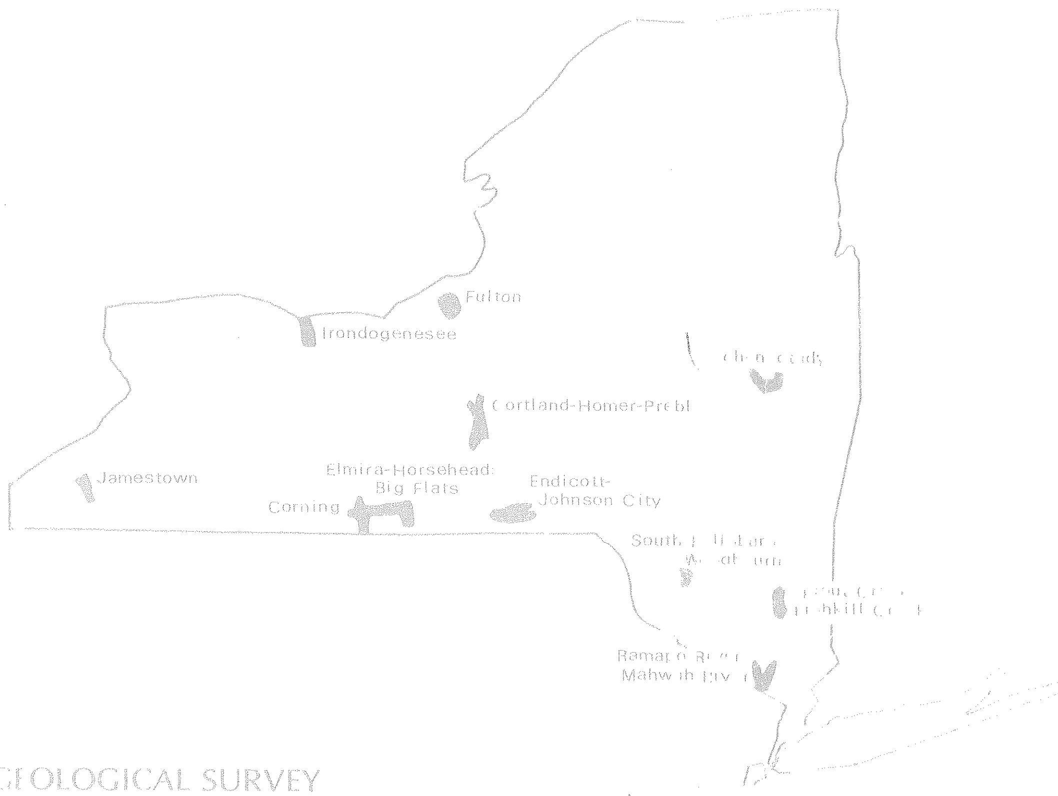
Atlas of Eleven Selected Aquifers in New York



U.S. GEOLOGICAL SURVEY
Water-Resources Investigations
Open-File Report 82-553

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Incl Errata Sheet

Prepared in cooperation with
NEW YORK STATE DEPARTMENT OF HEALTH
Bureau of Public Water Supply Protection

ATLAS OF ELEVEN SELECTED AQUIFERS IN NEW YORK

Compiled by Roger M. Waller and Anne J. Finch

U. S. GEOLOGICAL SURVEY

Water Resources Investigations
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Albany, New York
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UNITED STATES DEPARTMENT OF THE INTERIOR

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PREFACE

The U.S. Geological Survey, Department of the Interior, has been involved in a continuous series of water-resources investigations in New York for more than 80 years. Virtually all investigations have been made in cooperation with State and county agencies.

A large quantity of data on ground water has been obtained through these studies, and many technical reports have been published as a result. Most of the reports were published either by State and county agencies, by the U.S. Geological Survey, or in scientific journals.

In 1980, the Geological Survey began preparation of this report in cooperation with the New York State Department of Health. The objective is to summarize results of a 1980-81 study in which 11 major aquifers in New York were mapped, and to present this information in a form that will be useful to water managers and scientists as well as local citizens. Each chapter describes the following aspects of a single aquifer system and includes a comprehensive list of references:

- location and major geographic features
- population and ground-water use in 1980
- geologic setting
- geohydrology
- aquifer thickness
- well yields
- ground-water movement
- soil-zone permeability
- land use
- present and potential problems

The authors thank the many local, State, and Federal agencies, consultants, and private citizens who have provided cooperation and data during recent decades and also credit the previous researchers whose scientific contributions have made this compilation possible.

CONTENTS

CONTENTS (continued)

GLOSSARY[1]

A-horizon. The uppermost zone in the soil profile, from which soluble salts and colloids have been leached, and in which organic matter has accumulated.

Ablation till. Loosely consolidated rock debris, formerly in or on a glacier, that accumulated in place as the surface ice decayed and melted.

Alluvium. Rock material deposited by flowing water.

Aquifer. A saturated formation or part of a formation that yields significant quantities of water to wells and springs.

Artesian aquifer. A confined aquifer in which the water is under sufficent pressure to rise higher than the aquifer surface in a well tapping the aquifer.

B-horizon. The part of the soil zone that is enriched by the deposition or precipitation of material from the overlying A-horizon.

Base flow. Sustained or fair-weather stream discharge, composed primarily of ground water; the flow of a stream without runoff from precipitation.

Bedrock. General term for rock, generally solid, that underlies soil or other unconsolidated sediments.

Bedrock valley. A valley eroded into bedrock.

C-horizon. A mineral horizon of a soil, beneath the B-horizon, transitional between the parent material and the more developed horizons above.

Chloride concentration. A measure of the salt in water, expressed in milligrams per liter.

Cone of depression. A low in the potentiometric surface, centered in an area of concentrated pumping.

Confined aquifer. An aquifer bounded above and below by relatively impermeable beds and containing confined ground water. (See "artesian aquifer.")

Confined ground water. Ground water under pressure significantly greater than that of the atmosphere. Its upper surface is bounded by a relatively impermeable layer.

Confining layer. A layer of earth material, generally clay or other fine-grained sediment, that retards the movement of water.

Deglaciation. The uncovering of an area from beneath a glacier or ice sheet by shrinkage of melting ice.

Discharge area. The location at which water leaves an aquifer, such as a stream.

Drainage divide. The boundary between drainage basins; a topographic divide.

Drawdown. The distance by which a water table is lowered as a result of pumping.

Drift. Rock material (clay, silt, sand, gravel, boulders) transported by a glacier and deposited directly by the ice or water emanating from it. Includes both stratified and unsorted material.

Drumlin. A streamlined hill or ridge of drift with the long axis parallel to the direction of flow of the former glacier.

Esker. A narrow ridge of gravelly or sandy drift deposited by a stream bounded by glacier ice.

Evapotranspiration. Loss of water from a land area through transpiration by plants and evaporation from the soil.

Fragipan. A dense subsurface layer in the soil zone whose hardness and relatively low permeability are chiefly due to extreme compactness rather than high clay content. Contains much silt and sand but little clay and organic matter.

Ground water. Water saturating a geologic stratum beneath land surface; all water below the water table.

Hardness (water). A property of water causing formation of an insoluble residue when water is used with soap, and forming a scale in vessels from which water has evaporated. Primarily due to ions of calcium and magnesium ($CaCO_3$).Generally expressed in milligrams per liter.

Head, static. The height of the surface of a water column that could be supported by the pressure of ground water at a given point.

Hydraulic conductivity. A measure of the ability of a soil or rock material to transmit water.

Hydraulic gradient. The change in static head per unit of distance in a given direction. If not specified, the direction is generally understood to be that of the maximum rate of decrease in head.

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[1] Most definitions are quoted or paraphrased from Bates, R.L., and Jackson, J.A., eds., 1980, Glossary of Geology, second edition: Falls Church, Va., American Geological Institute, 749 p.

Ice-contact deposits. Stratified drift deposited in contact with melting glacier ice.

Kame. A low, steep-sided hill of stratified drift, formed in contact with glacier ice.

Kame terrace. A terracelike body of stratified drift deposited between a glacier and an adjacent valley wall.

Lacustrine deposit. Sand, clay, or silt deposited in a lake environment.

Loam. A rich, permeable soil, sometimes called topsoil, with approximately equal proportions of clay, silt, and sand, generally containing organic matter.

Lodgment till. Basal till plastered upon bedrock or other glacial deposits beneath a glacier, containing stones commonly oriented with their long axes parallel to the direction of ice movement.

Milligrams per liter (mg/L). A unit for expressing the concentration of a chemical constituent in solution; that is, the weight of constituent (thousandths of a gram) per unit volume (liter) of water.

Micrograms per liter (µg/L). A unit for expressing the concentration of a trace constituent in solution; that is, the weight of constituent (millionth of a gram) per unit volume (liter) of water.

Moraine. An accumulation of drift deposited in place by the direct action of ice.

Muck. Dark, finely divided, well-decomposed organic material with a high percentage of mineral matter, generally silt; forms surface deposits in some poorly drained areas such as former lake bottoms.

NGVD. National Geodetic Vertical Datum of 1929. Equivalent to mean sea level.

Outcrop. An area where a given rock unit is exposed at land surface.

Outwash. Stratified drift deposited by meltwater streams beyond active glacier ice.

Outwash plain. The surface of a broad body of outwash.

Permeability. Property or capacity of a porous rock, sediment, or soil for transmitting a fluid; a measure of the relative ease of fluid flow under unequal pressure.

Potentiometric surface. An imaginary surface, either above or below land surface, that represents the level to which water from an aquifer would rise in a tightly cased well. (See "head.")

Proglacial lake. A lake formed just beyond the frontal margin of a glacier, generally in contact with the ice.

Recharge area. The location at which water can enter an aquifer directly or indirectly; generally an area consisting of a permeable soil zone and underlying rock material that allows precipitation or surface water to reach the water table.

Soil zone (horizon). The layer of soil at land surface that has developed characteristics produced through the operation of soil-building processes. The letters A, B, and C are used to designate specific horizons in the soil.

Specific conductance. A measure of the ability of water to carry an electric current. A high value indicates a high concentration of dissolved minerals.

Specific yield. Ratio of volume of water that a given mass of saturated rock or soil will yield by gravity to the volume of the mass, stated as a percentage.

Till. Nonsorted, nonstratified sediment carried or deposited by a glacier.

Unconfined aquifer. An aquifer having a water table and containing unconfined water.

Unconfined ground water. Ground water having a free water table, not confined under pressure, beneath a relatively impermeable layer.

Unconsolidated material. A sediment or rock composed of particles that are not cemented together.

Unsaturated zone. The zone between the land surface and the water table, containing water held by capillarity, and containing air or gases generally under atmospheric pressure.

Valley fill. Unconsolidated sediment derived from erosion that fills or partly fills a bedrock valley; formed principally by glacial and alluvial processes.

Water table. Top of the zone of saturation.

Zone of saturation. Part of the water-bearing material in which all voids are ideally filled with water.

Abbreviations and Factors for Converting Inch-Pound Units to International System (SI) Units

Multiply Inch-Pound Units	*By*	*To Obtain SI Units*
inch (in.)	2.540	centimeter (cm)
feet (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (k)
square mile (mi^2)	2.59	square kilometer (km^2)
gallon (gal)	3.785	liter (L)
	0.003785	cubic meter (m^3)
gallons per minute (gal/min)	0.06308	liters per second (L/s)
gallons per day (gal/d)	3.785	liters per day (L/d)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)

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E R R A T A

page 9, fig. 1C: Well on right should be labeled "water-table well."

page 35, fig. 2J: Map modified from Brown and others, 1981.

page 66, 2d line of paragraph 1: "schist in the northwest, and... conglomerate to the southeast"

page 79, fig. 4I: Map modified from Moore and others, 1982.

page 113, fig. 6D, sections A-A', B-B', D-D': Lake sand units should be blue to indicate saturated aquifer material.

page 124, 2d line of paragraph 5: "before 1966" should read "in 1950."

page 144, footnote: 1976 updates by Southern Tier Central Regional Planning and Development Board include projected land use.

page 179, fig. 9C: The three kame sand and gravel units near Painted Post, the one south of South Corning, and the one at Presho should be till.

page 181, fig. 9D, section A-A': Sand, silt, and clay unit on right should be till.

page 190, footnote: 1976 updates by Southern Tier Central Regional Planning and Development Board include projected land use.

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ATLAS OF ELEVEN SELECTED AQUIFERS IN NEW YORK

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ABSTRACT

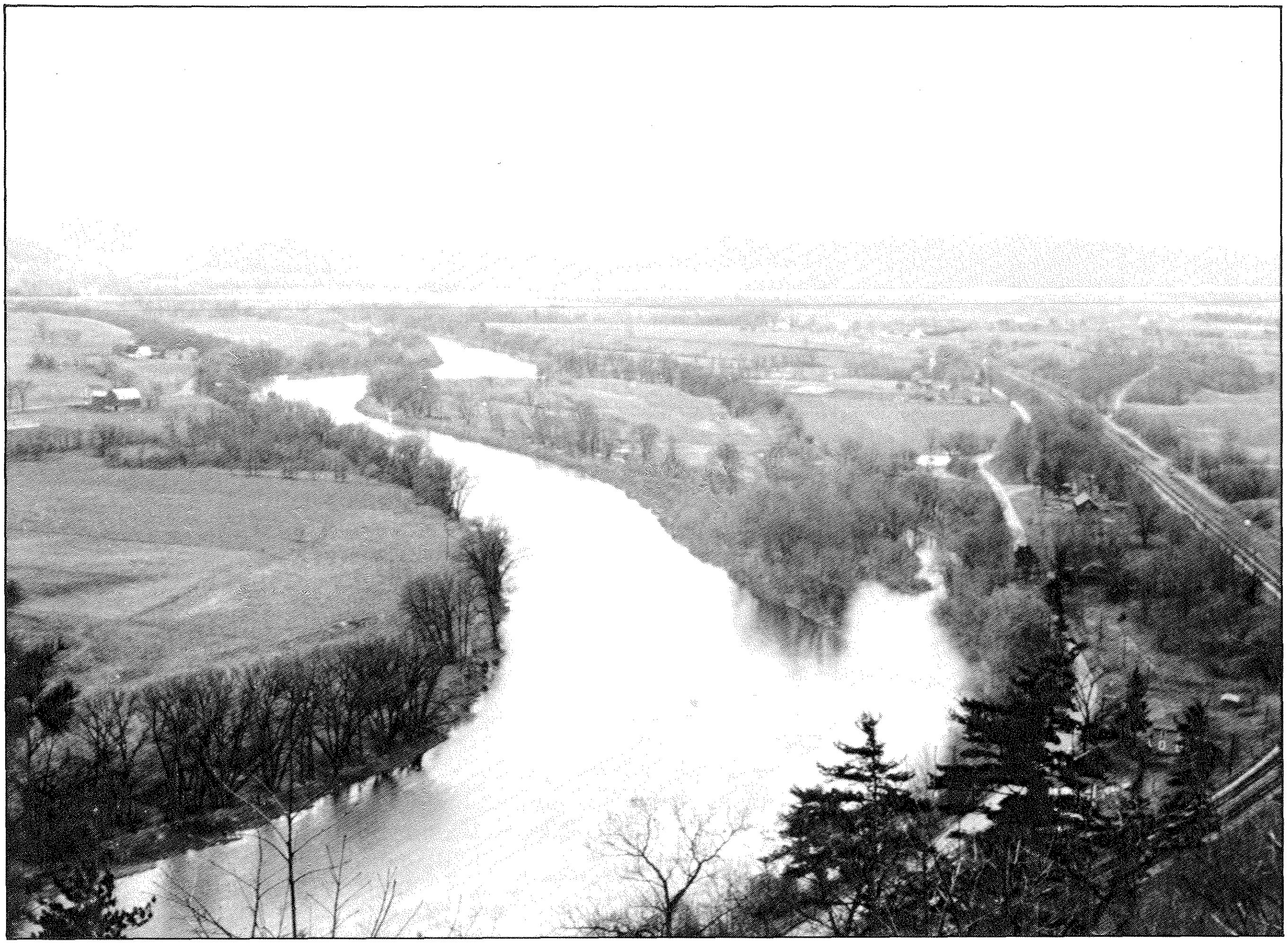
Eleven heavily used surficial-deposit aquifers in New York were mapped in 1981 to provide a basis for their protection from contamination, particularly through underground disposal of wastes. The resulting maps and sections, originally prepared and released by the U.S. Geological Survey at a scale of 1:24,000, are presented herein at a reduced scale and in simplified form. Each illustration is accompanied by a short text describing the major features and hydrologic characteristics of the given aquifer. The areas mapped are Schenectady, Endicott-Johnson City, Ramapo River-Mahwah River, Irondequoit Valley, Jamestown, Elmira-Horseheads-Big Flats, Cortland-Homer-Preble, Corning, Sprout Creek-Fishkill Creek, Fulton, and South Fallsburg-Woodbourne.

The eleven aquifers are typical of the numerous primary aquifer systems in the glaciated part of New York. Preglacial stream and river valleys that were carved in bedrock are now filled with thick deposits of drift that have been partly reworked by postglacial streams. These "valley-fill" deposits contain highly permeable saturated sand and gravel, are hydraulically connected with the main stream or river, generally have a shallow water table, and provide a large reserve of fresh ground water of acceptable quality for drinking. Interspersed within most of these aquifers are isolated bedrock knobs and scattered layers of till, silt, and clay, which are relatively impermeable and retard the movement of water, locally producing confined (artesian) conditions. In some aquifers, the confined areas are extensive.

Of upstate New York's population of 7.9 million (excluding New York City and Long Island), 36 percent, or 2.8 million, use ground water from community water systems. The aquifers described in this report together supply 92 million gallons of ground water per day to 560,000 people — 20 percent of the upstate population dependent on ground water. Wells for public and industrial supply generally yield several hundred gallons per minute.

The two most common problems facing those responsible for the long-term protection of these aquifers are (1) lack of knowledge of the ground-water systems, and (2) local vulnerability of the aquifers to contamination from a variety of sources. The chapters present information on present and potential sources of contamination within each area and the types of data needed for future ground-water management.

Several maps of each aquifer are included; these depict the surficial geology, soil-zone permeability, aquifer dimensions and well yield, ground-water movement, and land use within the area. Also included are tables of ground-water pumpage and population served and a comprehensive list of references for each aquifer.



U.S. GEOLOGICAL SURVEY 1953

Typical valley-fill setting along Chemung River near Elmira, New York.

1
INTRODUCTION

By Roger M. Waller

A. Purpose and scope of study

B. Origin of aquifers

C. Occurrence and movement of ground water

D. Quality of ground water

E. General references

1 INTRODUCTION

A. Purpose and scope of study

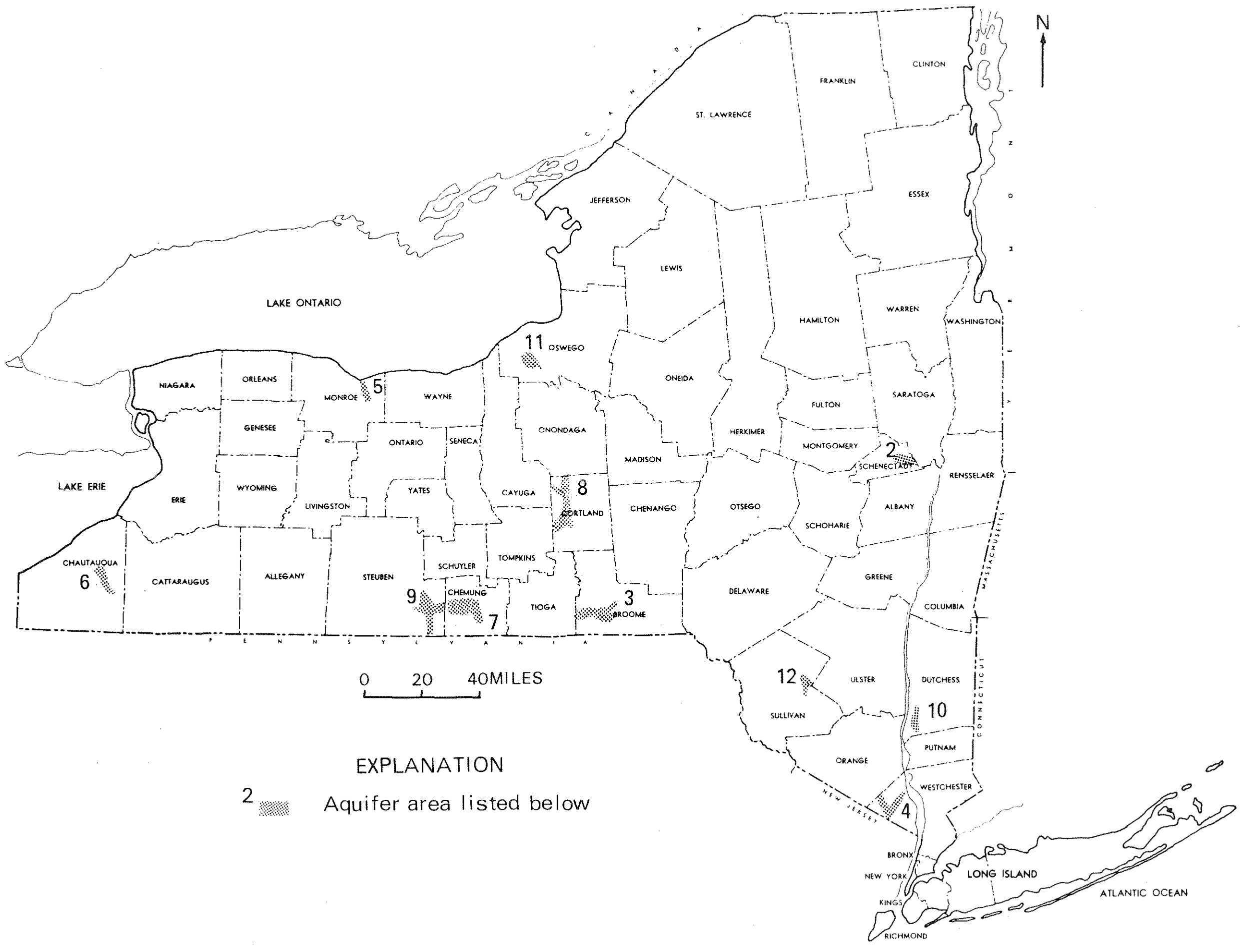
Aquifers are vulnerable to contamination from hazardous wastes

In 1979, the U.S. Environmental Protection Agency provided funding to individual States for the implementation of underground-injection-control programs. The New York State Department of Health contracted with the U.S. Geological Survey to identify the principal aquifers and define their extent and hydrologic characteristics so that contamination through underground disposal of hazardous or toxic wastes could be avoided. This report summarizes the information obtained through a detailed mapping study of 11 heavily used aquifers in New York.

New York has numerous unconsolidated-deposit aquifers in well-defined valley systems and in lake-plain areas. These aquifers, in contrast to the underlying bedrock aquifers, are generally highly productive, have water of better quality, and together readily supply 92 Mgal/d of water to 2.8 million people.

Of upstate New York's 7.9 million people (excluding Long Island and New York City), 36 percent depend on ground water for water supply (New York State Department of Health, 1981). In some regions, the ground water is vulnerable to contamination, either from surface sources or from underground disposal of wastes. In 1979, the United States Environmental Protection Agency (EPA) undertook a nationwide program of "underground-injection control" to protect aquifers used for drinking water against contamination from underground wastes. The New York State Department of Health (NYSDOH) was designated as the "lead agency" in New York State to evaluate implementation of this Federal program. To protect aquifers used for drinking water against contamination, NYSDOH determined it necessary to identify and describe the aquifers of concern.

The New York State Department of Health entered into an agreement with the U.S. Geological Survey to compile hydrologic information on 11 heavily used aquifer systems (fig. 1A). As a result of that study, 11 map reports were compiled and released in the U.S. Geological Survey's Open-File series. This report summarizes the information from those reports in a format convenient to water managers as well as the general public.



LOCATION OF AREAS STUDIED

Chapter	Aquifer Area	Principal Reference[1]
2	Schenectady	Brown and others, 1981
3	Endicott-Johnson City	Holecek and others, 1982
4	Ramapo River - Mahwah River	Moore and others, 1982a
5	Irondogenesee	Waller and others, 1982
6	Jamestown	Anderson and others, 1982b
7	Elmira-Horseheads-Big Flats	Miller and others, 1982a
8	Cortland-Homer-Preble	Miller and others, 1981
9	Corning	Miller and others, 1982b
10	Sprout Creek-Fishkill Creek	Moore and others, 1982b
11	Fulton	Anderson and others, 1982c
12	South Fallsburg-Woodbourne	Anderson and others, 1982a

[1] *See list of references, p. 12.*

Aquifers occur within glacial valley-fill deposits

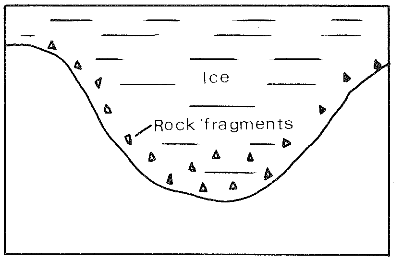
Many New York aquifers are valley-fill deposits in well-delineated glaciated bedrock valleys. Meltwater from the ice margins laid down clean, well-sorted sediments in extensive deposits downvalley that today readily yield water to wells. Deposits laid down at ice fronts and along valley walls also are good aquifer material.

