WATER-LEVEL SURFACES IN THE AQUIFERS OF WESTERN LONG ISLAND, NEW YORK, IN 1959 AND 1970

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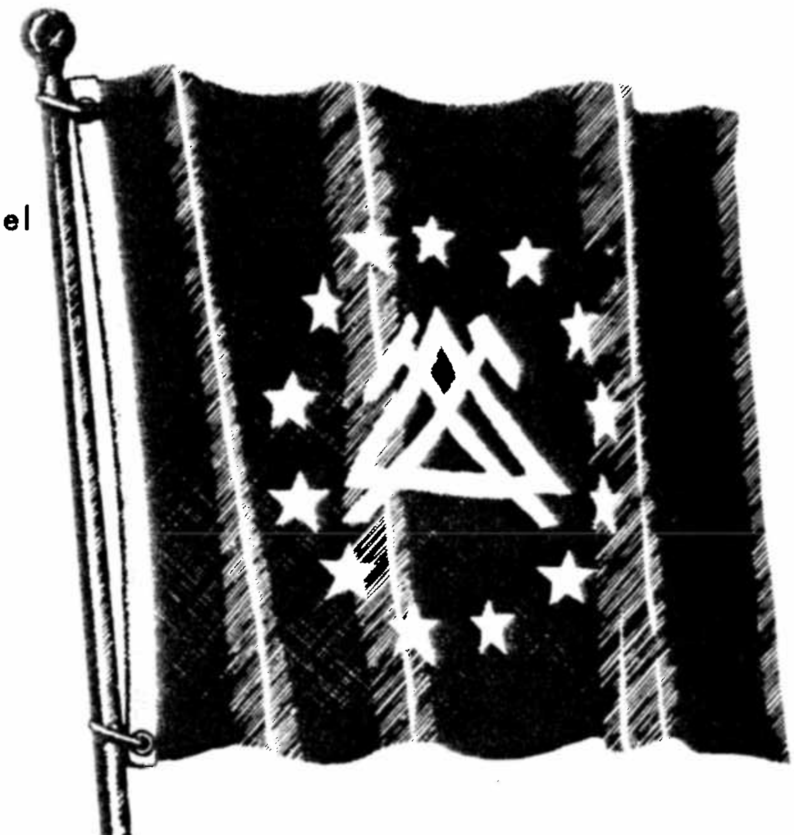

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WORK DONE IN COOPERATION WITH THE NASSAU COUNTY DEPARTMENT OF PUBLIC WORKS
AND THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION,
DIVISION OF WATER RESOURCES

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GEOLOGICAL SURVEY

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By G. E. KIMMEL, Mineola, N.Y.

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Abstract.—During the period 1959–70, ground-water levels in northwestern Nassau and east-central Queens Counties declined 20 to 25 feet. The magnitude and extent of the declines in the water table and in the Magothy potentiometric surface were roughly similar. The data suggest a high degree of hydraulic interconnection between the water table and the base of the Magothy aquifer, which includes from 200 to 1,100 feet of saturated unconsolidated deposits. The decline in water levels probably resulted from decreased recharge and increased pumping in an area of relatively low transmissivity.

Ground water in the underlying aquifer system is the sole source of fresh water in Nassau County and is a major source of fresh water in adjacent Queens County, Long Island, N.Y. (fig. 1). Ground-water withdrawals, decreased recharge related to naturai phenomena, and decreased recharge related to the activities of man have caused ground-water levels to decline significantly during the past several decades in these counties. The major purpose of this report is to document the water-level declines from 1959 to 1970 in the two most highly developed aquifers. In addition, some hydrologic implications of these declines are considered.

HYDROGEOLOGIC UNITS

The ground-water reservoir of Long Island consists of a wedge-shaped mass of unconsolidated deposits resting on a crystalline bedrock surface which dips gently toward the southeast (fig. 2). The major hydrologic units (after Cohen and others, 1968, p. 18), are described briefly in table 1.

The water table on Long Island mainly is in the upper glacial aquifer but locally is in the Magothy aquifer. In gross aspect, along the ground-water divide near the center of the island, ground water percolates downward from the water table through the ground-water reservoir. Near the shorelines, ground water moves upward and discharges into streams or into the sea.

