PREPARED IN COOPERATION WITH THE
NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
NASSAU COUNTY DEPARTMENT OF PUBLIC WORKS
SUFFOLK COUNTY WATER AUTHORITY AND DEPARTMENT OF HEALTH SERVICES

INTRODUCTION

Long Island, N.Y., is underlain by a mass of unconsolidated geologic deposits of clay, silt, sand, and gravel that overlie southward-sloping consolidated bedrock. These deposits are thinnest in northern Queens County (northwestern Long Island), where bedrock crops out, and increase to a maximum thickness of 2,000 ft in southeastern Long Island. This sequence of unconsolidated deposits consists of several distinct geologic units ranging in age from late Cretaceous through Pleistocene, with some recent deposits near shores and streams. These units are differentiated by age, depositional environment, and lithology in table 1.

Investigations of ground-water availability and flow patterns may require information on the internal geometry of the hydrologic system that geologic correlations and interpretation alone cannot provide; hydrologic interpretations in which deposits are differentiated on the basis of water-transmitting properties are generally needed also. This set of maps and vertical sections depicts the hydrogeologic framework of the unconsolidated deposits that form Long Island's ground-water system. These deposits can be classified into eight major hydrogeologic units (table 1). The hydrogeologic interpretations presented herein are not everywhere consistent with strict geologic interpretation owing to facies changes and local variations in the water-transmitting properties within geologic units.

These maps depict the upper-surface altitude of seven of the eight hydrogeologic units, which, in ascending order, are: consolidated bedrock, Lloyd aquifer, Raritan confining unit, Magothy aquifer, Monmouth greensand, Jameco aquifer, and Gardiners Clay. The upper glacial aquifer—the uppermost unit—is at land surface over most of Long Island and is, therefore, not included. The nine north-south hydrogeologic sections shown below depict the entire sequence of unconsolidated deposits and, together with the maps, provide a detailed three- dimensional interpretation of Long Island's hydrogeologic framework.

The structure-contour map that shows the upper-surface altitude of the Cretaceous deposits is included to illustrate the erosional unconformity between the Cretaceous and overlying Pleistocene deposits. Pleistocene erosion played a major role in determining the shape and extent of the Lloyd aquifer, the Raritan confining unit, and the Magothy aquifer, and thus partly determined their hydrogeologic relation with subsequent (post-Cretaceous) deposits.

PREVIOUS HYDROGEOLOGIC INVESTIGATIONS

The first attempt to map the complete sequence of geologic units on an islandwide scale was made by Suter and others (1949) despite a paucity of data. The most recent report to interpret the hydrogeology of Long Island on an islandwide scale was by McClymonds and Franke (1972) which gives the estimated thickness of the Lloyd, Magothy, Jameco, and upper glacial aquifers. Recent investigations have provided more detailed information in several local areas.

The hydrogeologic framework of Kings and Queens Counties has been evaluted by Buxton and Shernoff (U.S. Geological Survey, written comm., 1985), and the northern part of Nassau County has been studied by Kilburn (1980) and Kilburn and Krulikas (1986). The Roosevelt and Mitchell Field area in Nassau County has been studied by Eckhardt (in press), and the upper surface altitude of the Matawan Group and Magothy Formation and shallower geologic units of southern Nassau and Suffolk Counties have been mapped by Doriski and Wilde-Katz (1982).

Jensen and Soren (1974) mapped the complete sequence of aquifers and confining units in Suffolk county. Local hydrogeologic studies in Suffolk County include the Montauk Point area (Prince, 1986); the south fork (Nemickas and Koszalka, 1982); the northern part of the Town of Brookhaven (Koszalka, 1980); and the surface of the Matawan Group and Magothy Formation in Suffolk County (Krulikas, Koszalka, and Doriski, 1983). All of these reports define either geologic or hydrogeologic units, which may create some discrepancies upon comparision owing to the differing criteria for interpretation.

The hydrogeologic units on Long Island can be correlated with those of northeastern New Jersey, which have been investigated by Gill and Farlekas (1976), Minard (1969), Zapecza (1984). Although southern Connecticut parallels the north shore of Long Island (fig.1), it lacks the hydrogeologic units of Long Island because they pinch out beneath the Long Island Sound.

