POTENTIOMETRIC SURFACES ON LONG ISLAND, NEW YORK--A BIBLIOGRAPHY OF MAPS

by Douglas A. Smolensky

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CONVERSION FACTORS AND ABBREVIATIONS

Multiply inch-pound units	By	To obtain metric SI[1] units
million gallons per day	.0438	cubic meter per second (m^3/s)
inch	2.54	centimeter (cm)
foot	.305	meter (m)

National Geodetic Vertical Datum of 1929 (NGVD of 1929)

A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "mean sea level."

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[1] International System of Units

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ABSTRACT

Historic water-level records form a major basis for ground-water investigations and water-management decisions on Long Island. Potentiometric-surface maps, one of the major sources of historic data, are scattered within the literature or are available only through the publisher or sponsoring agency. This report presents a comprehensive list of available water-table and potentiometric-surface maps from the 19th century through 1979 with the scale, years represented, and area depicted, in addition to the complete bibliographic citations to facilitate retrieval.

The bibliography and list of maps are preceded by a description of the Long Island hydrologic system and a short history of ground-water development on the island, with emphasis on the effects of urbanization as reflected in ground-water levels. Six water-table maps from before 1900 through 1979 are included to illustrate the major historic ground-water trends.

INTRODUCTION

Ground-water levels in wells screened in the three major aquifers of Long Island have been measured since the late 19th century. The water-level measurements have been used over the years to construct maps of the potentiometric surface in each aquifer. Such maps are two-dimensional interpretations of the hydraulic potential distribution within the aquifer.

Potentiometric-surface maps of the two confined aquifers on Long Island (Lloyd and Magothy aquifers) represent an average vertical hydraulic potential, either through the entire vertical thickness of aquifer or some part thereof. Potentiometric-surface maps of the unconfined (upper glacial) aquifer, commonly referred to as the water-table aquifer, depict water levels from wells screened near the top of the saturated deposits.

Stresses such as ground-water pumping change the velocity and direction of ground-water flow and the quantity of water stored. Changes in the configuration or altitude of a potentiometric surface through time are indicative of the stresses put on the ground-water system. These changes may be seen by comparing potentiometric maps of the same area from different years. These maps are essential for hydrologic studies of an area and are indispensable in the development of digital models used to assess the effects of future stresses and management practices.

Since water levels were first recorded, a succession of manmade stresses on Long Island's ground-water system, coupled with natural water-level fluctuations due to variations in precipitation patterns, have continually altered the potentiometric surfaces of the three aquifers. The effects of large-scale pumping on the Long Island ground-water system were first noted during the late 19th century in Kings County. As urbanization and industrialization expanded eastward, the demand for freshwater increased. Through time, pumping to meet this steadily increasing demand has affected the ground-water system in several ways, among which are water-level declines, saltwater encroachment, and decreased base flow of streams.

Purpose and Scope

Many water-level and potentiometric-surface maps of Long Island have been compiled, but most are scattered within the literature, and some are unpublished or otherwise difficult to obtain. This report presents a comprehensive list of available maps and a bibliography giving information through which they can be located. The list contains all known water-table, potentiometric, and miscellaneous ground-water maps of Long Island and indicates their scale and area, and the time period represented. The bibliography gives the names of the author(s), date of publication or release, title, publisher, and number of illustrations or plates.

The first part of this report describes the island's hydrologic setting and history of ground-water development in terms of water-level changes and the practices that led to them. To illustrate these changes, a series of six water-table maps representing selected years from 1900 through 1979, and long-term hydrographs of a well from each of the four counties, are included. The second part of this report is the list of water-level maps and the biliography.

Sources

Most of the maps listed were obtained from U.S. Geological Survey publications dealing with Long Island. Several unpublished maps were also located; most were prepared by the Geological Survey during a series of ground-water investigations since the 1900's. Several documents cited herein were published by various local commissions and water-resource boards, many of which have since been disbanded. Additional material was provided by State and local agencies as well as local ground-water consultants.

Acknowledgements

This report was prepared in cooperation with the Nassau County Department of Public Works, the Suffolk County Department of Health Services, the Suffolk County Water Authority, and the New York State Department of Environmental Conservation.

Special thanks are extended to Robert O'Reilly of the New York State Department of Environmental Conservation and James Mulligan of the Nassau County Department of Public Works for providing bibliographic information and water-level maps to make this compilation complete.

LONG ISLAND GROUND-WATER SYSTEM

Long Island is underlain by a sequence of unconsolidated deposits of Late Cretaceous and Pleistocene age that in turn overlie crystalline bedrock of Precambrian (?) age (fig. 1A). The hydrogeologic units within these unconsolidated deposits have medium to high hydraulic conductivity and exhibit good to excellent water-transmitting properties. The intervening clay units retard the flow of ground water to varying degrees, depending on their thickness, extent, and conductivity. The major geologic units and their hydrologic equivalents are summarized in table 1 and described in the following paragraphs.

