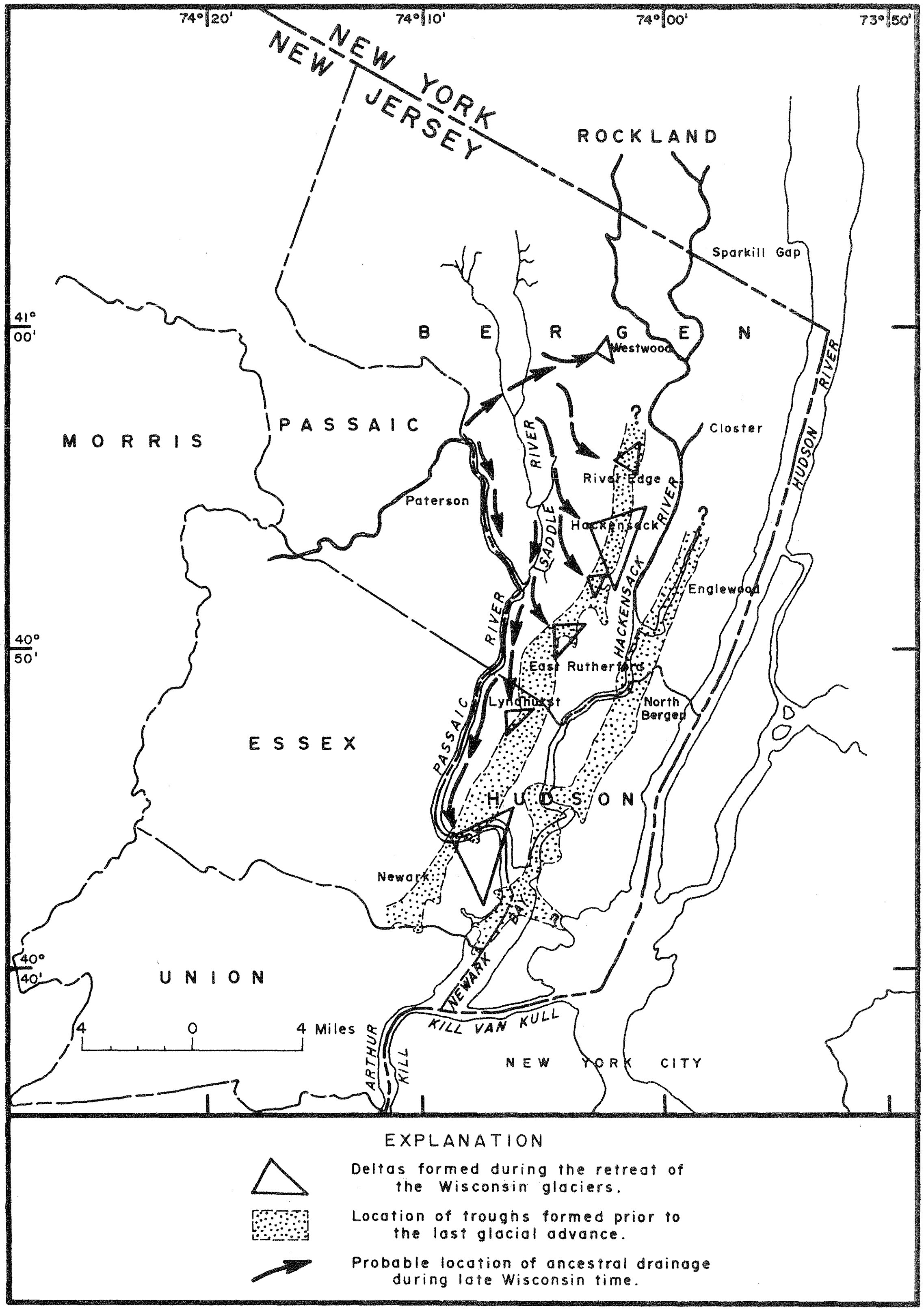

Figure 5.--Map showing the location of drainage and deltas formed during the retreat of the Wisconsin Glaciation.

The upper area is characterized by moderate to steep topographic slopes, hilly terrain, moderate to steep ground-water gradients, reasonably good quality of surface and ground-water, and virtually complete regulation of the Hackensack River for water supply.

The lower area is a broad area of low relief at altitudes near sea level, except along the flanks, and gentle ground-water gradients. The streams, including the Hackensack River, are tidal. About half of the lower area consists of a tidal marsh known as the Hackensack Meadows. The lower area receives very little runoff from the upper area during the summer months when water demand is highest. In years of low precipitation little water is permitted to flow into the lower area.

Water Utilization

Average annual precipitation in the upper area of the Hackensack River basin is 86.5 billion gallons of water. Figure 6 shows annual precipitation, in inches, and the percent of the precipitation, leaving this part of the basin as combined runoff and diversion during the period 1922-65. On the average, approximately 50 percent of the precipitation left the upper area of the basin as runoff and diversion for water supply. The remaining 50 percent was discharged as evapotranspiration.

The upper area is utilized by the Hackensack Water Company for water supply. Flow of the Hackensack River is controlled by DeForest Reservoir in Rockland County, New York, which has a storage capacity of 5.6 billion gallons. Other reservoirs downstream (see fig. 2) are Oradell Reservoir (3 billion gallons), Woodcliff Lake (900 million gallons), and Lake Tappan (3.4 billion gallons). Lake Tappan is considered to be the last suitable site for reservoir construction in the basin.

Much of the area served by the Hackensack Water Company is sewered and a large percent of the diverted water does not re-enter the upper part of the basin. Also, some water pumped for industrial and institutional use is subsequently diverted out of the Hackensack River basin to the Hudson River by disposal into Sparkill Creek. However, the northernmost townships are largely unsewered and for the most part residential. Furthermore, the water diverted by the Spring Valley Water Company from DeForest Reservoir and from wells in Rockland County is returned to the streams and ground water reservoirs through public and domestic sewage disposal systems.

Diversion of water from the Hackensack River at New Milford, as well as inflow to Oradell Reservoir (Pascack Brook at Westwood, and Hackensack River at River Vale) and outflow from Oradell Reservoir (Hackensack River at New Milford) for the years 1951-66 are shown

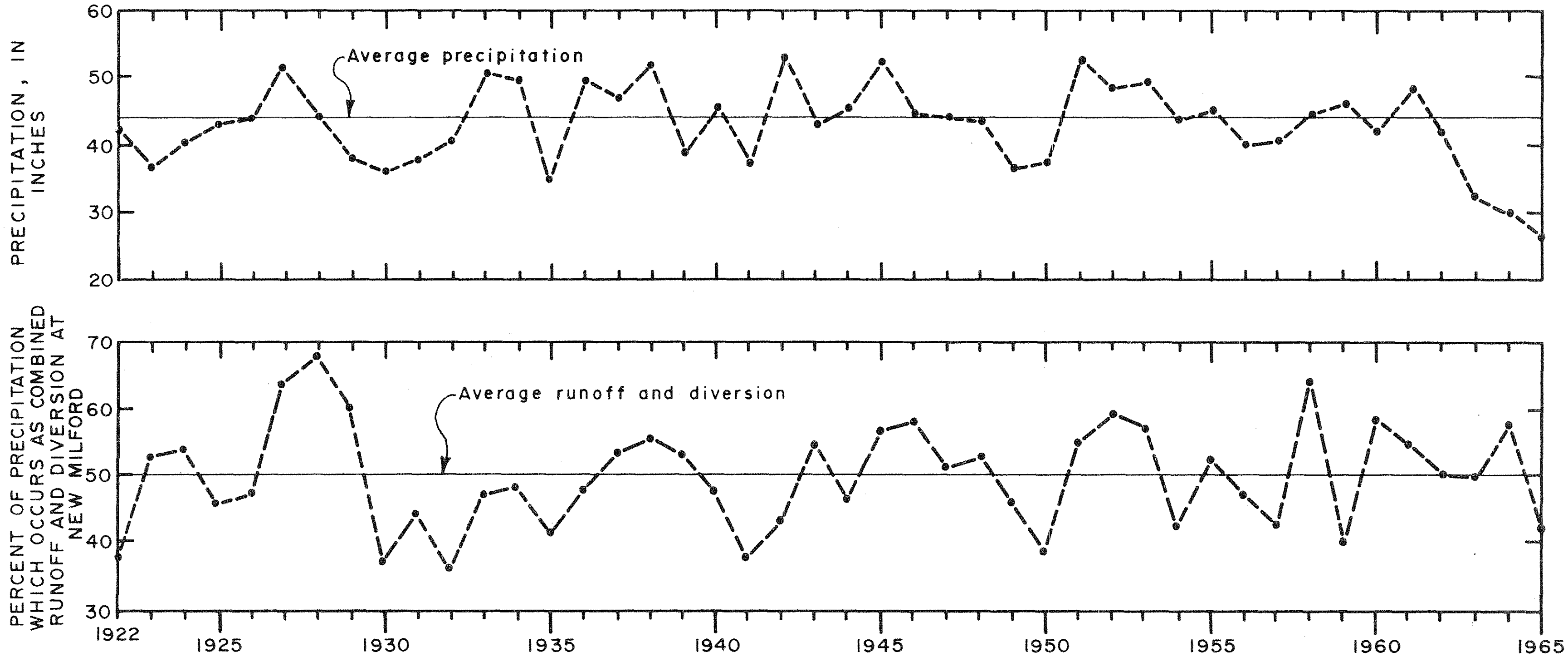

Figure 6.--Graphs showing precipitation at New Milford, and percent of precipitation occurring as combined runoff and diversion.

in figure 7. Streamflow gaging station locations are shown in figure 2. As the Pascack and Hackensack contain runoff from 77 percent of the basin above New Milford an adjusted total mean annual flow of the entire basin above New Milford is also shown in figure 7. The data used in plotting these graphs are not adjusted for changes in reservoir storage or evaporation. The difference between inflow to and outflow from Oradell Reservoir increased during the drought years from 1962 to 1966; comparatively little water was discharged to the lower part of the basin in 1965. Diversion from the river increased more or less steadily from 1951 to 1964, but decreased during 1965 reflecting the Governor's proclamation of a drought emergency and the imposing of limitations on water use.

Utilization of surface water in the Hackensack River basin above Oradell Reservoir is approaching its maximum limit. Consequently, in order to develop additional water supplies from the ground-water reservoir without decreasing ground-water discharge to streams or inducing recharge from surface supplies it would be necessary to capture water now being currently lost by evapotranspiration. Riggs (1965) has suggested that a decrease in evapotranspiration and increase in streamflow might be achieved by management of vegetation.

Water Quality

Increased urbanization of the upper part of the Hackensack River basin has brought changes in surface-water quality. As shown in figure 8 the average annual chloride content of water leaving the filter plant of the Hackensack Water Company at New Milford has increased from 1905 to 1963. An anomolous peak for the period 1949 through 1952 was caused by the effluent of an upstream industrial complex. The rise in chloride content of the water entering and stored in Oradell Reservoir reflects not only additions to the river system from domestic and municipal sewage, but the expanded use of salt during winter for controlling ice and snow on the roads traversing the area.

The effect of road salt upon chloride content in streams is illustrated in figure 9. The chloride content of Hirshfield Brook was monitored by the Hackensack Water Company on a daily basis during November and December of 1964. Prior to the advent of freezing weather in mid-December, the chloride content of the water ranged from 10 to 28 mg/l averaging about 20 mg/l. Cold weather from December 19-23 during which a snowfall was recorded was followed by above freezing temperatures and rain. The maximum peak of the chloride concentration in Hirshfield Brook from this event is unknown, for it was not monitored on December 24 and 25; however, on December 26 a chloride content of 60 mg/l was recorded.

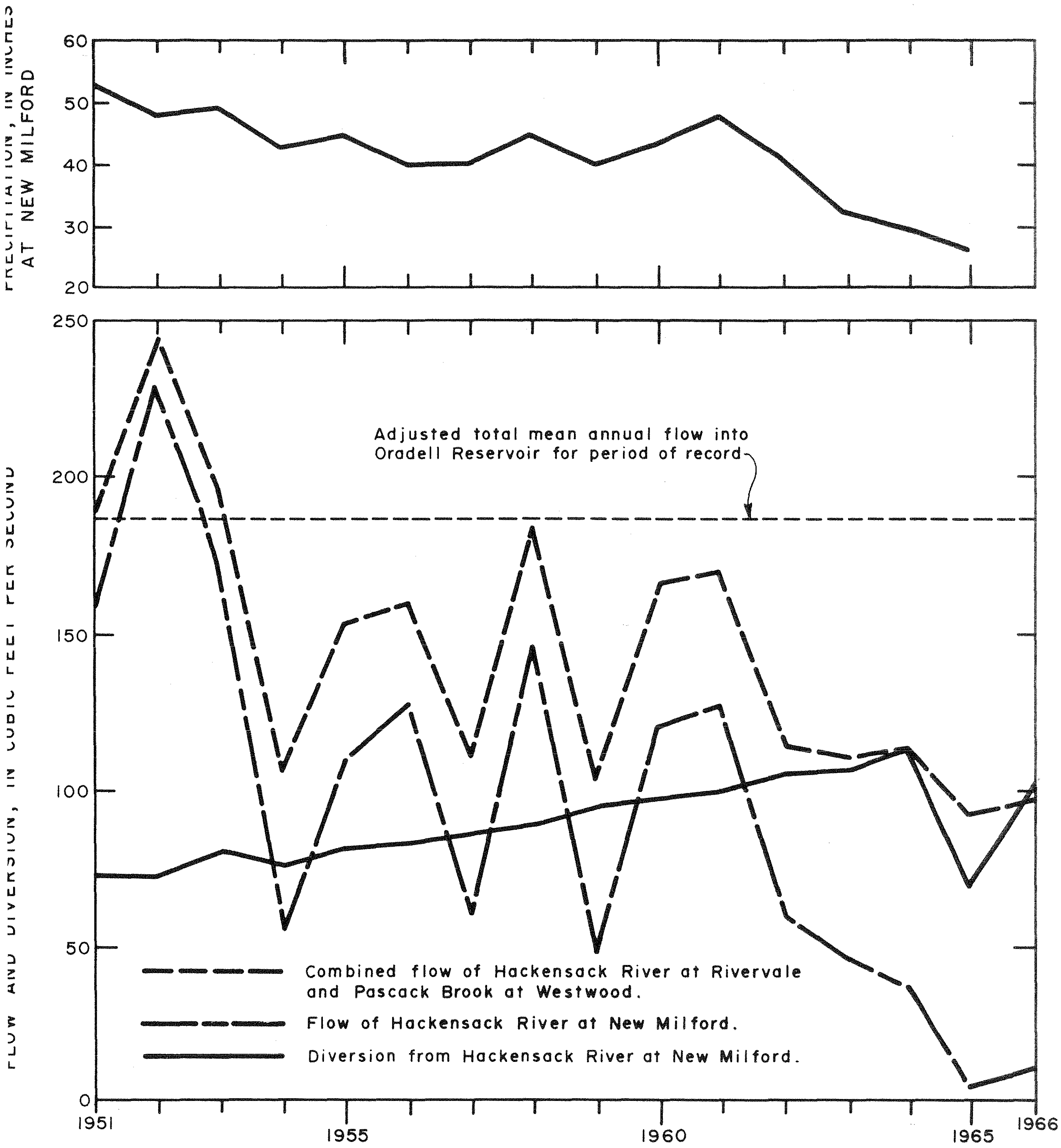

Figure 7.--Graphs showing precipitation and combined measured flow of the Hackensack River and Pascack Brook above Oradell Reservoir, diversion, and flow of the Hackensack River below Oradell Reservoir (at New Milford), 1951-66.