New York was almost completely glaciated during the ice age, which ended about 11,000 years ago. The preglacial bedrock surface, modified by erosion, had many deeply incised valleys that were subsequently filled with glacial and proglacial-lake and stream deposits. Some valleys still retain lakes developed during glacial retreat; among these are the Finger Lakes in central New York. As the ice melted, the hilltops and valley walls became mantled with unsorted till and scattered, localized ice-contact deposits. Lodgment till is common in the uplands and on the buried bedrock surface in the valleys; ablation till is most common on the upland bedrock surfaces.

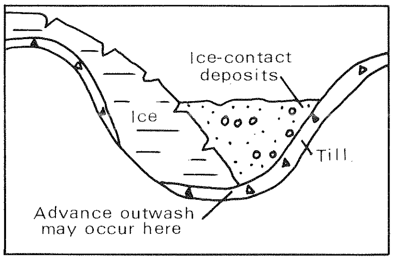
Meltwater streams deposited well-sorted sediments of sand and gravel size at the ice margins and along the valleys downstream from the ice front. The types of sand and gravel deposits that form the most productive aquifers are outwash and ice-contact material; their mode of formation is shown in figure 1B. Most outwash deposits have been modified locally by postglacial streams and are now covered with finer grained flood-plain alluvium. The ice-contact deposits generally remain as kame terraces along the edges of the valleys. Although the terraces are not continuous, they may contain a greater volume of permeable sediments than outwash deposits.

Outwash and kame deposits are present to some degree in most every valley in the State where meltwater streams flowed for an extended period over the same course. Outwash deposits cover most valley floors and in many places overlie glacial-lake deposits. Outwash from advancing glaciers or from earlier glaciation may lie beneath the lake-clay deposits, forming buried aquifers (fig. 1B), but these are rarely as extensive as those overlying the clay. Kame deposits extend to the base of the valley fill in some areas and are commonly hydraulically connected with buried outwash deposits.

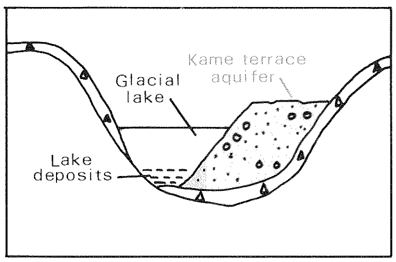
The glacial-lake deposits, which are relatively impermeable, may contain sandy zones that yield water to wells. The lake deposits also are saturated and may contribute water to adjacent aquifers.



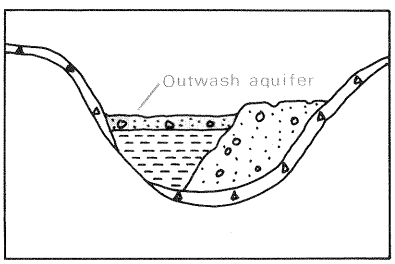
Ice advances over area and gathers load by eroding bedrock. Later, at the base of ice, rock fragments are deposited to form till. (See below.)



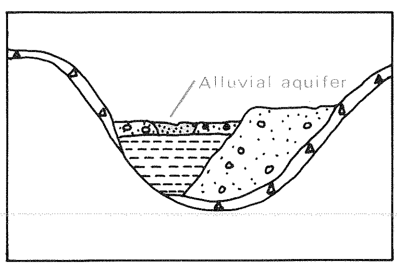
Ice begins to melt. Sand and gravel (ice-contact) deposits are laid down in a temporary valley between ice and valley wall.



Stagnant ice melts. Ice-contact (kame terrace) deposits slope toward center of valley. A glacial lake forms in which clay and silt accumulate.



Glacial lake is filled with sediment or is drained. Glacial streams flow over surface of lake deposits and lay down sand and gravel outwash deposits.



Recent stream cuts into glacial deposits and lays down alluvium consisting of silt, sand, and gravel.

Precipitation is the ultimate source of ground water

Ground water in most sand and gravel aquifers is under shallow water-table conditions but may be confined (artesian) in local subsystems. Aquifers are recharged by precipitation that infiltrates through the soil and also by infiltration from streams. Ground water moves downward and toward streams and lakes, where it is discharged.

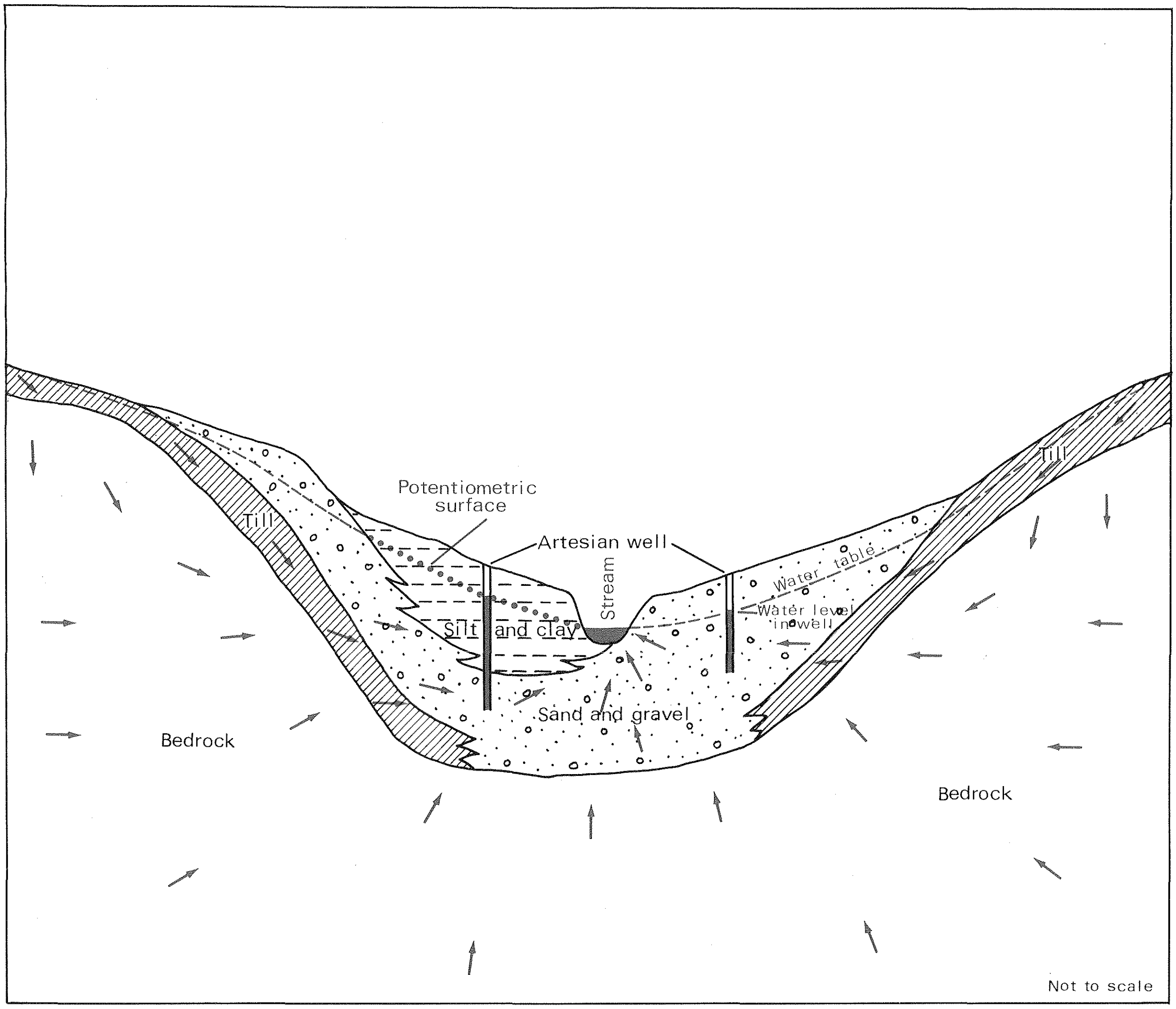
The source of ground water is precipitation and snowmelt. Of the total precipitation, some runs off the hillsides as rivulets into streams, some evaporates or is transpired back to the atmosphere by plants, and the remainder infiltrates into the ground.

Of the infiltrating water, some is retained in the soil zone, and the remainder reaches the water table (fig. 1C). Depending on many factors, the percentage of annual precipitation that reaches the water table in New York ranges from 20 to 50 percent. During the growing season, most of the water entering the soil zone replenishes soil moisture or is taken up by plant roots; thus, most recharge occurs from late fall to early spring. Precipitation generally ranges from 30 inches on the Lake Ontario Plain to 50 inches in southeastern New York.

The soil zone (weathered, organic-rich layer) is a principal factor in infiltration potential, but land use and permeability of underlying material may determine how much infiltrated water will reach the aquifer. Urbanization and associated modifications to the land surface, such as paving, severely reduce recharge locally. In addition, much runoff in urban areas is diverted by storm sewers to streams, further reducing the recharge.

Once water reaches the water table, it moves downgradient, generally parallel to a land surface, until it emerges at low points such as nearby streams, lakes, or swamps. Part of it also moves downward into the deep system and moves through the fractures in bedrock (fig. 1C). In valley-fill aquifers, most of the water ultimately discharges as base flow to the main stream in the valley.

Ground water occurs under both water-table (shallow) and confined (artesian) conditions, as shown in figure 1C. In the water-table systems, ground water is in contact with the unsaturated zone, whereas in the confined systems it is separated from the water-table system or the unsaturated zone by a confining layer of silt or clay and is commonly under pressure. In New York, most confining layers consist of clay or silt layers that formed on lake bottoms above a layer of unconsolidated permeable material. Many aquifer systems contain both water-table and confined conditions; in such systems, each aquifer has a different water level (potentiometric-surface altitude).



Occurrence of ground water under water-table and artesian conditions. Arrows indicate direction of flow

Ground-water quality has deteriorated locally

The quality of water in the valley-fill aquifers of New York is generally adequate for drinking. The characteristics that cause the most frequent difficulties are excessive iron and hardness. Toxic materials derived from wastes are becoming more prevalent in parts of some aquifers.

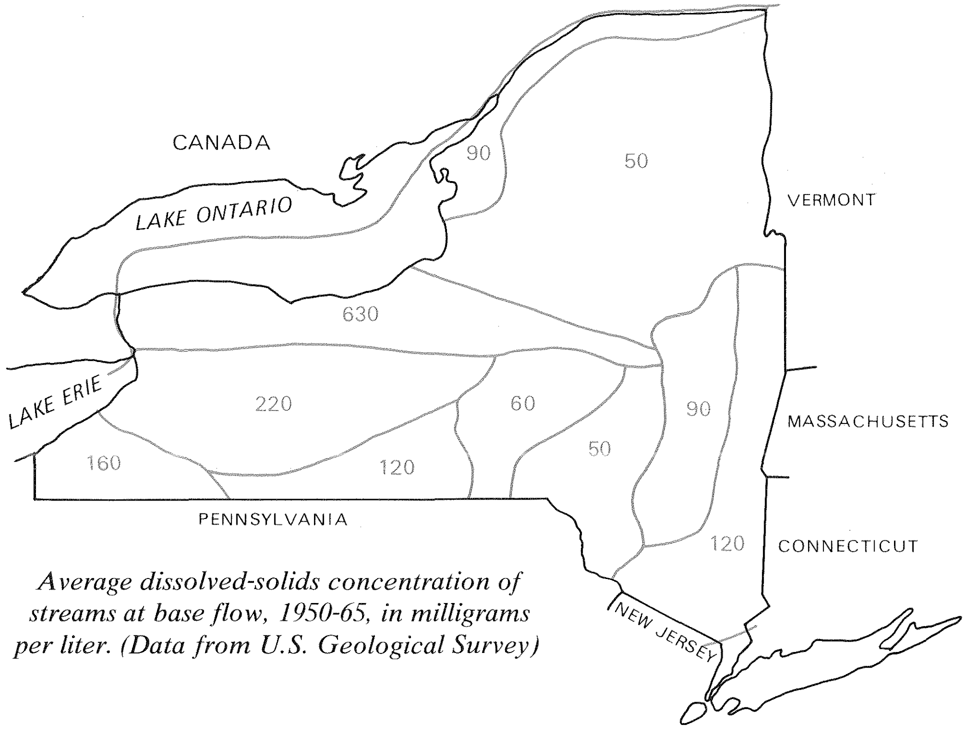
Water changes in chemical quality as it moves through the aquifers because chemical constituents from the soil zone and the aquifer material become dissolved in the water. Water quality can also change with temperature, with the introduction of substances from waste discharges, and with fluctuations in recharge rate.

A measure of water quality is the dissolved-solids concentration — the sum of all dissolved constituents in a given volume of water. Stream water during base flow, when all surface runoff from recent precipitation has dissipated, consists solely of discharged ground water. Thus, the chemical quality of stream water during base flow generally is representative of water quality in the adjacent aquifers. The general range of dissolved-solids concentration in the base flow of streams in upstate New York is shown in the map in figure 1D.

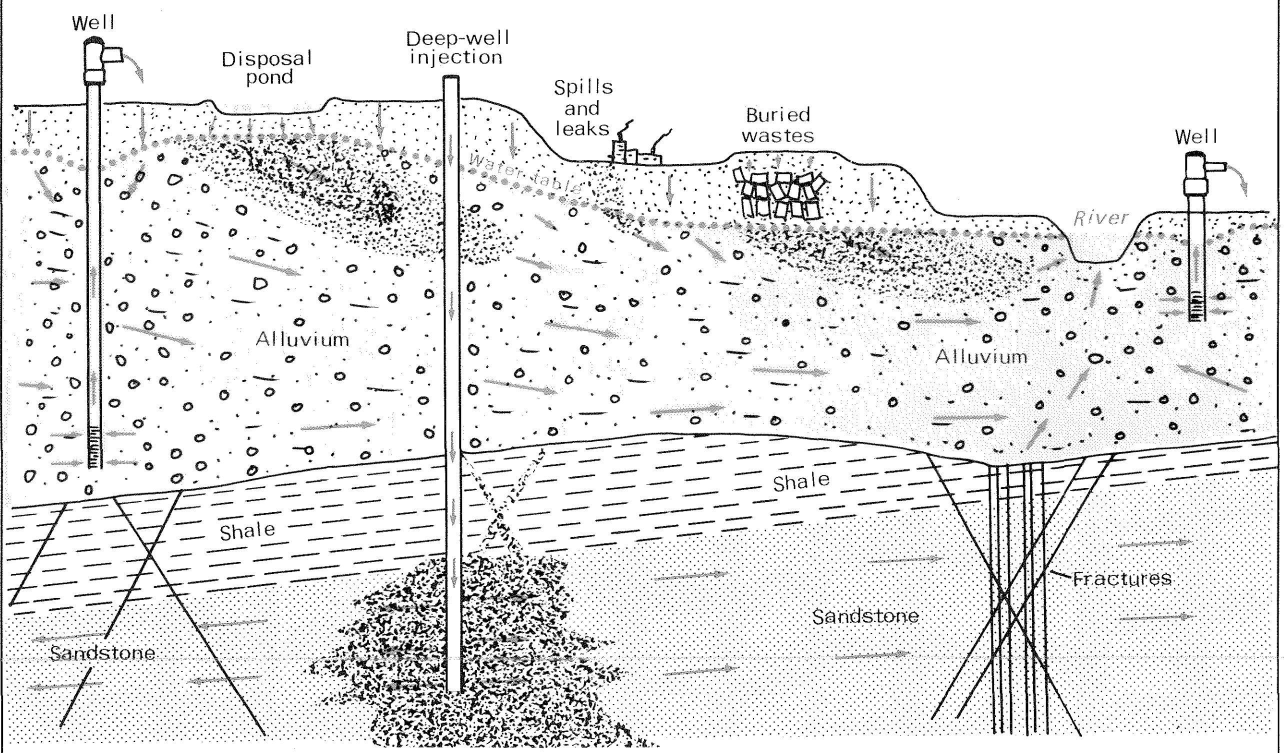
Temperature of ground water is commonly between 47-55°F but may vary seasonally in aquifers that are in hydraulic contact with streams. In such systems, ground-water temperatures may fluctuate by as much as 30°F seasonally (Randall, 1977).

Ground-water quality is also affected by wastes. For example, wastes generated in domestic and industrial practices may eventually reach the aquifers. Hydrocarbons, lead from leaded gasoline, and asbestos from brake linings are found in soils adjacent to roads and may infiltrate the underlying aquifers. Organic constituents from industrial, agricultural, and other types of wastes are also found in ground water. Unfortunately, detailed chemical procedures are needed to detect the presence of these constituents in ground water. Typical sources of contamination to ground-water bodies are depicted in the lower part of figure 1D.

In recent years, toxic wastes in ground water have been identified in some areas. Public-supply wells in 11 New York counties, and numerous private systems statewide, have been closed as a result of contamination. A few comprehensive surveys of dangerous constituents in ground water have been made. In two recent studies, 40 community water systems tapping valley-fill aquifers (several included herein) in New York were analyzed for organic chemicals (Kim and Stone, 1979, and Schroeder and Snavely, 1981). Traces of organic chemicals were found in water from many of the aquifers, and concentrations of several chemicals were relatively high. The New York State Department of Health has recently conducted two additional surveys for organic chemicals in ground-water sources of community water systems (New York State Department of Health, 1982 a, b).



Average dissolved-solids concentration of streams at base flow, 1950-65, in milligrams per liter. (Data from U.S. Geological Survey)



Schematic profile illustrating some typical processes by which ground-water resources become contaminated. (Modified from U.S. Geological Survey, 1982)

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2
SCHENECTADY AREA

By G. Allan Brown

A. Location and major geographic features

B. Population and ground-water use

C. Geologic setting

D. Geohydrology

E. Aquifer thickness

F. Ground-water movement

G. Temporal trends in ground-water levels

H. Well yields

I. Soil-zone permeability

J. Land use

K. Present and potential problems

L. Selected references

2 SCHENECTADY AREA

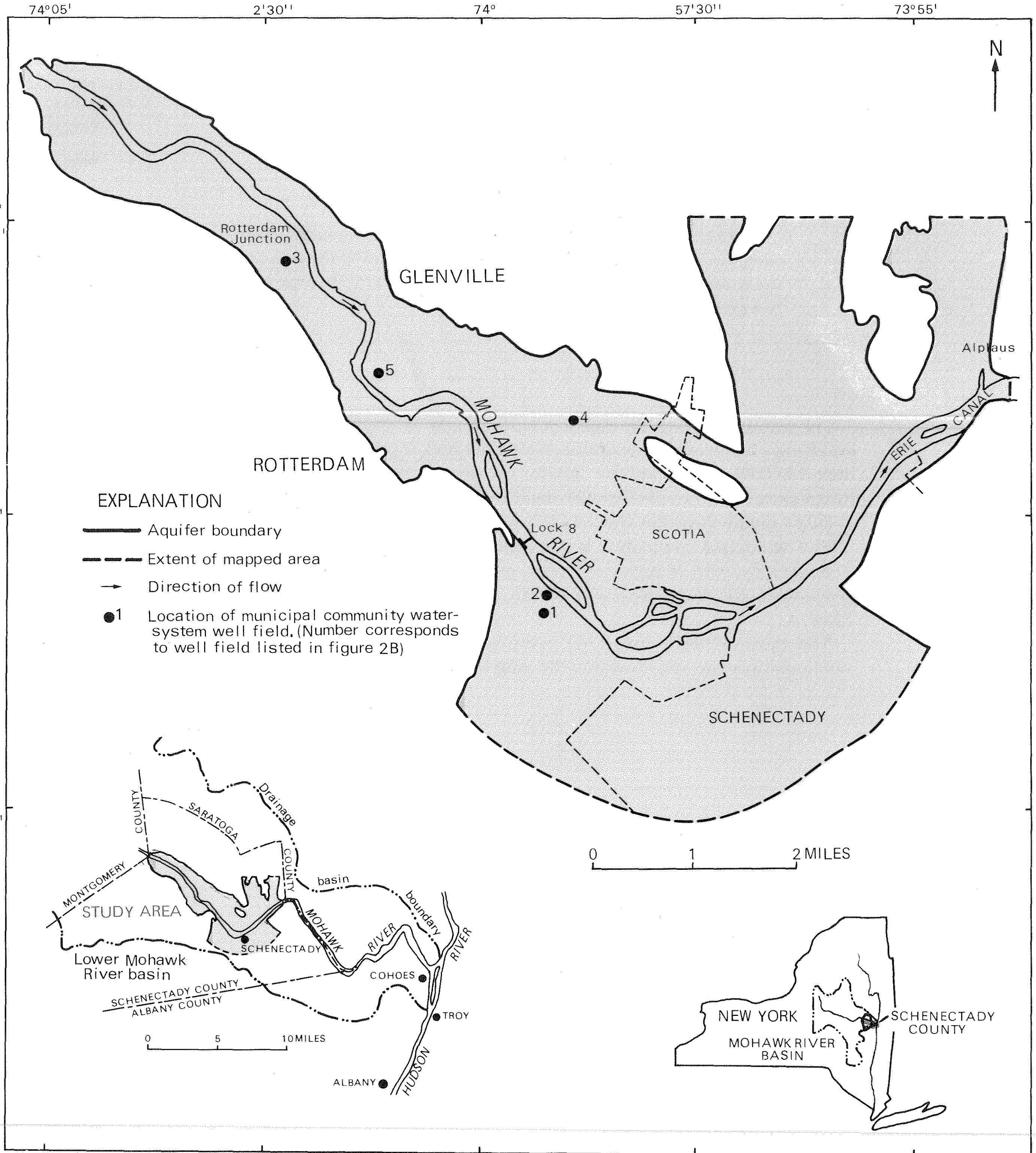
A. Location and major geographic features

This aquifer underlies the lower reach of the Mohawk valley

This aquifer, which serves the Schenectady area, lies in a highly urbanized part of the lower Mohawk River valley in eastern New York. The main part of the aquifer is about 14 miles long and 0.5 to 5 miles wide.

The Great Flats, or Schenectady, aquifer is about 14 miles long and underlies 25 square miles in the lowermost, highly urbanized part of the Mohawk River drainage basin in Schenectady County (fig. 2A). Near its western end at the Montgomery County border, the aquifer is about ½ mile wide but increases eastward to more than 5 miles wide at Schenectady. The east end of the aquifer terminates where the river valley narrows at Alplaus. The aquifer lies between the upland hills to the west and the Hudson River lowlands to the east.

FIGURE 2A SCHENECTADY AREA
Location and major geographic features



Base from U.S. Geological Survey, 1954

This aquifer is the principal source of water for Schenectady County

More than 80 percent of the population of Schenectady County lives on or near the aquifer. Ground water from this aquifer is the principal source of water for the county and is withdrawn at a rate of 25 million gallons per day. A high percentage of the area is urban.

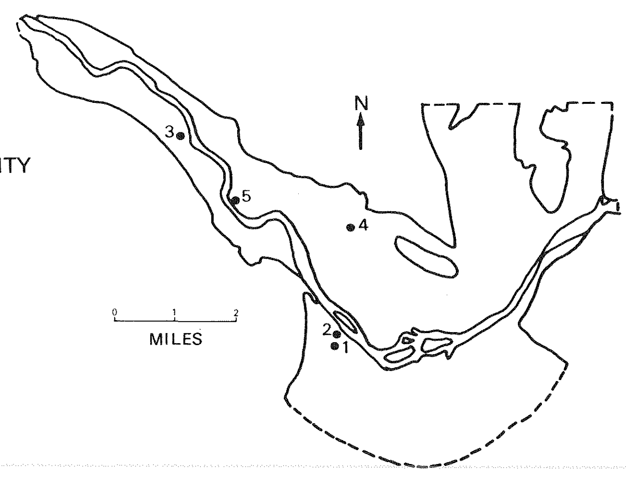
The aquifer serving the Schenectady area is in the most extensively urbanized area overlying a major aquifer in upstate New York and also supplies the largest population (more than 143,000) of any upstate aquifer. It serves the City of Schenectady, the Town of Rotterdam, the Town of Glenville, and the Village of Scotia (fig. 2A), about 84 percent of the county's population, and about 12,000 people in several outlying districts.

Five municipal community water systems pump from the aquifer (fig. 2B). The City of Schenectady, with 16 high-yield wells, pumps an average of 18.6 Mgal/d. In addition to the five municipal community water system, individual or private water systems pump about 0.5 Mgal/d.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 2A.

LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite



POPULATION AND PUMPAGE FROM SCHENECTADY AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. City of Schenectady (16 wells)	67,972	18.590
Niskayuna Water District Nos. 1, 2, 3, 6, 7, and 8	6,150	—
Rotterdam Water District No. 1	5,250	—
2. Rotterdam Water District No. 5 (3 wells)	25,949	2.740
3. Rotterdam Water District No. 3 (2 wells) (Village of Rotterdam Junction)	1,700	* 0.095
4. Village of Scotia (3 wells)	7,600	1.380
Glenville Water District No. 2	2,300	—
Glenville Water District No. 3	600	—
Glenville Water District No. 8	300	—
Glenville Water District No. 12	200	—
5. Glenville Water District No. 11 (3 wells)	14,000	1.800
Charlton Water District (Saratoga County)	2,000	—
Burnt Hills-Ballston Lake Water District (Saratoga County)	3,500	—
Rexford Water District (Saratoga County)	1,000	—
Subtotal	138,521	* 24.605
B. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per person per day is assumed	* 5,000	* 0.500
Total	* 143,521	* 25.105

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
* Estimated

This aquifer consists of sand and gravel overlain by flood-plain silt

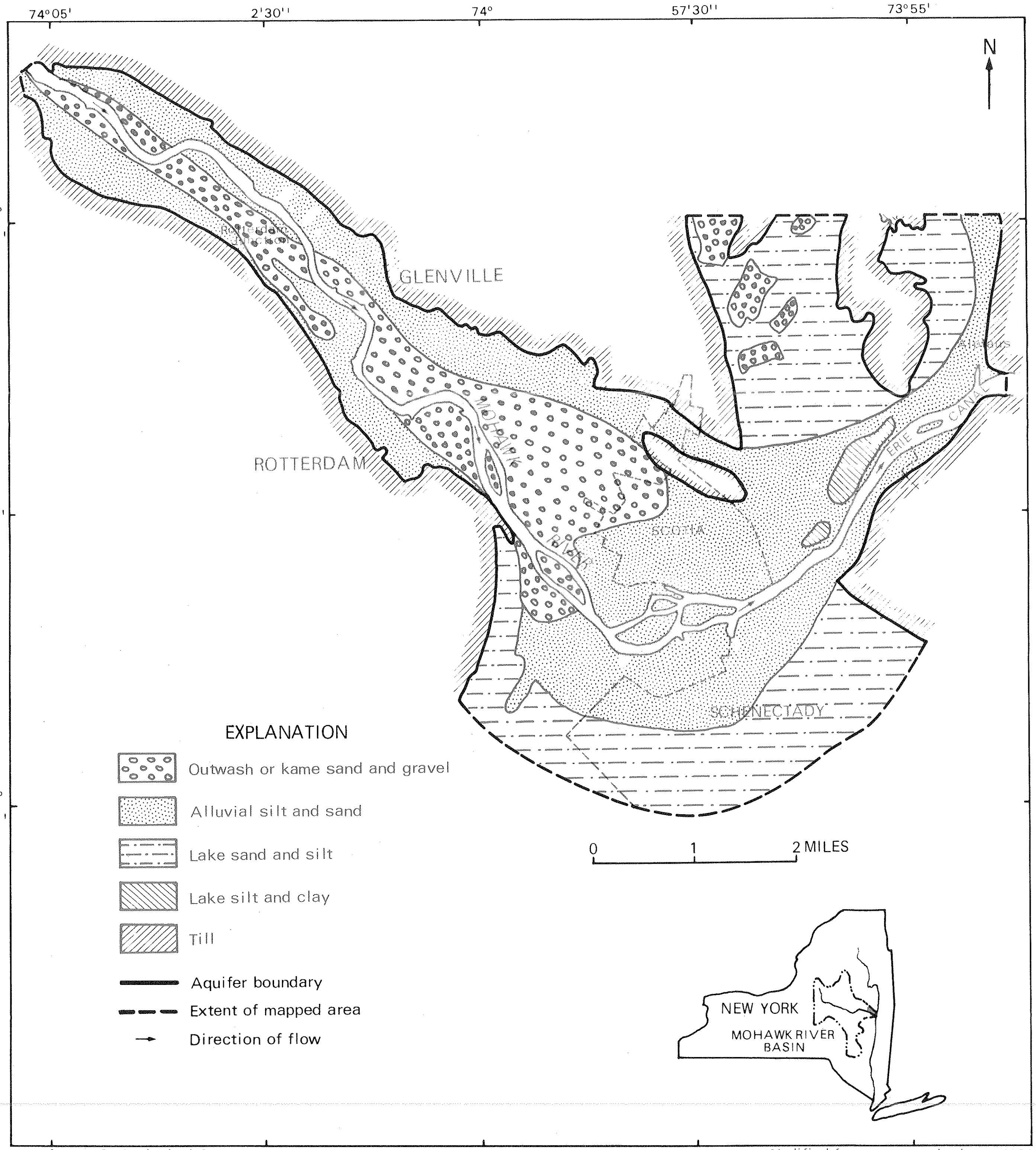
The downstream (east) end of the aquifer contains sand and silt deposits that formed in a large glacial lake. Upstream from the former lake, the valley contains coarse sand and gravel that was deposited by glacial meltwaters. The valley floor is covered by a veneer of postglacial flood-plain sand and silt.

Bedrock underlying the Mohawk valley in the Schenectady area is flat-lying shale with some interbedded siltstone. During the last glaciation, glaciers modified the regional topography by smoothing off hilltops, scouring out some valleys and filling in others, then leaving a mantle of unconsolidated material over the land surface nearly everywhere in the area (Winslow and others, 1965).

Till, silt, and sand overlie bedrock throughout most of the area (fig. 2C). The till is exposed primarily in the upland areas west and northwest of the aquifer and along a ridge east of it. Sand, silt, and clay carried by glacial meltwater were deposited in a large temporary glacial lake, now termed Lake Albany, which covered much of the mid-Hudson valley, including the Schenectady area. These fine sediments are found in the valley in the eastern part of the aquifer and also form the broad lowland plain in the northeastern and southern parts of the mapped area. Coarser sand and gravel, which was deposited upstream from the lake, occurs in the western part of the main valley. Most of the glacially derived deposits are now covered by sand and silt that form the modern flood plain.

In the northeastern part of the aquifer, kames consisting of highly permeable sand and gravel were deposited by meltwater streams at ice margins. Although the kames subsequently became partly buried by lake sand and silt of Lake Albany, a layer of sand and gravel that once formed the kames now extends southward beneath the lake sediments to the main valley of the Mohawk River (Winslow and others, 1965, p. 33).

FIGURE 2C SCHENECTADY AREA
Geologic setting



Base from U.S. Geological Survey, 1954

Modified from Brown and others, 1981

The coarsest deposits are along the 5-mile reach upstream from Scotia

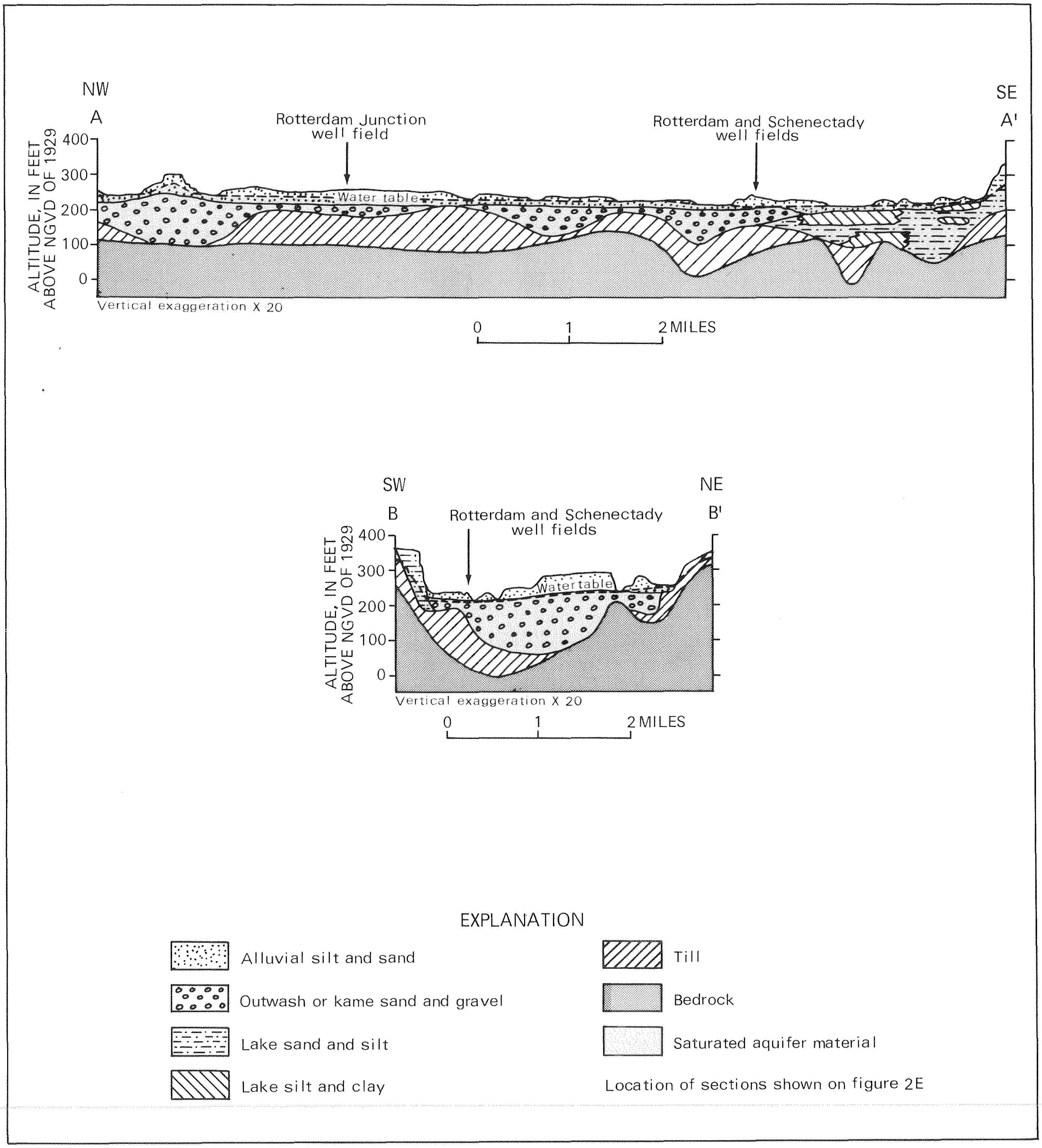
This aquifer system consists of tens to hundreds of feet of stratified unconsolidated deposits that fill the bedrock valley. The coarsest deposits are in the narrow valley reach upstream from Scotia.

The lower Mohawk valley contains a thick sequence of unconsolidated sediments, as shown in figure 2D. The coarser, well-sorted sediments make up the principal aquifer. The aquifer is mostly under water-table conditions with localized confinement under clay and silt beds.

In the south-central part of the aquifer, the bedrock surface contains several deep troughs. The deepest of these, which extends south from the present Mohawk valley just west of Schenectady (sec. A-A′), was probably the preglacial course of the Mohawk River (Winslow and others, 1965, p. 22). As much as 350 feet of unconsolidated glacial material now fills this channel.

The valley-fill material overlying till and bedrock was deposited by glacial meltwater. The coarse sands and gravels in the western part of the valley were deposited by fast-moving water flowing eastward through the valley; the finer sand and silty sand further east was deposited by more slowly moving water where the valley broadened out into Lake Albany. The silt and clay deposits in the eastern part of the area formed in the quiet waters of Lake Albany.

The sand and silty sand that now form a veneer over the valley floor are flood-plain deposits laid down by the present Mohawk River. In general, they are less permeable than the underlying stratified glacial deposits.


NW
A
Rotterdam Junction well field
Rotterdam and Schenectady well fields
SE
A'
ALTITUDE, IN FEET ABOVE NGVD OF 1929
400
300
200
100
0
Water table
Vertical exaggeration X 20
0
1
2 MILES
SW
B
Rotterdam and Schenectady well fields
NE
B'
ALTITUDE, IN FEET ABOVE NGVD OF 1929
400
300
200
100
0
Watertable
Vertical exaggeration X 20
0
1
2 MILES
EXPLANATION
Alluvial silt and sand
Outwash or kame sand and gravel
Lake sand and silt
Lake silt and clay
Till
Bedrock
Saturated aquifer material
Location of sections shown on figure 2E

This aquifer is continuous and is thickest in scattered pockets along the valley axis

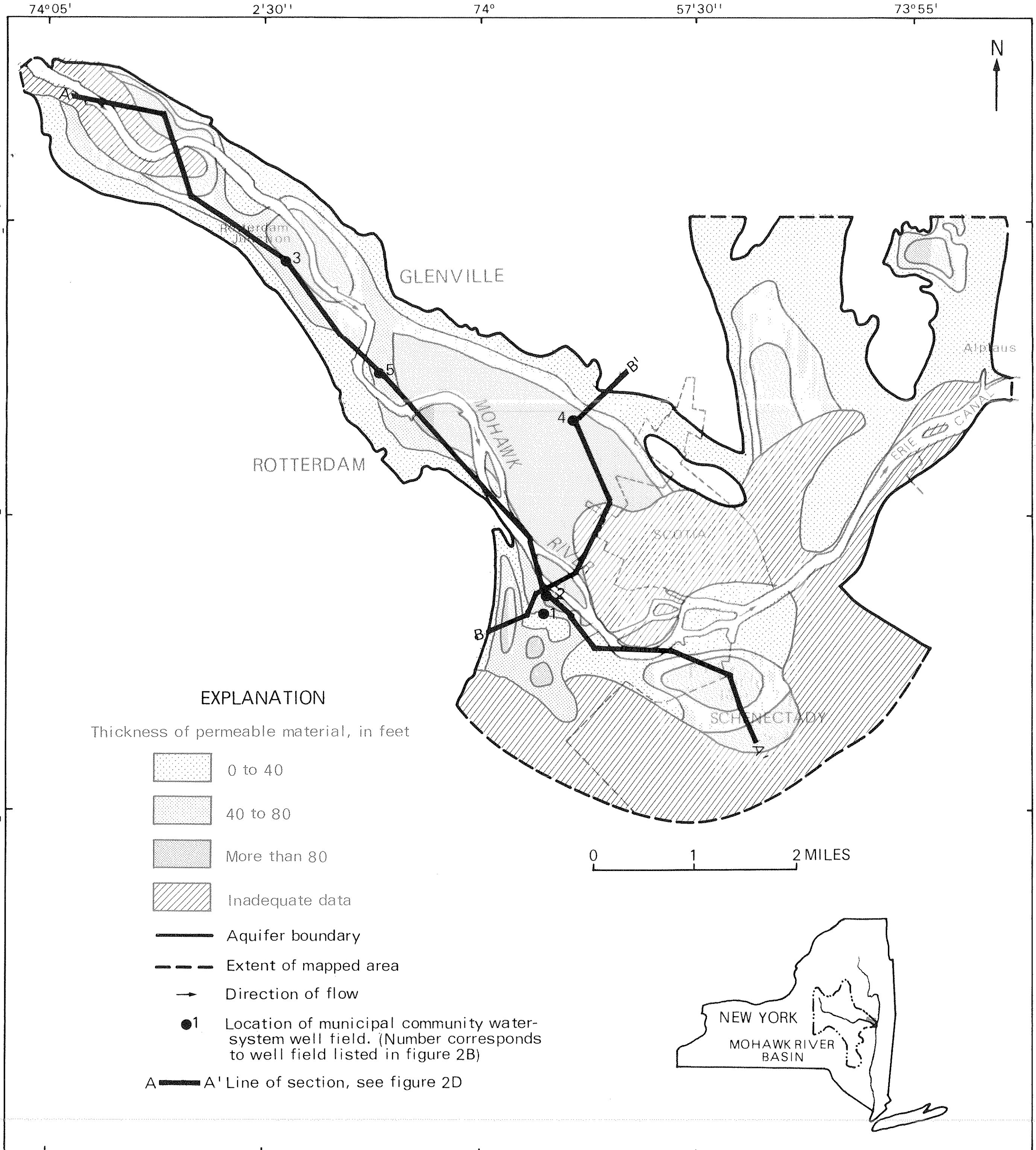
This aquifer is a moderately thick body of permeable sand and gravel. Thickness ranges from 0 at the valley walls to more than 200 feet in the center of the valley. The thickest parts are scattered along the main axis of the valley.

The thickest parts of the aquifer occur as pockets of sand and gravel along the valley floor (fig. 2E). The estimated thickness[1] of permeable sediments in the aquifer was determined from land surface to the top of the first extensive unit of low permeability, which may be bedrock or a layer of till, silt, or clay. Deeper, confined aquifers are included in these values where significant. The aquifer materials range in size from very fine sand and silty sand to coarse pebble and cobble gravel. Lenses of silt and clay less than 10 feet in thickness and discontinuous are included in the thickness values. Because thickness includes the unsaturated part of the aquifer and is measured from land surface, the contours reflect irregularities in the topography.

Very little data are available from which to determine aquifer thickness in the southeastern part of the valley. The sediments there may be as much as 200 feet thick in places but are probably finer grained and less permeable than those to the west.

[1] Aquifer thickness was computed from well logs given in Winslow and others (1965) and Haley and Aldrich (1981), and from files of the U.S. Geological Survey in Albany, N.Y.

FIGURE 2E SCHENECTADY AREA
Aquifer thickness



Base from U.S. Geological Survey, 1954

Modified from Brown and others, 1981

The water table in most places is less than 30 feet below land surface

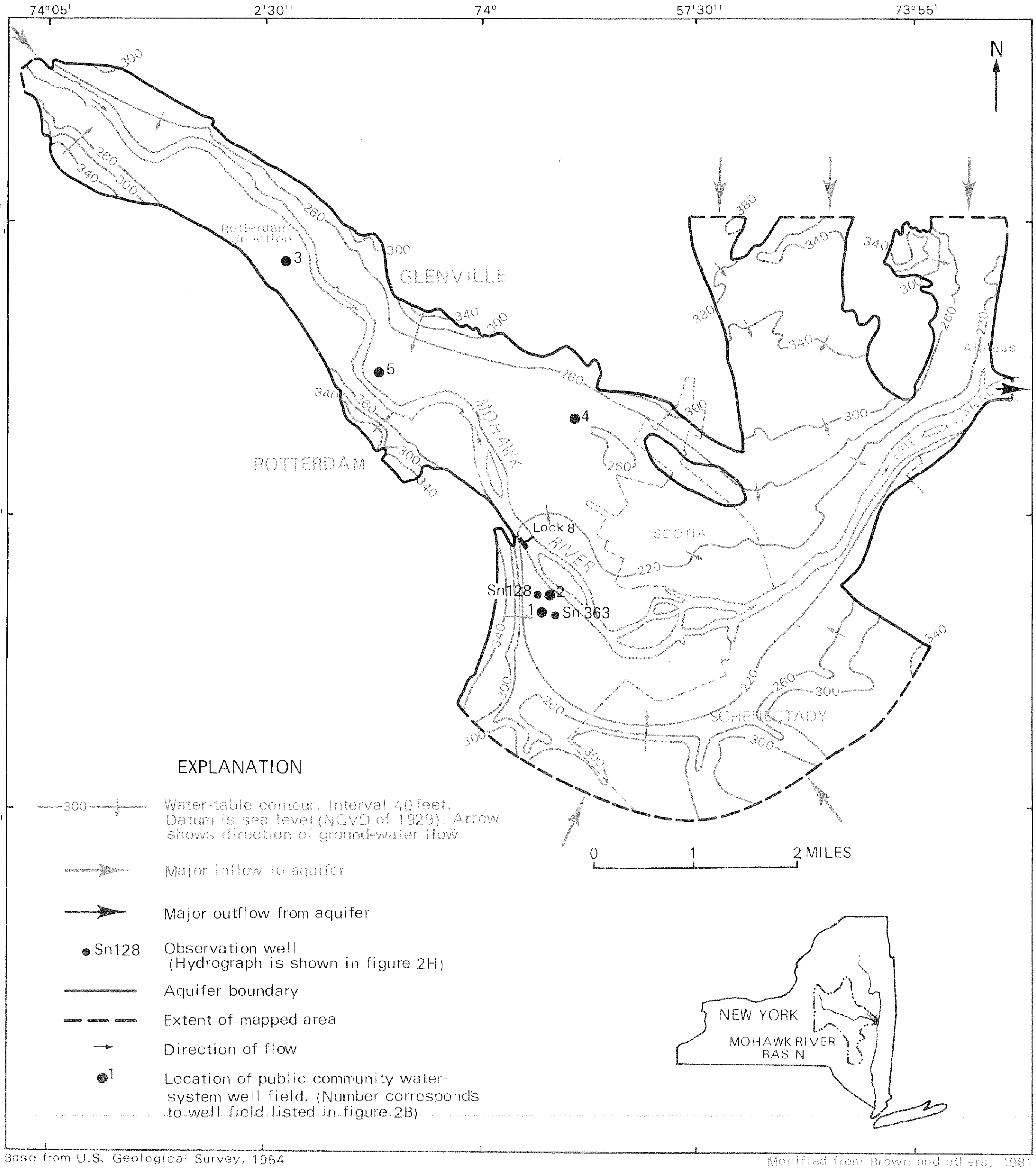
This aquifer is recharged by precipitation directly on the aquifer, by ground water flowing in from adjacent hillsides and valleys, and by seepage from streams crossing the aquifer. Discharge is principally to the Mohawk River and to wells.

Aquifer recharge occurs from precipitation directly on the land, by seepage from the tributary streams flowing across the aquifer, by subsurface flow from the till on the sides of the valley, and as seepage from bedrock and deposits of low permeability underlying the aquifer. In addition, recharge from streams may be induced by nearby large-capacity pumping wells. Aquifer discharge occurs as seepage into streams or lakes and as flow to pumping wells.

The long-term average water-table altitude in the Schenectady area aquifer as measured in wells, streams, and lakes is shown in figure 2F (Winslow and others, 1965; Haley and Aldrich, 1981). Ground-water levels closely reflect the level of the Mohawk River. Within the flood plain, depth to water is generally less than 30 feet but at higher elevations may be as much as 70 feet. Springs discharge at the base of some slopes. The water table extends up into the till and bedrock adjacent to the aquifer. In the lake sand in the eastern part of the aquifer, water levels are generally less than 25 feet below land surface but may be as deep as 50 feet in places adjacent to small downcut stream valleys.

A cone of depression has developed around the Rotterdam and Schenectady well fields (wells Sn 128 and Sn 363, fig. 2F), but because the cone of depression is less than 20 feet deep, it does not show on the map. Winslow and others (1965) depict the potentiometric surface and its intersection with the Mohawk River. They concluded that 90 percent of the well-field pumpage is induced recharge from the river, but ground water now moves toward the well field from all directions.

FIGURE 2F SCHENECTADY AREA
Ground-water movement



Base from U.S. Geological Survey, 1954

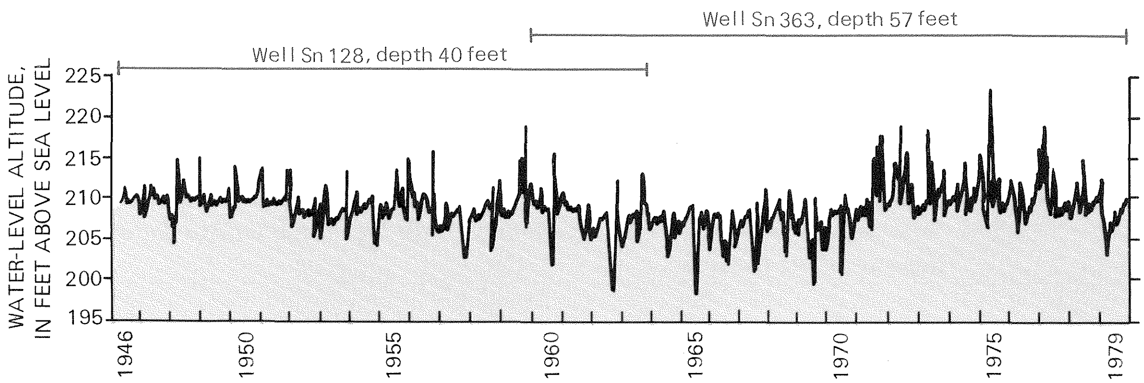
Modified from Brown and others, 1981

Seasonal water-table fluctuations are smallest near the river

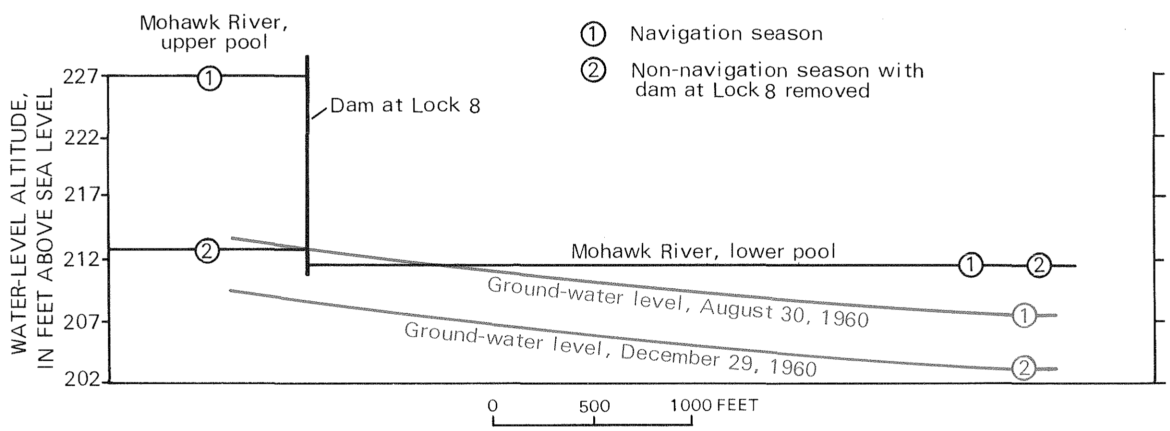
Seasonal variations in recharge to this aquifer cause water-table altitudes to fluctuate a few feet. Water levels may also be influenced by nearby pumping or by proximity to streams or lakes.