TABLE 1.—*Hydrogeologic units in Queens and Nassau Counties Long Island, N.Y.*

Hydrogeologic unit	Approximate range in thickness (feet)	Lithology and water-bearing characteristics
Upper glacial aquifer.	50–200	Mainly sand and gravel of moderate to high hydraulic conductivity; also includes clayey deposits of till of low hydraulic conductivity.
Gardiners Clay	0–80	Clay, silty clay, and a little fine sand of low to very low hydraulic conductivity.
Jameco aquifer	0–160	Mainly medium to coarse sand and gravel of moderate to high hydraulic conductivity.
Magothy aquifer	0–900	Coarse to fine sand and silt of moderate hydraulic conductivity, and abundant silt and clay of low to very low hydraulic conductivity. A basal zone of coarse sand and gravel of high hydraulic conductivity is common.
Raritan clay	0–300	Clay of very low hydraulic conductivity; some silt and fine sand of low hydraulic conductivity.
Lloyd aquifer	0–400	Coarse sand and gravel of moderate hydraulic conductivity; some silt and clay of low hydraulic conductivity.
Bedrock		Consolidated crystalline rocks that have little or no interstitial hydraulic conductivity.

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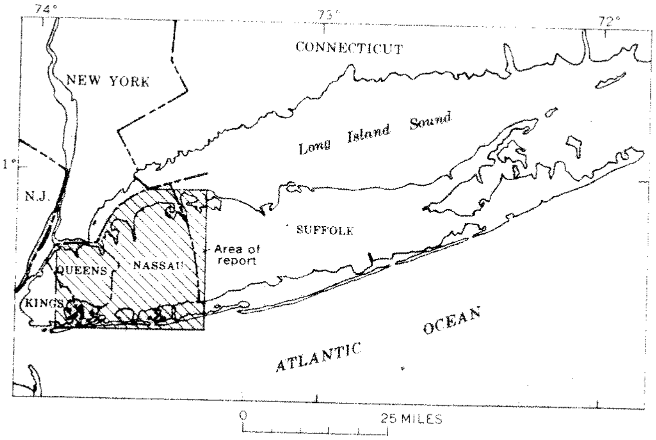

FIGURE 1.—Area of investigation (shaded) on Long Island, N.Y.

WATER-LEVEL SURFACES

Most of the ground-water withdrawals in Queens and Nassau Counties are from the Magothy and upper glacial aquifers, and, accordingly, ground-water levels in these aquifers are emphasized in this report.

Two water-level surfaces are shown on both figures 3 and 4. One surface is the water table (the upper surface of the zone of saturation), and the other is the potentiometric surface defined by the water levels in wells screened at or near the base of the Magothy aquifer. (For convenience, this surface is subsequently referred to in this report as the basal Magothy potentiometric surface.)

Data for the water-table contours were obtained from wetted-tape measurements in 19 wells in Queens County and 166 wells in Nassau County for figure 3, and from 31 wells in Queens County and 199 wells in Nassau County for figure 4. The measurements were made in April and May 1959 for figure 3 and in March 1970 for figure 4. Data for the basal Magothy potentiometric surfaces were obtained mostly from wetted-tape measurements in 55 wells for figure 3 and in 82 wells for figure 4. A few supplementary air-line measurements were used to help define the basal Magothy potentiometric surface in figure 3.

Because of the paucity of simultaneous measurements, the basal Magothy potentiometric surface in figure 3 was developed from data spanning the period 1957 to 1961. During this period, the maximum decline of water levels in Magothy aquifer was about 2 feet, and that decline was in the vicinity of the ground-water divide, where changes in water levels commonly are greatest. Accordingly, the basal Magothy potentiometric surface shown in figure 3 is considered ot be reasonably representative of that surface in 1959.

Throughout most of Nassau County, the heads in both aquifers are nearly the same, and, accordingly, the isopotentials are nearly vertical in most of the county (fig. 2). Directly beneath the ground-water divide, heads decrease with depth, and the isopotentials are virtually horizontal; however, the selected interval in figure 2 precludes showing the horizontal segments of the isopotentials. Near the shorelines, heads increase with depth, and the isopotentials become more nearly horizontal with increasing proximity to the shorelines. In general, these overall head relations reflect the gross directions of ground-water flow that existed under natural conditions; they have been modified only slightly in most of Nassau County.