SOURCES OF DATA

Two major sources of hydrogeologic data were used to construct the maps—records of wells and offshore seismic surveys.

Well Data

The well data used in this investigation include drillers' logs, geophysical logs, and geologists' descriptions of cores and other drilling samples. Hydrogeologic data from more than 3,100 wells on Long Island are available. Hydrogeologic interpretations of all wells used in this study, including the altitude of the upper surface of each unit penetrated, are given in a report by Buxton, Smolensky, and Shernoff (in press). Hydrogeologic data on these wells are on file at the U.S. Geological Survey office in Syosset, N.Y.

Offshore Seismic Surveys

Several seismic surveys conducted in recent years have produced a means of mapping offshore structures. Primarily through reflection techniques, the configuration of the bedrock and Cretaceous surfaces under the water surrounding Long Island have been defined. Grim and others (1970) and the U.S. Geological Survey (1970) contoured the eroded surface of the Cretaceous deposits and bedrock beneath Long Island Sound. Williams (1976) investigated the shallow bottom structure off Long Island with emphasis around the north and south forks. McMaster and Ashraf (1973) discuss paleo-drainage in New England and Long Island and resultant buried valleys. Hutchinson (written commun., 1984) has interpreted data from recent cruises on the Long Island Sound and on the inner continental shelf directly south of Long Island.

In this study, knowledge gained from offshore seismic survey was used to correlate onshore and offshore data and to project the extent of the hydrogeologic units offshore. The eroded surface of Cretaceous deposits or consolidated bedrock beneath Long Island Sound (U.S. Geological Survey, 1970) was correlated with the surface of the Upper Cretaceous unit onshore. The dip of the relatively flat underlying Cretaceous units was assumed to persist offshore; thus the onshore surfaces were extended northward to their contact with the Cretaceous or bedrock surface. The bedrock surface was similarly extended northward to the point at which the effects of post-Cretaceous erosion could be observed. The extent of each Cretaceous unit is defined by the point of post-Cretaceous erosion on the next underlying unit. The logic of this analysis is consistent with the concepts of the sedimentation model described in the following section.

EROSIONAL AND DEPOSITIONAL HISTORY

The unconsolidated deposits that comprise the hydrogeologic framework of Long Island reflect the island's erosional and depositional history.

Present-day depositional environments show the close relation between environment of deposition and type and rate of sediments deposited. These relations can be applied to the present sequence of sediments and their structure and characteristics to identify and correlate recurring intervals of deposition, nondeposition, and (or) erosion in the paleo-environments.

This study used a theoretical sedimentation model to help define the structure and configuration of the individual hydrogeologic units. The model was used to help conceptualize the type, location, and thickness of sediments on the basis of a sequence of changing physical environments through geologic time.

The following paragraphs briefly summarize the paleo-environments in Long Island's geologic past and their correlation with the present hydrogeologic units on Long Island.

Consolidated bedrock on Long Island (sheet 2) is of Precambrian and/or Paleozoic age, and its surface configuration is defined as a peneplain (Suter and others, 1949). Because Paleozoic and lower Mesozoic deposits are absent above bedrock, the period when erosion on the bedrock surface occurred cannot be dated.

The overlying Cretaceous age sediments can be characterized by three periods of deposition, each separated by an interval of nondeposition and (or) erosion. The lowermost Cretaceous sediments on Long Island, which form the Raritan Formation, were probably deposited in an environment dominated by streams and coalescing deltas (Buxton and others, 1981). These deposits exhibit a distinct fining upward that may be a result of changing stream gradients and (or) a prograding shoreline. The formation has been divided into two members—the Lloyd Sand Member (Lloyd aquifer) and a conformable overlying unnamed clay member (Raritan confining unit). These members are differentiated primarily by grain size. The intervening conformity is relatively flat lying and dips gradually to the southeast (sheet 2).

The first interval of nondeposition (or erosion) is shown by a distinct unconformity that separates the fine-grained clay member of the Raritan Formation from the coarse basal zone of the Matawan Group and Magothy Formation, undifferentiated (Magothy aquifer). This unconformity is shown on the surface configuration of the Raritan clay member (sheet 2) and indicates little erosion.