Water-table fluctuations and long-term trends in the aquifer are shown in figure 2G by the combined hydrograph of two observation wells approximately 0.3 miles apart near the municipal well fields of Schenectady and Rotterdam. (Well locations are shown in fig. 2F.) Because wells in this area are in close hydraulic connection with the river, the water level in the river is the predominant factor controlling the water level in the wells even though a pumpage of 21 Mgal/d is occurring nearby.

During the navigation season, which usually extends from early April to mid-December, the river level is controlled by a series of locks and dams. Both river and ground-water levels rise at the beginning of the navigation season and decline by a corresponding amount at the end of the season, producing a 2- to 4-foot seasonal change in water level in the vicinity of well Sn 363. The diagrammatic section along the river (fig. 2G) depicts the effect that opening the dam at lock 8 in 1960 had on water levels in nearby wells.



Hydrograph showing seasonal water-level fluctuations in observation wells near well fields of Schenectady and Rotterdam. Well locations are shown in figure 2F.



Profile along Mohawk River at Schenectady showing relationship of controlled seasonal changes of river level to water levels in aquifer during navigation and non-navigation seasons. Location of lock is shown in figure 2F. (Modified from Winslow and others, 1965.)

Coarse deposits in hydraulic contact with the river provide the largest yields

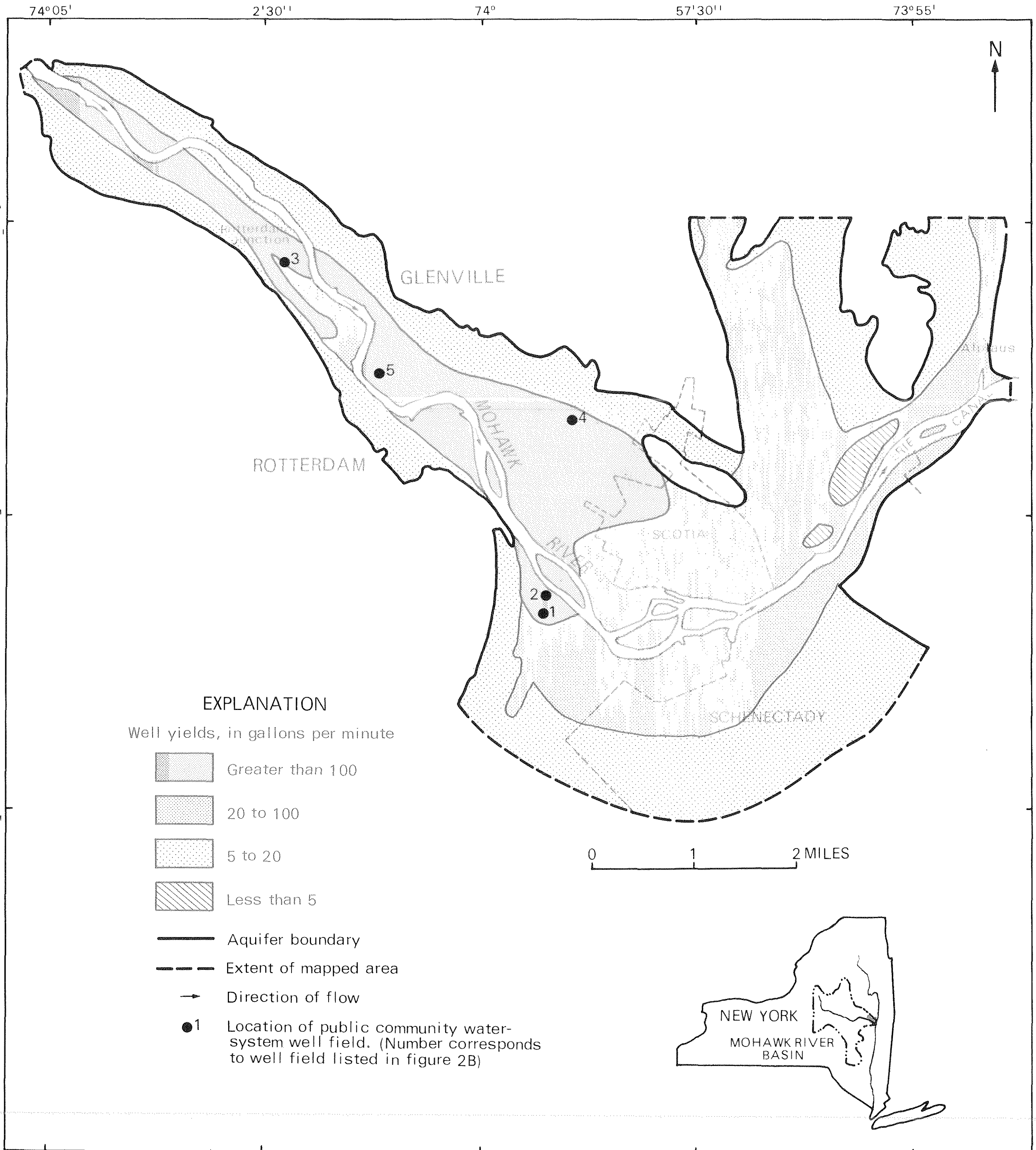
Well yields differ greatly from place to place depending on the composition of the aquifer material and proximity to the Mohawk River. Yields as high as 3,500 gallons per minute may be obtained from the coarse sand and gravel deposits along the river.

The largest well yields are obtained from the coarse sand and gravel deposits that underlie the flood plain in the northwest part of the aquifer (fig. 2H). Nearly all the aquifer's large-capacity wells are in this area; some yield more than 3,500 gal/min. Most of the water pumped from these wells is derived by induced infiltration from the river. Any properly constructed well tapping these deposits may be expected to easily yield at least 100 gal/min.

Yields of 20 to 100 gal/min may be expected in areas containing kame sand and gravel deposits or relatively thick flood-plain deposits. Well yields from kames or flood-plain deposits near the Mohawk River may be as high as 350 gal/min.

Lake sands and silts in the northeast and southern parts of the aquifer generally yield from 5 to 20 gal/min to wells; thin flood-plain deposits along the sides of the valley have similar yields. The upper layers of the lake sands and silts are coarser grained, less silty, and yield more water than the lower layers. Yields from these lake deposits are adequate for domestic wells and some small public supplies. Wells tapping some of the coarser lake sand may obtain as much as 100 gal/min. Wells tapping lake silt and clay have yields of less than 1 gal/min.

FIGURE 2H SCHENECTADY AREA
Well yeilds



Base from U.S. Geological Survey, 1954

Modified from Brown and others, 1981

Most soil overlying this aquifer is moderately to highly permeable

About three-quarters of this aquifer area is covered by sandy soil of moderate to high permeability. Extensive urbanization over the aquifer affects the soil permeability by disturbing or covering the soil surface and disrupting runoff patterns.

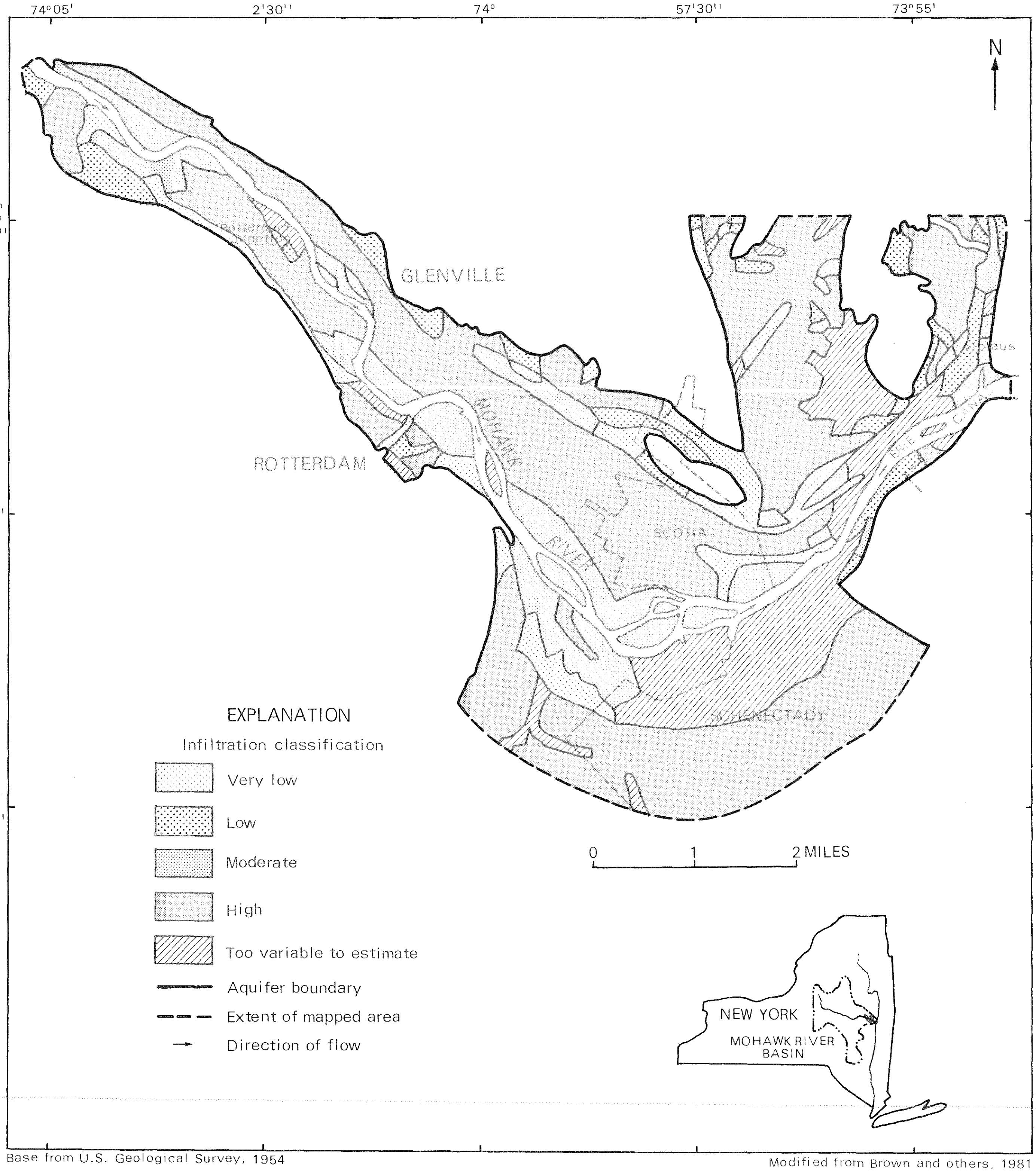
The soil-zone permeability map in figure 2I[1] indicates the generalized degree to which water can infiltrate through the soil zone. The soil zone is considered here to be only the weathered layer, which generally ranges in depth from 18 to 30 inches. The permeability classification in figure 2I is based on several factors, including surface drainage, slope, soil texture, depth to seasonal high water table, presence or absence of a fragipan (water-impeding layer), average soil-infiltration rates, septic-tank soil-percolation tests, and some engineering properties such as linear shrinkage and soil compressibility .

The soil overlying about half the aquifer has a high water-transmitting potential, and the soil overlying about three-quarters of the area can be classified in the moderate to high range. The effects of urbanization, such as the diversion of runoff to storm sewers and the disturbance or paving over of the soil, need to be considered in map interpretation.

The hills surrounding the aquifer are covered with till, which is rich in clay and ranges from low to moderate permeability. In contrast, the soils overlying most of the aquifer are relatively permeable and offer little protection against infiltration to the aquifer from land surface.

[1] This map is derived from soil-survey maps by Lounsbury (1942) and Davis and Landry (1978) by grouping soils with similar permeability.

FIGURE 21 SCHENECTADY AREA
Soil-zone permeability



Base from U.S. Geological Survey, 1954

Modified from Brown and others, 1981

Much of the area is urban, but several rural areas remain

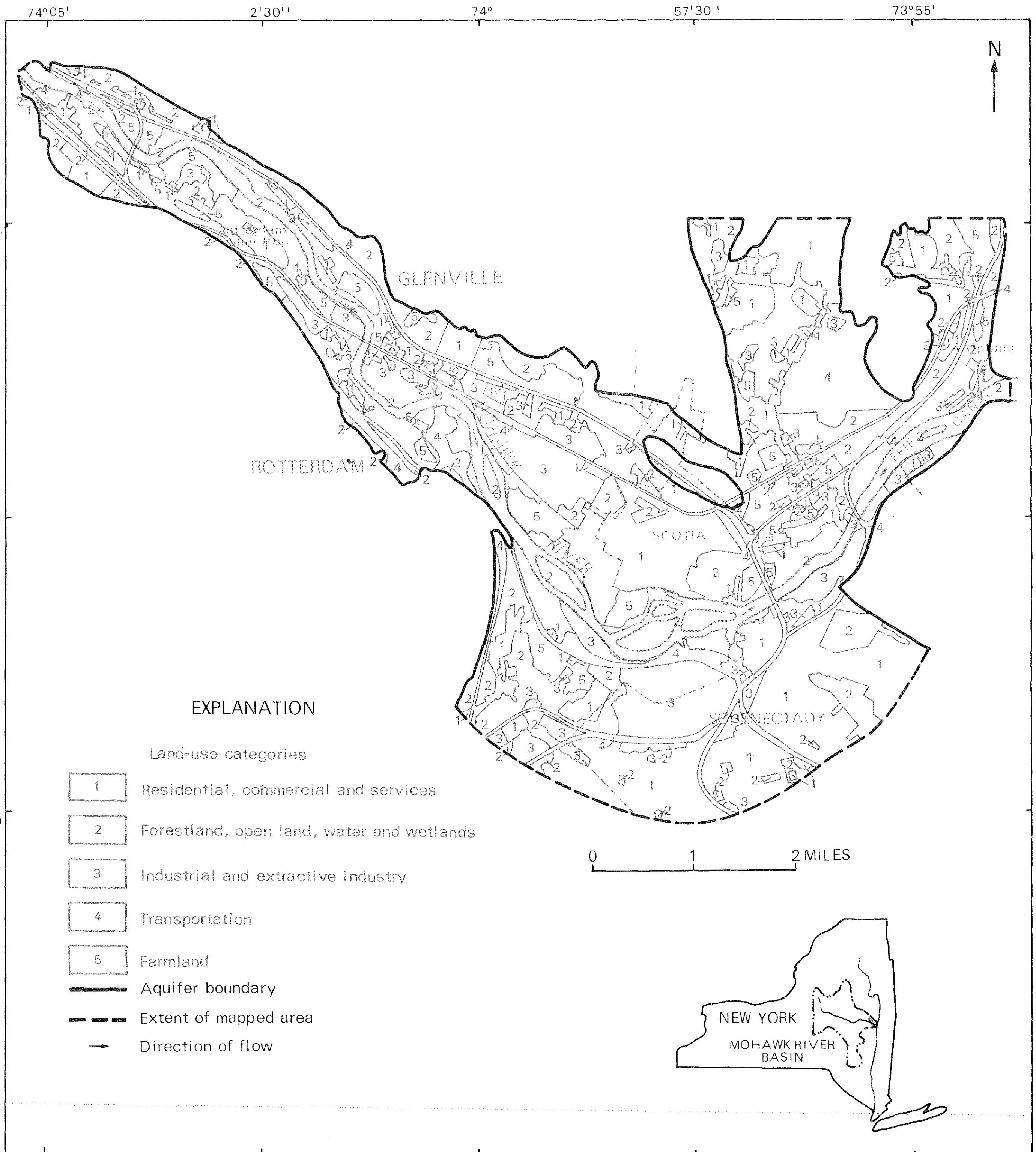
The flat land surface above this aquifer has led to extensive urbanization. The largest land-use category is residential-commercial.

The land overlying the aquifer has been extensively developed, yet some farmland remains (fig. 2J)[1]. Development is concentrated within the valley because the surrounding hillsides are generally too steep for most purposes.

The largest single land-use category[1] in terms of area is residential and commerical. The second largest includes open public land, forest, and wetlands. Industrial and extractive uses (sand and gravel mining) occupy about 8 percent of the land surface over the aquifer; many of these areas in the northwest part of the aquifer are sand and gravel pits. The railroad and highway networks are concentrated on the flat land over the aquifer and occupy a significant part of it. Suburban areas surrounding the aquifer are expected to grow, and outlying areas are expected to become more suburbanized (C.T. Male Associates, P.C., 1978, p. 7).

[1] Figure 2J is a modified and generalized version of a land-use inventory prepared jointly by the Schenectady County Environmental Advisory Council and the Schenectady County Planning Department (1977).

FIGURE 2J SCHENECTADY AREA
Land use



Base from U.S. Geological Survey, 1954

This aquifer may be vulnerable to contamination from surface sources

Ground water at the well fields is of excellent quality for drinking at present, but potential sources of pollution are on and near the aquifer.

Ground-water quality in the vicinity of the present well fields meets all State and Federal standards for drinking (U.S. Geological survey, 1980, and Allen and Waller, 1981). However, many potential sources of pollutants, both on the aquifer and in the area bordering it, could pose a threat. These sources include sewage-treatment plants, industrial and military facilities, landfills, dumping sites for septic-tank wastes, and transportation routes and facilities with their associated traffic. Urban runoff, polluted river water, and chemical and petroleum spills are other potential sources.

C.T. Male Associates, P.C. (1978) report on "critical areas" of the aquifer for present and future water development (fig. 2K). Factors considered in the selection of these critical areas were current and projected land use, hydrologic character of the site, distance of the location from anticipated water users, and the practicality of developing the new areas into well fields. Hydrologic characteristics included such properties as composition and thickness of the aquifer material, potential for infiltration of water from the Mohawk River, storage potential, river and ground-water levels, and water quality of tributary streams flowing across the aquifer.

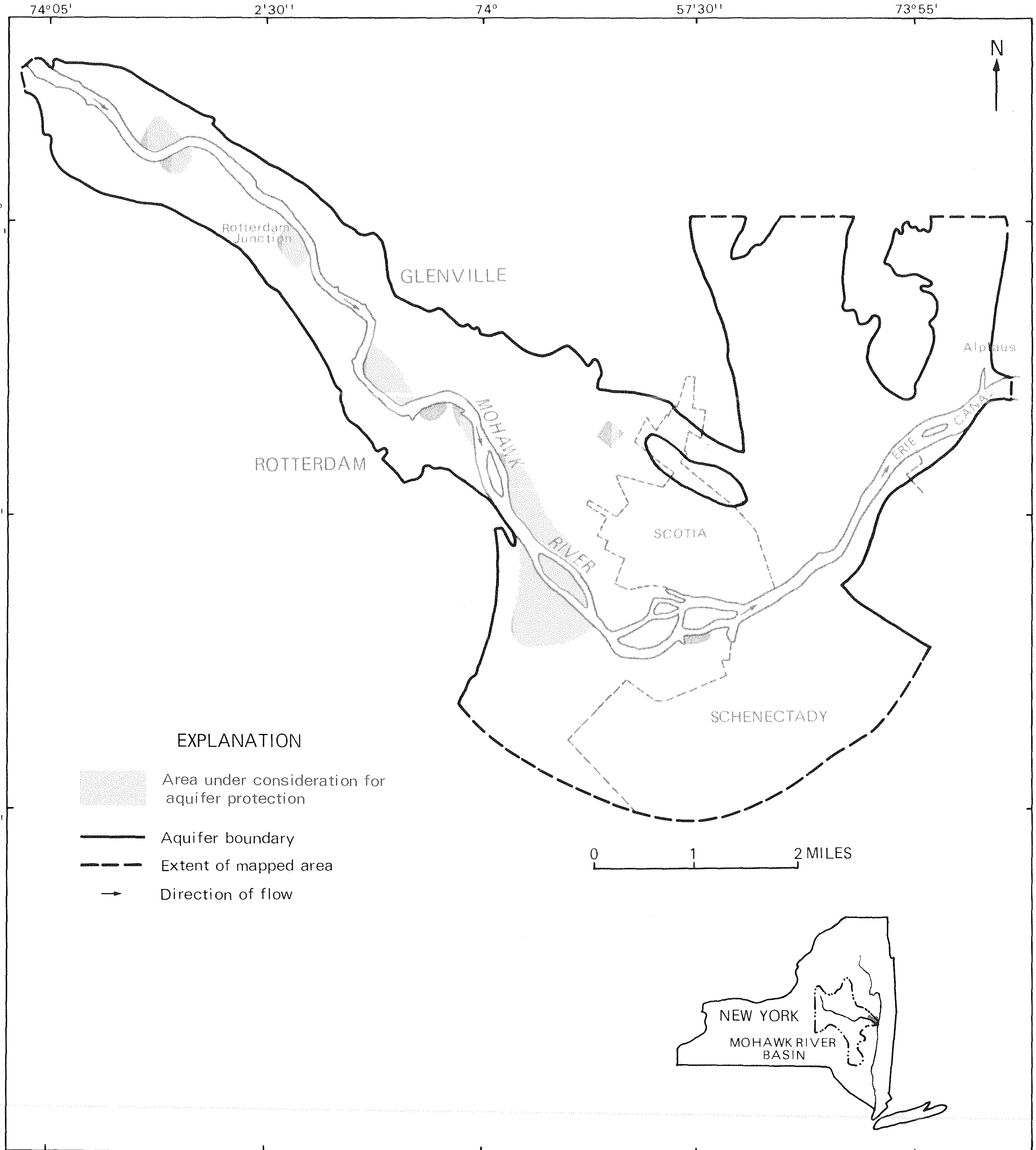
In 1961, the U.S. Geological survey sampled water from the Schenectady well field for tritium and beta radioactivity in an effort to study the possible contamination of the aquifer by fallout in the Mohawk River from nuclear weapons testing (Winslow and others, 1965). Results indicated that the movement of water from the river through the aquifer to the wells filtered the water and reduced the radioactivity to nonhazardous levels.

C.T. Male Associates, P.C. (1978) reported that the only substances in ground water that had exceeded State-recommended maximum levels were iron, manganese, and phenols. The phenols, which had probably infiltrated to the wells from the Mohawk River, were detected only in very small concentrations and on rare occasions.

Kim and Stone (1979) reported that small quantities of organic contaminants may be present in the water supplies. The Schenectady supply had 46 μg/L (combined) bis(2-ethylhexyl)phthalate, toluene, and trichloroethylene; the Rotterdam supply had 4 μg/L (combined) ethylbenzene, phenol, toluene, and trichloroethylene. Schroeder and Snavely (1981) concluded that the reported concentrations were within the range of laboratory error.

Allen and Waller (1981) reported an increase in chloride concentrations in water from the Schenectady city well field from 6 mg/L in the 1940's to 18 mg/L in the 1970's. The source was judged to be road salt, a conclusion supported by Peters and Turk (1981), who reported that the salting of roads accounted for virtually all the increase in sodium and chloride in the Mohawk River since 1952-53. Higher values of chloride were reported in water from other wells (Allen and Waller, 1981); for example, chloride in water from the Rotterdam Junction well fields increased from 27 to 68 mg/L during 1960-73.

FIGURE 2K SCHENECTADY AREA
Present and potential problems



Base from U.S. Geological Survey, 1954

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3
ENDICOTT-JOHNSON CITY AREA

By Thomas J. Holecek

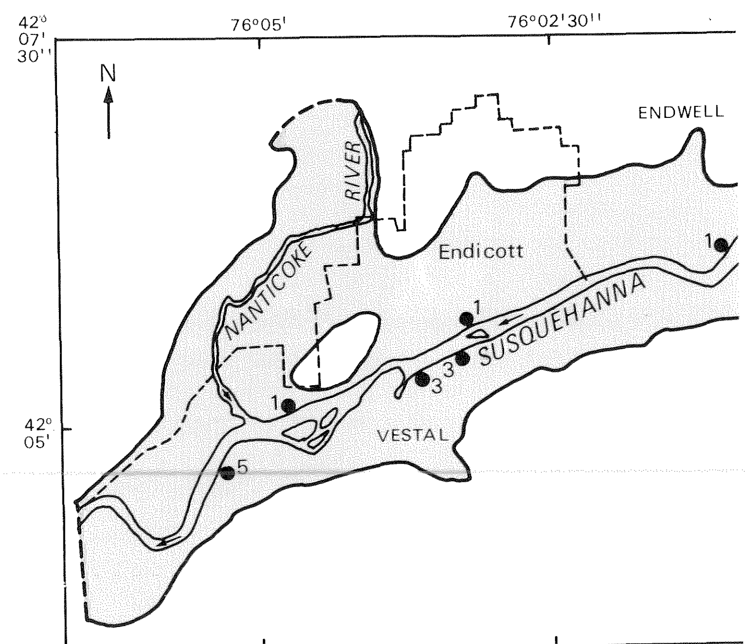
3 ENDICOTT-JOHNSON CITY AREA
A. Location and major geographic features

This aquifer system underlies the confluence of the Chenango and Susquehanna Rivers

This area lies in the highly urbanized valleys of the Susquehanna and Chenango Rivers in Broome County.