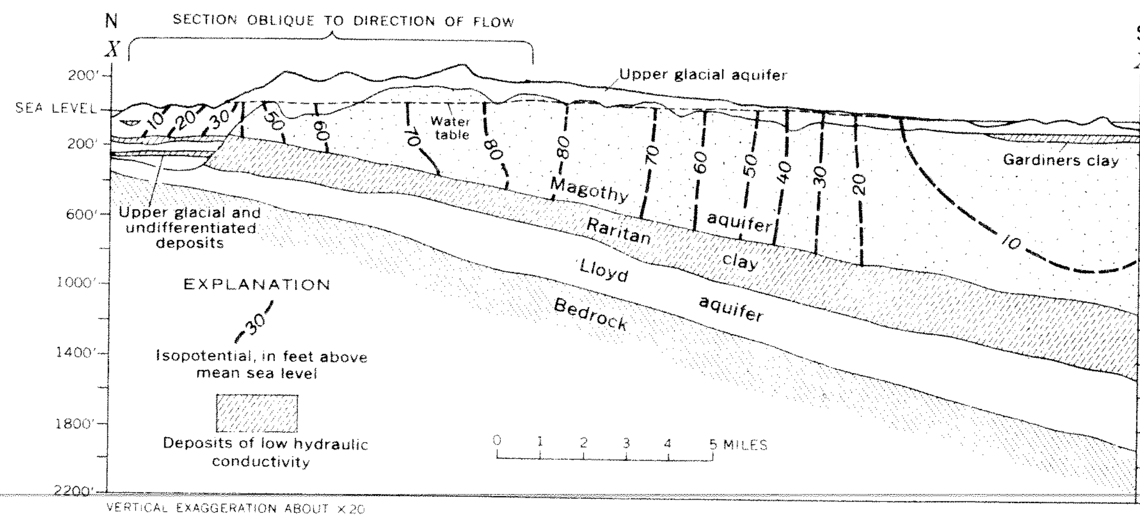

FIGURE 2.—Hydraulic section X–X′ in eastern Nassau County, Long Island, N.Y., showing isopotentials in the upper glacial and Magothy aquifers in March 1970. Location of the section is shown in figure 4.