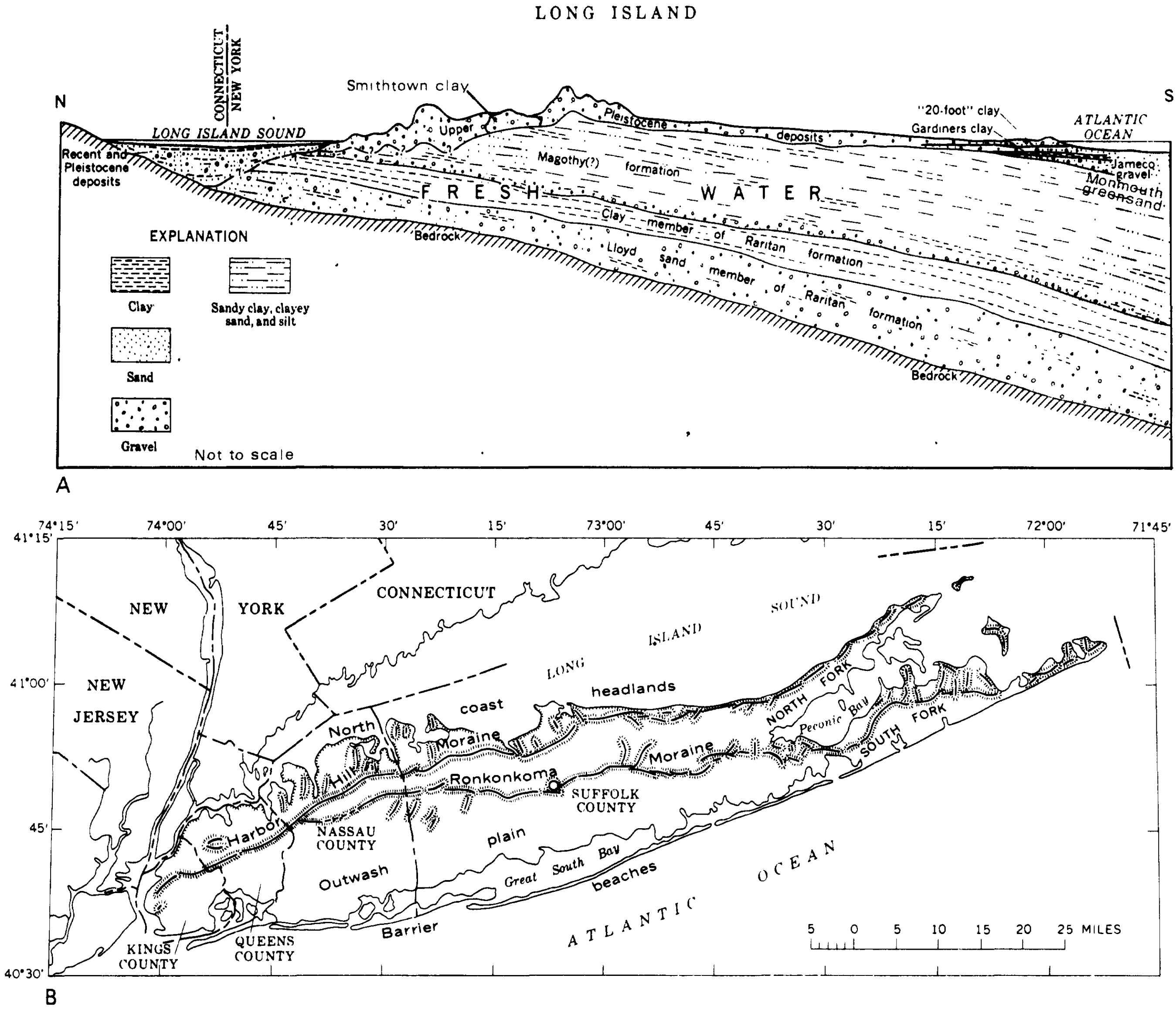


Figure 1.--Major hydrogeologic and geographic features of Long Island: A Representative hydrogeologic section (modified from Perlmutter and Geraghty, 1963) B. Surficial map (from McClymonds and Franke 1972).

Table 1.--Long Island stratigraphic column with geologic and hydrogeologic units. (From Reilly and Buxton, 1983)

SYSTEMS	SERIES	GEOLOGIC UNIT		HYDROGEOLOGIC UNIT
QUATERNARY	Holocene	Shore, beach salt-marsh deposits and alluvium		
	PLEISTOCENE	Till (ground and terminal moraine) Outwash "20-foot" clay (marine) "Smithtown clay unit" (glacio-lacustrine)		Upper glacial aquifer
		Unconformity ?		
		Gardiners Clay (marine)		Gardiners Clay
		Unconformity ?		
		Jameco Gravel		Jameco aquifer
		Unconformity ?		
CRETACEOUS	UPPER CRETACEOUS	Monmouth Group		Monmouth greensand
		Unconformity		
		Magothy Formation and Matawan Group undifferentiated		Magothy aquifer
		Unconformity ?		
		RARITAN FORMATION	Clay member	Raritan confining unit
			Lloyd Sand Member	Lloyd aquifer
		Unconformity ?		
PRE-CAMBRIAN		Crystalline bedrock		Bedrock

Major Aquifers and Confining Units

Cretaceous Deposits

Directly overlying the bedrock is the Raritan Formation of Late Cretaceous age, which consists of the Lloyd Sand Member (Lloyd aquifer) and an overlying unnamed clay member (Raritan confining unit). The Lloyd aquifer is the deepest confined aquifer on Long Island and supplies a small percentage of the ground water used on Long Island. The Raritan confining unit, with its large areal continuity, is a prominent factor in the flow system in that it retards the flow of water between the Lloyd and Magothy aquifers and diverts flow in the Magothy seaward, as illustrated in figure 2.

Overlying the Raritan Formation is the Magothy Formation-Matawan Group undifferentiated (Magothy aquifer), also of Late Cretaceous age. These deposits consist of clayey and silty fine to medium sand, some gravel, and clay layers. The Magothy aquifer is the island's largest source of fresh water for public-supply systems. The Magothy does not contain any extensive clay layers but has several small to extensive clay lenses. On a regional scale, these clay lenses produce a high degree of anisotropy in the aquifer.

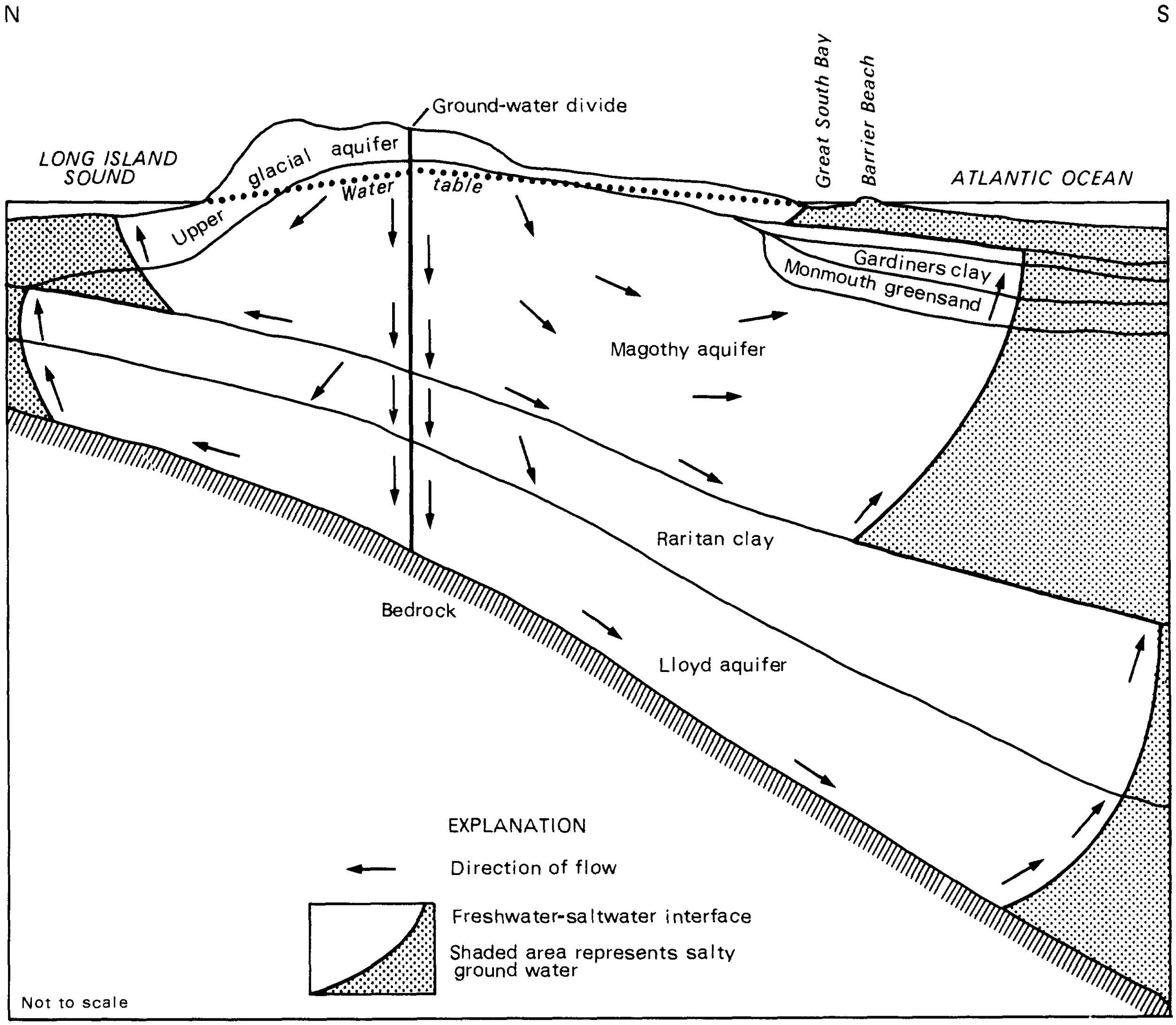


Figure 2.--Generalized hydrogeologic section showing ground-water flow paths under natural predevelopment conditions. (Modified from Franke and Cohen, 1972.)