After the interval of nondeposition, the Magothy Formation was deposited in an environment again dominated by streams and coalescing deltas (Doriski and Wilde-Katz, 1983). Its coarse basal zone indicates an environment of high energy that decreased rapidly, causing an upward gradation to the fine sands and clays that form the bulk of this unit.

The Monmouth Group (Monmouth greensand) unconformably overlies the Matawan Group and Magothy Formation, undifferentiated. The unconformity between these units indicates a second interval of nondeposition or erosion during the Cretaceous on Long Island. The surface of this deposit is gently rolling with no severe erosion (sheet 3). The clay and silty sand material that forms the Monmouth Group (sheet 3) was deposited by a transgressing sea. The abundance of glauconite indicates a quiet marine environment.

Although Tertiary deposits are reported offshore south of Long Island, they are not present onshore. Whether Tertiary deposition occurred and was subsequently eroded, or never occurred, is uncertain.

Several episodes of Pleistocene glaciation by a southward advance from New England and the Hudson River valley severely eroded the Cretaceous deposits. The unconformity, which extends across Long Island between all Cretaceous and overlying deposits, reflects the glacial scouring and glaciofluvial erosion typical of the high-energy Pleistocene environments.

The well-dissected surface of Cretaceous or older deposits is depicted on sheet 1. The erosion is most severe on the north shore and in Long Island Sound, where glacial processes locally cut through the entire sequence of Cretaceous deposits and, in some areas, into crystalline bedrock. Several deep channels in the Cretaceous surface in central Suffolk County indicate severe scouring by ice tongues and erosion in meltwater channels that trend both along the ice margin and southward.

The lack of ice-contact erosion on the relatively flat-lying Cretaceous surface in the south half of the island marks the furthest extent of any of the glacial advances.

The oldest Pleistocene deposit is the Jameco Gravel (Jameco aquifer), which is present only in western Long Island. It is a channel filling of gravel and coarse sand of Illinoian age and may be the remnant of a high-energy ancestral Hudson River (Soren, 1978). The surface of this unit (sheet 3) probably underwent extensive erosion and reworking by glaciation and fluvial processes during interglacial periods.

The effects of eustatic sea-level changes during the Pleistocene are shown by several lagoonal and shallow-bay clays along southern Long Island. The most prominent of these is the Gardiners Clay (sheet 3), which was probably deposited during Sangamon interglaciation (Soren, 1971).

Subsequent deposition on Long Island, except for small recent deposits, occurred in late Wisconsin glaciation. Long Island's present topography is characterized by the Ronkonkoma and Harbor Hill moraine ridges and a gradually southward sloping outwash plain south of the moraines.