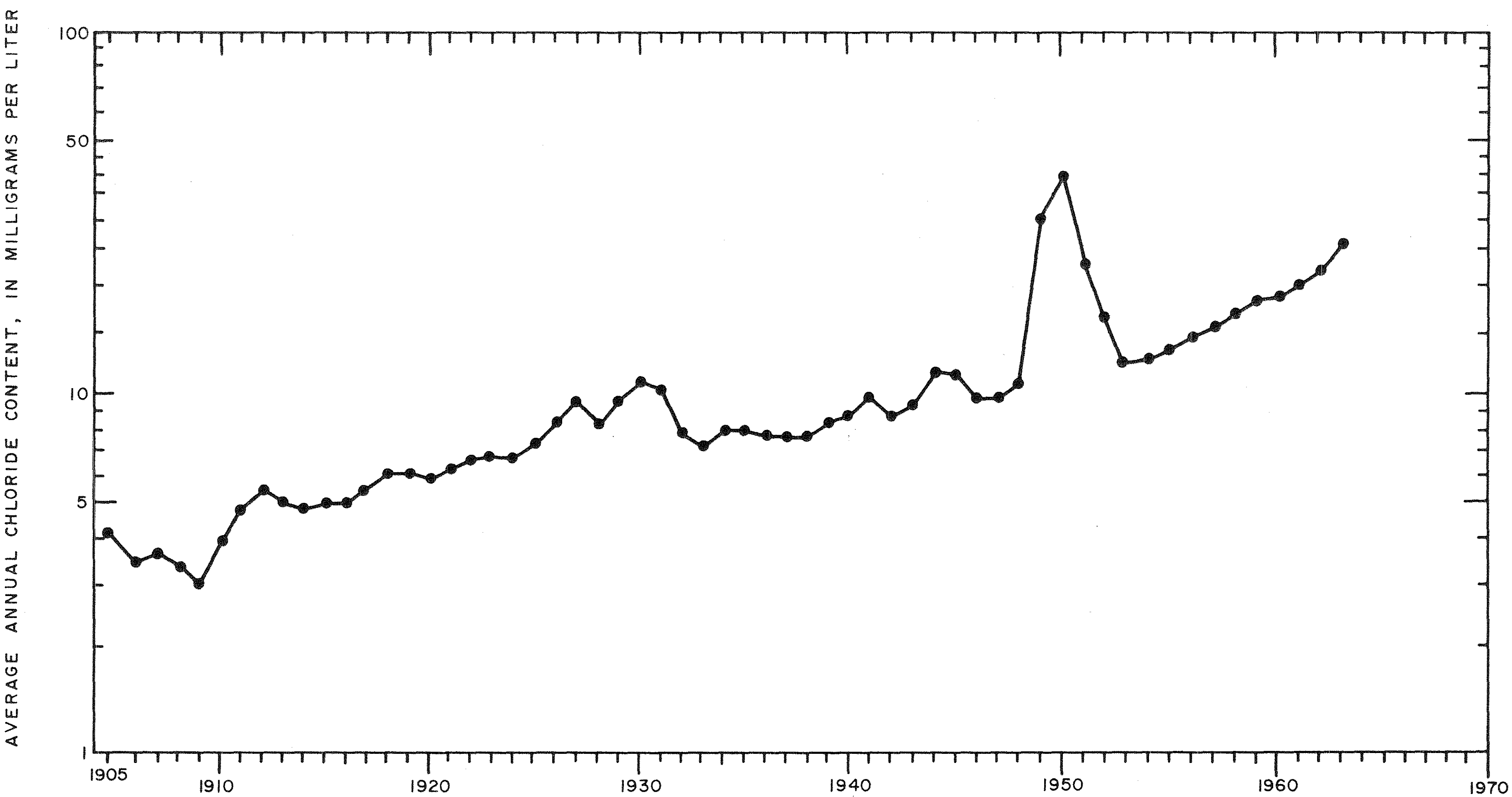

Figure 8.--Graphs showing chloride content of water from Oradell Reservoir after filtration at New Milford, 1905-63.

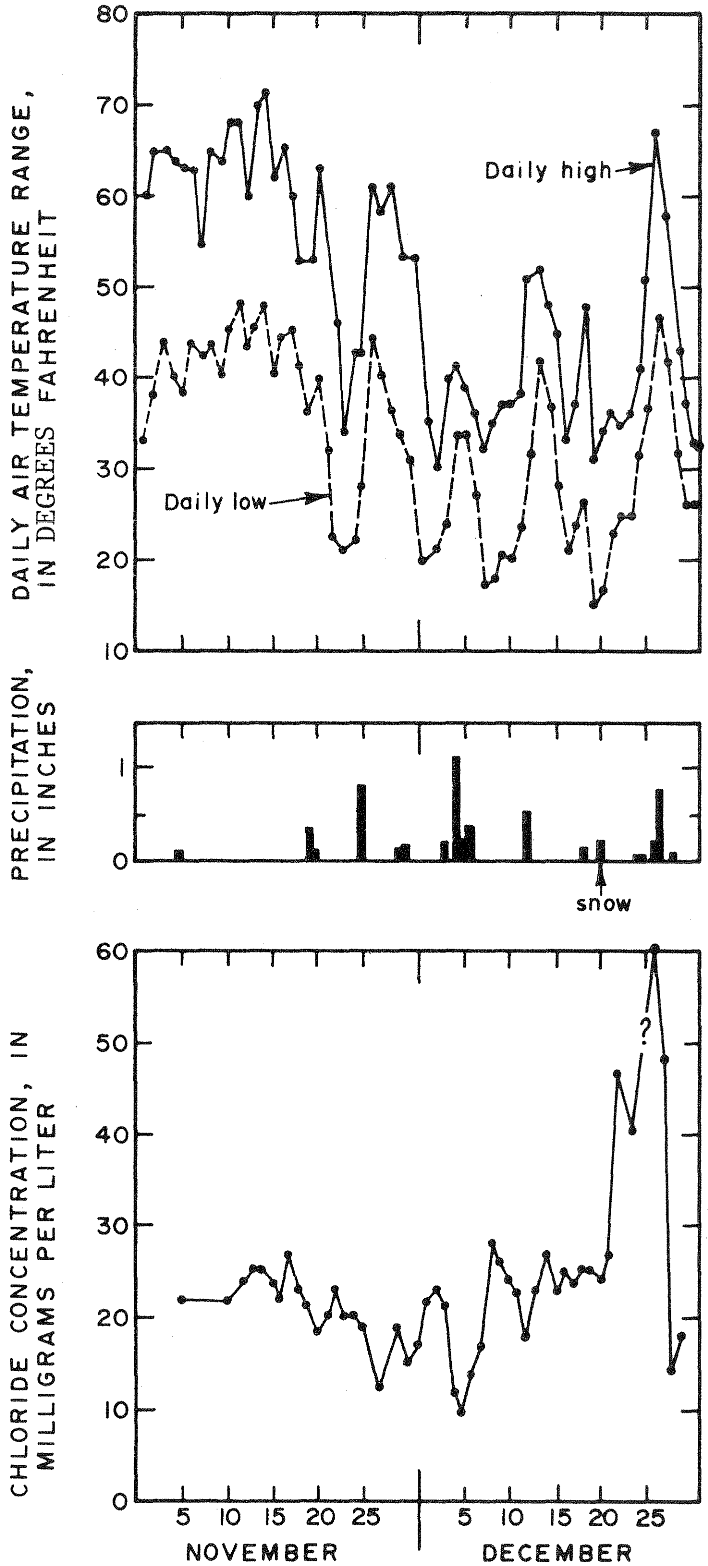

Figure 9.--Graphs showing comparison of temperature, precipitation, and chloride content of Hirshfield Brook, November and December 1964.

In the interval between 1927 and 1963 the average yearly total dissolved solids content of the Hackensack River in the upper area increased from 104 mg/l to 184 mg/l and the hardness calculated as calcium carbonate increased from 37 mg/l to 77 mg/l (analyses by the Hackensack Water Company). Some of the increased dissolved solids content resulted from cycling water through municipal and domestic sewage systems.

The Hackensack Meadows in the lower area of the basin are utilized for the disposal of 57 mgd of treated municipal sewage effluent and industrial waste, rich in nitrates and phosphates. During summer months, particularly when precipitation is deficient, brackish water from Newark Bay flows up the Hackensack River. The chloride concentration in Newark Bay is approximately 10,000 mg/l. In the late summer of 1961 concentrations as high as 4,000 mg/l were found in the Hackensack River as far north as Hackensack and concentrations of several hundred milligrams per liter occurred near the northern part of the area below New Milford. This high concentration of chloride makes the water in the lower Hackensack unsuitable for municipal and industrial processes although it is usable for cooling purposes.

Ground Water in Consolidated Rock

Stockton and Lockatong Formations

The Stockton Formation underlies a small area on the west side of the Palisades in the Hackensack River basin. Because of its limited areal extent in the basin and because it has hydrologic properties similar to those of coarser parts of the Brunswick Formation, the hydrology of the Stockton Formation is not discussed separately in this section.

The Lockatong Formation is thin and is known from only one exposure in the basin. No wells are known to penetrate it within the basin. Based on studies made elsewhere in New Jersey, the Lockatong can be expected to yield considerably smaller quantities of water than the finer-grained parts of the Brunswick Formation.

Brunswick Formation

Occurrence and Movement of Ground Water

Ground water in the Brunswick Formation occurs in a network of interconnected openings formed along joints, fractures, and solution channels. The intervening unfractured rock has negligible capacity to store and transmit ground water. The openings which contain ground water decrease in size and number with increasing depth below land surface. As some beds within the formation contain more openings than others, the ground-water system consists of a series of alternating tabular aquifers and aquicludes several tens of feet thick and dipping to the northwest at approximately 10 degrees. The water-bearing fractures in each tabular aquifer are more or less continuous, but hydraulic connection between individual tabular aquifers is poor. These tabular aquifers generally extend downdip for a few hundred feet and are continuous along strike for thousands of feet.

In an areally extensive, homogeneous, and isotropic aquifer, drawdown caused by pumping a well is equal at all points equidistant from the pumped well. This is not true, however, in a consolidated rock aquifer, such as the Brunswick Formation, where water is stored in and transmitted through secondary openings, which generally have some preferential alinement and are better developed in some beds than they are in others. In the Newark area, Herpers and Barksdale (1951, p. 29) observed a drawdown in an observation well located 2,400 feet from a pumped well in a direction parallel to the strike of the beds, whereas no distinct drawdown was evident in observation wells 600 feet from a pumped well in a direction transverse to the strike. They also observed that as a consequence of heavy pumping, high-chloride water from Newark Bay intruded the aquifer farthest along the strike of the beds. Similar observations on the anisotropism of the Brunswick Formation have been documented by Vecchioli (1967) and Vecchioli and others (1969). Their pumping-test data indicate that the direction of highest permeability and of the movement of water in response to pumping characteristically parallels the strike of the beds. Therefore, well fields, wherever possible, should be designed with wells alined transverse to the strike of the beds in order to minimize interference.

Thickness and Distribution of Water-Producing Zones

Estimates of the thickness of the ground water producing zone in the Brunswick Formation have been based typically on review of drilling records and on the observation that when a well has not successfully tapped a water-yielding zone in the first 400 feet of drilling, water-yielding zones are not likely to be penetrated by drilling deeper.

The zone in the Brunswick Formation containing joints and fractures that are capable of storing and transmitting fresh water has been variously estimated to be between 200 and 600 feet thick (Herpers and Barksdale, 1951, p. 27; Greenman, 1955; Rima, 1955; Perlmutter, 1959; and Parker and others, 1964). The depth and distribution of water-producing zones in the Brunswick Formation were determined at Lansdale, Pennsylvania, by Rima (1955) who injected water into several wells and traced the flow of the injected water by means of a flow meter. Rima concluded that the Brunswick in the Lansdale area contains an upper water-table aquifer of low permeability occurring at depths of less than 250 feet below land surface; below this depth there are one or more artesian or semiartesian aquifers of high permeability, generally less than 20 feet thick each, and occurring at depths as great as 600 feet.

The zone of fresh ground water in the Hackensack River basin locally appears to be thinner than 200 feet. Injected slugs of salt water were traced with an electric logger in seven wells, 400 to 500 feet deep, in the main valleys of the Hackensack River and Pascack Brook. When the wells were pumped at 25 to 35 gpm with a drawdown of about 5 feet, about 60 percent of the water entered the wells from above a 100-foot depth; about 90 percent entered from above a 200-foot depth. Below a depth of 200 feet, the maximum yield was 2 gallons for 5 feet of drawdown for the entire lower part of the well (fig. 10). Although none of these wells penetrated high-yielding zones below a depth of 200 feet, other wells in the main valleys reportedly have penetrated high-yielding zones below a depth of 200 feet. The relatively small thickness of the zone containing water-bearing openings in the seven wells shown on figure 10 may be a result of the removal by glacial scour of a considerable thickness of rock containing water-bearing openings.

Where there are differences in hydraulic head between water-bearing openings internal flow occurs under nonpumping conditions within the well from the zone of higher head to the zone of lower head. In upland areas where recharge is dominant, hydraulic heads generally decrease with increasing depth and internal flow is downward in the wells. In lowland areas where discharge is dominant, heads increase with increasing depth and flow is upward in wells. In some wells the water may flow at the surface.

To confirm this flow pattern borehole-velocity measurements were made under nonpumping conditions in seven wells in the valleys of the Hackensack River and Pascack Brook. In four of the wells no internal movement of injected brine slugs could be measured during a half hour or more of observation. Two wells (Emerson 3 and Hillsdale 6) flowed at the surface and upward internal flow occurred also in the third well (Harrington Park 6) although the well did not flow at the surface (fig. 11).

Borehole-velocity measurements were made under nonpumping conditions in six wells located in the upland valleys near minor tributaries of Pascack Brook and in one well on the divide between the Hackensack and Saddle River drainages. Figure 12 shows borehole flow from water-yielding zones in the upper 175 to 200 feet downward to "thieving" zones extending to within 50 feet of the bottom of the wells. These wells range in depth from 270 to 350 feet. This downward flow is a consequence of penetrating water-bearing beds having successively lower hydraulic heads with increasing depth.