The Monmouth Group (Monmouth greensand), a glauconitic sand and clay unit up to 200 ft thick, overlies the eroded Magothy Formation-Matawan Group surface and is found only in southern Suffolk County and southeastern Nassau County.

Pleistocene Deposits

A variety of Pleistocene deposits overlie the Magothy aquifer and Monmouth greensand. The oldest is the Jameco Gravel, a pre-Wisconsinan (upper Pleistocene) channel deposit (Soren, 1978) found only in Kings, southern Queens, and southwestern Nassau Counties. The pre-Wisconsinan Gardiners Clay overlies most of the Jameco Gravel. In southern Nassau and southwestern Suffolk Counties, where the Jameco Gravel is absent, this greenish-gray clay was deposited on the eroded Magothy-Matawan surface. Two other Pleistocene clay layers on Long Island are the Smithtown clay unit and the "20-foot" clay. Both are local confining units.

Most of Long Island's present topography is the result of Wisconsinan deposition near the end of the Pleistocene Epoch. Meltwater from deglaciation flowed southward off the terminal moraines along the center of the island (fig. 1B) and deposited the coarse to fine sand and gravel that forms the outwash plain. This outwash forms what has been termed the upper glacial aquifer, which was once a major source of public water supply. As a result of long-term surface contamination, however, it is no longer extensively used but is still a source of supply for many domestic wells, most of which are in eastern Suffolk County, where contamination is yet minimal.

Recharge and Ground-Water Flow

The sole source of natural freshwater recharge to the Long Island ground-water system is precipitation, which averages 44 inches per year. Seasonal fluctuations in the water-table altitude are a reflection of the amount of precipitation, amount of percolation through the unsaturated zone, evapotranspiration losses, and rate of seaward discharge from the system.

Under natural (predevelopment) conditions, overland flow of precipitation to streams represents less than 1 percent of the total precipitation, and evapotranspiration has been estimated to equal 50 percent of the total precipitation. Subtracting these amounts from total precipitation leaves a total natural recharge rate of 22 to 23 in/yr (Cohen and others, 1968, p. F21).

The upper boundary of the ground-water flow system is the water table, whose fluctuations in altitude reflect the recharge to and discharge from the system. The lower boundary of the hydrologic system is the crystalline bedrock, which is virtually impermeable.

A generalized north-south vertical section of Long Island showing the directions of ground-water movement under natural (predevelopment) conditions is given in figure 2. Near the ground-water divide, which runs east-west along the northern part of the island, ground water flows vertically downward and then horizontally. Ground water north of the divide eventually discharges into Long Island Sound, and ground water south of the divide discharges into Great South Bay and the Atlantic Ocean. Discharge from the system occurs at (1) saltwater interfaces that flank the north and south shores of Long Island and form the lateral boundaries of the ground-water reservoir; (2) stream channels that intersect the water table; and (3) nearshore marshes and wetlands, which are conducive to ground-water evapotranspiration.

Long Island's many streams do not replenish the ground-water system but act as drains that receive seepage from the surrounding aquifer. Consequently, the streams are discharge areas where ground water leaves the system and flows to the surrounding salt-water bodies.

More complete descriptions of Long Island's geologic history and hydrogeologic units are given in Suter and others (1949), Soren (1978), Jensen and Soren (1971), Perlmutter and Geraghty (1963), Kilburn (1980), Buxton and others (1981), and Franke and McClymonds (1972).

HISTORY OF GROUND-WATER DEVELOPMENT AND SYSTEM RESPONSE ON LONG ISLAND

Since the late 1800's, the industrial and residential development of Long Island has stressed the ground-water system. The effects of the physical stresses have caused concern as to the condition of the system and how future demands on it will be met. Many hydrologic maps and reports addressing this problem have been published during the 20th century; they are the source of information presented in the following paragraphs.