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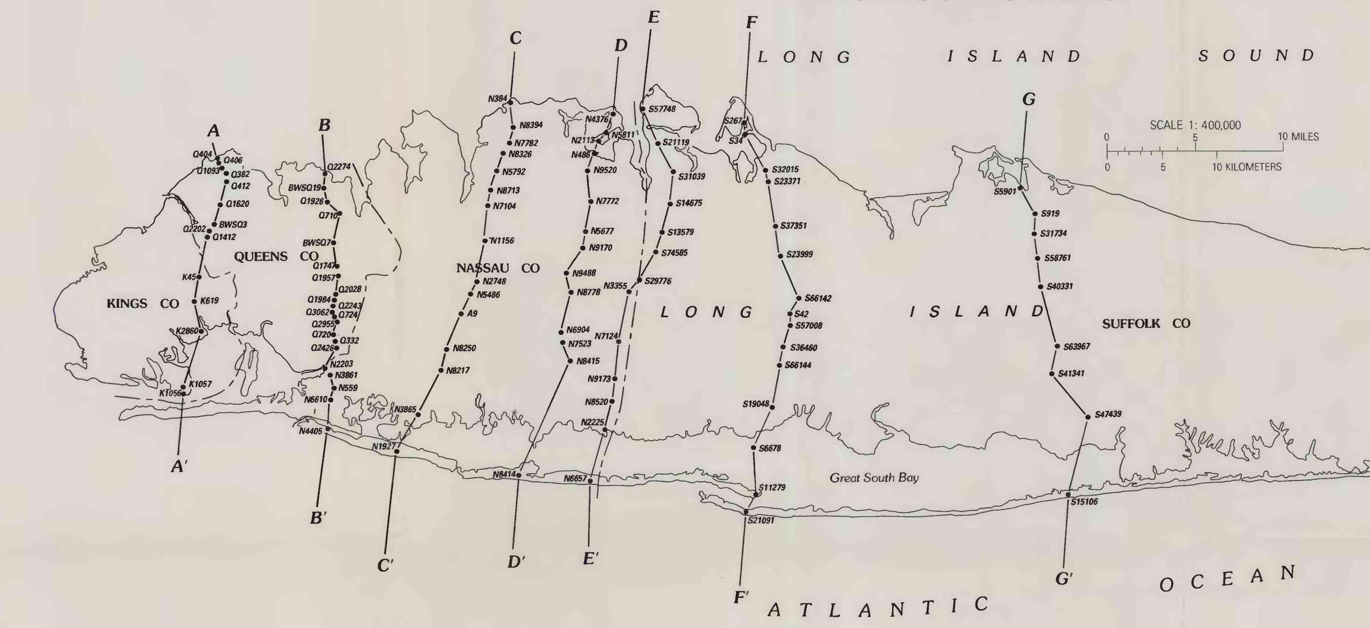
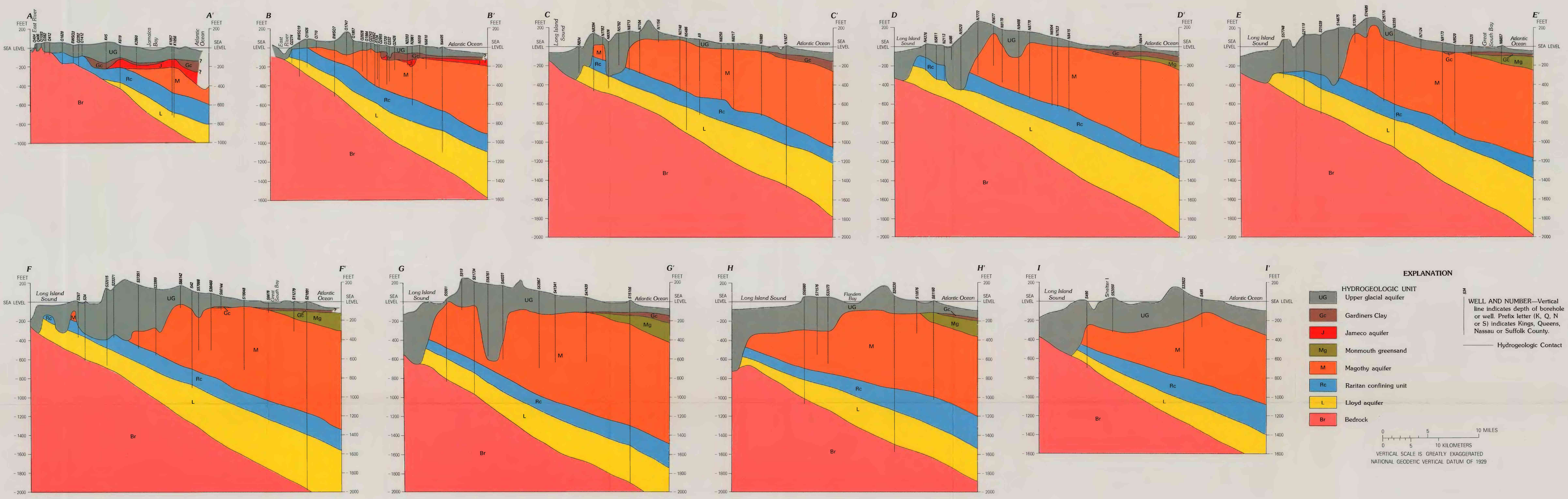