Two of the six wells in upland valleys, which showed downward internal flow at depth, simultaneously flowed at the surface at 10 to 15 gpm. Three of the six wells were subsequently pumped at rates from 35 to 100 gpm and additional borehole velocity measurements were made while pumping. In each case the water pumped from the well

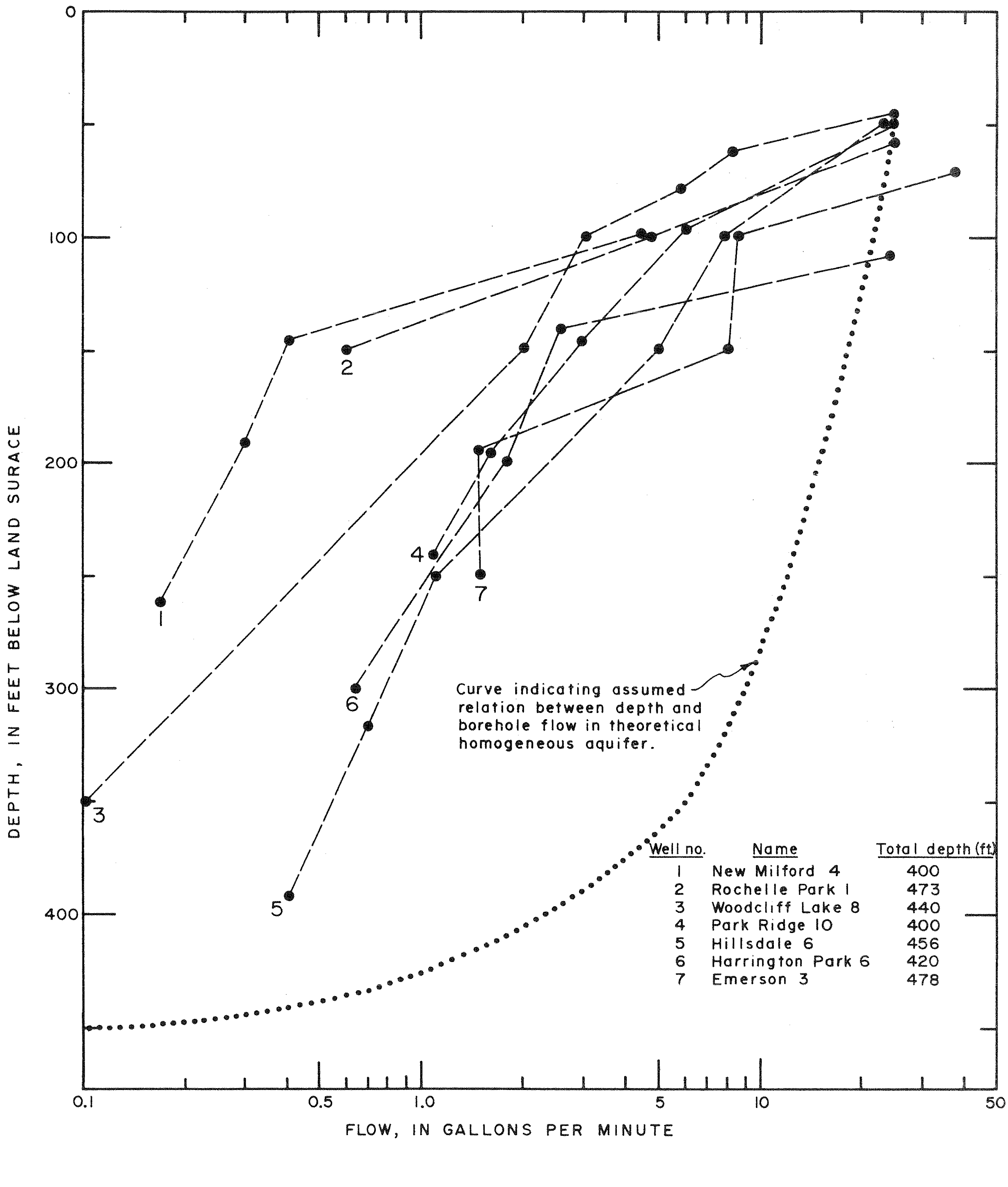

Figure 10.--Graph showing relationship between flow and depth in pumping wells in major valleys.

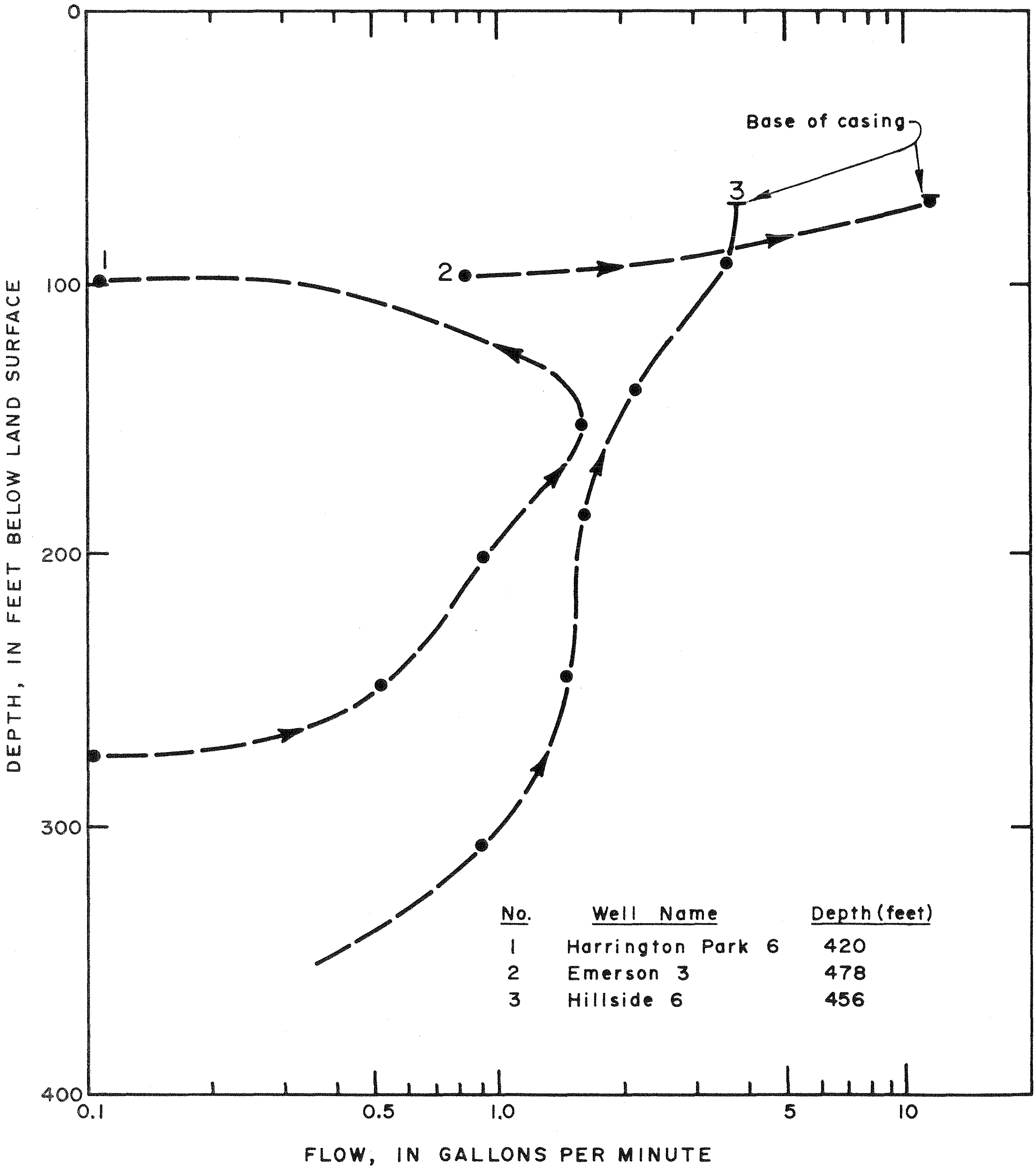

Figure 11.--Graph showing upward movement of water under nonpumping conditions in three wells in the Hackensack and Pascack valleys.

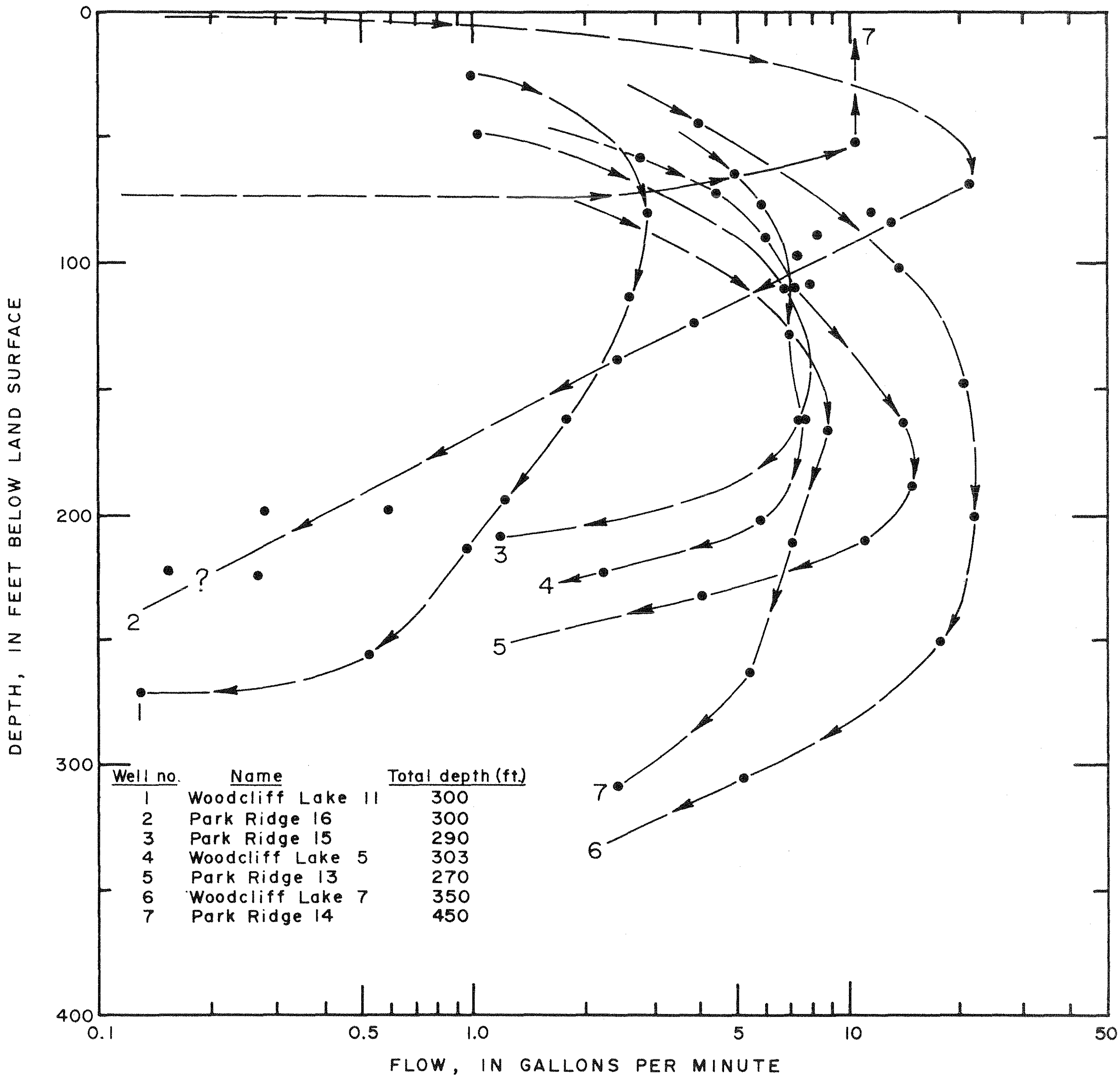

Figure 12.--Graphs showing downward internal flow in wells in upland valleys and divides under nonpumping conditions.

came from a zone 50 to 100 feet below land surface. Below this depth the internal flow was downward but at a lower rate than under nonpumping conditions. Figure 13 shows the downward internal flow of water in Park Ridge well No. 16 under nonpumping conditions and the simultaneous upward and downward internal flow when the well was pumped at 100 gpm.

When the water level in a pumping well declines below the top of a water-producing zone the rate of drawdown can increase because that part of the producing zone which is above the water level in the well no longer contributes as much water to the well. Figure 14 shows the time-drawdown relation during a pumping test on Emerson well No. 3. When the well was pumped at 250 gpm the water level in the well declined at a constant rate until the water level dropped below the base of the casing and into the zone which was transmitting water to the well. When this occurred the rate of drawdown increased markedly.

Wells having downward internal flow under nonpumping conditions may not have penetrated to the maximum depth of the fresh-water circulation system. In the seven wells in which measurements were made (fig. 12), no measurable flow was found near the bottom of the well regardless of the depth of the wells. This lower zone of no flow may result from either plugging of fractures during drilling or lack of adequate development near the bottom of the borehole. The maximum velocity of the water moving down the borehole of most of the wells was near a depth of 200 feet below land surface. The lower or "thieving" zone in the deepest wells appear to be as thick or thicker than the producing zones (fig. 12). The zone which thieves under nonpumping conditions may become a producing zone while pumping, provided that there is sufficient drawdown in the well. Therefore, the potential yielding zone in the uplands or in small valleys in the uplands is probably more than 300 feet thick and may be as great as 400 to 500 feet thick. The difference in head between the top producing zone and the base of the lowest thieving zone is not known, but a suggestion of its magnitude is provided by data from a well in Park Ridge. Deepening the well from 200 to 500 feet caused a drop of 30 feet in the water level. This new water level in the well represents a composite of all heads at the well and is presumably higher than the head in the lowest water-bearing zone.

The internal flow in wells under nonpumping conditions results from the penetration of a hydrologic system having hydraulic gradients that have vertical components. Flow through the borehole therefore is a short-circuiting of natural flow. One effect of this short-circuiting is to accelerate the movement of water from areas of recharge to areas of discharge. The effects of short-circuiting can be put in perspective when related to recharge. For example, precipitation at a rate of 45 inches per year averages about 3,340 gallons per day per acre. If one half of the precipitation is

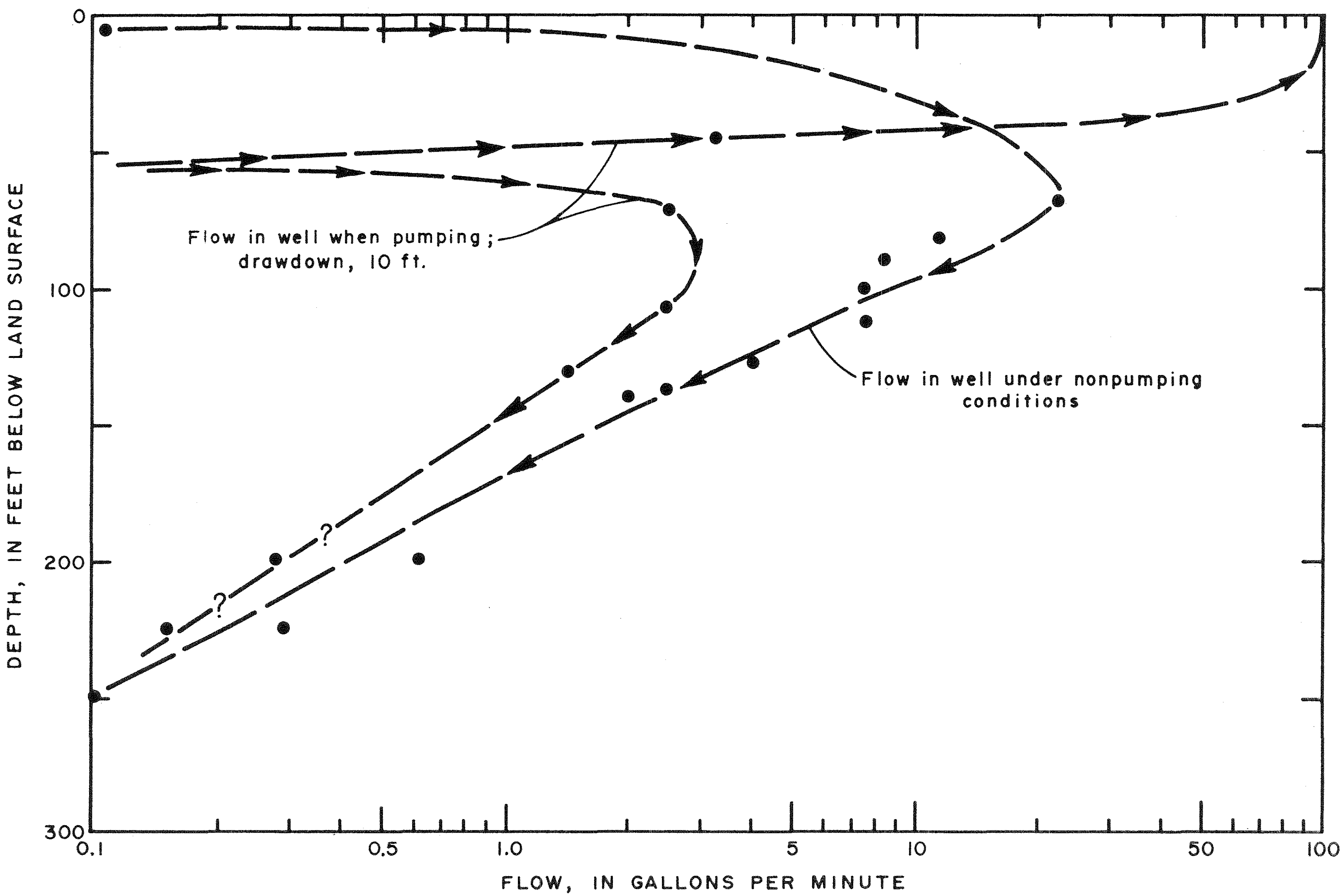

Figure 13.--Graph showing internal flow in Park Ridge well No. 16.