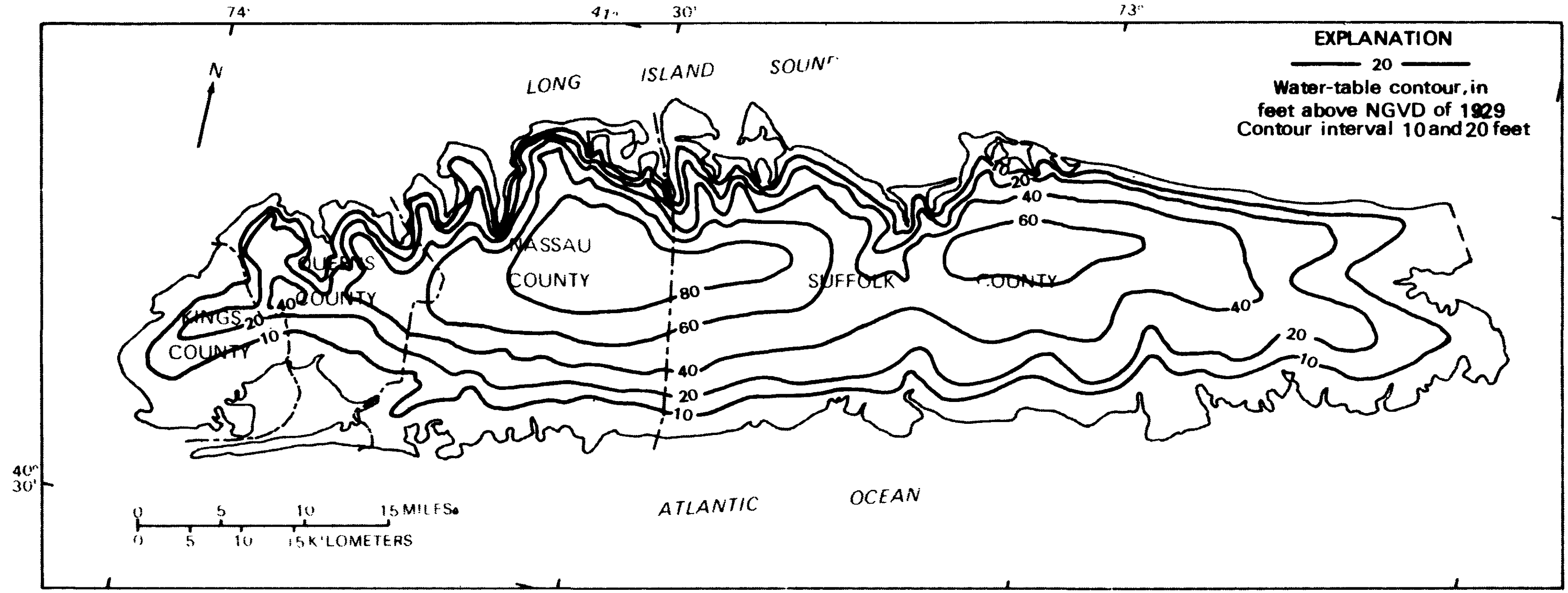
Before 1930

Although no islandwide map representing water-table altitudes before 1900 was ever published, the configuration under natural equilibrium conditions has been estimated from early records and is shown in figure 3. This map, derived from water levels observed in 1903 and shortly thereafter, is representative of an equilibrium period rather than a particular instant. Water-level records from later years indicate that the water-table altitudes shown in figure 3 were higher than in subsequent years.

The earliest regional water-table map (fig. 4) was based on observations made during 1903. At this time, pumping in western Long Island from the upper glacial aquifer was already extensive. Approximately 28 Mgal/d was being pumped in Kings County for public supply and industrial use (Lusczynski, 1952, p. 5), and approximately the same amount was also being pumped for public supply in Queens County. An even larger quantity was being pumped in Nassau County and exported to New York City. Comparison of figures 3 and 4 shows that by 1903, the water table in Kings County had already declined from its predevelopment level.

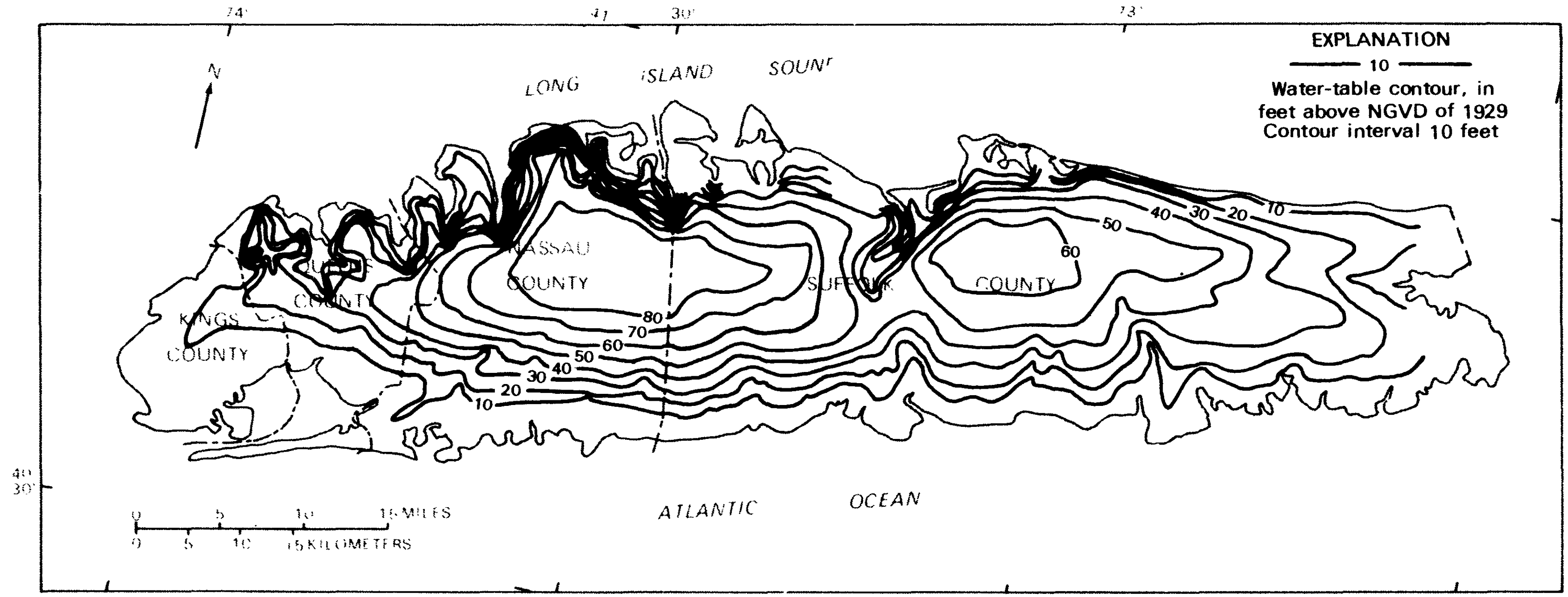
Pumping cannot be considered the sole cause of water-level declines in western Long Island, however. Building construction, paving, and sewer installations during this period of intense urbanization reduced the amount of recharge to the ground-water reservoir by covering the land surface and diverting storm runoff to tidewater and streams. By 1917, surface-water reservoirs in upstate watersheds supplied most of the public-supply water for New York City. The upper glacial aquifer was used primarily by industry, and pumping in the deeper aquifers remained small.

Although shallow ground water in western Long Island at this time was becoming contaminated by leachate from landfills, by sewage disposal, by saltwater, etc., and water levels were declining, shallow ground water in eastern Long Island was relatively unaffected. The small to moderate growth of towns in eastern Nassau County and Suffolk County caused only insignificant local changes in the water-table altitude. Water pumped from the upper glacial aquifer for domestic use was returned to the system through cesspools, which prevented consumptive loss. However, the continuous discharge of septic waste was beginning to have a cumulative effect on water quality.



Base from U.S. Geological Survey
State base map, 1 500,000, 1974

Figure 3. Estimated average water-table configuration under natural (predevelopment) conditions. (From Franke and McClymonds, 1972.)



Base from U.S. Geological Survey
State base map, 1:500,000 1974

Figure 4. Water-table configuration in 1903. (From Spear, 1912.)

1930's

During the early 1930's, growing concern over ground-water quality throughout most of Long Island prompted many agencies to begin continuous monitoring of the ground-water system. This concern also prompted the Water Conservation Law of 1933, which required reinjection of large quantities of water into the aquifer from which it was pumped. Both of these actions resulted in improved records of potentiometric levels, and the latter also put a new stress (injection) on the system.

The water table in 1936 reached new low levels in Kings and Queens Counties. The four hydrographs in figure 5 are indicative of the extent to which water levels had declined in each county by that time; the declines in southern Queens and Kings Counties were extensive. In northwestern Kings County, a large cone of depression had developed, in which the water table had dropped 50 ft since 1903 (fig. 6), and the newly formed landward gradients enabled seawater to enter both the upper glacial and artesian aquifers causing the chloride concentration of ground water near the coast to increase. In Kings County, saltwater moved into the cone of depression in the upper glacial aquifer and contaminated ground water as far inland as the center of the county.

1940's

The water-table configuration by 1943 (fig. 7) showed the effects of continued overpumping, especially in Kings County. The slight recovery in some areas of eastern Queens and Kings County since 1936 may have been due to local reinjection by industry, but the hydrographs in figure 5 show generally low water levels in both counties.