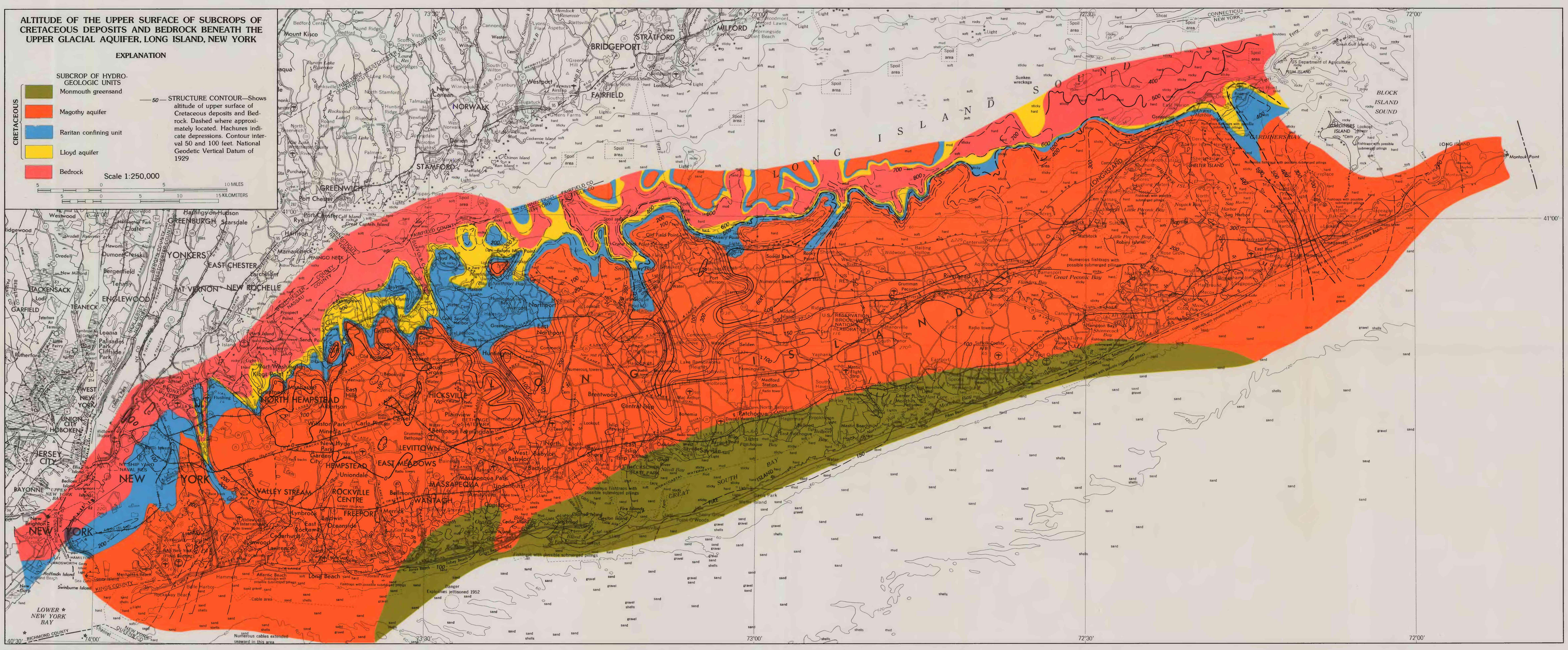
Table 1.—Hydrogeologic units of Long Island and their water bearing properties
[ft/d, feet per day; ft, feet]