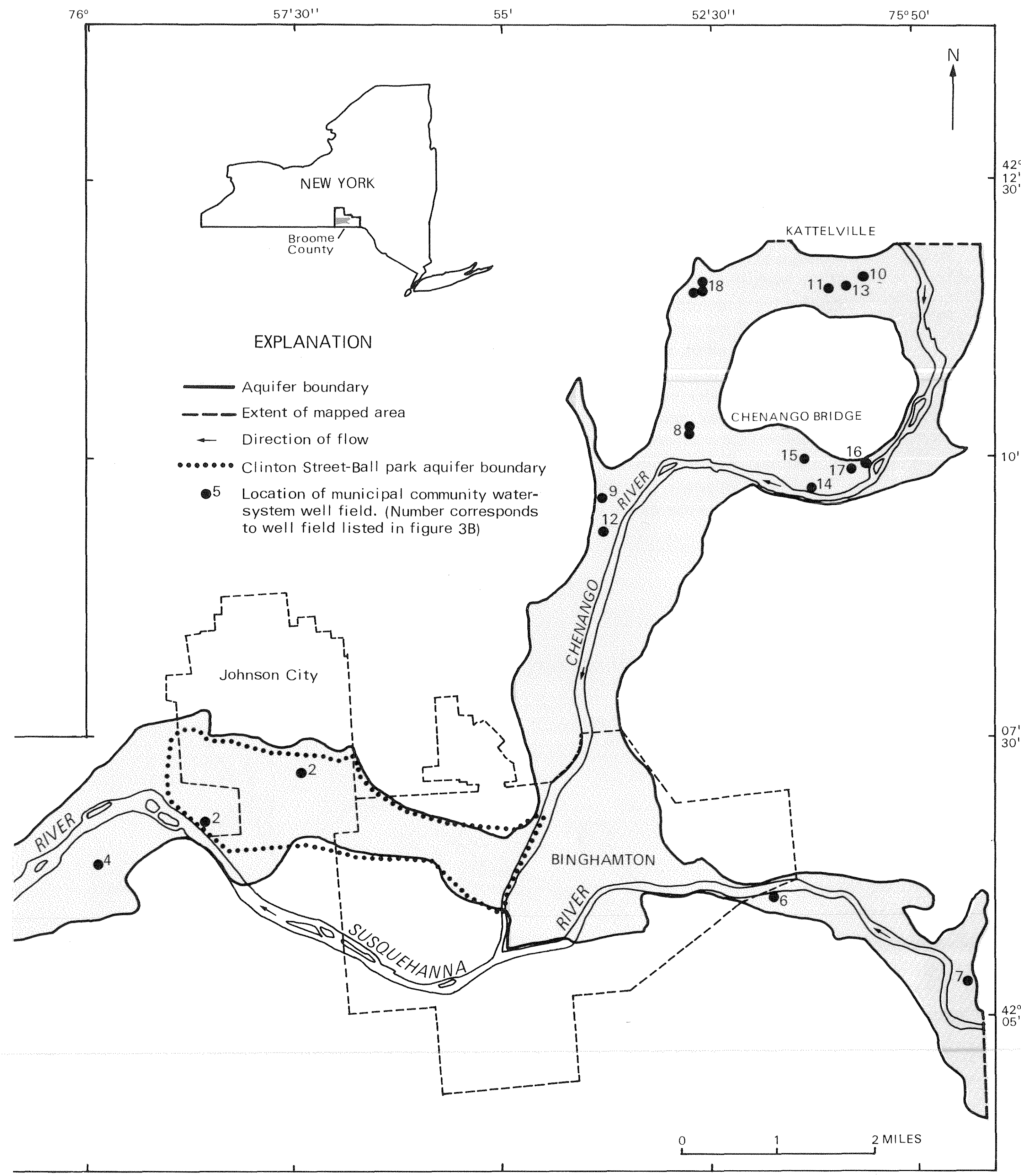
This area, in the southwest corner of Broome County, is in the southeast part of the Susquehanna River basin (fig. 3A). The aquifer area occupies 21 square miles within the Susquehanna and Chenango River valleys, which intersect at Binghamton. The area overlying the aquifers is largely urban and heavily industrialized.

The hills surrounding the valley system are steep in places and rise as much as 800 feet above the valley floor. The profile of the valley floor is variable. In the 14 miles between Endicott and Johnson City it is terraced and entrenched by the Susquehanna River; near Binghamton it is hilly with a maximum relief of 150 feet. North of Binghamton and near Kattellville, it is terraced and pitted by depressions and entrenched by the Chenango River.



Base from U.S. Geological Survey, 1969

FIGURE 3A ENDICOTT-JOHNSON CITY AREA
Location and major geographic fea[illegible]es



This aquifer provides water to about 111,000 people

The aquifer supplies water to more than half of Broome County's population. During 1980, more than 16 million gallons per day was pumped.

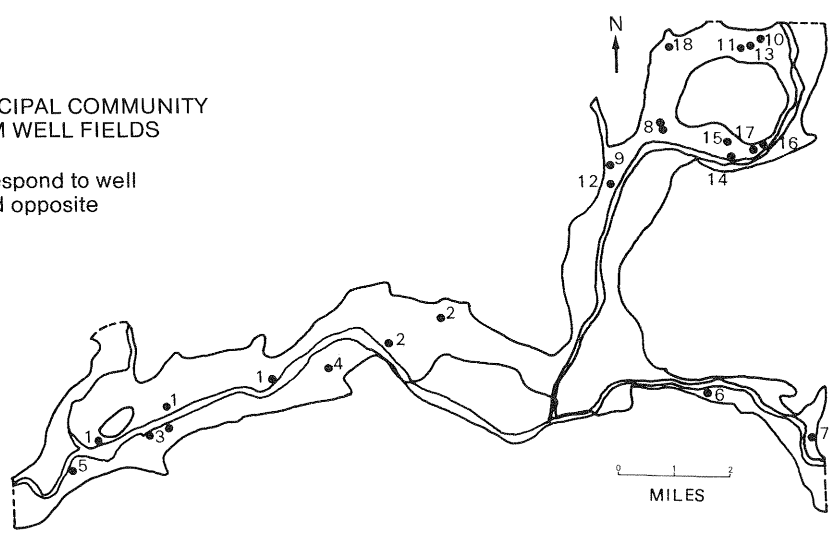
About 111,000 people, more than half the population of Broome County, are supplied with water from this aquifer. An estimated average of 16.25 Mgal/d was withdrawn from the aquifer for community water systems during 1980 (fig. 3B). Large corporations, private domestic-well owners, and farms pump additional quantities not indicated in figure 3B.

More than half the water pumped is used by the City of Endicott and the adjacent area of Endwell to the north. Johnson City and Vestal account for about one-fourth of the water used; the remainder is used by 22 water districts in five municipalities (fig. 3B), by independent water associations, and by trailer parks. The City of Binghamton draws water directly from the Susquehanna River from a source 20 miles upstream but has two emergency pumping sites within its boundaries.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 3A.

LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite



POPULATION AND PUMPAGE FROM ENDICOTT-JOHNSON CITY AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEM		
1. Endicott Municipal Water Works (11 wells)	45,000	9.000
Endwell Water District	21,620	—
2. Johnson City Water Works (4 wells)	17,126	3.550
3. Vestal Water District No. 1 (3 wells)	8,760	0.906
Vestal Water District No. 9	152	—
Vestal Water District No. 2	200	—
Vestal Water District No. 8	384	—
Vestal Water District No. 7	160	—
4. Vestal Water District No. 4 (3 wells)	3,700	.500
Vestal Water District No. 3	92	—
5. Vestal Water District No. 5	900	.056
6. Conklin Water District No. 2 (1 well)	1,868	.275
Conklin Water District No. 1	132	—
7. Kirkwood Water District No. 4 (1 well)	800	1.000
Kirkwood Water District No. 4 (Extension 1)	88	—
Kirkwood Water District No. 1 (Valley Vista)	68	—
Kirkwood Water District No. 3	1,200	—
Kirkwood Water District No. 3 (Extension 1)	152	—
Kirkwood Water District No. 3 (Langdon Park)	140	—
8. Chenango Water District No. 1 (2 wells)	1,532	.150
9. Chenango Water District No. 3 (1 well)	680	.109
Chenango Water District No. 15	366	—
10. Chenango Water District No. 4 (1 well) (Woodland Park)	225	.013
11. Chenango Water District No. 4 (1 well)	272	.040
12. Hillcrest Water District No. 1 (3 wells)	3,356	.500
13. Applewood Acres (1 well)	280	.020
14. Bert and Alice Hale Water Corporation (3 wells)	540	.050
15. Keller Ave. Water Association (1 well)	104	.006
16. River Rd. Water Association (1 well)	40	.003
17. River Side Co-op Water Association (1 well)	110	.008
18. Runacre Estates (Chenango Water District 11)	180	.012
Subtotal	110,227	16.200
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer Parks (8)	* 500	* 0.050
Total	110,727	* 16.250

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
* Estimated

Thick unconsolidated deposits overlie shale bedrock

Glacial deposits mantle the adjacent hills and partly fill the bedrock valley. Kame and outwash sand and gravel are the dominant deposits within the valleys.

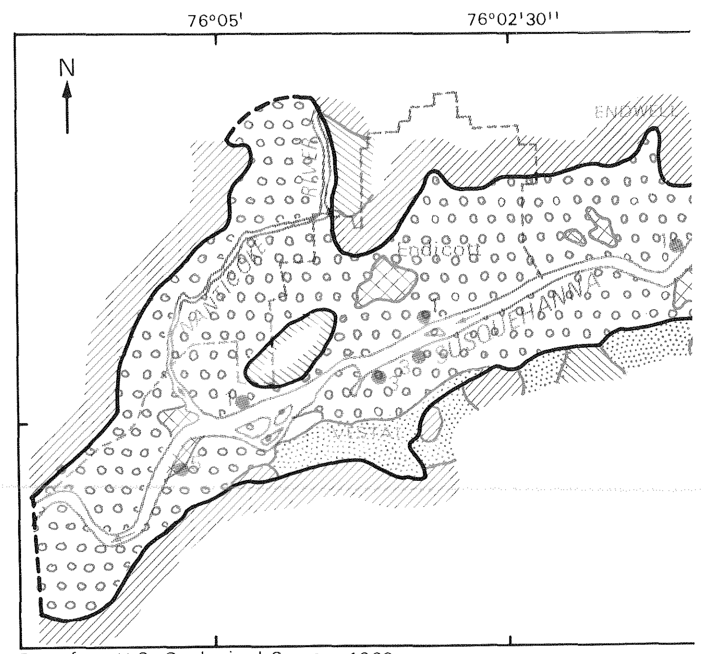
Thick glacial deposits mantle the hills and cover the bedrock valley floor. The shale bedrock underlying the aquifer and adjacent to it dips gently to the south. Valleys that had been cut into the shale by preglacial streams were subsequently widened into their present U-shape by glacial erosion.

The bedrock valleys now contain glacial drift that may be as much as 200 feet thick along the valley axes; this material tapers to negligible thickness toward the valley walls. Unconsolidated deposits of silt, sand, and gravel left by the melting glacier overlie both bedrock and till (fig. 3C).

Kame terraces formed between the ice and the valley walls. As the ice melted, the terraces collapsed partially or totally and, in some areas, became covered by younger outwash or lake sediments. Kames also formed where gravel was deposited in depressions on the glacier surface; when the ice melted, these deposits were left as isolated kames. Outwash now blankets most of the valley floor; kame deposits remain along the valley sides and beneath the outwash. The outwash and buried kame deposits are the most productive water-bearing components of the aquifer.

In several places, proglacial lakes formed at the front of the receding glacier. Fine particles that were carried by streams into these lakes formed thick deposits of lake silt and clay. Many of these fine-grained deposits are now covered by outwash and postglacial stream deposits.

Postglacial silt, sand, gravel, and modern flood-plain deposits now partly cover the low-lying areas. Although these deposits are generally less than 15 feet thick and are discontinuous, they are still considered to be part of the outwash.



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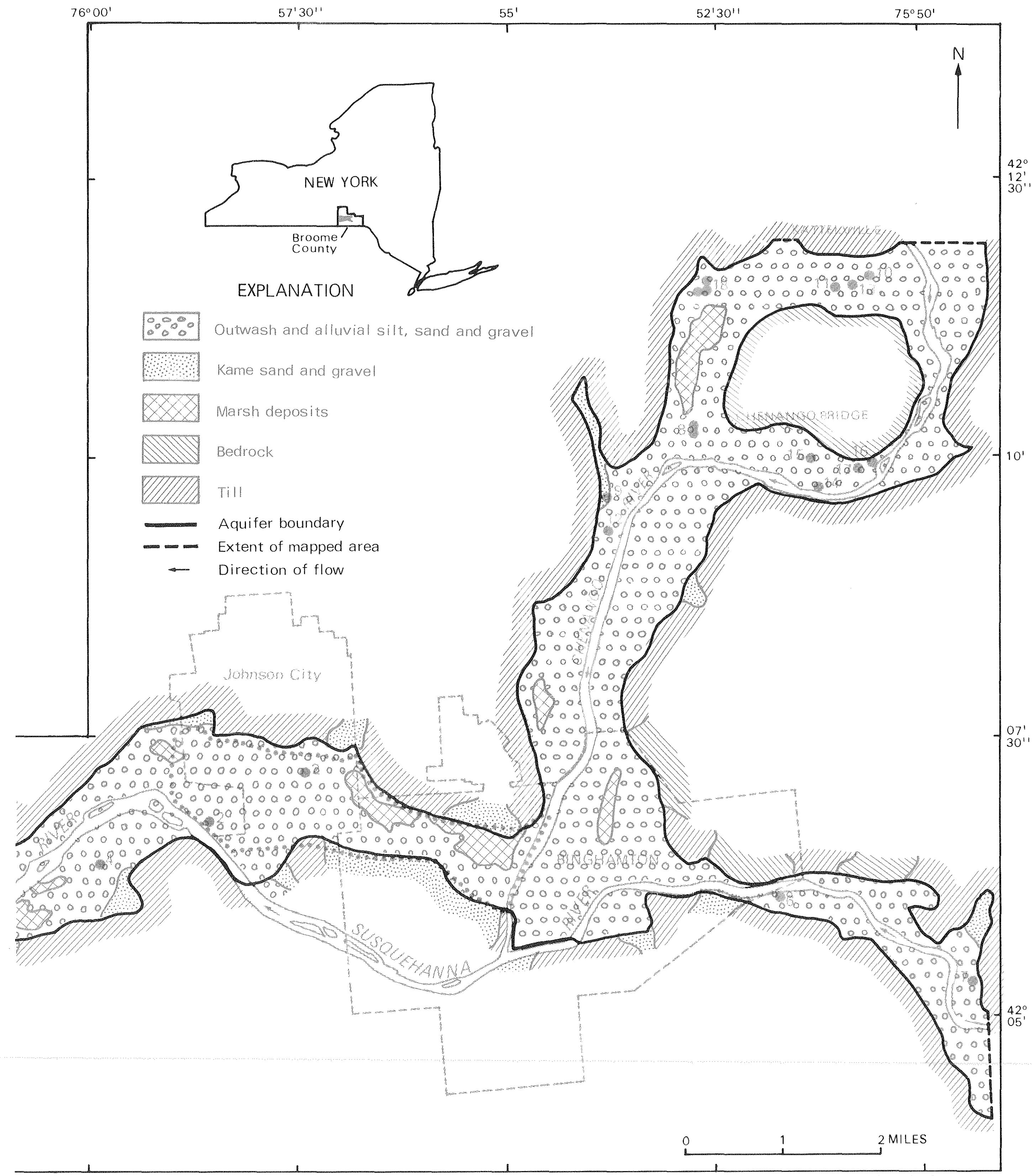


Modified from Holecek and others, 1982

An upper and a lower aquifer are partly separated by clay

This ground-water system consists of an upper and lower aquifer separated by an impermeable layer of silt and clay.

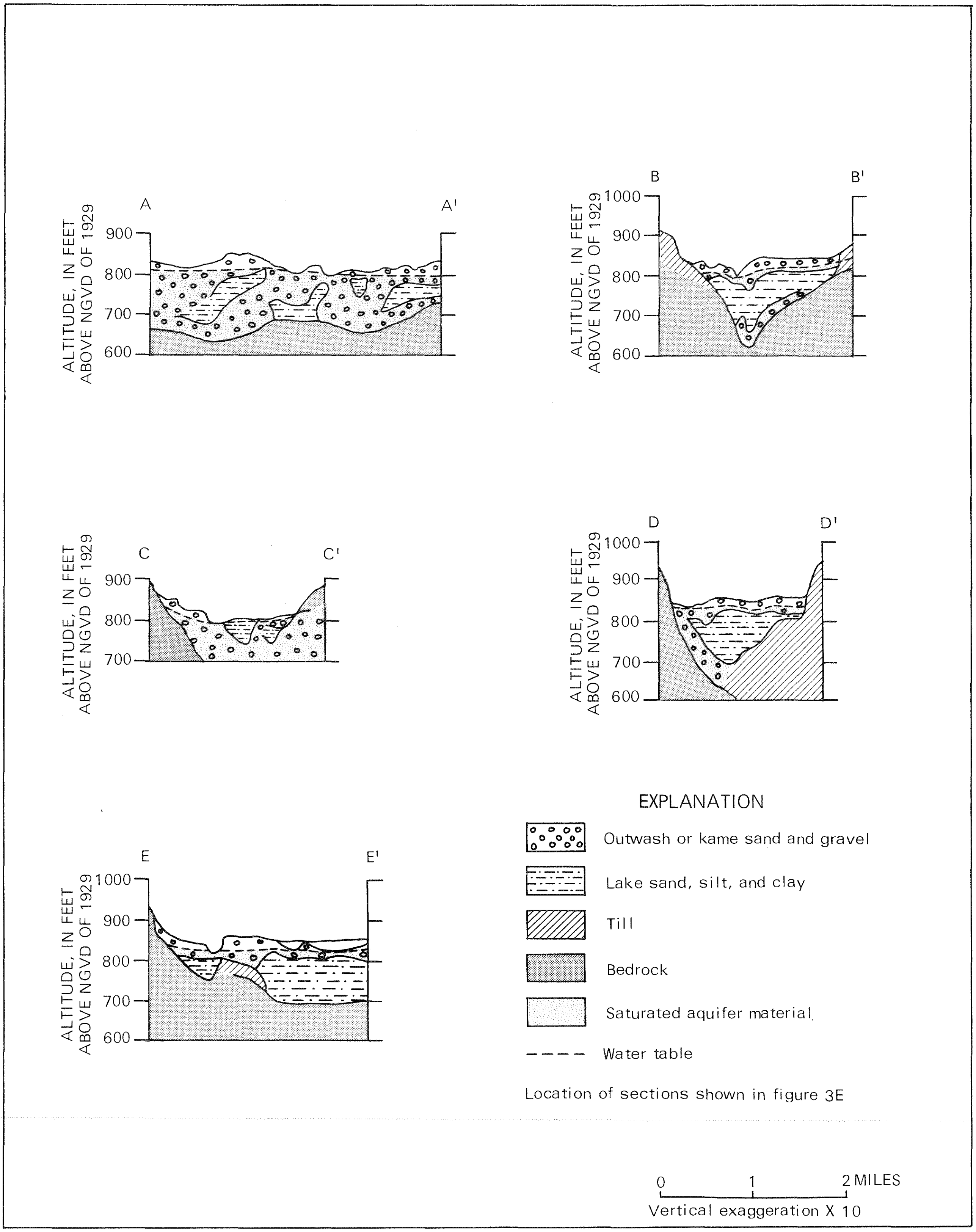
The bedrock valleys contain glacial sediments having a maximum thickness of 200 feet. The deposits of major hydrologic significance are outwash and kame sand and gravel. A series of geologic sections representing the subsurface geologic units are shown in figure 3D.

The outwash is thickest (100 feet) at Endicott (sec. A-A′), although it is also thick (90 feet) near the valley wall at Binghamton (sec. D-D′). The vertical continuity of the outwash unit is interrupted by the lake silt and clay deposits, which may be as thick as 120 feet (sec. E-E′, D-D′, B-B′) and occur throughout most of the valley. Generally the lake deposits are at most 50 feet thick and discontinuous, as in section A-A′.

The kame-terrace gravels at the valley sides are generally above the top of the aquifer. Although they are insignificant as a source of water, they act as channels through which water enters the aquifer from the valley walls (sec. B-B′, E-E′). The buried kame gravels, which are evident in all sections in figure 3D, are generally separated from the outwash gravels by the lake silt and clay but may be hydraulically connected to them in places (sec. A-A′). Most of the well data used to construct the geologic sections are from wells finished in the deep kame gravels.

The Clinton Street-Ballpark aquifer, which contains the same hydrogeologic units as those described above, has been considered a separate aquifer (Randall, 1977; see fig. 3A for location). For most of its 3-mile extent, it is separated from the Susquehanna River by till or bedrock. The rest of the aquifer is in hydraulic contact with the river.

FIGURE 3D ENDICOTT-JOHNSON CITY AREA
Geohydrology



Modified from Holecek and others, 1982

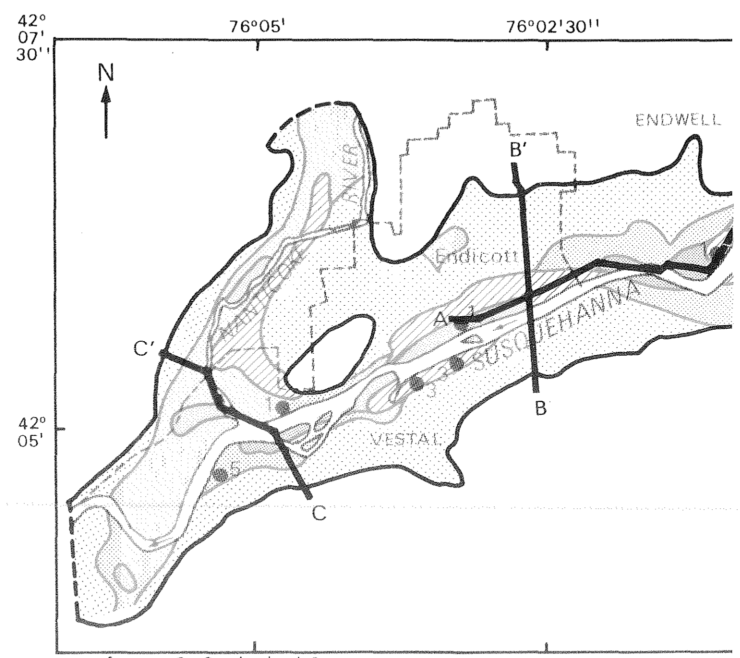
The aquifers in this system are thickest along the valley axis

Saturated thickness is greatest where the upper and lower aquifers are hydraulically connected. Potential well yield ranges from 100 to more than 2,000 gallons per minute.

Aquifer thickness is the thickness of saturated sand and gravel from the water table to the first impermeable layer but may include a deeper aquifer. Thickness of the aquifer system is indicated in figure 3E. The upper aquifer, which consists of outwash and covers most of the valley, is generally thickest along the valley axis. Thick deposits also occur at the valley margin at Nanticoke Creek west of Endicott and at the Chenango River north of Binghamton.

The inferred location of relatively thick buried aquifer material is also indicated in figure 3E. Such deposits are in most places separated from the upper aquifer by a confining layer of relatively impermeable lake sediments. The thickness and extent of the confining layer is variable and at some points is absent (sec. A-A′), in which case the entire saturated section is mapped as a single unit. (See also sec. A-A′, fig. 3D.)

Potential well yields tend to increase with aquifer thickness, although maximum yields may differ greatly between nearby points of identical thickness as a result of variation in grain size and siltiness of gravel layers. Well yields exceeding 500 gal/min and ranging to 2,000 gal/min are available in much of the aquifer system.