The mid- and late 1940's saw a reduction in industrial pumpage in Kings County, and in 1947, all public-supply pumpage in Kings County was stopped as a result of saltwater intrusion. Since then, the county has relied upon upstate reservoirs for all public-supply water. The hydrographs in figure 5 reflect the resulting water-table rise at well K1265 during this time.

1950's

During the late 1950's, the quality of water from the upper glacial aquifer continued to deteriorate in the more populated areas. In response, pumping from the deeper aquifers increased, adding to the stresses on the ground-water system, especially in Nassau and southeastern Queens Counties, which depend solely on ground water. Potentiometric levels in the Magothy aquifer had already been lowered in Queens County through the loss of recharge from the upper aquifer.

The 1959 water-table altitude is shown in figure 8. The most significant change since 1943 is the recovery of water levels in Kings County. The cone of depression in the northwest part of Kings County had risen to less than 10 ft below sea level, and water levels in most parts of Kings were above sea level and were continuing to rise slowly.

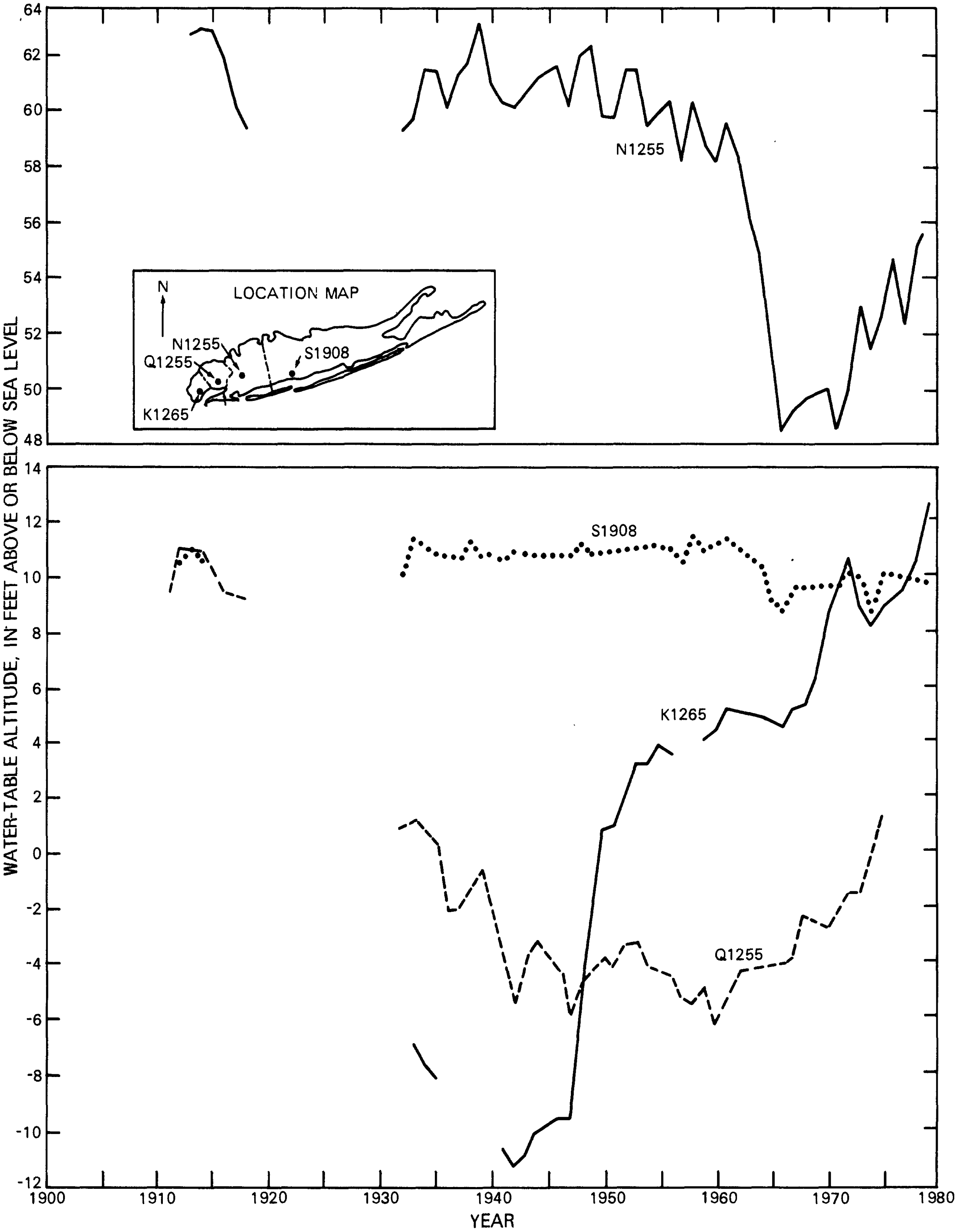
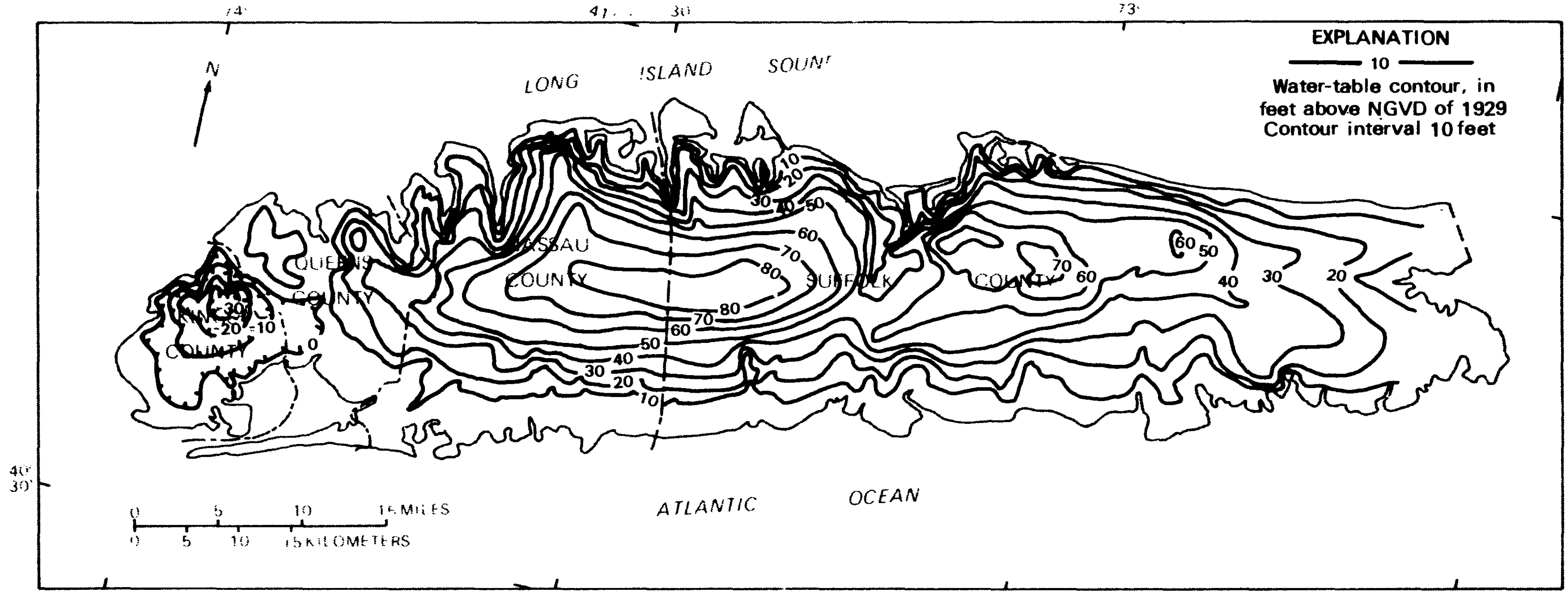
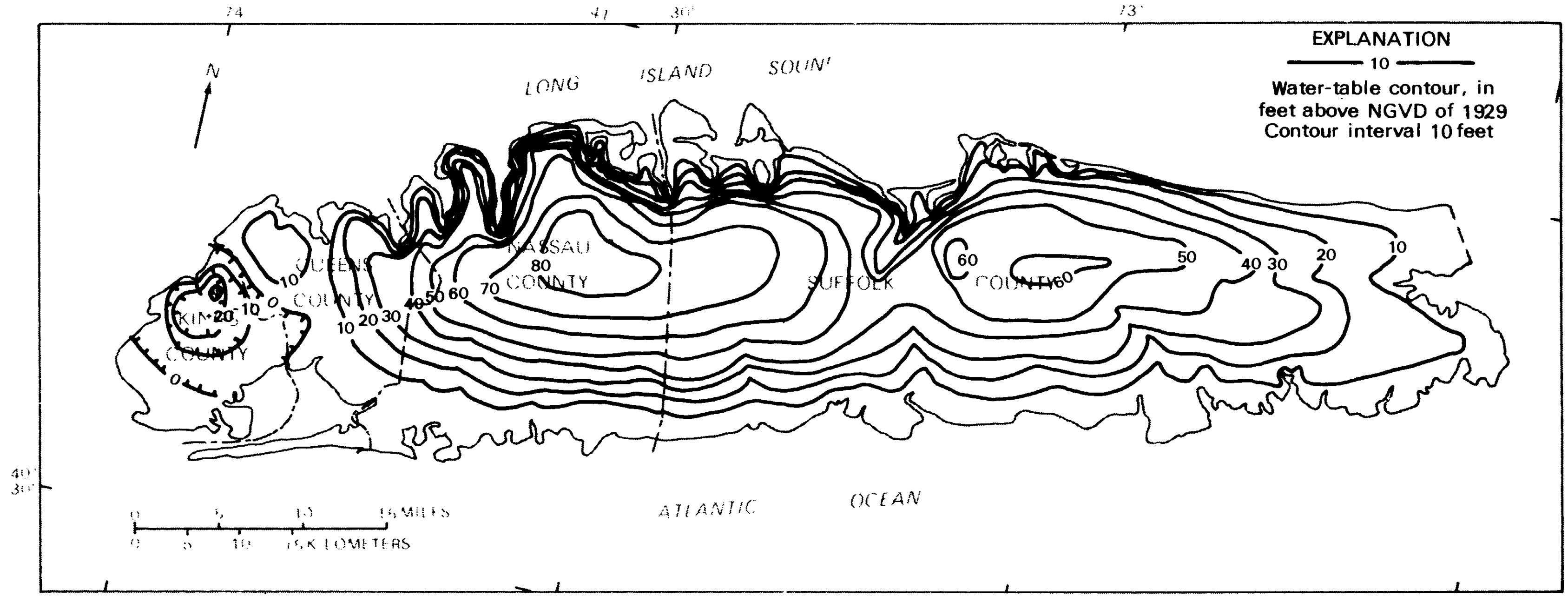