System	Series	Geologic unit	Hydrogeologic unit	Approximate maximum thickness (ft)	Character of deposits	Water bearing properties
Quaternary	Holocene	Recent deposits: Salt marsh deposits, stream alluvium, shoreline deposits and fill	Recent deposits	50	Sand, gravel, clay, silt, organic mud, peat, loam, and shells. Colors are gray, brown, green, black, and yellow.	Beach deposits are highly permeable; marsh deposits poorly permeable. Locally hydraulically connected to underlying aquifers.
	Pleistocene	Upper Pleistocene deposits	Upper glacial aquifer	700	Till composed of clay, sand, gravel, and boulders, forms Harbor Hill and Ronkonkoma terminal moraines. Outwash deposits consist of quartzose sand, fine to very coarse, and gravel, pebble to boulder sized. Also contains lacustrine, marine, and reworked deposits. Local units are Port Washington aquifer and confining unit, "20–foot clay," and clay at Smithtown.	Till is poorly permeable. Outwash deposits are moderately to highly permeable. Glaciolacustrine and marine clay deposits are mostly poorly permeable but locally have thin, moderately permeable layers of sand and gravel. Average horizontal hydraulic conductivity is approximately 270 ft/d; conductivity of morainal material is approximately 50 percent of outwash deposits; anisotropy is approximately 10:1.
		unconformity				
		Gardiners Clay	Gardiners Clay	150	Clay, silt, and few layers of sand. Colors are grayish green and brown. Contains marine shells and glauconite.	Poorly permeable; constitutes a confining layer for underlying aquifer. Some sand lenses may be permeable. Average vertical hydraulic conductivity is approximately 0.001 ft/d.
		unconformity				
		Jameco Gravel	Jameco aquifer	200	Sand, fine to very coarse, and gravel to large-pebble size; few layers of clay and silt. Gravel is composed of crystalline and sedimentary rocks. Color is mostly brown.	Moderately to highly permeable. Confined by overlying Gardiners clay. Average horizontal hydraulic conductivity is 200 to 300 ft/d; anisotropoy is approximately 10:1.
Cretaceous	Upper Cretaceous	Monmouth Group	Monmouth greensand	200	Interbedded marine deposits of clay, silt, and sand, dark-greenish gray, greenish-black, greenish, dark-gray, and black, containing much glauconite.	Poorly permeable: primarily a confining unit for underlying Magothy aquifer. Average vertical hydraulic conductivity is approximately 0.001 ft/d.
		unconformity				
		Matawan Group – Magothy Formation, undifferentiated	Magothy aquifer	1,100	Sand, fine to medium clayey in part; interbedded with lenses and layers of coarse sand and sandy and solid clay. Gravel is common in basal zone. Sand and gravel are quartzose. Lignite, pyrite, and iron oxide concretions are common. Colors are gray, white, red, brown, and yellow.	Most layers are poorly to moderately permeable; some are highly permeable locally. Water is unconfined in uppermost parts, elsewhere is confined. Constitutes principal aquifer for public supply. Average horizontal hydraulic conductivity is 50 ft/d; anistrophy is approximately 100:1.
		unconformity				
		Raritan Formation: Unnamed clay member	Raritan confining unit	200	Clay, solid and silty; few lenses and layers of sand. Lignite and pyrite are common. Colors are gray, red, and white, commonly variegated.	Poorly to very poorly permeable; constitutes confining layer for underlying Lloyd aquifer. Average vertical hydraulic conductivity is approximately 0.001 ft/d.
		Raritan Formation: Lloyd Sand Member	Lloyd aquifer	500	Sand, fine to coarse, and gravel, commonly with clayey matrix; some lenses and layers of solid and silty clay; locally contains thin lignite layers. Sand and most of gravel are quartzose. Colors are yellow, gray, and white; clay is red locally.	Poorly to moderately permeable. Water is confined by overlying Raritan clay. Average horizontal hydraulic conductivity is 40 ft/d; anisotropy is approximately 10:1.
Paleozoic and Precambrian		Bedrock	Bedrock		Crystalline metamorphic and igneous rocks; muscovite-biotite schist, gneiss, and granite. A soft, clayey zone of weathered bedrock locally is more than 70 ft thick.	Poorly permeable to virtually impermeable; constitutes lower boundary of ground-water reservoir. Some hard fresh water is contained in joints and fractures but is impractical to develop at most places.







Base from U.S. Geological Survey
New York, 1960–79; Hartford, 1962–75;
Providence, 1947–69 and Newark, 1944–69

ALTITUDE OF THE UPPER SURFACE OF CRETACEOUS DEPOSITS, LONG ISLAND, NEW YORK

INTERIOR—GEOLOGICAL SURVEY, RESTON, VIRGINIA—1990
For sale by U. S. Geological Survey Map Distribution, Box 25286, Federal Center, Denver, CO 80225

HYDROGEOLOGIC FRAMEWORK OF LONG ISLAND, NEW YORK

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1989