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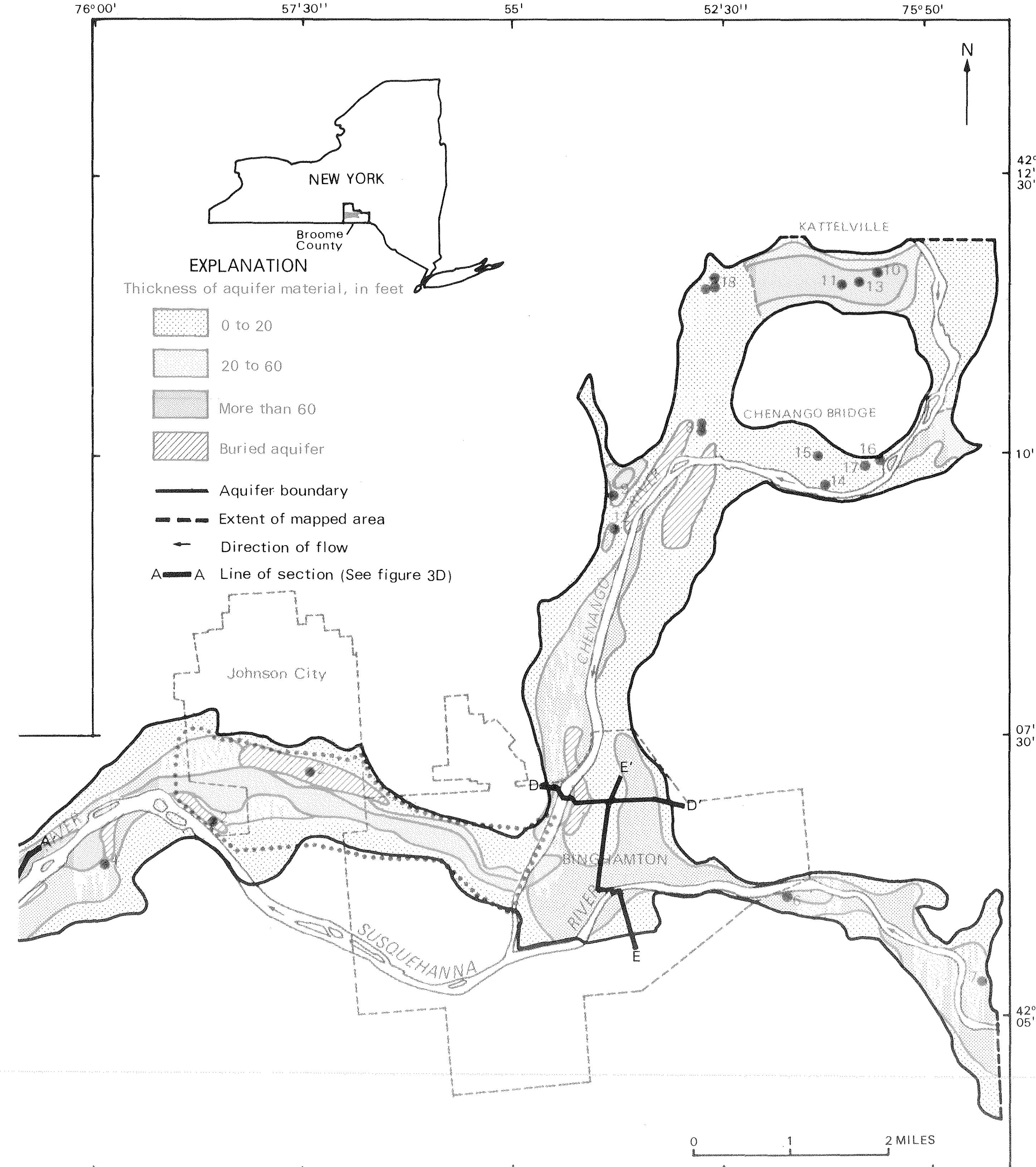


Modified from Holecek and others, 1982

Ground water flows toward the main rivers

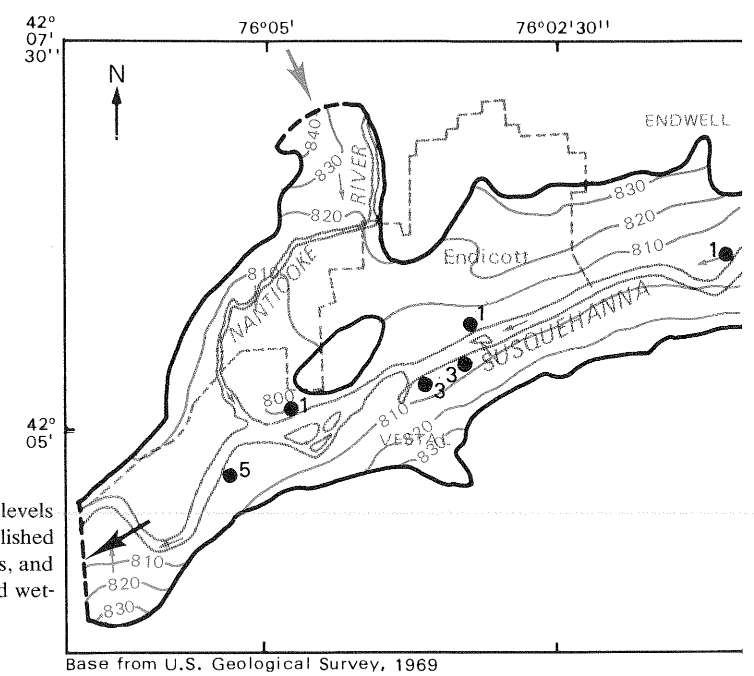
The major sources of recharge are precipitation, streams and runoff flowing into the aquifer from valley slopes, and underflow from adjacent areas. Water is discharged from the aquifer by seepage into the major rivers, underflow, evapotranspiration, and pumpage.

Ground water flows into the aquifer from the valley slopes, bedrock, and saturated gravel beyond the mapped areas, and thence toward the master stream (fig. 3F)[1]. Ground water reaching the aquifer originates as precipitation, either as runoff captured by streams on hill slopes or as direct infiltration through permeable soil zones overlying the aquifer. Significant recharge also occurs where heavy pumping draws river water into the aquifer. Dense urbanization reduces direct recharge locally.

Water leaves the aquifer through pumpage, by seepage into the Susquehanna and Chenango Rivers, by underflow out the southwest aquifer boundary, and by evapotranspiration. Direction of flow is controlled by hydraulic gradients in the potentiometric surface (water table) and is indicated by arrows in figure 3F.

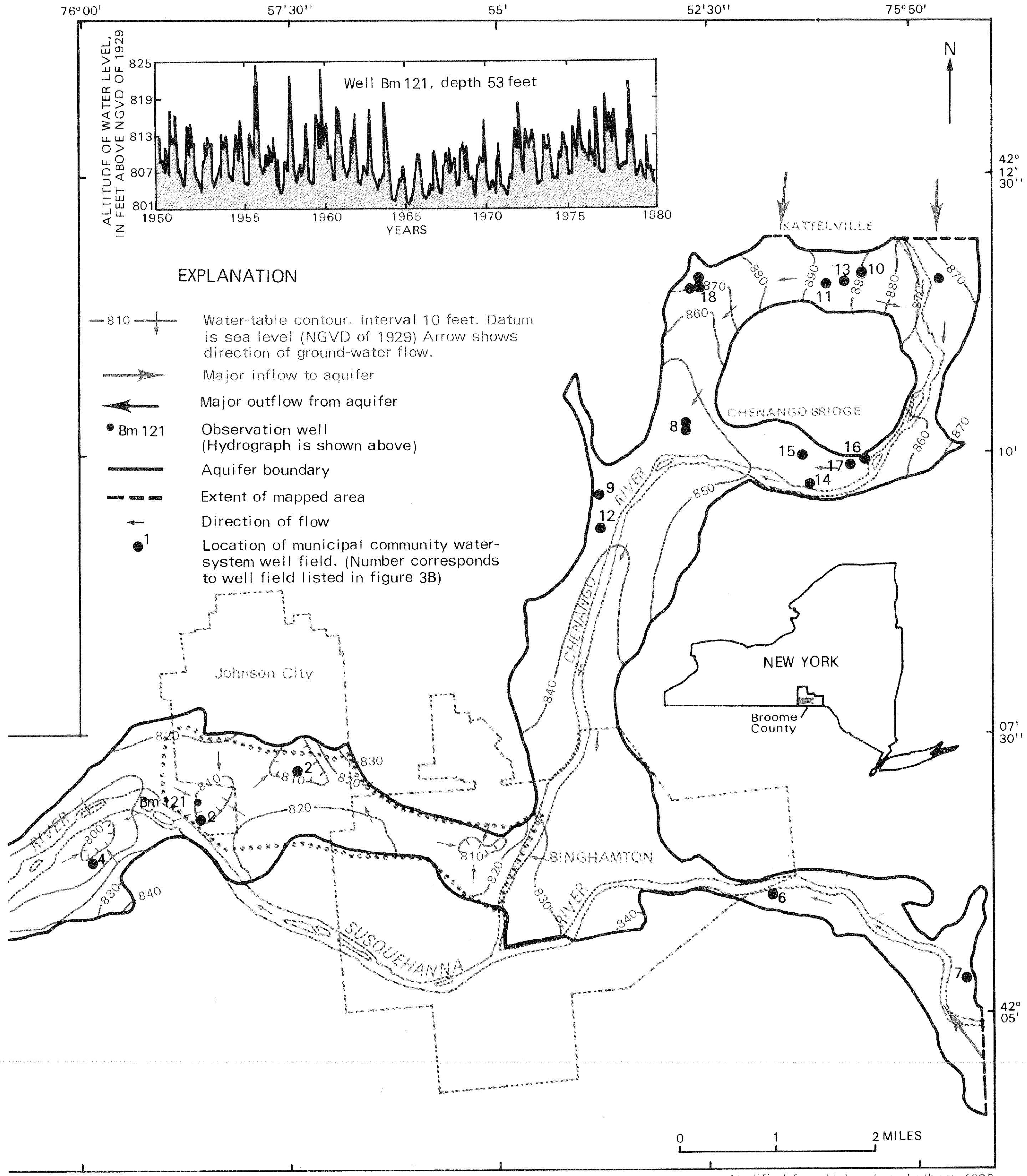
The altitude of the water-table surface fluctuates in response to seasonal variations in precipitation, evapotranspiration, and river stage, and also to changes in rate and distribution of pumping from municipal or industrial wells. Thus, the contours in figure 3F are an approximation of average annual conditions.

The 30-year hydrograph shows the range and seasonal fluctuations of the water table just west of Johnson City and also reflects the decline and gradual recovery of water levels during the drought of the mid-1960's. This well is affected by steady pumping of four municipal wells in the western part of the Clinton Street-Ballpark aquifer but shows no dewatering trend.



[1] Water-table contours were derived from water levels measured in 1981 (U.S. Geological Survey, unpublished data) in about 130 wells penetrating the aquifers, and from altitudes of perennial streams and selected wetlands shown on topographic maps.

Base from U.S. Geological Survey, 1969



Modified from Holecek and others, 1982

Soils overlying this aquifer have medium to high permeability

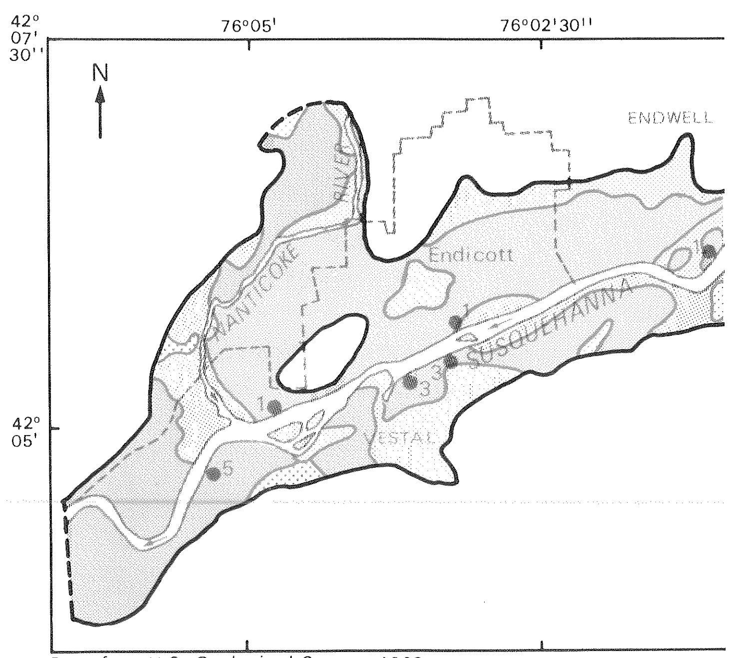
Soils of medium to high permeability overlie the aquifer; soils of low to very low permeability cover adjacent hillsides. Runoff from hillsides flows onto the soils overlying the aquifer, whose high infiltration potential enables rapid recharge of the aquifer.

The map of soil-zone permeability (fig. 3G) indicates the degree to which water can be transmitted through the soil zone. Soil maps of Broome County (Giddings and others, 1971) were used to evaluate water-infiltration potential. Permeability and infiltration potential depend upon such factors as soil moisture and temperature, density of vegetation, slope, soil texture, depth of seasonal high water table, presence of a water-impeding layer, several meteorological factors, including intensity and duration of rainfall.

The soil zone described herein is considered to be the B horizon and the unweathered surficial geologic materials. The A horizon throughout the mapped area has high permeability (Giddings and others, 1971) and thus does not limit the infiltration potential.

Soils of low permeability are generally those derived from or underlain by till or bedrock on the hillsides. These soils produce high runoff, which flows overland to the valley floors, which are moderately to highly permeable and enable rapid infiltration. Soils that developed on the sandy to silty flood-plain deposits are less permeable than those that developed in gravel of outwash and alluvial fans.

FIGURE 3G ENDICOTT-JOHNSON CITY AREA
Soil-zone permeability



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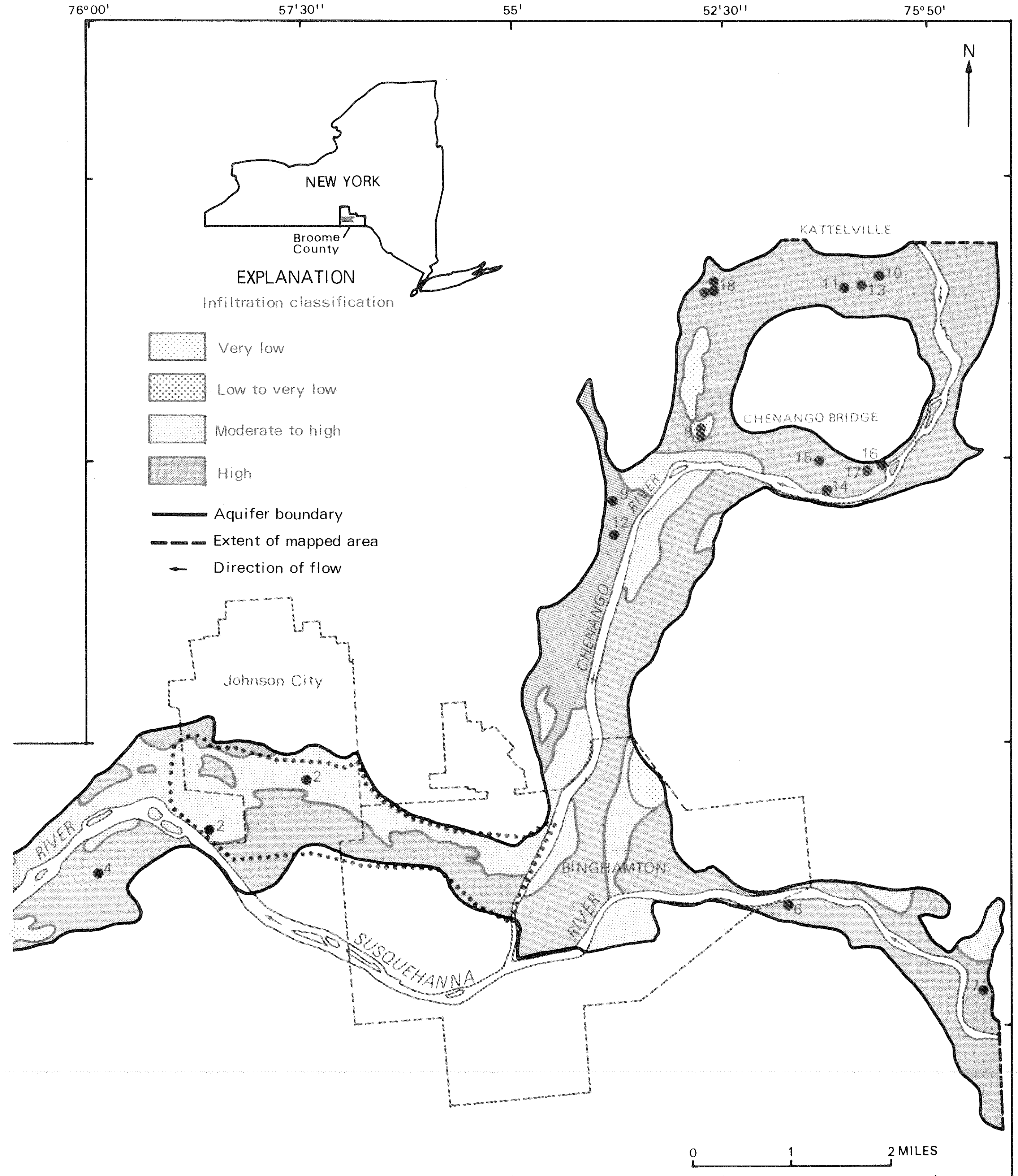


Modified from Holecek and others, 1982

Most of the valley area is residential and commercial

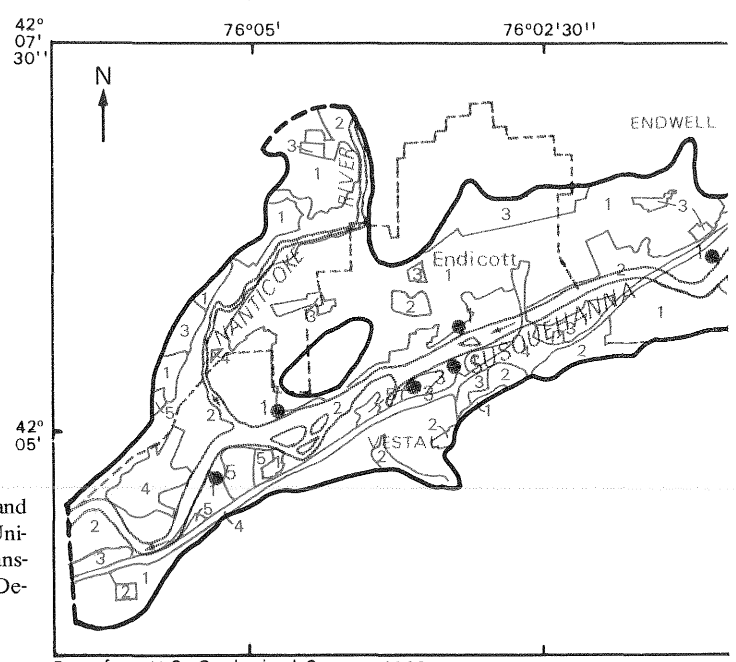
Most of the land overlying this aquifer is urban or suburban. Forest, open public land, wetlands, and farming together occupy only 20 percent of the area.

The Endicott-Johnson City area is predominantly residential and commercial, as indicated in figure 3H[1], and may be divided into the following land-use categories:

- residential plus commercial and services (more than half is residential), 60 percent;
- forest, open public lands, water, and wetlands (more than half is water), 15 percent;
- transportation, about 7 percent;
- industrial and extractive uses, about 6 percent;
- farming, less than 5 percent.

Residential and commercial areas cover most of the valley floor and extend beyond the aquifer boundaries part way up the valley slopes. The Endicott-Johnson City urban area is covered with a network of streets interrupted by small patches of nonresidential, noncommercial areas. Most of these are golf courses, gravel pits, marshes, or open water. Industrial sites and the transportation network cover a relatively small percentage of the area. Few undeveloped areas remain.

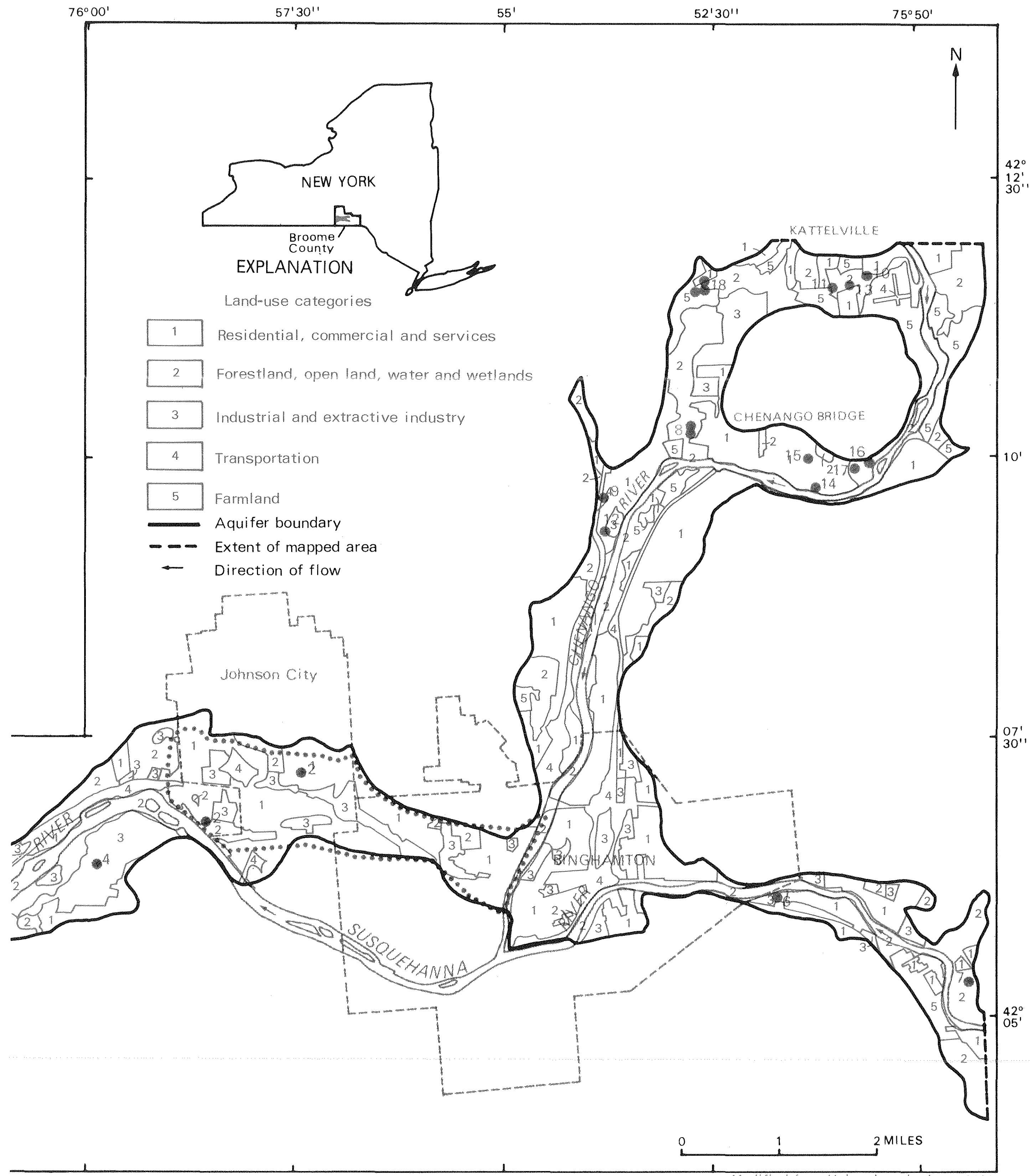
Further development along the transportation corridor is possible but limited by the potential for river flooding. Generally the Endicott-Johnson City area is highly developed, and land-use patterns probably will not change much in the future.



Base from U.S. Geological Survey, 1969

[1] Figure 3H was compiled from the 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University for the New York State Department of Transportation and from the Broome County Planning Department (1977).

FIGURE 3H ENDICOTT-JOHNSON CITY AREA
Land use



Modified from Holecek and others, 1982

3 ENDICOTT-JOHNSON CITY AREA
I. Present and potential problems

This ground-water system has become contaminated and heavily pumped in isolated areas

Contamination of several wells, either by bacteria or chemicals, has been reported. Some water systems are inadequate, but plans to improve and integrate them have been proposed.

Ground-water quality in the Endicott-Johnson City area is satisfactory for drinking and most other purposes, although several wells reportedly show signs of increasing contamination. Availability of uncontaminated water has become an important issue as a result of the pressures of urban growth.

The presence of coliform bacteria in well water has been related to excavation of the river bottom during bridge construction, river realignment, quarrying, and dredging (Randall, 1981). A municipal well in Endicott, close to the Susquehanna River, showed signs of contamination by bacteria shortly after river dredging in the mid-1960's.

Reduced oxygen content, increased dissolved solids, and offensive odor are commonly associated with water that comes in contact with landfill materials. Two industrial wells in Binghamton were closed as a result of contamination from a nearby landfill in the late 1950's (Randall, 1981).

Two wells in Vestal were shut down in 1980 because of high concentrations of chlorinated hydrocarbons; recent investigations suggest that a nearby industrial facility may be the source (Randall, 1981). The Town of Vestal has reported serious ground-water contamination, so that prompt management decisions are necessary (Martin, 1981b). It has been suggested that monitoring systems be installed around the main well fields.

Water hardness and chloride concentrations are increased by the use of road salt and possibly by leakage of waste from sewers. Observed increases in both constituents in the aquifer between Binghamton and Johnson City may be related to increased road salting during the 1950's and 1960's (Randall, 1977). Although no documentation is yet available, leakage from sewers may contribute chloride as well as nitrate to the water supply.

Reports concerning aquifer management and local needs for additional water supply have been prepared for the Town of Vestal (Martin, 1981b), the Village of Endicott (Martin, 1981a), and for the area between and partly including Binghamton and Johnson City. A countywide investigation (Martin and Shumaker, 1968) offers suggestions for integrating the smaller water-supply systems into a single water district or several large ones.

Pumpage from the Clinton Street-Ballpark aquifer equals or occasionally exceeds recharge. Randall (1977) described alternative arrangements of additional wells to maximize yield while maintaining optimum water quality and also described techniques for recharging the aquifer artifically.