Figure 5. Hydrographs of water-table wells representing the four counties of Long Island. (Well-number prefix: K, Kings; Q, Queens; N, Nassau; S, Suffolk.)



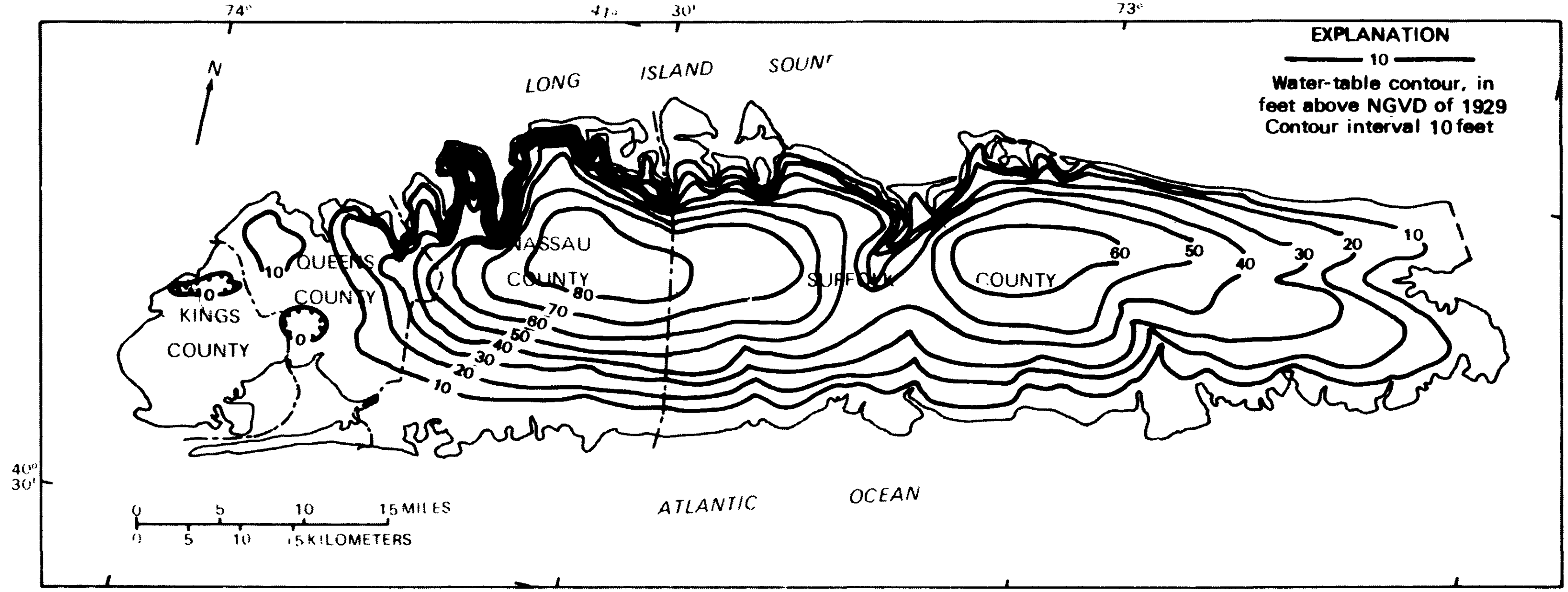
Base from U.S. Geological Survey
State base map, 1:500,000, 1974

Figure 6.--Water-table configuration in 1936. (Modified from Suter, 1937.)