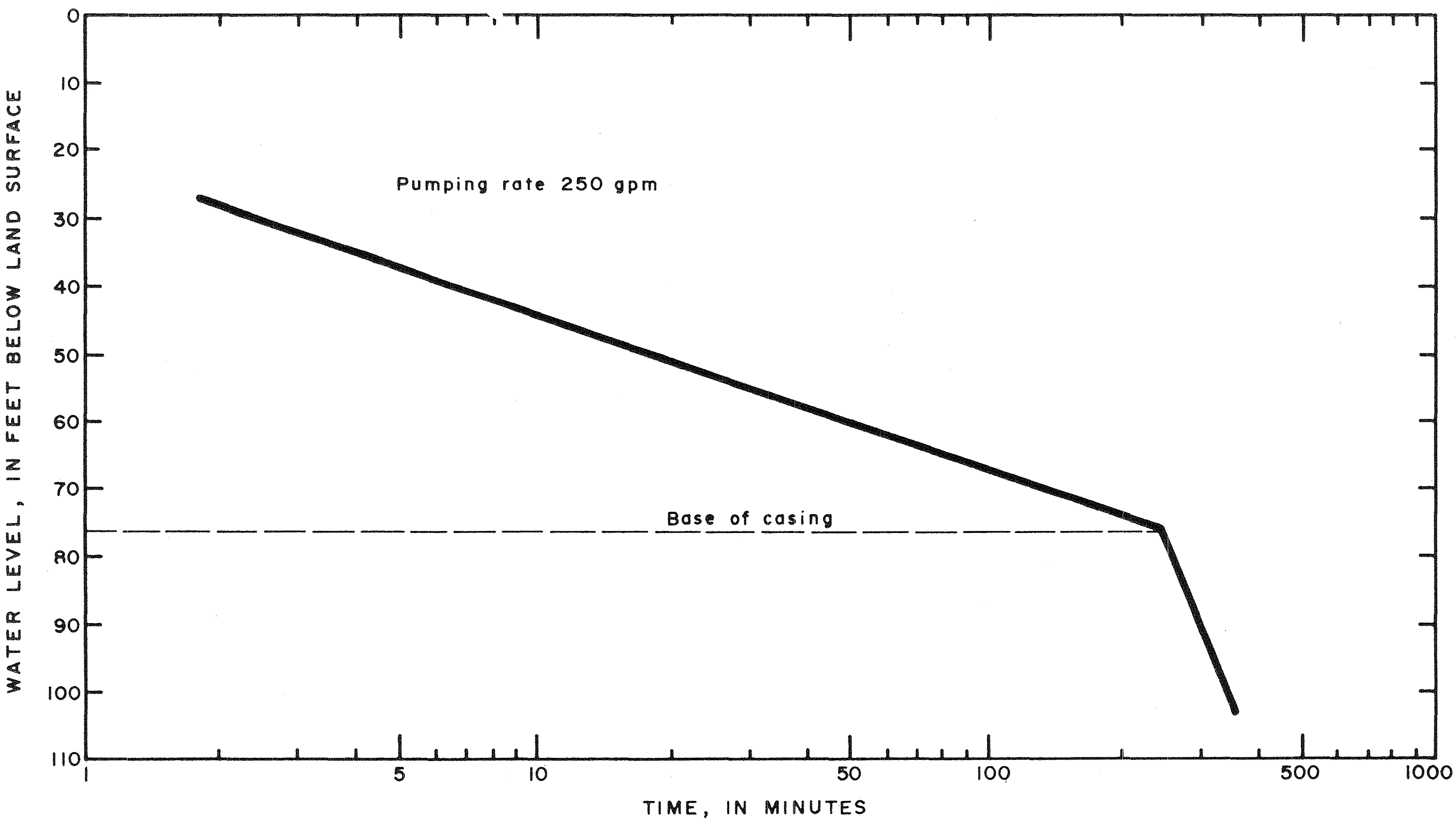

Figure 14.--Graph showing drawdown in Emerson well No. 3 during a pumping test.

evaporated or transpired, 1,670 gallons remain to run off directly to streams and to enter the ground-water system. A well having downward internal outflow of only 1 gallon a minute, or 1,440 gpd, is accelerating the movement of all the recharge available from about one to two acres of land. A number of such wells in an area with downward flow can result in a substantial water-table decline.

Another consequence of downward internal flow in wells is that the cleaning and development of the lower part of a well is made difficult or impossible unless the head relations in the well are artificially reversed because any surging action will tend to move drilling mud out into fractures in the "thieving zone" in the well. However, the downward flow assists in the cleaning and development of the upper part of the hole where there is a gradient toward the borehole. Well development generally increases the yield of a consolidated rock well; but which zones are actually developed is rarely known.

Yields and Specific Capacities of Wells

In most of the Hackensack River basin and Bergen County, the Brunswick Formation yields only small to moderate supplies of ground water to wells. A few wells outside the study area in Ridgewood, N. J., have yields of 500 to 1,000 gpm.

The frequency of occurrence of yields, specific capacities, and depths from available data on wells tapping the Brunswick Formation in Bergen County are shown on figures 15, 16, and 17. In general for the same frequency of occurrence, industrial and municipal-supply well yields are 10 times as great as domestic well yields. Industrial and municipal-supply wells are at least twice as deep and have twice the specific capacity of domestic wells. The median industrial or municipal-supply well is 260 feet deep, yields 100 gpm, and has a specific capacity of 1.5 gpm per foot of drawdown; the median domestic well is 120 feet deep, yields about 10 gpm, and has a specific capacity of about 0.7 gpm per foot of drawdown.

The difference between yields of industrial and municipal-supply wells and those of domestic wells result from the vastly different requirements of the owner, and the economics of well construction and development. For most domestic purposes small-diameter (6-inch) wells are drilled and the well is typically located for convenience and low costs. A well yield of a few gallons a minute is adequate and when such a yield is obtained drilling is stopped. Little effort is expended in developing the maximum potential yield of the well. In contrast, a maximum supply of ground water is sought for industrial or municipal-supply wells. Such wells are of large diameter (8 to 12 inches) and may be located utilizing the advice of a ground-water consultant. The consultant may specify and supervise drilling techniques and the extensive development and testing of the completed well.

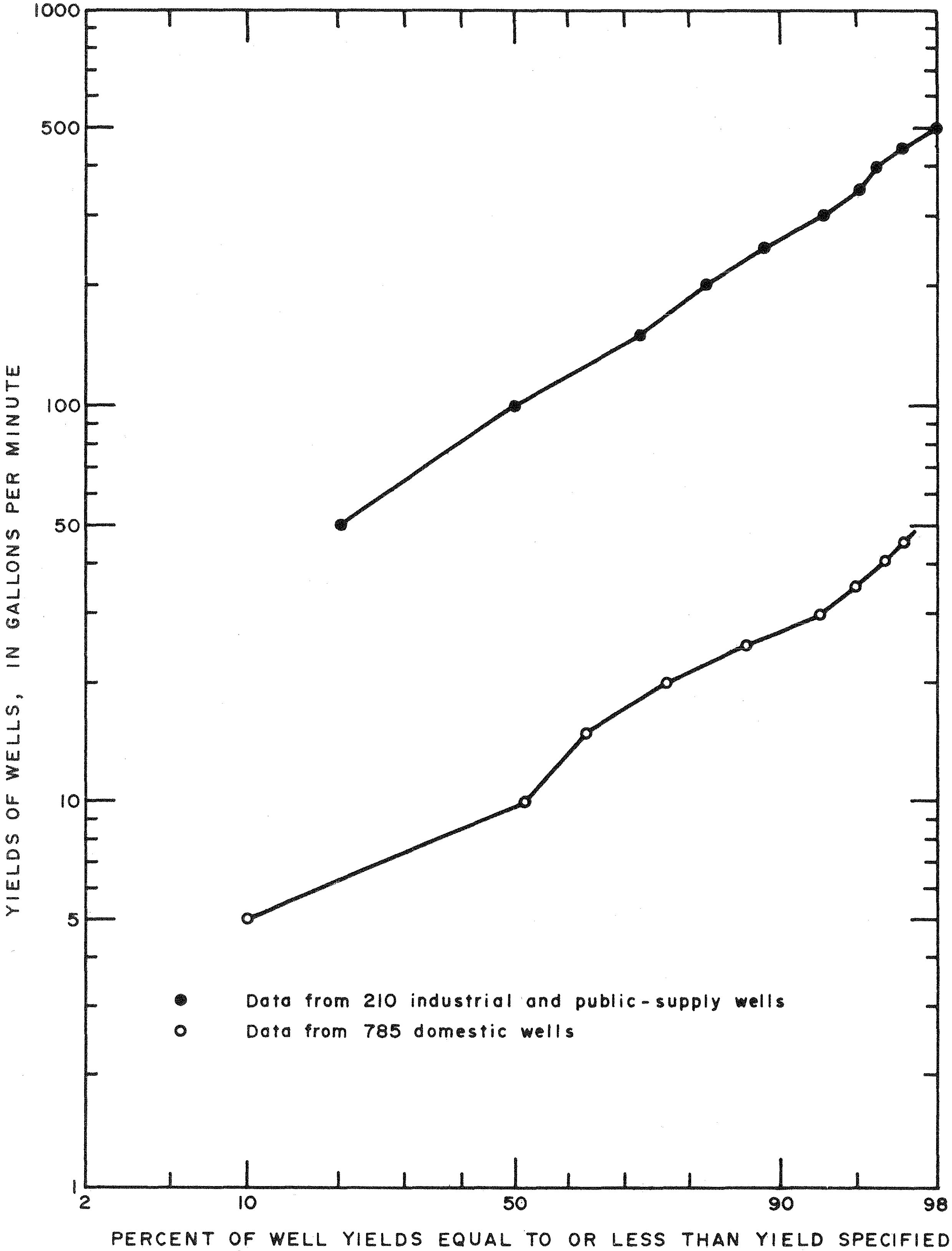

Figure 15.--Graph showing frequency of occurrence of yields from wells in the Brunswick Formation in Bergen County.

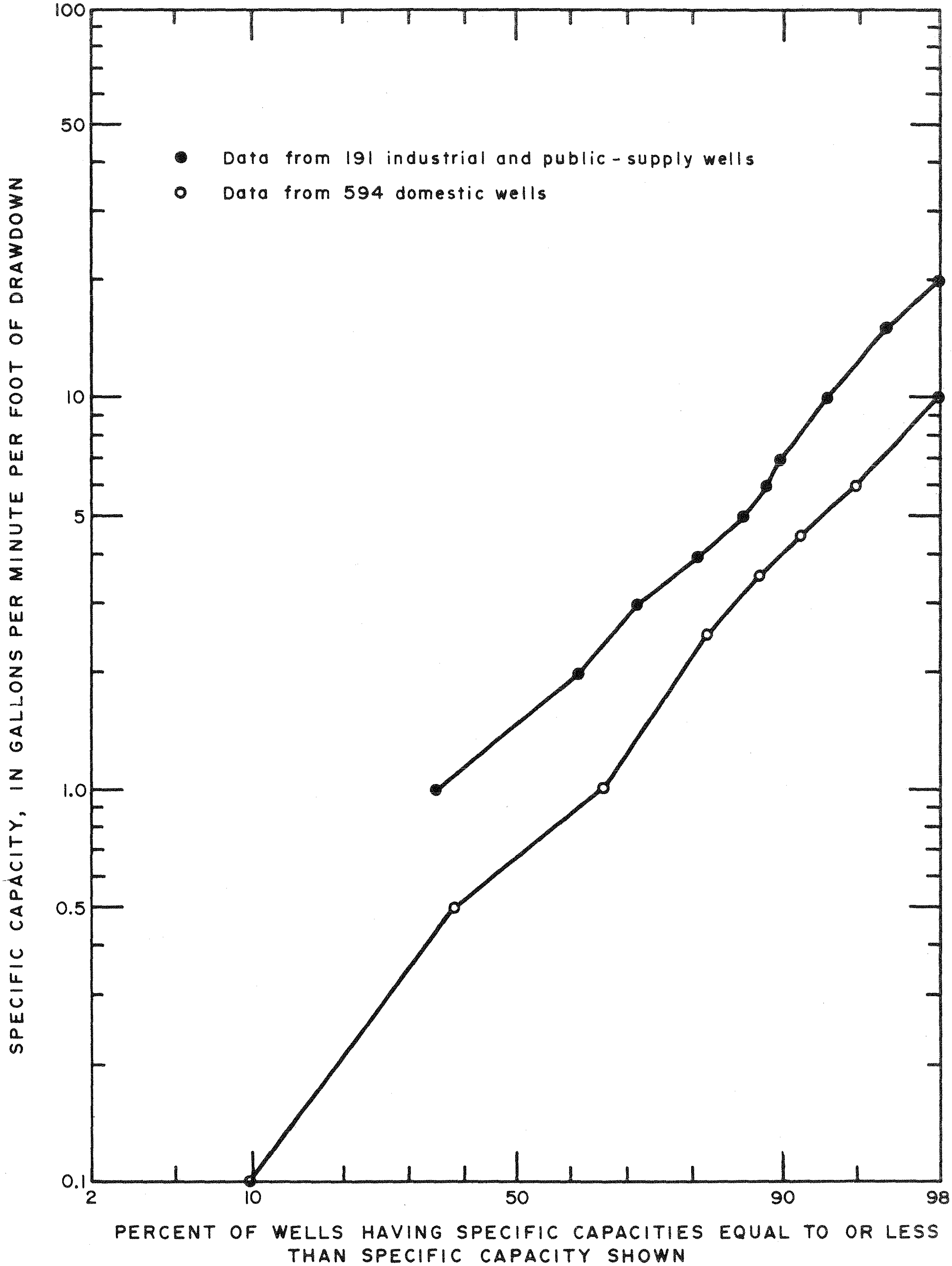

Figure 16.--Graph showing frequency of occurrence of specific capacities of wells in the Brunswick Formation in Bergen County.