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4
RAMAPO RIVER—MAHWAH RIVER AREA

By Richard B. Moore

4 RAMAPO RIVER—MAHWAH RIVER AREA

A. Location and major geographic features

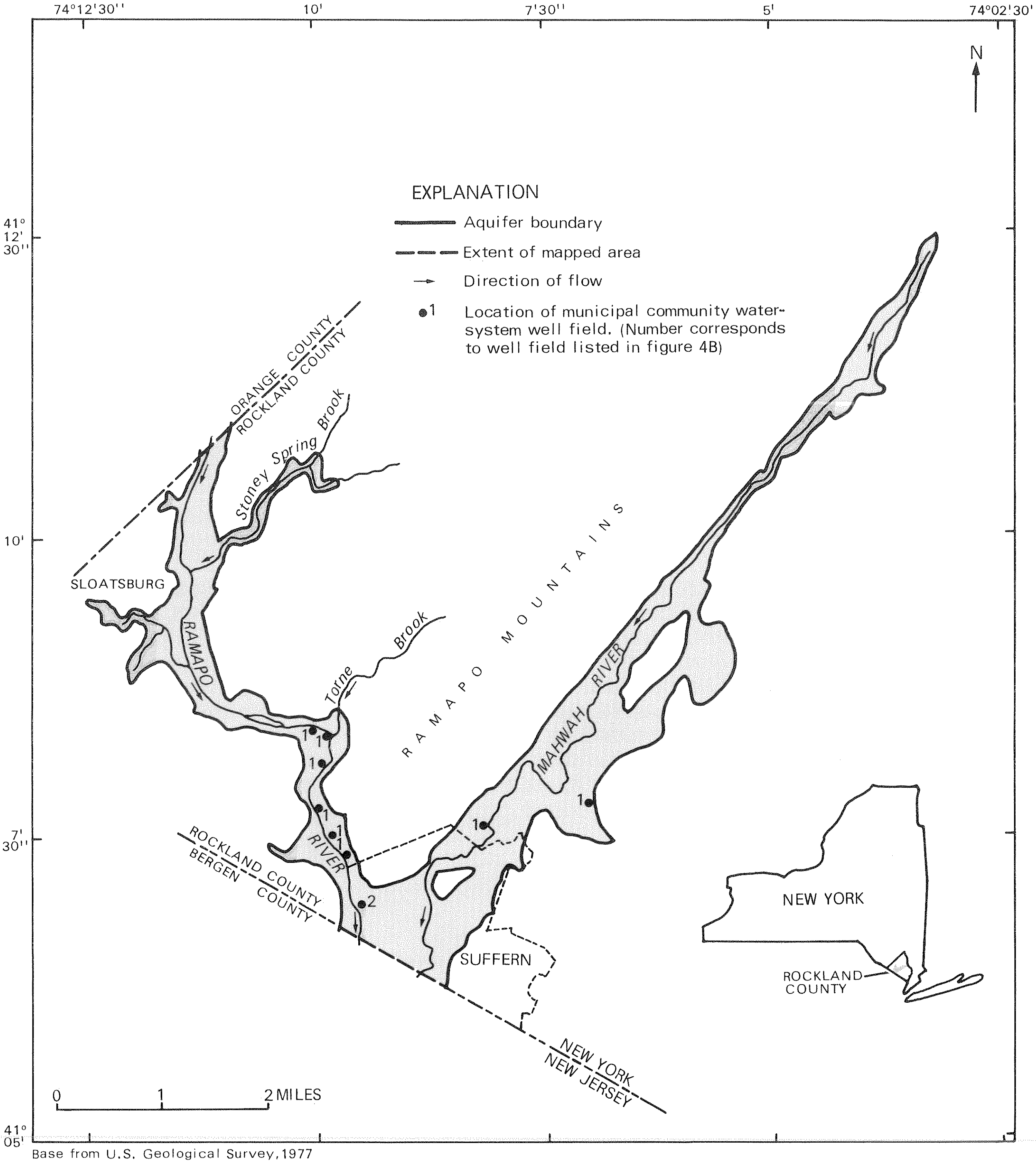
Much of this aquifer system underlies a heavily urbanized area

This aquifer system occupies the valleys of the Ramapo and Mahwah Rivers, which are tributary to the Passaic River in New Jersey. The area contains three physiographic sections — the Ramapo Mountains in the central and west part, a low, hilly terrain in the east, and the flat, Y-shaped valley. Industry and urbanization are heaviest near the confluence of the two rivers, near Suffern.

This aquifer system underlies the valley floor of the Ramapo and Mahwah River valleys. It lies mostly in Rockland County but extends into Orange County to the northwest and into Bergen County, N.J., to the south (fig. 4A). Within Rockland County, the aquifer system occupies 6 square miles. The Ramapo River flows from Orange County southward through Rockland County into New Jersey; the Mahwah River, which originates approximately ½ mile northeast of the aquifer, flows southwestward and enters the Ramapo 1 mile south of the New Jersey border. The Ramapo River is tributary to the Passaic River, which discharges into the ocean from northern New Jersey.

The valley floor has a gently sloping surface ranging in altitude from 270 to 530 feet above sea level. The drainage area (fig. 4A) to the aquifer occupies 115 square miles. The narrow valley floor of the Ramapo River is a corridor for the New York State Thruway and a railroad. Heavy urbanization and industry have developed at the confluence of the two valleys.

FIGURE 4A RAMAPO RIVER—MAHWAH RIVER AREA
Location and major geographic features



Base from U.S. Geological Survey, 1977

This aquifer provides water to over 81,000 people

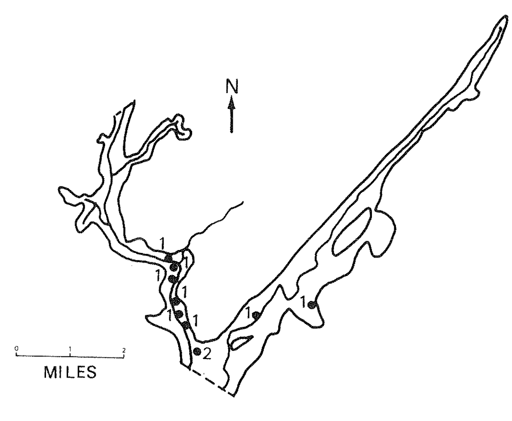
More than 81,000 people use water from this valley-fill aquifer. An estimated 9.6 million gallons per day is withdrawn.

Ground-water use in the Ramapo and Mahwah River area is unique in that a private water company serves most of the area (fig. 4B). The Village of Suffern has its own ground-water supply, and some homes and industries or commercial enterprises have private supplies. More than 81,000 people use a total of 9.6 Mgal/d from this aquifer.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 4A.

LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite



POPULATION AND PUMPAGE FROM RAMAPO RIVER — MAHWAH RIVER AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. Spring Valley Water Co. (several well fields)	* 69,000	7.789
2. Village of Suffern	11,100	1.821
Subtotal	80,100	9.610
B. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per day per person is assumed	* 1,500	* .015
Total	* 81,600	*9.625

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
* Estimated

A fault along the Mahwah valley bisects the area

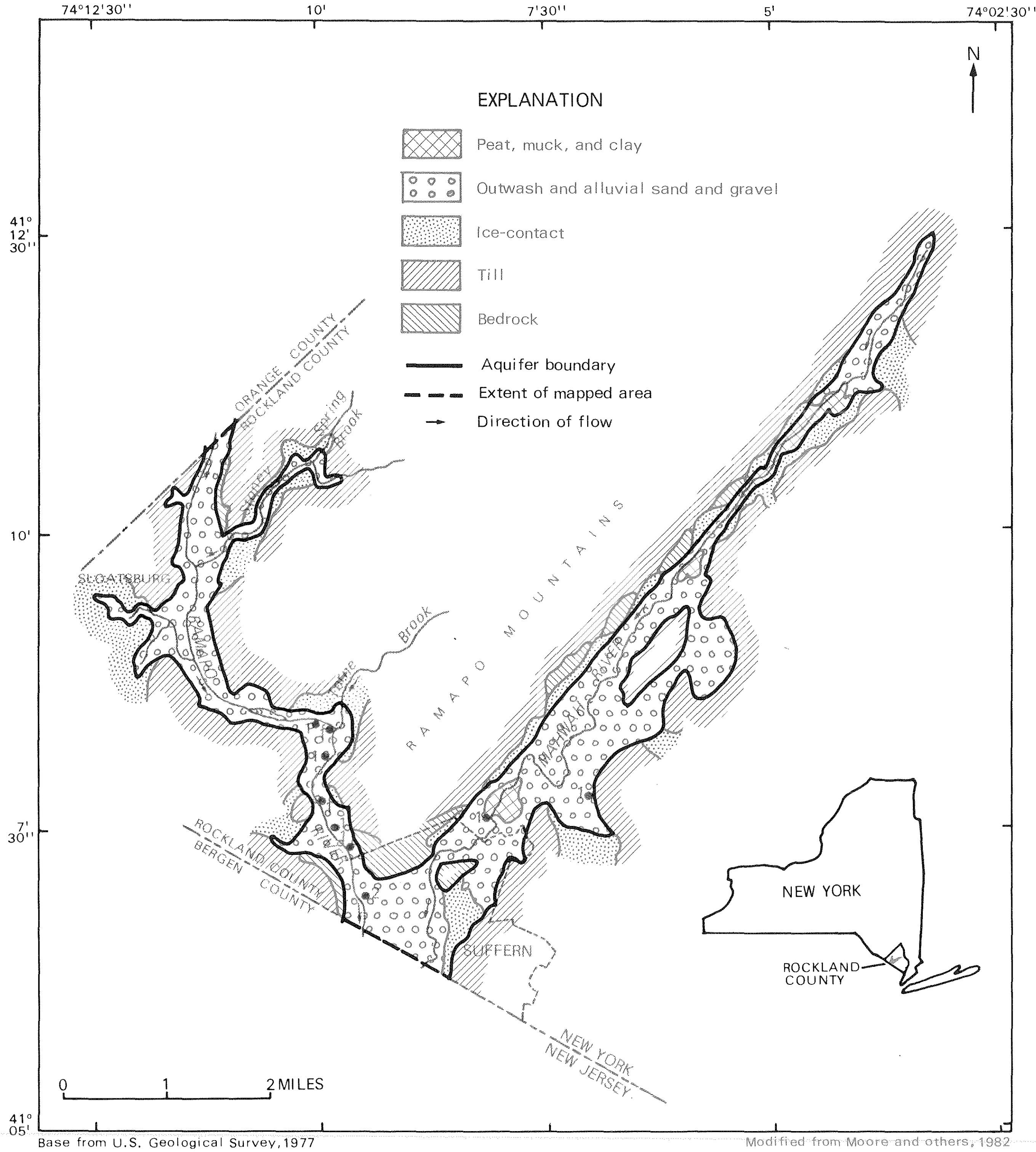
The area contains two distinct zones — a highland and a lowland — both of which have been modified by glacial and alluvial deposition. The aquifer lies within the valley-fill deposits.

Bedrock within this area consists of two main categories of rock — granite, gneiss, and schist in the southeast, and sedimentary sandstone, shale, and conglomerate to the northwest (Perlmutter, 1959). These two major units are separated by a fault running along the Mahwah valley (fig. 4C).

This general setting was modified by glaciation. At the time of glacial maximum, ice covered the entire county and deposited poorly sorted clay, silt, sand, and boulders over most of the area except on steep hillsides. Small hills of lodgment till (drumlins) are common east of the fault, but only one major one is shown at this scale (fig. 4C). During deglaciation, meltwater streams deposited gravel, sand, and some silt and clay in the valleys. Postglacial alluvium consisting mostly of reworked glacial materials now blankets the valley floors. A few deposits of peat, muck, and clay, also formed postglacially, lie along the Mahwah valley axis.

This region contains deposits associated with two cycles of glaciation. These could have been a local fluctuation of the ice terminus during a general period of retreat or they could have been two major advances, each followed by extensive deglaciation. Evidence that the area was twice covered by glacial ice is indicated by two layers of till in the glacial deposits in the middle of the lower Mahwah valley, where till overlying bedrock is overlain by outwash that is in turn overlain by a large lens of lodgment till.

FIGURE 4C RAMAPO RIVER—MAHWAH RIVER AREA
Geologic setting



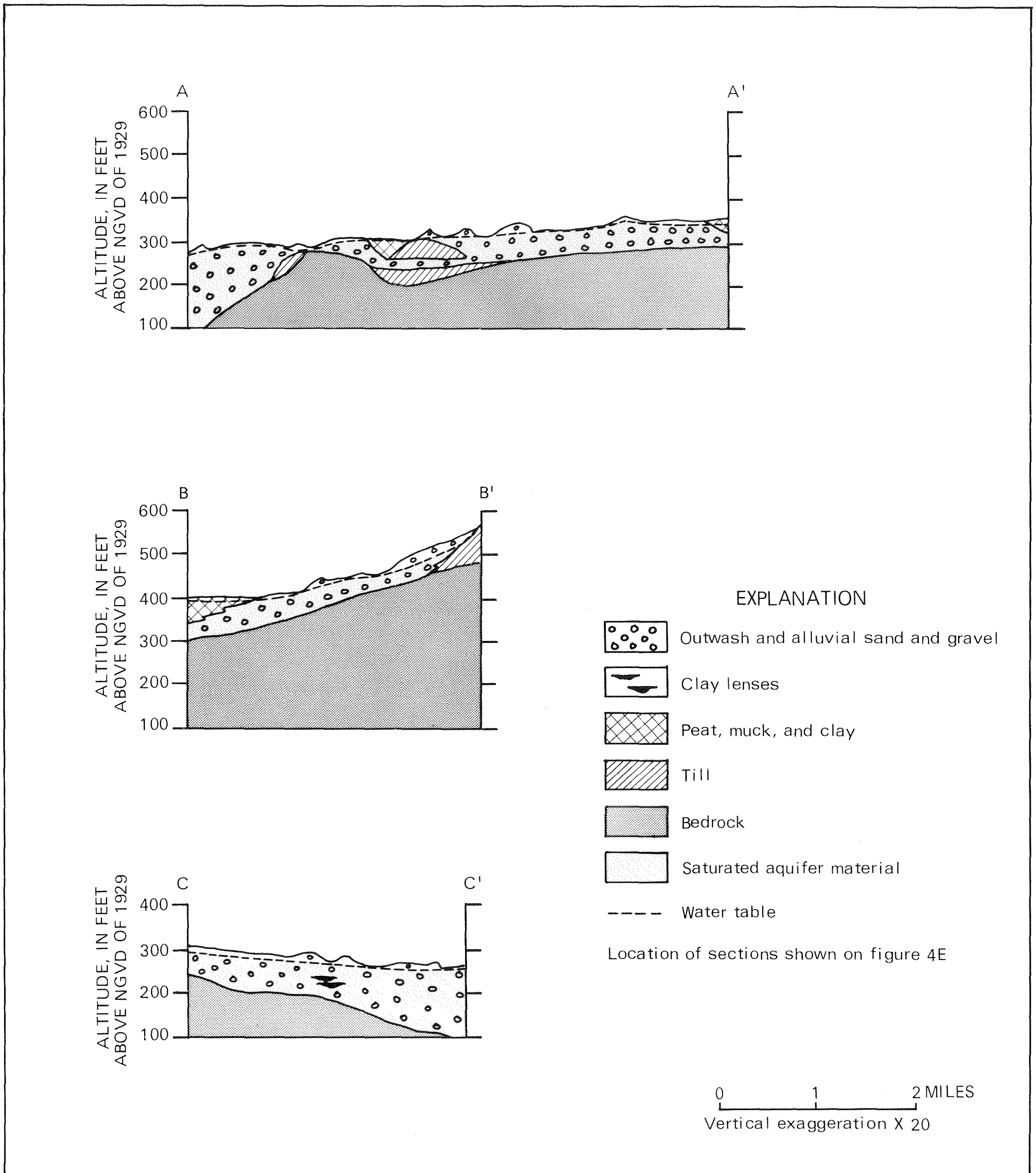
This aquifer system contains two layers locally

Two buried bedrock channels roughly parallel the modern riverbeds. The channels were carved by streams ancestral to the modern rivers and are filled with sand and gravel from at least two glacial periods.

The bedrock surface, which forms the base of the aquifer system, contains two major channels buried by unconsolidated deposits. These channels, which were carved by preglacial equivalents of the Ramapo and Mahwah Rivers, converge beneath the southern part of the aquifer near Suffern (fig. 4D). These channels diverge from the present rivers in places. The northeastern part of section A-A′ and all of section B-B′ roughly follow the preglacial Mahwah River channel; the southern part of this channel presumably continues south of section A-A′ into New Jersey. The preglacial Mahwah River channel roughly follows the fault zone between the igneous-metamorphic and sedimentary bedrock. In New Jersey, the present-day Ramapo River continues along this fault.

The aquifers consist of highly permeable outwash sand and gravel (fig. 4D). Each of the two glacial advances laid down outwash sand and gravel units, shown in section A-A′. Clay lenses within the lower outwash in section C-C′ contain wood fragments (Leggette, Brashears and Graham, 1974), which indicates that the clay was deposited during a period when the area had been free of ice long enough for woody plants to grow.

Postglacial stream erosion has reworked the glacial sediments, and alluvial silt and sand now overlies outwash throughout the two valleys. The peat and muck deposits along the valley floor were formed postglacially in temporary tranquil-water environments.



Modified from Moore and others, 1982

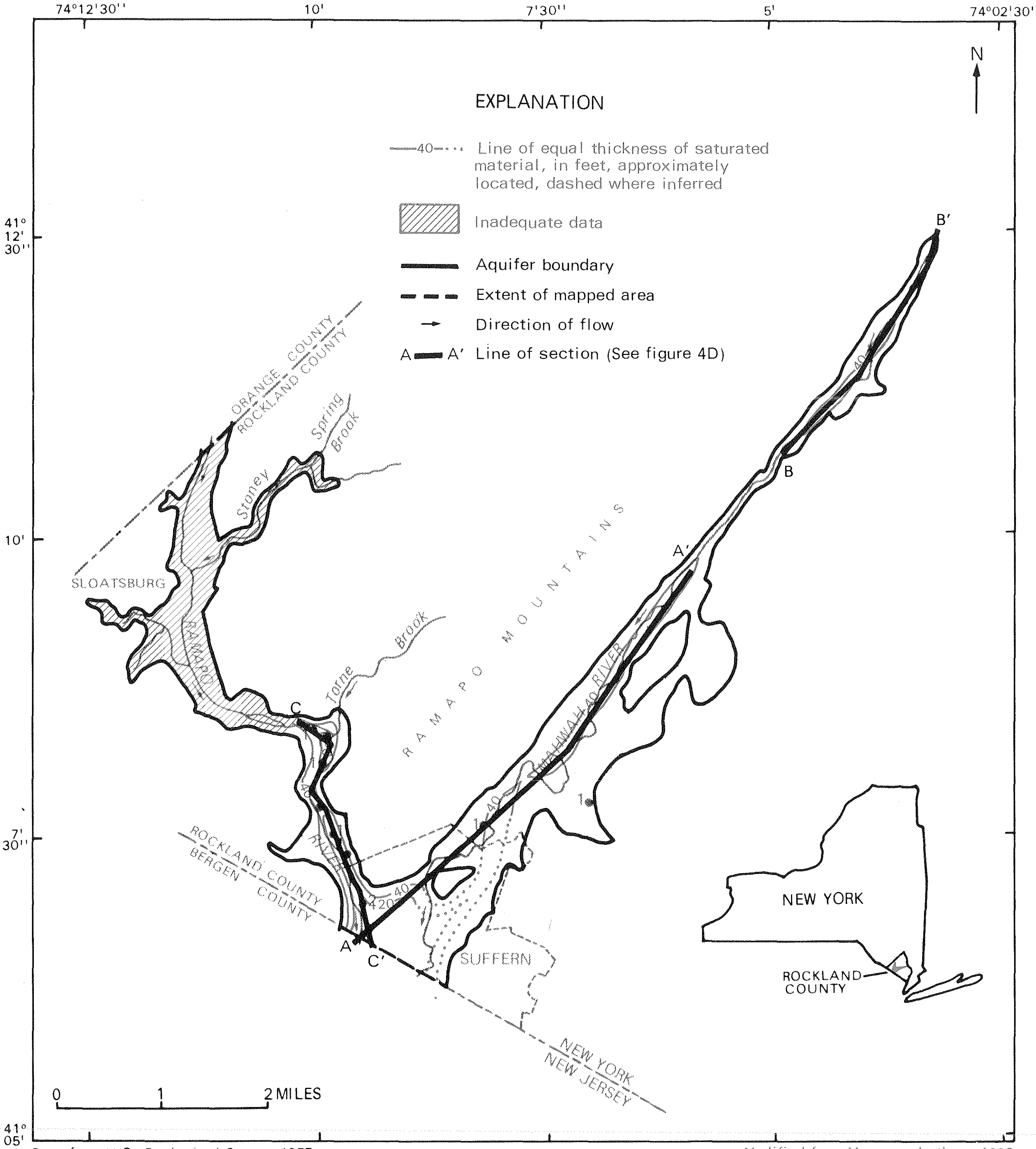
This aquifer system is thickest near the New Jersey border

This aquifer system contains sediments ranging from very fine to coarse, with scattered lenses of silt and clay near the New Jersey border. Saturated sand and gravel is thickest where the bedrock channels are deepest.

The estimated total aquifer thickness (saturated sand and gravel) from the static water table to bedrock is given in figure 4E. The sediments range from very fine sand to coarse gravel and include a few lenses and layers of silt and clay, especially near the New Jersey border. Deposits of till, silt, clay, or muck have low permeability and are not considered part of the aquifer thickness.

Saturated thickness of sediments within a part of the bedrock channel underlying the Mahwah River valley is suggested by dotted lines; the exact size and location of this part of the buried channel can be only inferred. The gap in the area enclosed by the 40-foot contour 1.5 mile northeast of the bedrock knob (fig. 4E) is where the channel is partly filled by lodgment till, which is not considered part of the aquifer. (See also section A-A′ in fig. 4D.) Saturated thickness of channel-fill sand and gravel in the southern section of the Ramapo limb of the aquifer is indicated, but data are insufficient to enable mapping of the northern section.

FIGURE 4E RAMAPO RIVER—MAHWAH RIVER AREA
Aquifer thickness



Base from U.S. Geological Survey, 1977

Modified from Moore and others, 1982

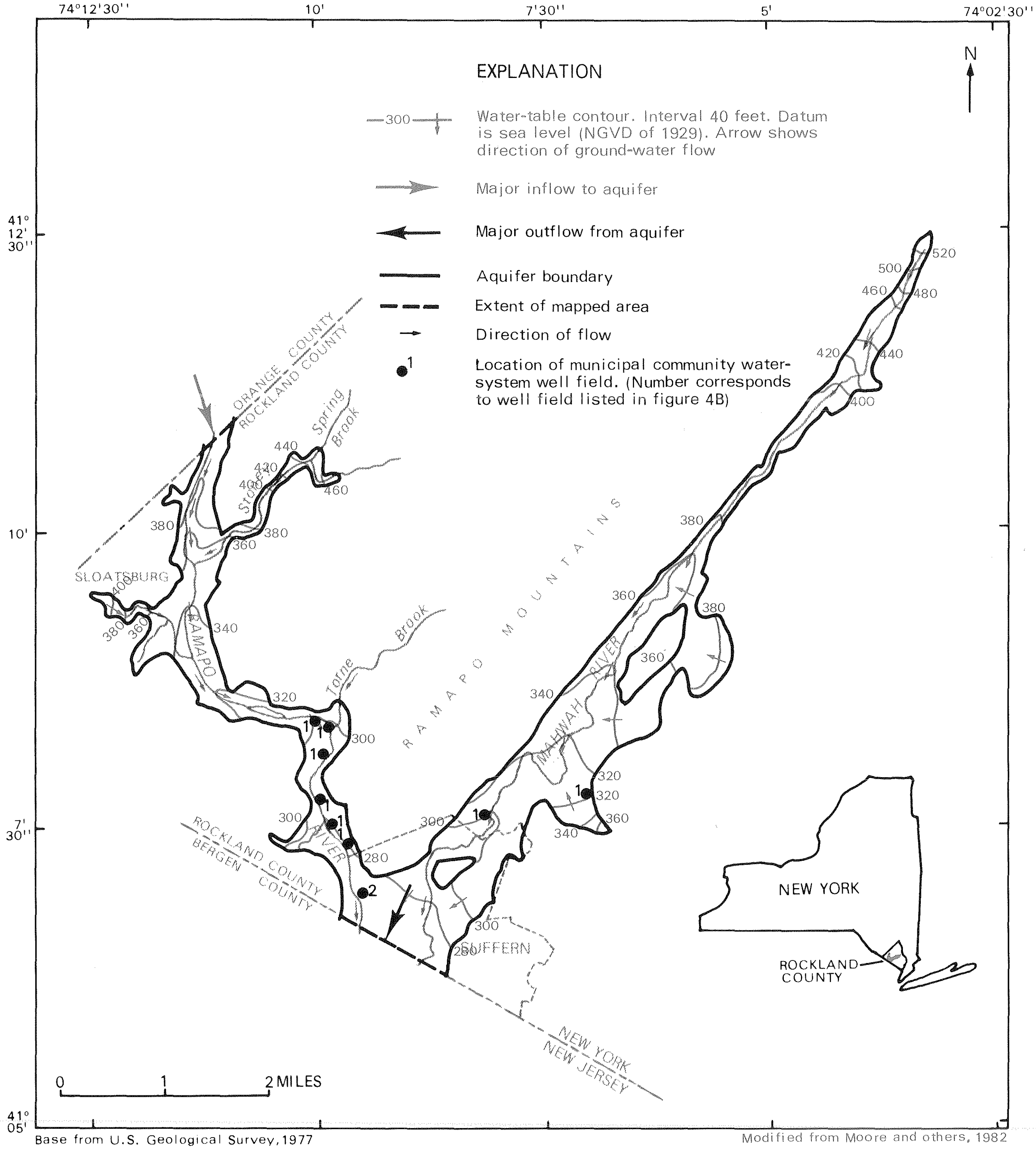
Sustained heavy pumping may reduce flow in the Ramapo River

The ground-water flow system discharges to the surface-water system. Recharge occurs from direct precipitation upon the aquifer area, from runoff, and ground-water flow from adjacent areas. Recharge may be induced locally from rivers by pumping wells.