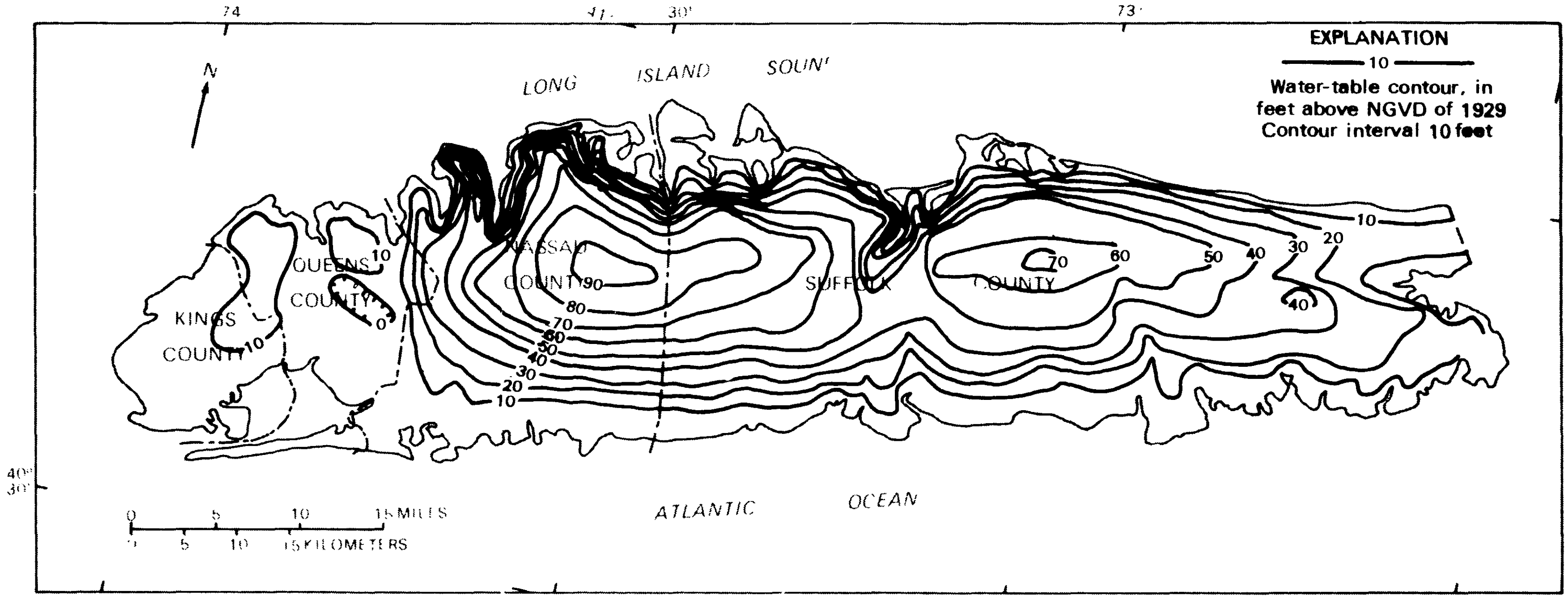
Base from U.S. Geological Survey State base map, 1:500,000, 1974

Figure 7. Water-table configuration in 1943 (Modified from Vaupel and others, 1977.)



Base from U.S. Geological Survey
State base map, 1:500,000, 1974

Figure 8. Water-table configuration in 1959. (Modified from Vaupel and others, 1977.)



Base from U.S. Geological Survey
State base map, 1:500,000, 1974

Figure 9. Water-table configuration in 1979. (Modified from Donaldson and Koszalka, 1983.)

1960's

During 1962-66, the northeast, including Long Island, experienced a severe drought. For 5 consecutive years, precipitation was substantially below normal. On the island, water levels near the ground-water divide declined as much as 10 ft, and streamflow in 19 principal streams declined 47 percent from the predrought long-term average (Cohen and others, 1969, p. F10). The hydrographs for wells N1255 and S1808 (fig. 5) show proportionate declines of 10 ft and 3 ft, respectively. Water levels at well Q1255 continued to recover during the drought because the water levels had been drawn down far lower than normal and were recovering in response to the cessation of public-supply pumping. Recovery in these areas continued into the 1970's.

1970's

After the drought, the water table at well N1255 continued to rise but did not reach its original 1903 level, mainly because of continued ground-water development and the construction of extensive sewer systems, which remove from the ground-water system some of the water that would have been available for recharge. Water levels in Queens rose slightly after 1974, when public-supply pumpage in Woodhaven was discontinued to halt seawater intrusion.

Comparisons of the 1979 water-table map (fig. 9) with those for previous years indicate a recent water-level rise in Kings County. Water levels in southwestern Queens also rose, in contrast to those in eastern Queens and adjacent parts of Nassau County, which continued to decline as a result of dewatering for subways, increased pumpage, and sewers, in addition to public-supply pumping.

SUMMARY

Water-level maps and historic records are the basis for interpretation of trends in ground-water flow. Throughout the 20th century, overdraft and decreasing recharge have changed the water levels and flow patterns of the Long Island ground-water system. Interaquifer flow and the movable system boundaries (water table and saltwater interfaces) yield complex stress-response relationships within the system. The response to stress becomes evident upon comparison of potentiometric-surface maps representing different years. Six islandwide water-table maps ranging from the predevelopment period (1900) through 1979 reveal the effects of ground-water development on the upper glacial aquifer and reflect changes in the potentiometric surfaces of the two deeper aquifers on Long Island.

The section that follows gives a comprehensive list of available water-table and potentiometric-surface maps of Long Island. The maps are arranged by aquifer and listed in chronological order. The bibliography provides the information needed for location and retrieval.

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LIST OF MAPS

AND

BIBLIOGRAPHY

The list of maps is divided into four sections: (1) water-table maps, (2) potentiometric-surface maps of the Magothy aquifer, (3) potentiometric-surface maps of the Lloyd aquifer, and (4) miscellaneous hydrologic maps. Within each section the maps are listed in chronological order. Also listed are the scale and the area depicted.

The bibliography (p. 25) provides complete information needed for retrieval of works cited in the list of maps.