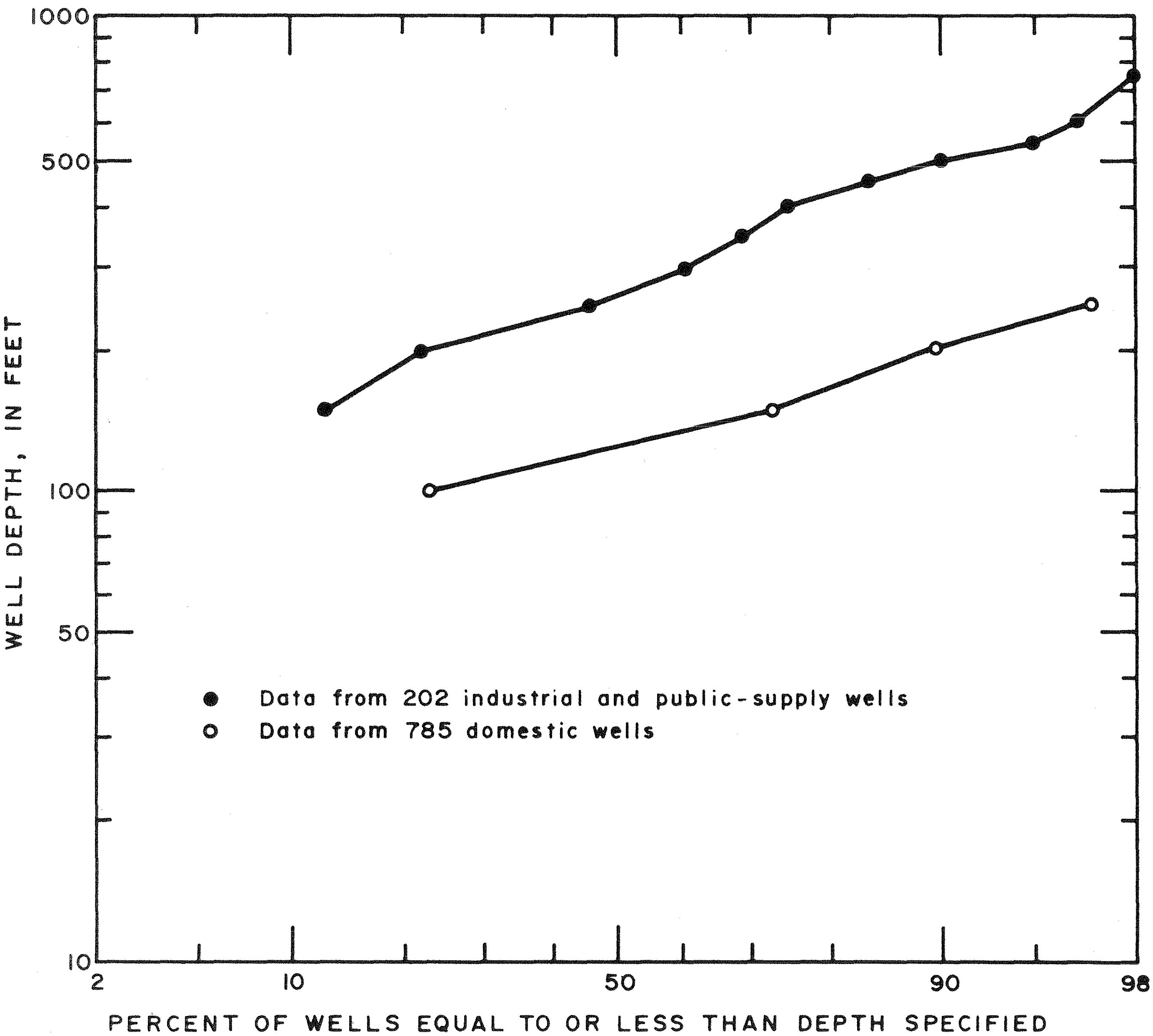

Figure 17.--Graph showing frequency of occurrence of well depths in the Brunswick Formation in Bergen County.

Within the Hackensack River basin areal variations in yields and specific capacities of wells tapping the Brunswick are dependent on lithology penetrated and position of the wells within the ground-water flow system. In the lower area of the basin the most productive wells (300 to 600 gpm) are located in narrow belts along the east and west sides of the Hackensack Meadows between the ridges which form the divides of the basin and the two troughs. Specific capacity of six industrial wells located on the flanks of the meadows are from 2 to 10 gpm per ft of drawdown whereas 26 wells drilled in the central part of the meadows have specific capacities of less than 1.5 gpm per ft, and an average specific capacity of less than 1 gpm per ft. The higher specific capacities along the flanks of the meadows may be due to the presence there of local coarse-grained unconsolidated deposits which contain large amounts of water and are hydraulically connected to the Brunswick. In the central part of the meadows the Brunswick is overlain largely by poorly permeable lake beds.

In the upper area of the Hackensack River basin wells that have higher specific capacities are generally located in valleys at higher altitudes (fig. 18). The valleys at higher altitudes are areas of ground-water recharge, whereas the valleys at lower altitudes are areas of discharge. In the recharge area ground water tends to be lower in dissolved solids, slightly more acidic, and therefore capable of weathering rock and enlarging water-bearing openings along joints and other fractures. Ground water in the discharge areas has traveled for longer periods and greater distances, is higher in dissolved solids, and tends to be in chemical equilibrium with adjacent rocks.

Water Quality

In Rockland County, New York, Perlmutter (1959, p. 33-41) found the ground water in the Brunswick Formation to be relatively low in mineral content (median dissolved solids 170 mg/l), of moderate hardness (112 mg/l median), and low in iron (0.06 mg/l median). The chloride content of the water ranged from 2 to 38 mg/l, and the median was 8 mg/l. The sulfate content ranged from 5.9 to 64 mg/l with a median value of 21 mg/l. The water is acid (pH 5.4) to alkaline (pH 8.4) and has a median pH of 7.7. The water is suitable for most domestic and industrial use without treatment (Perlmutter, 1951, p. 39).

The quality of ground water from the Brunswick Formation in the upper area of the basin in New Jersey is probably similar to that in Rockland County, New York, although the total amount of dissolved solids may be slightly higher in New Jersey.

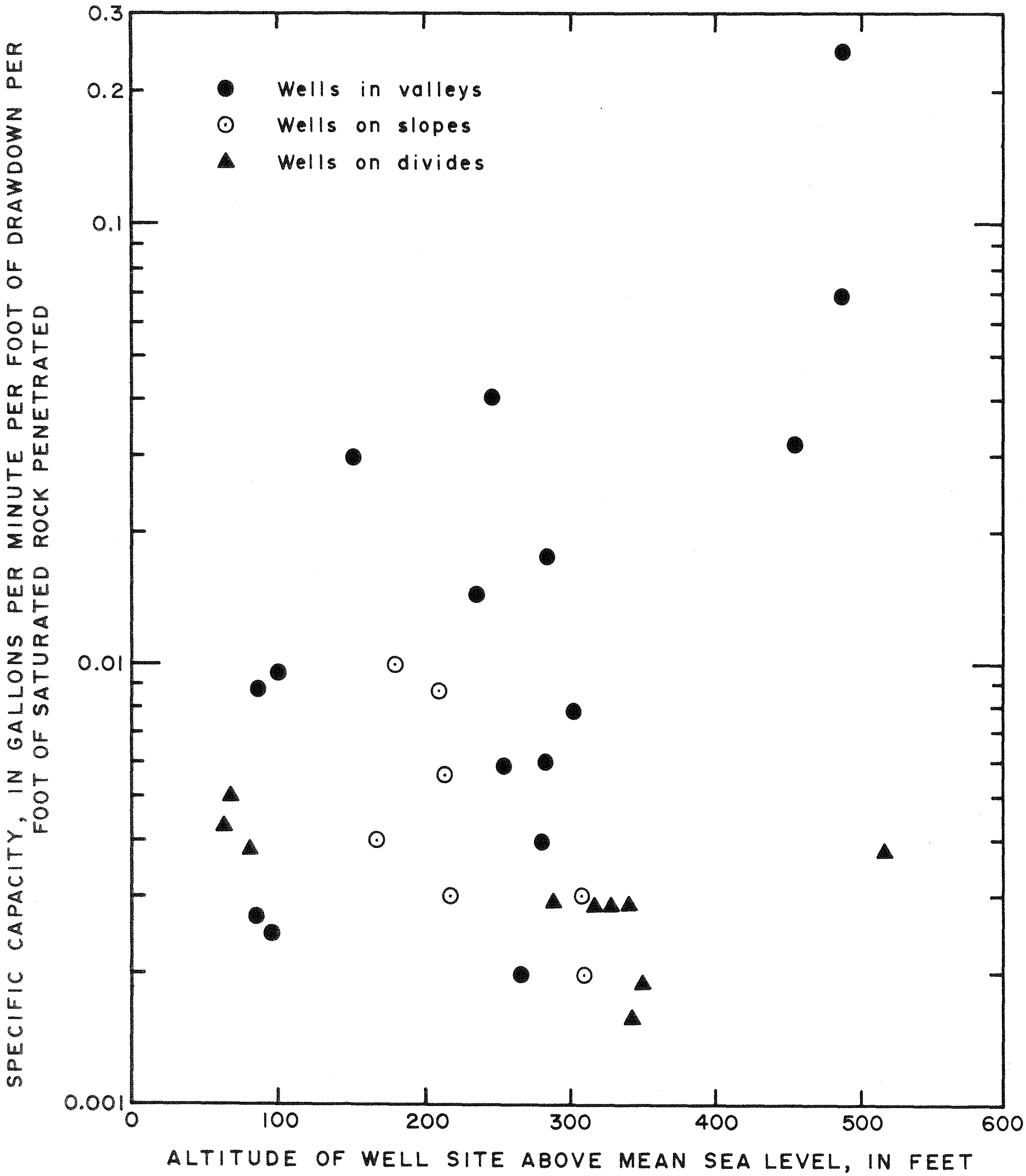

Figure 18.--Scatter diagram showing the specific capacity per foot of saturated rock penetrated.

Water pumped from the Brunswick in the lower area of the basin is hard to very hard (192 to 1,240 mg/l), contains moderate amounts of iron (.36 mg/l median), is alkaline (pH 7.3 to 7.7), and highly mineralized (specific conductance 579 to 3,480 micromhos per cm). Chloride concentrations range from 19 to 755 mg/l and sulfate concentrations from 87 to 966 mg/l. High sulfate concentrations may be related to the depth of the producing zone, as suggested by Herpers and Barksdale (1951, p. 37), but appear to be restricted to deep wells in the lower part of the basin where gradients in the flow system are low and movement of ground water is negligible. Thus, the high sulfate concentrations may represent the quality of water in the longest, deepest, and slowest moving flow path in the ground-water-circulation system.

Ground water quality in the lower area of the basin, and in particular in the meadows, has been affected locally by heavy pumpage which has caused the intrusion of poor quality water from both the Hackensack River and Newark Bay. Herpers and Barksdale (1951) suggest that the intrusion of poor quality water in the vicinity of Harrison and Kearny, N. J., may, in part, result from the dredging of canals in areas adjacent to Newark Bay and the Passaic River thereby exposing permeable material to the bay water. Other hydraulic connections between the Brunswick Formation and Newark Bay and Hackensack and Passaic Rivers may be through (1) sand deposits of Holocene age, (2) coarse-grained deltaic deposits formed by the ancestral Passaic River in Lake Hackensack during the Pleistocene (fig. 5), or (3) gravels of uncertain origin at the base of the pre-glacial or inter-glacial stream valley underlying Newark (Herpers and Barksdale 1951, p. 20).

The high sulfate content causes hard scale in boilers and makes the water unsuitable for this use. The water in the Brunswick Formation in the lower area of the basin is suitable for cooling although some corrosion problems will be experienced because of the high chloride content.

Diabase

Diabase, which has a very low primary porosity, contains ground water in joints and fractures. These openings decrease in size and number with depth below land surface and probably become too narrow to yield significant amounts of ground water below a depth of 300 feet. Yields of wells tapping the diabase are too low to consider the diabase as a potential source of ground water for other than small supplies. The median yield of 10 domestic wells in the diabase in Rockland County is 5 gpm (Perlmutter, 1959, p. 23). Industrial wells drilled in the diabase on the east side of the meadows generally yield less than 35 gpm; however, one well yielded 100 gpm.

Ground Water in Unconsolidated Deposits

Ground water occurs in the interstices, or pores, between grains in unconsolidated deposits. Unconsolidated deposits in the Hackensack River basin consist of till, varved silt and clay, alluvium, sand and gravel. Small quantities of ground water are stored in till which overlies the bedrock throughout most of the basin. Till characteristically has low permeability because of its poorly sorted nature and does not yield water to wells in sufficient quantities for other than domestic use. Deposits of varved silt and clay such as the lake beds that overlie bedrock and till in most of the meadows, are poorly permeable and impede the movement, discharge, and recharge of water. Alluvium is thin, not widely distributed, and has little value as a source of ground water.

Sand and gravel may store and transmit large quantities of ground water where they are coarse, saturated, and near a source of recharge. However, areas in the Hackensack River basin where large supplies of ground water may be developed from coarse sand and gravel are limited. In the upper area of the basin only small quantities of ground water have been developed from unconsolidated deposits with the exception of a few wells at Park Ridge where recharge is induced from Pascack Brook. Furthermore, large-scale ground-water development in the limited areas along stream valleys would reduce streamflow which is currently utilized for water supply at Oradell Reservoir.

Coarse sand and gravel deposited in deltas at the mouths of streams that entered Lake Hackensack (fig. 5), yield large supplies of ground water at Hackensack, Rutherford, and Newark. Deltaic deposits at Westwood, Ridge Edge, Lyndhurst, and in the southern part of Hackensack have not been outlined by drilling and may be small and thus have little potential as sources of ground-water.

In a narrow area between the eastern buried valley and the Palisades Ridge is a poorly defined but probably continuous sequence of coarse sand and gravel that extends at least as far north as Englewood and possibly as far north as Closter (fig. 5). Near North Bergen, wells yielding more than 300 gpm derive water from the sand and gravel where they are in hydraulic connection with the Hackensack River.

The chemical quality of ground water in the unconsolidated deposits in the Hackensack Meadows is highly influenced by the quality of water in the Hackensack River and waters that flood the meadows as a result of tides. Pumping has reversed the natural gradients and induced recharge from these generally highly mineralized sources. For example, heavy pumping at Hackensack and near North Bergen has induced recharge of poor chemical quality from the Hackensack River into the sand and gravel aquifers.

As the upper area of the basin has become more urbanized and water demands have increased, progressively smaller quantities of fresh water have been permitted to enter the meadows from upstream sources of the Hackensack River. During the drought from 1960 to 1965 practically no fresh water flowed into the meadows. Furthermore, the lower area is used for disposal of 57 mgd of sewage and industrial wastes, an amount equivalent to about one third the average precipitation that falls on the area. The preceding combination of factors makes surface water of poor quality available for induced recharge to the unconsolidated deposits in the meadows. This water is suitable for cooling if precautions are taken to prevent corrosion by water that may have a chloride content of several thousand milligrams per liter.

SUMMARY AND CONCLUSIONS

Bedrock in the Hackensack River basin is composed of sedimentary and igneous rocks of the Newark Group of Triassic age. The Brunswick Formation of the Newark Group is composed of mudstone, siltstone, and sandstone and is the most important bedrock aquifer in the basin. Water occurs in this formation in a network of interconnected openings formed along joints, fractures, and solution openings. Because of preferential alinement of these openings the formation is anisotropic: greatest permeability and the major component of water movement in response to pumping is parallel to the strike of the beds. Consequently, well fields designed with wells alined transverse to the strike would have minimum interference between wells.

The zone in the Brunswick Formation that contains fresh-water-bearing openings is generally less than 200 feet thick in the main valleys of the Hackensack River and Pascack Brook. In upland areas the zone is greater than 300 feet thick and may be as much as 400 to 500 feet thick.