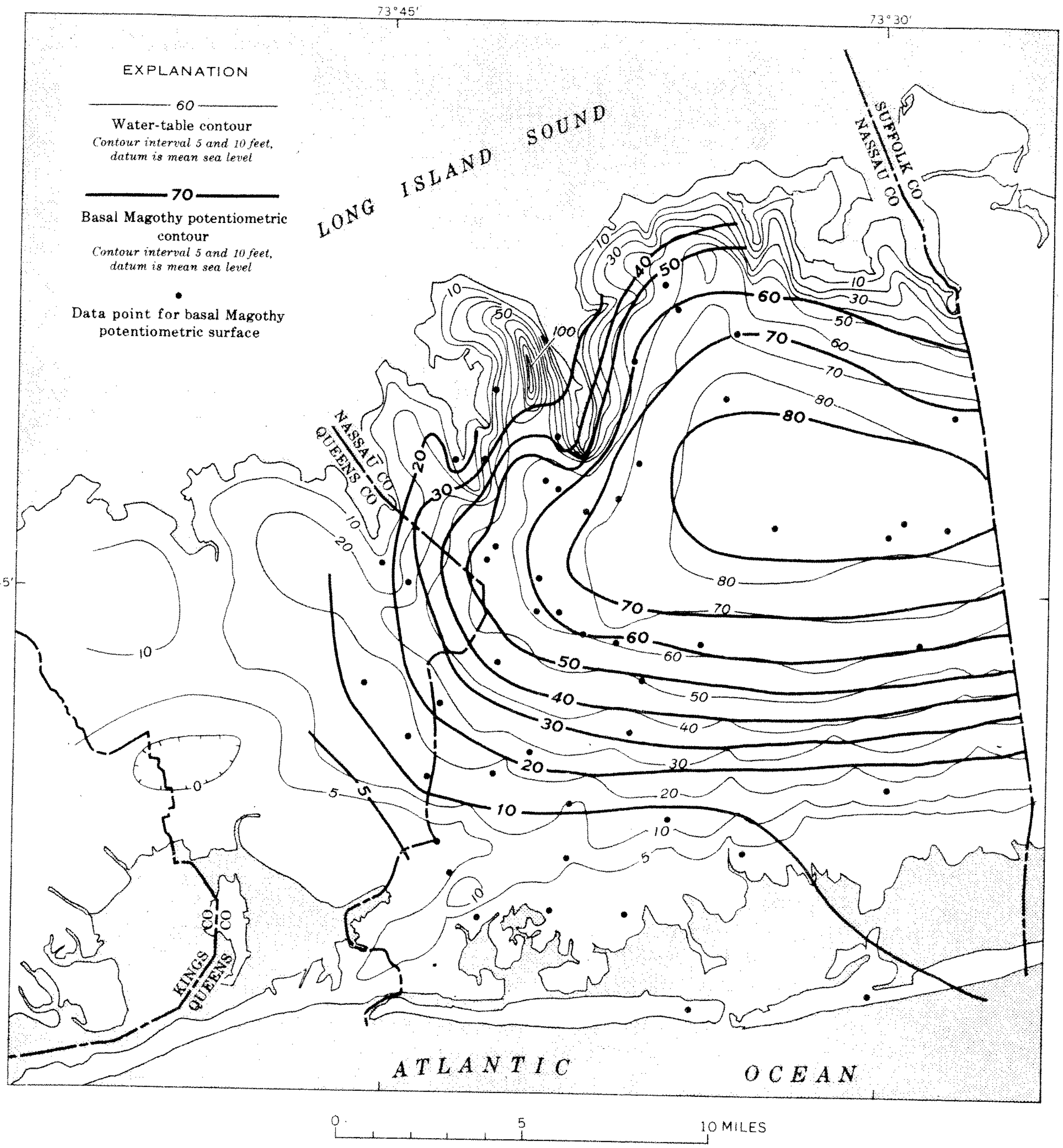

FIGURE 3.—Comparison between the water table and the basal Magothy potentiometric surface in Nassau and Queens Counties, Long Island, N.Y., in spring, 1959.

Both the water table and the basal Magothy potentiometric surface locally are below sea level in central Queens County because of intensive pumping of ground water and several factors related to urbanization.

NET CHANGE IN HEAD

Net declines in the water table and the basal Magothy potentiometric surface from 1959 to 1970 are shown in figures 5 and 6. The water-level declines in the basal part of the Magothy aquifer ranged from about 1 foot near the shorelines to a little more than 20 feet in parts of northeastern Queens and northwestern Nassau Counties. Similar declines occurred in the water table except at the shorelines, where the water table is hydrologically connected to the sea, and, accordingly, the decline was negligible. The general distribution and magnitude of the declines in both net-change maps are roughly similar. The similarity of the water-level declines in both aquifers reflects the high degree of hydraulic interconnection between them. Where the declines do not