LIST OF MAPS
(arranged by aquifer in chronological order)

1. Water-Table Maps

Year Represented	Reference no.[1]	Scale	Area or county depicted
1859	25	1:62,500	Southern Queens
1903	11	250,000	Long Island
1903	75	250,000	Long Island
1903	3	100,000	Long Island
1903	64	125,000	Nassau and Queens
1903	4	200,000	Kings and Queens
1903	36	62,500	Kings and Queens
1903	25	62,500	Southern Queens
1903	62	62,500	Kings
1907	17	250,000	Suffolk
1907	64	125,000	Long Island
1914	2	1,000	Southeast Nassau and Southwest Suffolk
1933	78	62,500	Kings and Queens
1933	36	250,000	Kings and Queens
1936	4	200,000	Kings and Queens
1936	49	--	Kings and Queens
1936	36	62,500	Kings and Queens
1936	71	62,500	Long Island
1936	62	62,500	Kings
1941	49	--	Long Island
1943	36	62,500	Kings and Queens
1943	4	200,000	Kings and Queens
1943	74	125,000	Long Island
1943	19	125,000	Western and Central Long Island
1943	45	62,500	Nassau
1946	33	125,000	Suffolk
1947	32	25,000	Kings and Queens
1949	43	62,500	Nassau
1950	36	62,500	Kings and Queens
1950	72	62,500	Kings, Queens, and Nassau
1950	37	75,000	Southold Township
1950	15	170,000	Southern Suffolk
1950	62	62,500	Kings
1951	36	250,000	Central Long Island
1951	77	48,000	Central Suffolk
1951	38	170,000	Long Island
1951	4	200,000	Kings and Queens
1951	76	250,000	Long Island
1952	77	24,000	Brookhaven Township

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[1] Refers to bibliographic citations, see part B.

LIST OF MAPS (continued)
(arranged by aquifer in chronological order)

1. Water-Table Maps (continued)

Year Represented	Reference no.[1]	Scale	Area or county depicted
1952	77	1:48,000	Central Suffolk
1953	77	24,000	Brookhaven Township
1953	11	125,000	Southampton Township
1954	51	100,000	Southern Nassau and Queens
1956	49	62,500	Kings, Queens, and Nassau
1956	30	12,000	North Hempstead Township
1957	49	62,500	Long Island
1957	73	48,000	Northwest Nassau and Northeast Queens
1967	14	--	Eastern Queens, Nassau, Western Suffolk
1957	79	190,000	Suffolk
1959	74	125,000	Long Island
1959	56	62,500	Babylon-Islip Township
1959	31	62,500	Huntington-Smithtown Township
1959	7	50,000	Southold Township
1959	21	325,000	Nassau and Queens
1960	18	48,000	Northern Nassau
1960	55	62,500	Islip Township
1961	4	200,000	Kings and Queens
1961	13	48,000	Southeast Nassau
1961	50	16,000	Montauk Point, East Hampton Township
1961	16	1,400,000	Long Island
1961	41	24,000	Nassau
1961	62	62,500	Kings
1961	12	100,000	East Meadow Brook, Hempstead Township
1961	60	125,000	Queens
1962	54	6,000	Farmingdale-Massapequa, Oyster Bay Township
1965	5	300,000	Long Island
1965	13	375,000	Kings and Queens
1957	17	250,000	Suffolk
1966	74	125,000	Long Island
1966	17	250,000	Suffolk
1967	53	190,000	Southwest Suffolk
1968	61	62,500	Mid-western Suffolk
1968	60	125,000	Queens
1970	22	125,000	Long Island
1970	11	125,000	East Hampton Township
1970	21	325,000	Nassau and Queens
1971	28	250,000	Long Island
1971	20	250,000	Suffolk

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[1] Refers to bibliographic citations, see part B.

LIST OF MAPS (continued)
(arranged by aquifer in chronological order)

1. Water-Table Maps (continued)

Year Represented	Reference no.[1]	Scale	Area or county depicted
1972	74	1:125,000	Long Island
1974	27	125,000	Long Island
1974	24	24,000	Islip Township
1974	24	24,000	Babylon Township
1974	1	125,000	Southampton Township
1974	1	30,000	Southampton Township
1974	62	62,500	Kings
1974	4	200,000	Kings and Queens
1974	63	62,500	Shelter Island
1975	42	125,000	Long Island
1975	47	62,500	East Hampton Township
1975	46	--	Nassau
1976	62	62,500	Kings
1976	48	48,000	East Hampton Township
1977	69	62,500	Suffolk
1977	58	20,000	Connetquot Brook, Islip Township
1978	68	62,500	Suffolk
1978	58	20,000	Connetquot Brook, Islip Township
1979	8	62,500	Long Island
1979	29	62,500	Brookhaven Township
1979	67	62,500	Suffolk
1980	70	62,500	Suffolk
1981	66	62,500	Suffolk
1981	4	200,000	Kings and Queens

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[1] Refers to bibliographic citations, see part B.

LIST OF MAPS (continued)
(arranged by aquifer in chronological order)

2. Potentiometric Surface--Magothy Aquifer

Year Represented	Reference no.[1]	Scale	Area or county depicted
1954	51	1:95,000	Southern Nassau and Queens
1954	52	--	Southern Nassau and Queens
1957	73	48,000	Northwest Nassau and Northeast Queens
1959	74	125,000	Long Island
1959	31	250,000	Huntington, Smithtown Township
1959	21	325,000	Nassau and Queens
1960	56	380,000	Babylon-Islip Township
1960	18	50,000	Northeast Nassau
1961	60	125,000	Queens
1966	74	125,000	Long Island
1968	60	125,000	Queens
1970	21	325,000	Nassau and Queens
1971	20	250,000	Suffolk
1972	26	125,000	Long Island
1972	74	125,000	Long Island
1975	57	125,000	Long Island
1975	46	--	Nassau
1979	9	62,500	Long Island
1979	29	62,500	Brookhaven Township

3. Potentiometric Surface--Lloyd Aquifer

Year Represented	Reference no.[1]	Scale	Area or county depicted
1900	23	1:730,000	Inferred--Long Island
1947	35	62,500	Long Island
1957	73	48,000	Northwest Nassau and Northeast Queens
1959	31	250,000	Huntington-Smithtown Township
1961	60	125,000	Queens
1961	18	84,000	Northeast Nassau
1968	60	125,000	Queens
1975	46	--	Nassau
1970	23	730,000	Long Island
1975	59	125,000	Long Island
1968	17	250,000	Suffolk
1979	10	62,500	Long Island

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[1] Refers to bibliographic citations, see part B.

LIST OF MAPS (continued)
(arranged by aquifer in chronological order)

4. Miscellaneous Maps

Year Represented	Reference no.[1]	Scale	Area or county depicted
1903-68	61	1:125,000	Change in water table in midwestern Suffolk
1903-71	20	250,000	Change in water table in Suffolk
1936-49	44	62,500	Highest position of water table
1943-72	74	250,000	Average water table for Long Island
1947-50	36	62,500	Recovery of water table
1959-70	21	125,000	Water table declines in Nassau and Queens
1959-70	21	500,000	Magothy aquifer declines in Nassau and Queens
1959-70	46	--	Water table declines in Nassau and Queens
1959-70	46	--	Magothy aquifer declines in Nassau and Queens
1960	39	200,000	Cross section of Long Island with saltwater (chloride) content
1961-66	6	1,400,000	Change in water table in Nassau and Suffolk
1969-73	46	--	Water table declines in Nassau
1970-74	27	125,000	Change in water table in western and central Long Island
1972	13	1,250,000	Estimated position of water table under natural conditions
1972	12	400,000	Cross section through Nassau

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[1] Refers to bibliographic citations, see part B.

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