The median reported yield of industrial and public supply wells tapping the Brunswick Formation in Bergen County, which includes most of the Hackensack River basin is 100 gpm. The median specific capacity of wells tapping the Brunswick is 1.5 gpm per ft drawdown. The most productive wells (300 to 600 gpm) are located in narrow belts on the east and west flanks of the Hackensack Meadows where the Brunswick Formation is hydraulically connected to coarse-grained, highly permeable, unconsolidated deposits.

The Stockton and Lockatong Formations of the Newark Group have very limited areal extent and are not important aquifers in the basin. Diabase, an igneous rock, yields small quantities of water to wells; generally less than 35 gpm to industrial wells.

Overlying the Newark Group throughout the basin are unconsolidated deposits consisting of alluvium of Holocene age and till, varved silt and clay, and sand and gravel of Pleistocene age. The sand and gravel have value as a source of ground water, yielding large supplies (greater than 300 gpm) of ground water locally.

Ground water from the Brunswick Formation in the upper area of the basin is relatively low in mineral content and of moderate hardness. Water from the Brunswick in the lower area is hard to very hard and highly mineralized. Here the water quality in both the Brunswick and unconsolidated deposits is influenced by water quality of the Hackensack River and Newark Bay. Heavy pumpage has induced recharge of poor quality water, high in chloride, from these sources. Both surface and ground-water quality in the lower area is influenced by the disposal of large quantities of sewage and industrial wastes in the Hackensack Meadows.

Utilization of surface water in the Hackensack River basin above Oradell Reservoir is approaching its maximum limit. Consequently, development of additional water supplies from the ground water reservoir is limited, because it would decrease surface-water supplies. Ground-water development is limited also by the small amount of ground water stored in the basin and by the intrusion of surface water of poor quality into the ground-water reservoir in the lower area of the basin.

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TABLES

Table 1 indicates the construction and yield characteristics of selected wells in the Hackensack River basin. Aquifer designations are: Trb Brunswick Formation, Trdb diabase, Q Quaternary deposits. The use of the well is indicated by letter symbols which are: A abandoned, C commercial, D domestic, I industrial, and T test well. In the remarks column the current status and use of the well and quality of produced water is further defined where known. The letters BT indicate that borehole velocity measurements were made in the well during the course of this investigation. The location of the wells is shown on figure 2. The wells are numbered serially in each political subdivision. Table 2 is a compilation of chemical data on water from wells in the New Jersey part of the basin.

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-ALPINE																
1	Virgil L. King	23.45.4.7.5	Georgi	1-20-50	110	105	21	6	28	--	Trdb	4	12	71	0.2	D	
2	James S. Carson	23.44.6.6.3	Richardson	8-28-51	340	121	--	6	47	--	do.	14	30	6	5.0	D	
	BERGENFIELD																
1	H. Patterson & Sons	26.4.2.2.5	Rinbrand	5-8-50	70	200	20	8	20	--	Trb	11	55	49	1.1	C	Greenhouse
2	Grand Union Co	26.4.1.5.6	Burrows	6-2-53	130	102	35	6	36	--	do.	12	80	35	2.3	C	Air Conditioning
3	John Vetter	26.4.1.6.4	Rinbrand	4-14-55	100	105	10	6	28	--	do.	25	5	10	.5	D	
	BOGOTA																
1	Bogota Water Co.	26.4.4.7.4	--	--	17	275	--	8	--	--	Trb	50	180	--	--	A	
2	do.	do.	--	--	59	550	--	10	--	--	do.	50	180	--	--	A	
3	do.	26.4.4.4.8	--	10-38	69	350	8.5	12-10	50	--	do.	0	179	75	2.4	PS	Emergency use
4	do.	26.4.4.7.1	Rinbrand	6-46	59	235	10.5	18-12	45.5	--	do.	0	153	180	.8	PS	do.
	CARLSTADT																
1	Hackensack Water Co.	26.13.2.2.6	Artesian	8-54	5	103	86	8	93	--	Q	--	--	--	--	T	Abandoned
2	do.	26.3.8.8.8	do.	2-55	5	271	263	8-6	263	--	Q	17	--	--	--	T	do.

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Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-CARLSTADT-Cont																
3	Hackensack Water Co.	26.3.8.8.8	Artesian	11-55	5	86	--	8	65	65-70	Q	--	305	30	11.6	T	Abandoned-high mineral content
	CLOSTER																
1	Theodore Landgren	23.44.3.9.1	E. Hamilton	1-11-51	80	106	73	6	73	--	Trs	30	10	25	0.4	D	
2	Richard Snyder	23.44.3.9.2	Georgi	10-22-51	180	110	35	6	36	--	do.	--	8	--	--	D	
3	Porfiris G. Paccagnini	23.44.3.4.6	J.W. Sikkema	1-1-52	80	65	16	6	16	--	Trb	2	12	16	0.8	D	
4	Frank Massaro	23.44.2.9.9	Richardson	1-15-52	50	86	56	6	56	--	do.	6	20	14	1.4	D	
5	Gabriel Magnabos Co.	23.44.3.9.1	Georgi	8-8-52	120	123	--	6	53	--	Trs	1.5	10	7	1.4	D	
6	Giovinazzo Bros. Co.	23.44.3.4.8	Rinbrand	4-27-54	50	105	--	6	40	--	Trb	1	10	9	1.1	D	
7	Hackensack Water Co.	23.44.2.8.4	Artesian	9-28-58	40	75	--	8	72	--	Q	--	--	--	--	T	Abondoned-casing pulled
8	Charles Stambaugh	23.44.3.7.6	C. Sikkema	12-28-58	115	85	40	6	40	--	Trs	2	50	--	--	D	
	CRESSKILL																
1	William Koch	23.44.6.8.7	Georgi	8-27-51	140	68	32	6	32	--	Trs	8	7	24	.3	D	
2	Hoke Valve Co	23.44.6.7.4	Burrows	10-57	40	279	72	8	73	--	Trb	0	250	96	2.6	C	Air conditioning

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-CRESSKILL-Cont																
3	Hoke Valve Co	23.44.6.7.4	Burrows	4-24-58	40	276	72	8	73	--	Trb	0	329	--	--	C	Air Conditioning
	DEMAREST																
1	John F. Wuerth	23.44.6.3.7	Rinbrand	7-28-48	79	127	--	6	41	--	Trs	10	2	--	--	D	
2	Otto Boeltcher	23.44.5.3.6	Richardson	4-15-52	40	144	103	6	103	--	Trb	27	15	18	.8	D	
	DUMONT																
1	Henry J. Sealy	23.44.5.7.6	Bummerlyn	2-8-55	140	185	--	6	18	--	Trb	10	25	15	1.7	--	
	E. RUTHERFORD																
1	Alpha Refining Co.	26.13.2.9.8	--	--	5	400	--	--	--	--	Trb	--	115	--	--	I	
2	Trubek Labs	--	--	1933	5	140	--	8	--	--	Q	--	100	--	--	I	
3	do.	26.13.2.2.2	Rinbrand	5-49	10	140	--	8	110	110-140	Q	6	500	44	11.4	I	
4	do.	26.13.2.1.6	do.	10-14-58	5	146	--	10	140	140-146	Q	40	400	70	5.7	I	
5	do.	26.13.2.1.4	do.	10-10-56	5	201	--	10	191	191-201	Q	20	105	130	.8	I	
6	do.	26.13.2.1.5	do.	10-1-56	5	140	--	10	120	120-140	Q	15	250	95	2.6	I	
7	Caughey Bar	26.13.2.1.3	Burrows	8-14-51	10	276	201	6	201	--	Trb	25	45	38	1.2	C	Air Conditioning
8	Belmead Dev. Corp.	26.13.2.9.3	Artesian	9-17-48	5	416	260	6	277	--	Trb	10	27	7	3.8	I	

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-E. RUTHERFORD-Cont.																
9	Vestal Builders Inc.	26.13.2.9.4	Algier	8-20-54	5	130	95	6	95	--	Trb	15	20	15	1.3	C	
	EMERSON																
1	Emerson Hotel	23.44.1.7.5	Burrows	2-17-53	30	65	--	6	45	45-55	Q	4	40	40	1.0	C	
2	Magnetic Devices Corp.	23.44.1.7.5	Rinbrand	3-31-59	40	175	--	6	80	--	Trb	1	35	14	2.5	I	
3	Hackensack Water Co.	23.44.1.8.2	Artesian	4-9-65	30	478	77	12	78	--	Trb	flows	200	78	2.5	PS	BT
	ENGLEWOOD																
1	L.F. Morrissey	26.4.5.3.8	Rinbrand	4-52	190	195	--	6	20	--	Trdb	2	20	62	0.3	D	
2	Dumont Corp.	26.4.5.3.7	Algier	5-2-52	10	410	55	8	55	--	Trb	flows	60	150	.4	I	
3	Tube Sales	26.4.5.5.8	Artesian	5-53	5	450	67	10	89	--	Trb	3	82	187	.4	C	
4	Grand Union Co	26.4.2.9.2	Burrows	11-18-53	40	158	76	6	90	--	Trb	18	180	30	6.0	C	
5	C & C Realty	26.4.5.5.2	Artesian	12-53	5	354	135	8	135	--	Trb	flows	115	187	.6	I	
6	Tube Sales	26.4.5.5.8	do.	3-54	5	470	--	10	101	--	Trb	10	20	190	.1	I	
7	Solo Products	26.4.5.8.1	Burrows	1-28-54	3	200	71	8-6	50	--	Trb	3	250	22	11.3	I	
8	do.	do.	--	--	5	200	--	6	--	--	Trb	--	55	--	--	--	
9	Paramont Photo	26.4.5.5.6	--	6-55	10	310	--	6	64	--	Trb	1	100	59	1.7	I	

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-ENGLEWOOD-Cont																
10	Cart-Wright Ind	26.4.5.8.1	C. Sikkema	10-12-60	25	298	115	6	115	--	Trb	2	100	88	1.1	I	
	HACKENSACK																
1	Hackensack Water Co.	26.3.6.3.2	Artesian	5-54	24	194	183	8	146	141-166	Q	17	670	64	10.5	T	
2	do.	do.	do.	9-15-54	14	168	--	36-20	149	149-168	Q	20	1700	83	20.5	PS	
3	do.	do.	do.	7-15-54	14	200	200	8-6	180	179-188	Q	9	215	81	2.6	T	
4	do.	do.	do.	7-21-55	25	190	--	20	168	168	Q	7	1420	100	14.2	PS	
5	Noca Corp.	26.3.6.6.1	--	10-45	20	240	--	12	--	--	Trb	--	300	--	--	--	
6	Metropolitan Playhouses	26.3.6.6.1	Lauman	1-19-49	25	252	--	8	238	234-252	Q	19	150	116	1.3	C	
7	J. Muscarelle	26.3.3.8.5	Rinbrand	10-12-49	80	185	--	6	32	--	Trb	35	30	--	--	D	
8	Bergen Evening Record	26.3.6.6.7	Artesian	1-51	5	504	236	10	236	--	Trb	2	140	157	0.9	C	
9	Red Lion Inn	26.3.6.3.5	Burrows	12-12-53	30	241	222	10-6	211	209-216	Q	17	400	82	4.9	C	
10	Food Fair Stores Inc.	26.3.6.6.7	do.	11-54	10	525	270	10-9	270	--	Trb	70	55	130	.4	U	

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	BERGEN COUNTY-HACKENSACK-Cont.																
11	Board of Education	26.3.6.5.5	Rinbrand	10-7-55	15	200	--	8	46	--	Trb	20	100	60	1.7	C	Irrigation
12	Spartan Typographers	26.3.3.9.5	do.	10-12-55	20	145	--	10	135	135	Q	25	75	45	1.7	C	
13	Galler Bottling Co.	26.3.6.5.7	Artesian	12-17-56	10	390	123	8	133	--	Trb	13	253	62	4.1	I	
14	Seilheimer Beverage Co.	26.3.6.9.1	do.	4-8-58	10	415	104	8	115	--	Trb	8	76	112	.7	I	
15	Hackensack Cable Co.	26.3.3.9.4	Rinbrand	9-21-57	10	439	112	10	120	--	Trb	40	55	160	.3	I	
16	do.	do.	do.	8-1-58	15	120	--	10	106	105	Q	28	171	72	2.4	I	
17	Bowler City	26.3.6.5.9	do.	9-20-58	10	400	--	8	120	--	Trb	25	108	--	--	C	
18	Tobiason & Son	26.3.6.3.4	Ziegenfuss	3-31-53	20	120	--	6	34	--	Trb	8	12	32	.4	C	
19	Central Auto Laundry	26.3.6.6.4	Sikkema	2-2-50	50	325	258	6	258	--	Trb	3	50	53	.9	C	
	HARRINGTON																
1	Hackensack Water Co.	23.44.2.8.1	Artesian	7-54	40	95	--	--	--	--	Q	--	--	--	--	T	Abandoned-casing pulled
2	do.	23.44.2.7.3	do.	8-54	40	96	82	8	70	70-79	Q	13.5	180	44	4.1	T	

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	BERGEN COUNTY-HARRINGTON Cont.																
3	Hackensack Water Co.	23.44.2.7.1	Artesian	2-55	35	89	79	8	--	--	Q	--	--	--	--	T	Abandoned-casing pulled
4	do.	do.	do.	6-56	40	106	--	8	80	80-87	Q	12.2	133	48	2.8	T	
5	do.	23.44.2.7.3	do.	7-56	40	94	--	8	--	--	Q	--	--	--	--	T	Abandoned-casing pulled
6	do.	do.	do.	4-18-65	40	420	99	8	102	--	Trb	--	--	--	--	T	BT
	HAWORTH																
1	Myrtle Compte	23.44.2.7.9	Rinbrand	11-1-51	40	100	44	6	44	--	Trb	20	10	--	--	D	
2	Dominic Serafine	23.44.5.3.7	Richardson	12-1-52	110	106	23	6	23	--	Trb	17	25	13	1.9	D	
3	Ralph Carletta	23.44.4.6.1	Burrows	2-14-54	30	260	138	6	138	--	Trb	30	10	80	.1	D	
4	Hackensack Water Co.	23.44.4.2.7	Artesian	4-54	30	162	158	8	158	--	Q	--	--	--	--	T	Casing removed
5	do.	23.44.4.2.8	do.	6-54	30	125	110	8	112	--	Q	--	--	--	--	T	do.
6	do.	23.44.4.2.7	do.	6-54	20	227	204	8	--	--	Q	--	--	--	--	--	do.