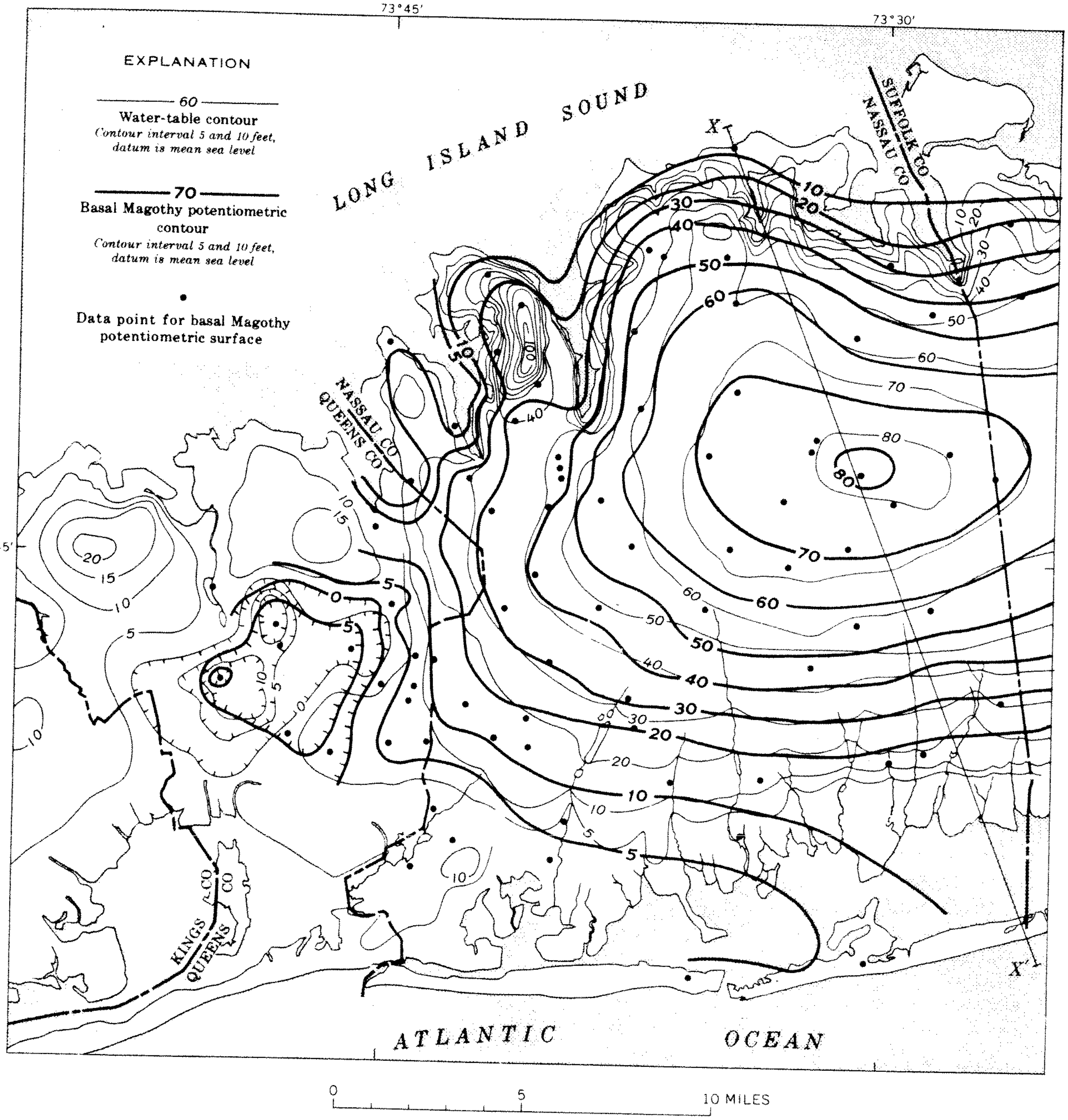

Figure 4.—Comparison between the water table and the basal Magothy potentiometric surface in Nassau and Queens Counties, Long Island, N.Y., in March 1970.

roughly coincide, the apparent dissimilarities probably are mainly due to the distortion of head in the aquifer system as a result of local pumping or to inaccuracies in the water-level contours.

Part of the decline in ground-water levels on Long Island from 1962 to 1966 was caused by a severe drought (Cohen and others, 1969). These writers estimated that the maximum net decline in the water table from 1961 to 1966 near the ground-water divide in Nassau County was about 10 feet. Despite 3 years of normal to above-average precipitation from 1967 to 1970, the water table in part of Nassau County has continued to decline, in places by more than the maximum decline of 10 feet shown by Cohen and others (1969, fig. 10), probably partly as a result of continued intensive pumpage.

In Nassau County, public-supply pumpage, which is mainly from the Magothy aquifer, increased from 125 mgd (million gallons per day) in 1959 to 173 mgd in 1968 (New York Water Resources Commission, written commun., 1969). Although the pumpage is fairly