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

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	BERGEN COUNTY-HILLSDALE																
1	Alfred Campbell	23.33.9.5.3	Rinbrand	9-7-49	120	135	33	6	33	--	Trb	20	10	--	--	D	
2	Richard Prell	23.33.9.7.3	Wm. Sikkema	6-10-56	420	170	34	6	34	--	Trb	90	12	--	--	D	
3	Earl F. Barsh	23.33.9.9.4	D.W. Sikkema	7-7-52	220	110	32	6	32	--	Trb	4	30	12	2.5	D	
4	Roger Schliet	23.33.8.6.9	Wm. Sikkema	1-28-59	145	165	20	6	20	--	Trb	26	40	--	--	D	
5	Leo R. Goldman	23.33.9.8.8	C. Sikkema	2-9-59	175	150	21	6	21	--	Trb	8	35	14	2.5	D	
6	Hackensack Water Co.	23.33.9.5.9	Artesian	3-31-65	70	456	69	8	44	--	Trb	flows	190	70	2.7	PS	
	LITTLE FERRY																
1	Atlas Plastics	26.3.9.3.7	Georgi	9-15-48	10	157	50	6	54	--	Trb	18	17	52	.3	I	
	LYNDHURST																
1	L. DelGrasso	26.13.1.8.2	Burrows	4-30-52	65	110	23	6	23	--	Trb	24	55	16	3.4	--	Air Conditioning
	MONTVALE																
1	Rosario Blanda	23.34.4.8.2	Rinbrand	11-18-48	240	125	--	6	31	--	Trb	20	9	12	.8	D	
2	Andre Piplate	23.33.6.1.6	E. Hamilton	2-10-52	450	118	45	6	47	--	Trb	35	12	7	1.7	D	
3	Edward De Pierc	23.33.6.2.7	C. Sikkema	7-8-52	396	118	74	6	74	--	Trb	64	24	--	--	D	
4	P. Belnay	23.33.6.1.6	J. Sikkema	7-16-52	448	136	64	6	64	--	Trb	50	18	4	4.5	D	

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	BERGEN COUNTY-MONTVALE-Cont																
5	Standard Oil	23.33.5.3.9	Algier Bros.	1-6-56	430	110	35	6	35	--	Trb	20	20	20	1	C	
6	Texas Co.	23.33.5.6.7	C. Sikkema	1-6-59	430	150	85	6	85	--	Trb	60	30	26	1.1	C	
	MOONACHIE																
1	Hackensack Water Co.	26.3.8.6.8	Artesian	6-27-55	5	243	233	8-6	8-139 6-233	113-123	Q	23	60	177	.3	T	Casing removed
2	Frank A. Rity	26.3.8.9.5	Peerless	5-26-52	5	166	131	6	131	--	Trb	30	20	30	.7	I	
3	Little Ferry Al. Foil & Bronze	26.3.8.9.8	A. Wilhelm	10-18-51	5	160	96	6	96	--	Trb	30	5	20	.2	I	
4	Atlantic Pipe Bending & Fab.	26.3.8.9.6	do.	10-22-51	5	160	79	6	79	--	Trb	15	5	35	.1	I	
5	Terminal Const.	26.3.9.7.9	do.	10-6-51	5	190	113	6	113	--	Trb	20	10	10	1.0	C	
	NEW MILFORD																
1	Food Fair Mkt.	23.44.4.1.8	Burrows	6-16-62	3	438	244	8	244	234-244	Q	1	100	200	.5	C	
2	W.H. Byrne	23.44.4.9.7	Richardson	9-6-52	55	106	39	6	39	--	Trb	16	15	9	1.7	D	
3	Hackensack W.C.	23.44.4.4.9	Artesian	4-54	30	122	113	8	118	--	Q	--	--	--	--	T	Casing removed
4	do.	23.44.4.7.3	Artesian	4-8-65	30	400	90	8	95	--	Trb	8	20	165	.1	T	BT

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Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-N. ARLINGTON																
1	Food Fair Stores	26.13.4.7.1	Burrows	11-26-56	105	320	30	8	30	--	Trb	42	82	108	.8	U	
	NORTHVALE																
1	Richard Rosenberg	23.34.9.4.8	J.W. Sikkema	4-8-49	265	185	88	6	88	--	Trb	7	20	5	4	D	Boys Camp
	NORWOOD																
1	J.F. McDonald	23.44.3.6.6	Rinbrand	10-25-48	100	140	--	6	30	--	Trdb	30	11	--	--	D	
2	Shaum Wiltshire	23.34.9.7.8	do.	8-30-49	120	120	30	6	30	--	Trdb	25	6	2	3	D	
3	Frank Heenan	23.34.9.7.8	do.	10-14-51	40	175	--	6	58	--	Trdb	35	10	1	10	D	
4	Hackensack W.C.	23.44.3.4.5	Artesian	7-25-55	25	54	50	8	--	--	Q	4	--	--	--	T	Casing pulled
5	do.	do.	do.	10-55	40	400	138	18-12	156	--	Trb	flows	--	--	--	T	
	OLD TAPPAN																
1	Leon Gielis	23.34.7.6.2	Rinbrand	6-30-49	126	125	--	6	28	--	Trb	15	5	5	1	D	
2	E. Rappold	23.34.8.6.1	do.	10-19-49	126	135	35	6	35	--	Trb	18	10	4	2.5	D	
3	Madlia Hadley	23.34.8.6.3	do.	11-9-50	100	130	--	6	42	--	Trb	22	10	8	1.2	D	
4	John Pest	23.34.8.9.3	Richardson	9-8-51	100	70	--	6	23	--	Trb	4	25	16	1.6	D	

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-OLD TAPPAN-Cont.																
5	Lester Bennett	23.34.8.9.3	Richardson	12-28-51	100	61	--	6	24	--	Trb	5	25	15	1.7	D	
6	W.H. Samstead	23.34.8.3.9	do.	2-13-52	126	84	--	6	51	--	Trb	23	20	2	10.0	D	
7	C. De Wolf	23.34.8.2.9	do.	10-23-52	100	127	--	8	41	--	Trb	13	40	17	2.3	D	
8	Wm. Damm	23.34.7.9.2	Burrows	11-14-53	110	82	33	6	34.5	--	Trb	10	20	--	--	D	
9	Hackensack W.C.	23.34.7.9.1	Artesian	9-15-54	55	451	--	18-12	84	--	Trb	0	150	138	1.1	T	
10	Hackensack W.C.	23.34.7.9.2	Artesian	9-54	55	75	70	8	68	--	Q	--	--	--	--	T	
11	do.	23.34.7.9.1	do.	do.	55	75	69	8	69	--	Q	--	--	--	--	T	
12	do.	23.34.7.9.6	do.	do.	55	68	60	8	60	--	Q	--	--	--	--	T	
	ORADELL																
1	Cronenberg Homes	23.43.6.2.3	Rinbrand	6-2-50	100	150	23	6	32	--	Trb	10	20	--	--	D	
2	Walter Brown	23.43.6.6.8	do.	12-24-52	70	105	19	6	29	--	Trb	7	10	--	--	D	
3	Hackensack W.C.	23.44.4.1.9	Artesian	8-54	30	163	155	8	154	--	Q	--	--	--	--	T	Casing removed.
4	do.	23.44.4.2.7	do.	10-54	30	203	194	8	168	--	Q	--	--	--	--	T	Casing removed.
5	do.	23.44.4.4.2	do.	2-55	30	63	--	8	--	--	Q	--	--	--	--	T	Casing removed.

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-PARAMUS																
1	H.C. Thomsen	23.43.6.5.8	Rinbrand	6-18-49	110	110	29	6	29	--	Trb	45	6	--	--	D	
2	B. Zelauch	23.43.6.5.3	do.	4-30-49	80	100	23	6	23	--	Trb	16	7	--	--	D	
3	Cooper Plywood & Door Co.	23.43.6.7.8	do.	8-10-51	80	75	22	6	22	--	Trb	12	10	1	10	C	
4	H. Ferrante	23.43.3.7.8	W.J. Sikkema	3-20-53	70	161	87	6	87	--	Trb	16	45	--	--	D	
5	Blue Ridge Stables	23.43.6.8.8	Burrows	6-29-53	50	126	--	6	42	--	Trb	12	30	20	1.5	C	
6	Karl Andres	23.43.6.5.2	Rinbrand	10-25-53	80	95	28	6	28	--	Trb	2	7	18	.4	D	
7	Hackensack W.C.	23.43.6.1.2	Artesian	7-1-54	60	66	59	8	--	--	Q	--	--	--	--	T	Casing removed.
8	do.	23.43.6.2.1	do.	7-54	60	69	56	8	54	--	Q	--	--	--	--	T	Casing removed.
9	do.	do.	do.	8-54	60	59	49	8	49	--	Q	--	--	--	--	T	do.
10	Elton R. Baird	26.3.3.1.9	Rinbrand	8-22-48	80	118	--	6	30	--	Trb	6	10	10	1.0	D	
11	B. Puchaleshi & J. Falk	26.3.3.4.2	do.	7-21-51	80	125	30	6	30	--	Trb	17	10	--	--	D	

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-PARK RIDGE																
1	W. Darkert	23.34.7.2.7	A. Wilhelm	1-14-52	150	150	97	6	97	--	Trb	35	15	20	.8	D	
2	G. E. Klug	23.33.6.6.9	Algier Bros.	7-12-54	160	200	68	6	68	--	Trb	27	60	33	1.8	I	
3	Glen Rock Girl Scout Camp	23.33.6.7.1	C. Sikkema	7-24-59	220	90	--	6	32	--	Trb	5	50	13	3.8	D	
4	Boro of Park Ridge	23.33.6.9.8	J. F. Harris	1924	120	252	35	16-12	35	--	Trb	4	200	84	2.4	PS	
5	do.	do.	Grundy	1925	145	435	35	12-10	120	--	Trb	--	185	130	1.4	PS	
6	do.	23.33.6.7.8	J. P. Harris	7-23-34	300	502	12	17-12	62	--	Trb	32	160	164	1.0	PS	
7	do.	23.34.4.7.7	Rinbrand	4-1-48	97	445	138	12	144.2	--	Trb	45	170	115	1.5	PS	
8	do.	23.33.9.3.1	Artesian	2-55	100	41	41	22	30	--	Q	5	207	20	10.1	PS	
9	do.	23.33.9.3.5	do.	2-55	100	38	--	22	36	--	Q	2	200	30	6.7	PS	
10	do.	23.33.9.3.2	Caisson Wells	5-26-59	110	400	58	100	36	36-38	Q & Trb	1.35	719	23	31.4	PS	
11	do.	23.33.9.3.2	do.	3-3-54	110	24	--	--	27.5	22-23	Q	5	210	14.3	14.7	PS	
12	do.	23.33.9.5.2	Burrows	9-58	103	663	45	12-8	60	28-38	Q & Trb	5.25	302	25	12.8	PS	
13	do.	23.33.6.8.3	do.	11-12-65	240	450	42	18-12	57	--	Trb	6	172	114	1.5	PS	BT

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Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Drawdown (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-PARK RIDGE-Cont.																
14	Boro of Park Ridge	23.33.6.8.3	Burrows	1965	240	300	47	8	47	--	Trb	8	151	127	1.2	TS	
15	do.	23.33.6.5.7	Rinbrand	1966	265	300	45	8	45	--	Trb	18	132	184	.7	T	
16	do.	23.33.9.2.1	Burrows	1966	180	305	11	10	16	--	Trb	3	173	106	1.6	T	
	RIDGEFIELD																
1	Merrill Corp.	26.14.1.2.9	Rinbrand	10-30-48	10	300	--	8	30	--	Trb	11	90	139	.6	I	
2	Pfister Chem.	26.4.7.9.1	do.	3-2-48	5	358	63	8	70	--	Trb	10	105	110	1.0	I	
3	do.	do.	do.	4-6-48	5	327	63	8	67	--	Trb	17	150	133	1.1	I	
4	J. Turner & Co	26.14.1.2.9	do.	1940	20	183	--	6	18	--	Trb	8	35	13	2.7	I	
5	do.	do.	do.	1940	20	250	--	8	--	--	Trb	--	70	--	--	--	
6	do.	do.	do.	1947	20	260	--	8	--	--	Trb	--	70	--	--	--	
	RIDGEFIELD PK.																
1	Lincoln Paper	26.4.7.4.6	do.	4-6-51	10	350	117	6	117	--	Trb	21	125	--	--	I	
	RIVER EDGE																
1	Cornwell Inc.	26.3.3	Rinbrand	10-1-60	50	210	45	6	45	--	Trb	30	75	40	1.9	I	
2	Ercole Tamburelli	26.3.3.6.8	Burrows	3-55	50	300	14	8	26	--	Trb	20	275	130	2.1	I	

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Alti-tude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diam-eter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-RIVERVALE																
1	O. H. Mildner	23.34.4.8.2	Rinbrand	3-9-49	257	158	70	6	80	--	Trb	30	15	8	1.9	D	
2	J. Basralian	23.34.7.9.4	R. Ellison	--	55	312	63	6	63	--	Trb	6	20	14	1.4	D	
3	do.	do.	do.	--	55	300	60	6	--	--	Trb	8	10	22	.5	D	
4	W. Karl	23.34.7.2.6	A. Wilhelm	2-15-52	180	174	112	6	112	--	Trb	65	15	9	1.7	D	
5	G. K. Walker	23.34.4.9.6	do.	3-17-52	160	128	30	6	30	--	Trb	30	20	1	1	D	
6	J. Nugent	23.34.7.3.2	Georgi Bros.	7-29-52	150	181	97	6	102	--	Trb	51	9	34	.3	D	
	ROCHELLE PARK																
1	Hackensack W.C.	26.3.2.6.4	Artesian	3-31-65	40	473	74	12	78	--	Trb	7	250	121	2.1	C	Air Condition-ing
	RUTHERFORD																
1	Rutherford Trust Co.	26.13.1.3.7	--	4-8-49	100	210	--	--	--	--	Trb	--	15	--	--	C	
2	D. McCullagh Mayer	26.13.1.3.7	Algier	5-5-54	100	166	3	6	11	--	Trb	65	15	5	3.0	D	
	S. HACKENSACK																
1	Stage Coach Inn	26.3.9.2.6	Rinbrand	6-14-50	10	565	75	8	75	--	Trb	8	110	92	1.20	C	
2	H. Maurydi	26.3.9.6.6	Parkhurst	11-18-48	5	293	48	6	53	--	Trb	20	30	35	.9	C	

Table 1.--RECORDS OF SELECTED WELLS IN THE HACKENSACK RIVER BASIN

Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-S. HACKENSACK-Cont.																
3	Spinner Yarn Co., Inc.	26.3.6.8.7	Artesian	1947	9	300	160	10	160	--	Trb	9	200	140	1.4	I	Cl 51 ppm 1950
4	Superior Tape	26.3.6.7.6	Rinbrand	7-15-59	15	213	--	6	200	200-213	Q	25	50	150	.3	I	
	TEANECK																
1	S. D. Elia	26.4.4.5.8	Richardson	8-20-52	140	189	18	6	18	--	Trb	37	40	13	3.1	C	
2	A & P Tea Co.	26.4.1.9.9	Rinbrand	5-1-52	110	150	--	6	35	--	Trb	20	35	40	.9	C	
3	Garden State National Bank	26.4.1.9.8	Burrows	1-16-53	90	150	27	6	27	--	Trb	flows	87	16	5.4	C	
4	Feibels Rec. Center	26.4.4.5.4	Burrows	6-25-53	100	292	10	8	22-8	--	Trb	6	60	100	.6	C	
5	do.	do.	do.	7-7-53	90	203	20	6	23	--	Trb	13	180	50	3.6	C	
6	Jewish Com. Center	26.4.4.6.4	do.	8-55	100	300	--	8-6	17	--	Trb	35	40	160	.2	C	
	TENAFLY																
1	Bd. of Education	26.4.2.3.6	do.	2-15-53	45	125	74	6	74	--	Trb	5	60	40	1.5	--	Used for park pond.
2	Grand Union Co	26.4.2.3.6	GS Art W&P	5-27-53	50	50	--	6	37	--	Trb	6	82	2	41	C	
3	Marderosian	26.4.2.2.7	Rinbrand	9-27-53	50	100	22	6	22	--	--	7	25	3	8	D	

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	BERGEN COUNTY-TENAFLY-Cont.																
4	Tenafly Mutual Savings & Loan	26.4.2.3.5	Rinbrand	5-6-55	100	85	--	6	29	--	--	--	15	--	--	C	
5	J. D'Agostino	26.4.2.6.6	Burrows	6-11-58	50	202	52	8	50	--	Trb	0	600	40	15	A	
6	do.	do.	do.	7-3-58	50	200	43	8	43	--	Trb	4	200	96	2.1	A	
7	do.	do.	do.	8-2-58	50	250	36	8	37	--	Trb	4	270	96	2.8	A	
	TETERBORO																
1	Detroy Press	26.3.9.2.4	GS Art W&P	12-8-56	5	150	67	8	67	--	Trb	8	95	9	10.5	I	
2	Bendix Corp.	26.3.9.1.8	PH&J Colan	1917	9	597	222	6	224	--	Trb	12	150	39	3.9	I	
	WASHINGTON																
1	F. Gaudagmino	23.43.2.2.6	Rinbrand	11-48	160	115	--	6	60	--	Trb	20	7	10	.7	D	
2	C. Mastroicovc	23.43.2.6.3	Rinbrand	11-23-48	140	125	--	6	40	--	Trb	23	2	--	--	D	
3	A. Algargotti	23.43.2.3.9	Slater Bros.	8-1-49	140	120	58	6	68	--	Trb	35	10	--	--	D	
4	Karl T. Schander	23.43.3.5.4	Rinbrand	11-17-50	60	200	98	6	98	--	Trb	60	10	--	--	D	
5	H. J. Rissetto	23.43.2.6.7	W.J. Sikkema	11-20-52	110	193	90	6	90	--	Trb	57	24	8	3.0	D	
6	C. Claus	23.43.3.4.9	C. Sikkema	12-8-55	165	233	125	8	125	--	Trb	60	25	15	1.7	D	
7	G. O'Brien	23.43.2.6.8	J.W. Sikkema	10-6-55	220	182	90	6	90	--	Trb	55	22	10	2.2	D	

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	BERGEN COUNTY-WESTWOOD																
1	H.J. Bauman	23.43.3.6.2	Rinbrand	1-28-50	80	150	60	6	60	--	Trb	15	10	5	2.0	D	
2	F. Rochester	23.44.1.1.9	do.	8-29-52	60	150	--	6	38	--	Trb	30	10	10	1.0	D	
3	G. Davis	23.43.3.6.7	Richardson	8-25-52	70	82	38	6	38	--	Trb	9	20	11	1.8	D	
4	Durby Labs	23.44.1.2.8	Rinbrand	6-28-54	50	170	35	6	35	--	Trb	15	20	--	--	I	
5	Sjostrom & Selander	23.43.3.6.5	do.	9-25-54	60	86	30	6	30	--	Trb	10	20	--	--	D	
6	Grand Union	23.44.1.1.4	NJ Art WD	2-56	60	201	--	6	33	--	Trb	28	90	28	3.2	C	
	WOODCLIFF LK.																
1	C. Edwards	23.33.5.9.2	Sikkema	3-10-49	166	164	58	6	58	--	Trb	8	12	32	.4	D	
2	Tice Bros.	23.33.5.9.9	do.	8-11-49	410	326	34	8	34	--	Trb	110	150	35	4.3	I	
3	N. Bergman	23.33.8.3.9	Rinbrand	10-15-51	360	110	6	6	13	--	Trb	53	7	--	--	D	
4	Fred Musson	23.33.9.4.2	A. Wilhelm	1-23-52	400	71	22	6	23	--	Trb	1	15	4	3.8	D	
5	Boro of Park Ridge	23.33.5.9.8	Burrows	8-30-63	320	303	18	6	18	--	Trb	39	195	65	3.0	T	
6	do.	23.33.8.3.9	Rinbrand	4-16-62	200	300	--	12	40	--	Trb	21	200	39	5.1	PS	
7	do.	23.33.2.9.8	do.	1964	340	350	16	18-12	42	--	Trb	35	204	150	1.4	PS	BT
8	Hackensack WC	23.33.9.5.2	Artesian	3-65	105	440	33	12	39	--	Trb	18	178	180	1	PS	BT

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Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	BERGEN COUNTY-WOODCLIFF LK-Cont.																
9	Hackensack W C	23.33.9.6.4	Artesian	4-65	105	400	112	8	113	--	Trb	21	55	179	.3	T	BT
10	Boro of Park Ridge	23.33.5.6.7	Rinbrand	1965	450	300	--	8	60	--	Trb	26	30	--	--	T	
	<u>HUDSON COUNTY</u>-HARRISON																
1	Worthington Pump & M Co.	26.12.9.5.9	----	--	15	400	295	9	--	--	Trb	80	250	40	6.3	I	
2	Harmon Color Wks. Inc.	26.12.9.5.9	----	1910	10	362	--	8	--	--	Trb	100	200	100	2.0	I	Cl 1.800 in 1950
3	T. Schriver Co	26.12.9.5.5	----	--	15	40	--	8	--	2	Q	29	46	--	--	I	
4	do.	do.	----	--	15	40	--	6	--	?	Q	29	30	--	--	I	
5	Liquid Carbonic Corp.	26.12.9.8.1	----	1938	20	489	307	8	--	--	Trb	67	225	87	2.6	I	
6	do.	do.	----	1934	20	465	320	8-6	--	--	Trb	67	90	90	1.0	I	
7	Hyatt Roller Bearing Co.	26.12.9.8.4	----	1918	9	950	277	8-6	395	--	Trb	79	336	--	--	I	
8	do.	do.	----	1918	9	987	282	8	--	--	Trb	--	347	--	--	I	
9	do.	do.	----	1914	8	241	--	8	--	--	Trb	--	--	--	--	I	

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Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	HUDSON COUNTY-HARRISON-Cont																
10	Hyatt Roller Bearing Co.	26.12.9.8.4	----	--	8	90	--	8	--	--	Q(?)	11.5	150	--	--	I	
11	Driver Harris Co.	26.12.9.7.6	----	--	9	337	292	12	--	--	Trb	76	600	--	--	I	Cl 1.680 1948
12	do.	do.	----	1946	9	300	279	8	--	--	Trb	38	469	41	11.4	I	
13	Pub. Serv. & Gas Co.	26.12.9.7.9	----	1932	11	699	218	12	--	--	Trb	37	406	139	2.9	I	
14	Crucible Steel Co. of America	26.12.9.8.4	----	1943	10	600	160	16-10	--	--	Trb	134	600	66	9.1	I	
15	Delaware & Western RR	26.12.9.8.3	H. W. Smith	8-27-52	20	225	--	6	115	--	Trb	96	18	--	--	I	
	JERSEY CITY																
1	Dodge & Bliss	26.13.8.9.5	----	1920	20	80	--	--	--	--	Q	--	50	--	--	I	
2	Spalding & Jennings	26.23.2.5.7	----	--	20	422	57	--	--	--	Trs	--	75	--	--	I	
3	Crucible Steel Co. of America	26.23.1.9.3	----	1925	12	210	--	--	--	--	Trb	--	100	--	--	I	
	KEARNY																
1	Wilpet Tool Mfg. Co.	26.12.9.6.4	Rinbrand	4-26-61	10	700	--	10	290	--	Trb	40	520	135	3.8	I	
2	Pfaft Tool & Mfg. Co.	26.12.6.9.9	Frank Bott	2-16-60	8	590	46	8	54	--	Trb	67	185	113	1.6	I	

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Well	Owner or Tenant	New Jersey Grid No.	Driller	Year Drilled	Altitude above msl (ft)	Total depth drilled below lsd (ft)	Depth to bedrock below lsd (ft)	Diameter of well (in)	Depth to which well is cased (ft)	Screen setting (ft)	Aquifer	Static level below lsd (ft)	Yield (gpm)	Draw-down (ft)	Specific Capacity (gpm/ft)	Use	Remarks
	HUDSON COUNTY-KEARNY-Cont.																
3	Pfaft Tool & Mfg. Co.	26.12.6.9.9	Frank Bott	1963	8	740	60	8	--	--	Trb	80	145	120	1.2	I	
4	E. I. DuPont	26.12.6.8.9	Stothoff	10-9-20	20	401	166	10-4	175	--	Trb	29	148	156	1.0	I	
5	do.	26.12.9.3.3	do.	10-30-20	5	202	124	10	130	--	Trb	--	174	--	--	I	
6	do.	26.13.4.7.7	do.	2-15-21	5	504	185	10	221	--	Trb	28	124	40	3.1	I	
7	E. I. DuPont	26.12.6.9.8	do.	9-1-16	70	802	47	10	49	--	Trb	25	90	--	--	I	
8	Joe Davis Plastics Co.	26.12.9.5.3	----	1930	10	350	17	8	--	--	Trb	17	168	54	3.1	I	
9	do.	26.12.9.5.3	----	1958	10	400	26	--	--	--	Trb	--	20	--	--	I	
10	Lawter Chem.	26.13.7.8.9	----	1939	8	200	112	8	--	--	Trb	--	--	--	--	I	Abandoned
11	American Stores	26.13.7.9.8	----	1941	8	1041	82	8	--	--	Trb	28	60	322	.2	I	
12	Koppers Gas & Coke Co., Inc.	26.13.8.8.2	----	1915	5	--	--	--	--	--	Trb	--	53	--	--	--	
13	N. Verzalero	26.12.9.6.1	Burrows	--	5	235	145	6	146	--	Trb	100	150	15	10	I	
	N. BERGEN																
1	Meer Corp.	26.14.1.5.6	Burrows	6-6-50	4	153	32	8	32	--	Trdb	2	100	22	4.5	I	
2	do.	26.14.1.5.3	do.	9-56	5	200	--	8	33	--	Trdb	--	60	--	--	I	

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	HUDSON COUNTY-N. BERGEN-Cont.																
3	Meer Corp.	26.14.1.5.5	Rinbrand	9-14-60	15	303	14	8	21	--	Trdb	30	35	270	.1	I	
4	Consolidated Bleaching Co.	26.14.1.8.3	Stothoff	7-31-50	10	528	93	10-8	93	--	Trdb	flows	44	155	.3	I	
5	Gibralter Paper Co.	26.14.1.4.6	Burrows	11-10-51	5	228	120	8	120	?	Q-Trdb	12	10	82	.12	T	Abandoned
6	do.	do.	do.	1-23-52	1	170	118	6	136	--	--	--	--	--	--	T	
7	Grand City Cont. Corp	26.13.6.8.9	Artesian	3-5-53	5	34	225	6	--	--	--	--	--	--	--	--	
8	Armour & Co.	26.14.1.7.3	----	--	5	101	--	--	--	--	Trb	--	98	--	--	I	
9	do.	do.	----	--	5	350	40	8	--	--	Trb	--	15	--	--	I	
10	do.	do.	----	1930	5	108	--	12	--	--	Q	--	250	--	--	I	33 ppm cl 1933 230 " cl 1937 440 " cl 1938
11	do.	do.	----	1933	5	113	113	24-12	--	--	Q	--	325	--	--	I	
12	do.	do.	----	1937	5	108	--	12	--	--	Q	--	--	--	--	I	
13	do.	do.	----	1937	5	113	113	24-12	--	--	Q	--	--	--	--	I	
14	do.	do.	----	1937	5	106	106	18-12	--	--	Q	32.5	300	63.5	4.7	I	

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	HUDSON COUNTY-N. BERGEN-Cont.																
15	Nat. Cylinder Gas Co.	26.14.1.8.2	----	1935	5	--	70	--	--	--	Trb	--	75	--	--	I	685 ppm cl 1938 430 ppm cl 1960
16	Mundet Cork	26.14.1.8.7	----	1954	40	65.5	--	12	--	--	Q	13	305	15	20.3	I	
17	W. Bergen Realty Co.	26.13.6.6.6	----	1962	8	72	--	16-12	--	--	Q	20	90	50	1.8	C	Brackish
18	DeAngelis Packing Co.	26.13.9.2.4	----	1947	10	60	60	10	--	--	Q	5	15	23	.7	I	
19	Chas. Miller & Co.	26.13.9.2.4	----	1934	5	35	--	12	--	--	Q	.5	700	14.5	48.3	I	
	SECAUCUS																
1	L. Vander Wall	26.13.3.7.6	Rinbrand	12-26-51	5	200	37	6	37	--	Trb	5	20	5	4.0	I	
2	Keystone Metal	26.13.6.4.2	do.	3-3-50	10	200	18	8	18	--	Trb	flows	76	101	.8	I	
3	do.	do.	do.	8-30-60	10	150	--	8	21	--	Trb	35	150	110	1.4	I	
4	Erie Railroad	26.13.8.3.1	----	1933	15	184	15	10	--	--	Trb	6	200	38	5.3	A	Water unsuitable for boiler use
5	do.	do.	----	1933	15	182	16	10	--	--	Trb	--	5	--	--	A	
6	Charles Haag, Inc.	26.13.6.7.6	----	1934	10	465	--	--	--	--	Trb	--	36	--	--	A	

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	HUDSON COUNTY-N. BERGEN-Cont.																
7	Charles Haag, Inc.	26.13.6.7.6	Stothoff Co	5-1-53	10	294	20	10	31.6	--	Trb	12	65	138	.5	A	
8	Gateway Motor Inn.	26.13.6.5.1	----	1962	8	160	--	6	--	--	Trb	8	55	7	7.9	C	

Table 2.--CHEMICAL ANALYSES OF SELECTED WELLS

(analyses in milligrams per liter, except as noted)

Analyses by U.S. Geological Survey, except as noted

Well No.	Location and Owner	Date	Silica (SiO_2)	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 (residue at 180°C)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25°C)	pH	Notes
															Calcium, magnesium	Noncarbonate			
1	BOGOTA Bogota Water Co.	12-4-64	--	--	--	--	--	--	--	--	29	--	1.8	--	--	--	--	7.3	H
2	do.	do.	--	--	--	--	--	--	--	--	19	--	2.4	--	--	--	--	7.5	H
3	do.	do.	--	--	--	--	--	--	--	--	30	--	1.9	--	--	--	--	7.5	H
2	CRESSKILL Hoke Valve Co.	11-19-64	--	--	--	--	--	--	--	--	15	--	2.2	--	--	--	--	7.7	H
2	EAST RUTHERFORD Trubek Chemical Co.	9-1-64	33.1	--	180	100	--	--	--	92	42	--	--	--	86	--	700	7.5	T
3	do.	do.	30.5	--	260	105	--	--	--	177	68	--	--	--	108	--	890	7.5	T
4	do.	do.	31.5	--	270	100	--	--	--	190	100	--	--	--	108	--	925	7.4	T
1	ENGLEWOOD Tube Sales	5-15-64	--	--	--	--	A 14	--	90	17	5.5	--	6.1	--	75	1	208	8.2	--
1	KEARNEY Pfaff Tool & Mfg. Co.	5-12-64	--	--	--	--	A 37	--	220	612	68	--	1.5	--	835	655	1610	7.4	--
2	do.	do.	--	--	--	--	A 4.8	--	142	966	88	--	5.5	--	1240	1120	2320	7.7	--
11	American Store	5-7-64	--	--	--	--	A274	--	80	566	755	--	.0	--	1210	1150	3480	7.3	--
1	LITTLE FERRY Atlas Plastics	5-12-64	--	--	--	--	A 30	--	100	87	58	--	3.6	--	192	110	579	7.3	--
8	PARK RIDGE Park Ridge Boro	4-29-59	11	.58	34	8.3	17	1.3	96	36	26	--	6.4	188	119	41	326	6.6	--
2	SECAUCUS Keystone Metal Finishing Co.	5-7-64	--	--	--	--	A 11	--	115	108	25	--	21	--	234	142	558	7.3	--
3	do.	do.	--	--	--	--	A 14	--	171	102	23	--	7.1	--	254	114	567	7.4	--

Source of Analysis: H Hackensack Water Co.
T Trubek Chemical Co.

A Calculated Na plus K, reported as Na.