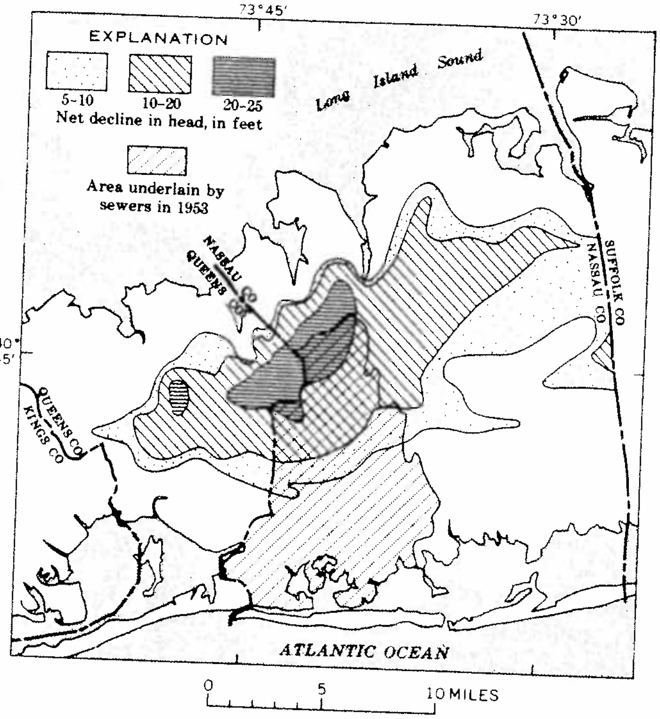

FIGURE 5.—Generalized net decline of the water table in Nassau and Queens Counties, Long Island, N.Y., from 1959 to 1970.

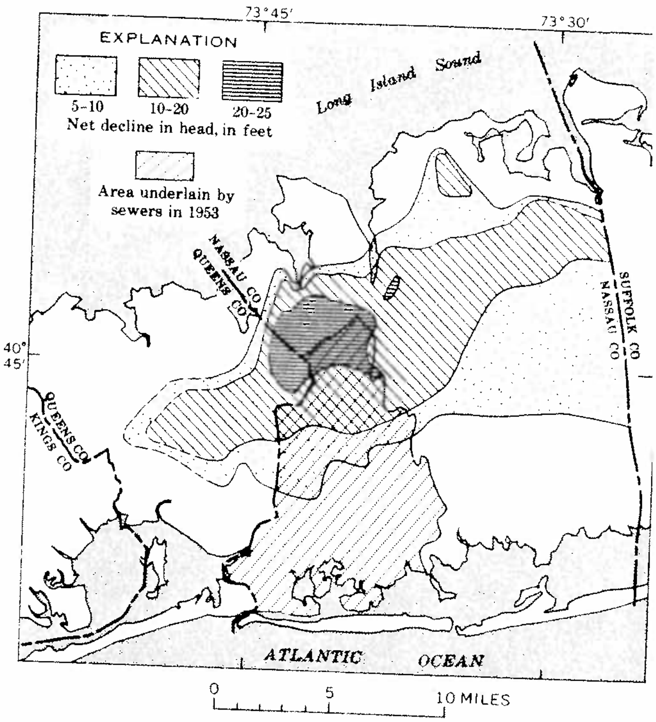

FIGURE 6.—Generalized net decline in the basal Magothy potentiometric surface in Nassau and Queens Counties, Long Island, N.Y., from 1959 to 1970. Dashed lines in left center enclose area of estimated or inferred decline in head.

evenly distributed throughout the county, it is greater in the southern part somewhat south of the area of maximum declines in ground-water levels. The greater net declines in the northern part of the county as compared to the declines in the southern part probably largely reflect the fact that the Magothy aquifer thins markedly northward (fig. 2) and, accordingly, the transmissivity of the aquifer decreases appreciably in that direction.

Ground-water levels in some parts of Nassau County also declined because of the construction of sanitary sewers and the concurrent decrease in recharge resulting from the discontinued use of many thousands of cesspools. Franke (1968, p. 205–209) found that the average decline attributable to sewering in southwestern Nassau County from 1953 to 1966 was about 7 feet. Accordingly, at least part of the net decline in the water table (fig. 5), and perhaps part of the decline in the Magothy potentiometric surface (fig. 6), was related to the construction of sewers.

Pumpage in Queens County, which increased from about 52 mgd in 1959 to 62 mgd in 1968 (New York Water Resources Commission, written commun., 1969), probably is the main cause of the water-level declines in that country since 1959. The net decline is most pronounced in the central and southern part of the county, where the water table and the Magothy potentiometric surface presently are more than 10 feet below sea level.

Since 1903, ground-water levels in Queens County have declined as much as 40 feet, resulting in local but highly significant encroachment of salty water into the fresh ground-water reservoir (Soren, 1970). Periodic chloride determinations (Cohen and Kimmel, 1971) and periodic rounds of water-level measurements and the resulting water-level maps, such as those shown in this report, will help those concerned with the development and management of Long Island's ground water to monitor some of the major effects of present and future ground-water withdrawals.

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