The water table fluctuates seasonally in response to recharge and discharge. Recharge occurs over the entire aquifer, especially where the soils have high permeability. Recharge also occurs along the valley margins, where runoff from the hillsides reaches the valley floor, and from underlying and adjacent till and bedrock, as well as from the upstream section of the Ramapo valley in Orange County. Recharge may also be induced from the rivers by heavily pumped wells. Discharge occurs principally through evapotranspiration, seepage to streams, through wells, and as ground-water flow downvalley into New Jersey.

The water-table contours in figure 4F represent the estimated average altitude of the water table under nonpumping conditions. The map was constructed from water-level measurements in shallow wells and from surface-water levels. Water levels near the well fields are significantly lowered by pumping, and heavy sustained pumping also reduces flow in the Ramapo River. Although the effects of pumping are not evident on the map, cones of influence surround each pumping center.

FIGURE 4F RAMAPO RIVER—MAHWAH RIVER AREA
Ground-water movement



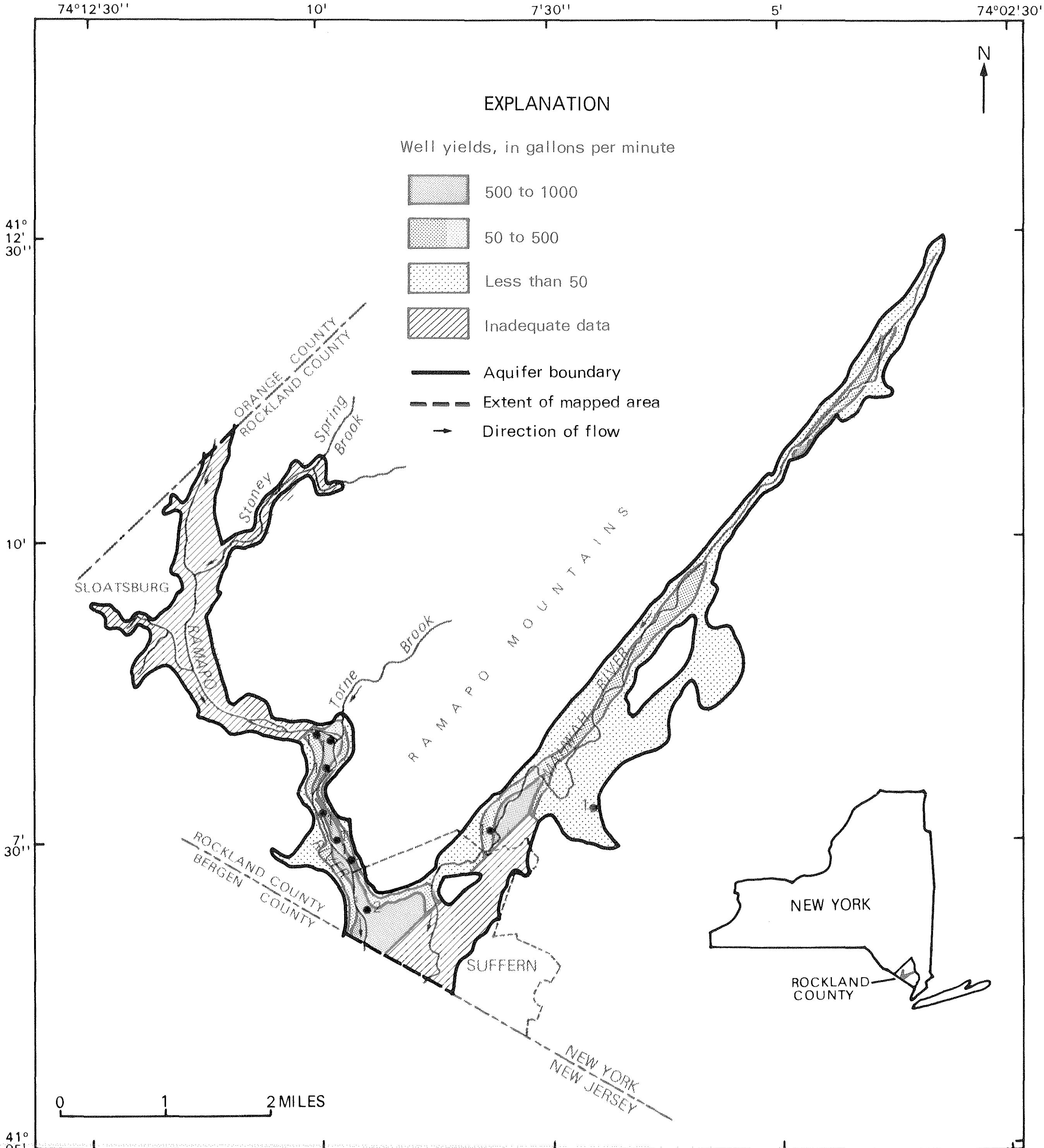
Well yields are largest near the rivers and in thick, coarse deposits

Yields exceeding 500 gallons per minute can be obtained from wells at several locations within this aquifer, particularly near the rivers, where river water can be induced to flow through the aquifer toward the well.

High well yields are generally obtainable adjacent to rivers, where pumping can induce river water to move into the aquifer. High yields are also available where saturated thickness of aquifer material is greatest. Yields up to 1,000 gal/min can be obtained in the southern part of the Ramapo limb of the aquifer and locally along the Mahwah limb. Where aquifer thickness is unknown or only inferred, well yields cannot be estimated.

Long-term yields may be affected by several factors, especially well design and proximity to other pumping wells. The values in figure 4G were derived from individual well yields (Leggette, Brashears and Graham, 1974), saturated thickness of permeable sand and gravel (see fig. 4E), and proximity to rivers. These yields are estimates of the maximum long-term yields from public-supply-type wells that fully penetrate the aquifer.

FIGURE 4G RAMAPO RIVER—MAHWAH RIVER AREA
Well yields



Base from U.S. Geological Survey, 1977

Modified from Moore and others, 1982

Much of the soil overlying the aquifer area is highly permeable

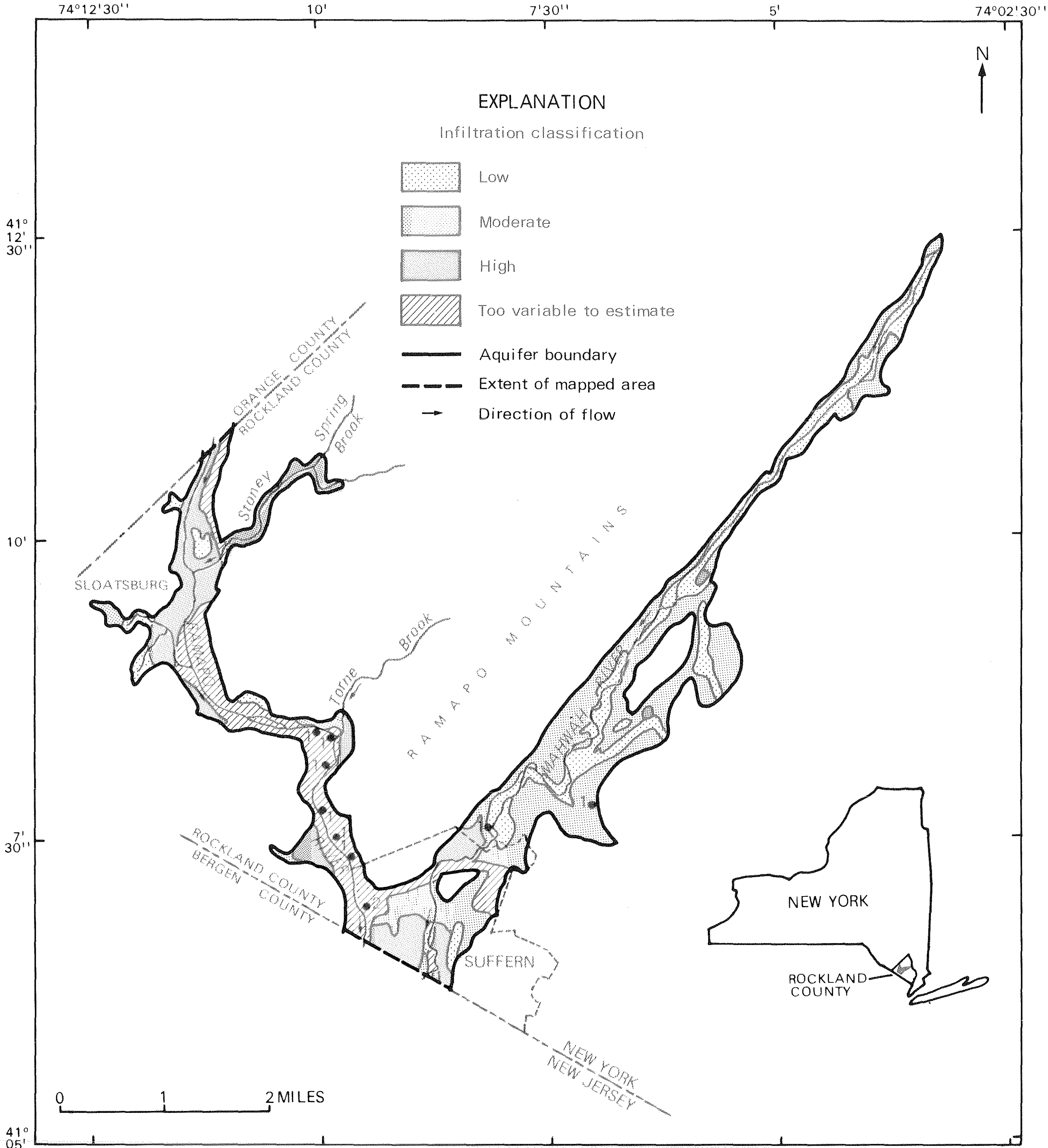
Permeability of soils overlying this valley-fill aquifer ranges from moderate to high. Soils in some areas are too variable to map, largely as a result of man's activities.

The Ramapo-Mahwah area contains a complex pattern of soil types. Much of the area is overlain by soils with moderate or high permeability. In some of the area, permeability is too variable to map because of changes resulting from human activity. Recharge and inflow in areas of moderate and high soil permeability will reach the aquifer more readily than in areas of low permeability.

The classification in figure 4H is a general estimate of how readily water can enter the soil zone and percolate into the underlying aquifer. Soils having the highest infiltration rates are those rich in sand; those having the lowest rates are those rich in clay and silt. The soil zone in this map is considered to be only the weathered part of the surficial geologic materials, which in this area is 18 to 30 inches thick.

Infiltration rate varies locally and seasonally, depending upon such factors as soil moisture and temperature, density of vegetation, slope, soil porosity, grain-size distribution, depth to seasonal high-water table, presence or absence of a water-impeding layer (fragipan), and the intensity and duration of rainfall, as well as other meteorological factors.

FIGURE 4H RAMAPO RIVER—MAHWAH RIVER AREA
Soil-zone permeability



Base from U.S. Geological Survey, 1977

4 RAMAPO RIVER—MAHWAH RIVER AREA
I. Land use

The southern part of the area is commercial; the rest is mostly rural

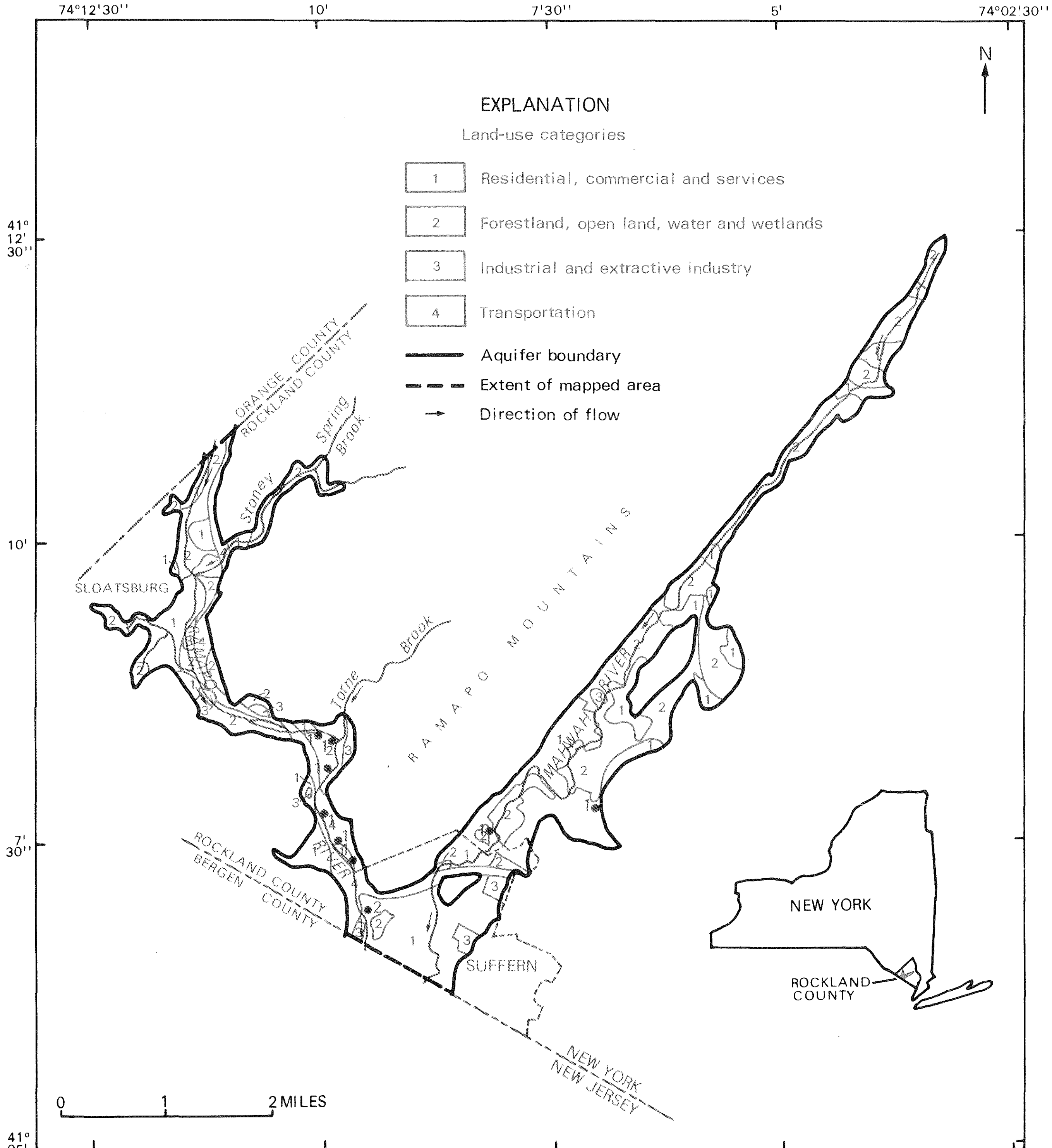
Land overlying this aquifer contains a major highway, commercial land, residential land, forests, open public land, wetlands, and some industry.

A major transportation corridor, including a railroad and part of the New York State Thruway, crosses over the southern part of the aquifer and extends up the Ramapo limb (fig. 4I)[1]. In addition, the southern section of each limb contains extensive commercial and residential land uses. The northern sections, which are predominantly forest, open public land, open water, and wetlands, contain pockets of residential and commercial development, the largest of which is the Village of Sloatsburg in the Ramapo Valley.

[1] Land use was compiled from the 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University for the New York State Department of Transportation.

FIGURE 41 RAMAPO RIVER—MAHWAH RIVER AREA

Land use



Base from U.S. Geological Survey, 1977

Modified from Waller and others, 1982

The southern part of this aquifer is vulnerable to contamination and overdraft

Extensive localized ground-water withdrawals are decreasing river flow. Detectable levels of an organic contaminant in some wells indicate that man is adversely affecting the aquifer.

Extensive well-field development in the Ramapo limb of the aquifer has diminished the aquifer's ability to yield adequate quantities of water elsewhere. In addition, the aquifer extends into New Jersey, which raises legal questions as to the ownership of ground water and the related streamflow in the Ramapo River. Recent pumping tests have shown the close relationship between ground-water withdrawals and streamflow declines. Streamflow was reduced dramatically after several well fields were pumped simultaneously for a 24-hour period (New York State Department of Environmental Conservation, unpublished data, 1981). During times of drought, this reduction may be significant and may adversely affect New Jersey residents downstream.

Changes in water quality through man's activities are highly probable in this aquifer system. The free (unconfined) water table, highly permeable soils, an extensive transportation network, and extensive urbanization together create a large potential for ground-water contamination.

Analyses of two water samples from the aquifer have been documented. The first was a composite sample taken on January 10, 1972, from Suffern village wells (locations shown in fig. 4I). Concentrations of the 48 chemicals analyzed indicated that the water was of acceptable quality for drinking (U.S. Geological Survey, 1980). However, a moderate concentration of sodium (29 mg/L) may be of concern to those on severely restrictive sodium diets. The second sample, also from the Suffern wells (Kim and Stone, 1979), revealed detectable levels of synthetic organic contaminant 1,1,1 Trichloroethane at a concentration of 170 μg/L (roughly 170 parts per billion). This test was made in response to a consumer complaint to State and local health departments.

A large municipal landfill within soil of high permeability adjacent to the aquifer at the junction of Torne Brook and the aquifer (see fig. 4A) has a high potential for contaminating the aquifer. Leachate from the landfill may have reached the Ramapo River and aquifer.

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5
IRONDOGENESEE AREA

By Roger M. Waller

5 IRONDOGENESEE AREA

A. Location and major geographic features

This aquifer occupies a preglacial buried valley on the Lake Ontario plain

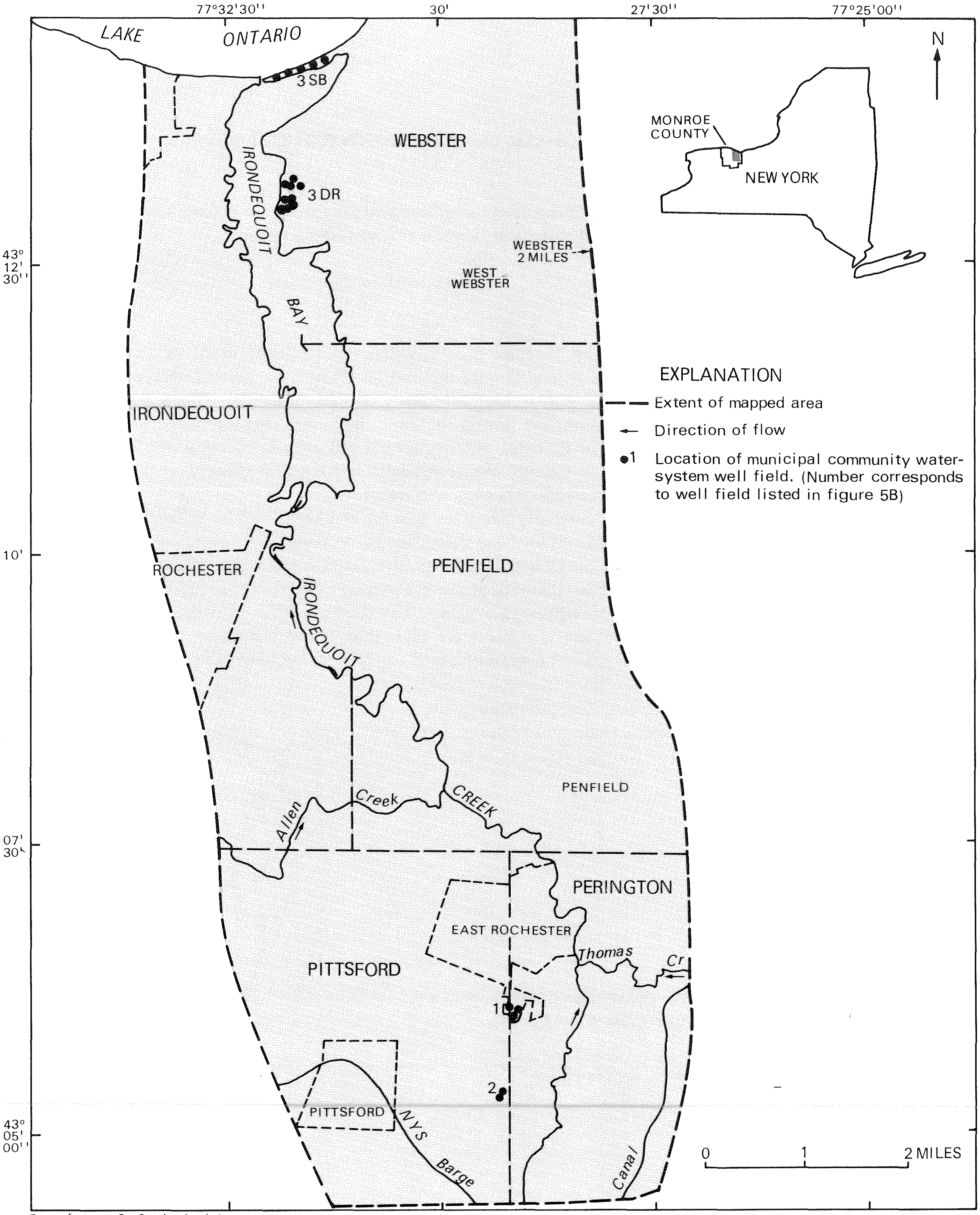
The preglacial buried valley (Irondogenesee) lies beneath the Irondequoit Creek and Irondequoit Bay drainage area, on the Lake Ontario plain in Monroe County. The area is characterized by heavy urbanization and extensive wetlands.

The Irondogenesee buried valley is in eastern Monroe County beneath the Irondequoit Creek drainage basin (fig. 5A). The City of Rochester lies along the west edge of the area. Three villages — East Rochester, Pittsford, and part of Fairport — lie within the area, as well as part of the towns of Irondequoit, Penfield, Perington, Pittsford, and Webster. The Village of Webster (the principal ground-water user of this aquifer) is about 4 miles east of the bay (fig. 5A). The area is heavily urbanized.

Irondequoit Creek and Bay are the dominant geographic features. The creek, which drains about 150 square miles of rolling glaciated topography to the south, has incised as much as 200 feet into fine-grained sediments on the relatively flat lake plain from East Rochester north to the bay (fig. 5A). Irondequoit Bay covers about 2.6 square miles and has a maximum reported depth of 75 feet (Diment and others, 1974). The bay connects with Lake Ontario through a narrow inlet shielded by a sandbar. Steep, wooded bluffs 100 feet high border the bay and expose glacial and proglacial-lake sediments. At the head of the bay and in the lower reaches of Irondequoit Creek are extensive wetlands. The bay has been the subject of comprehensive studies because of its deterioration in water quality for several decades. The history of the bay is described in Bannister and Bubeck (1978).

FIGURE 5A IRONDOGENESEE AREA

Location and major geographic features



Base from U.S. Geological Survey, 1968

This aquifer provides water to more than 47,000 people

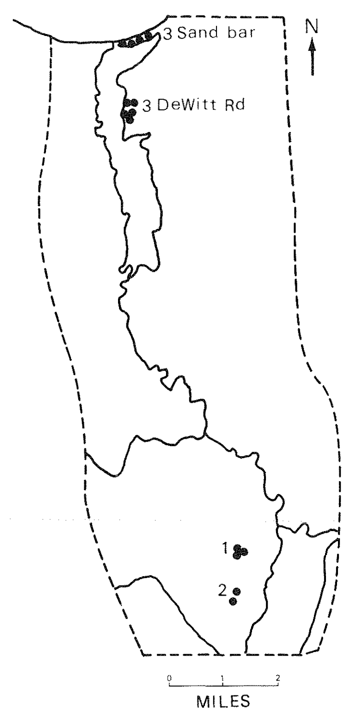
Some 47,000 people use about 4 million gallons per day of ground water from the aquifer. Lake Ontario supplies the remaining needs.

The buried-valley aquifer first became used by villages and industry in the 1930's. Ground-water pumpage remained fairly stable until the mid-1950's, when suburbanization began to increase. By the 1970's, the population had nearly tripled. Only the Village of Webster substantially increased its pumpage during this time, however; this was when it extended water service to the Town of Webster. Rochester and other areas obtain water from Lake Ontario through the Monroe County Water Authority. About 75 percent of the mapped area's estimated population of 200,000 uses lake water.

Four well fields (fig. 5B) currently pump the aquifer at 4 Mgal/d. The Village of Webster pumps more than 3 Mgal/d from two well fields, but in the early 1970's pumped as much as 7 Mgal/d from its well field on Dewitt Road (fig. 5B). At that time, the village was seeking additional water for industrial demands and subsequently developed a second well field (fig. 5B) on the sandbar at the mouth of Irondequoit Bay (Larsen, 1973; Morrison, 1974).

Industrial ground-water use is considered negligible. Some industries and towns have developed large-capacity wells but have deferred using them because surface-water sources from Lake Ontario and elsewhere are available.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map to the right and in figure 5A.



LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite

POPULATION AND PUMPAGE FROM IRONDOGENESEE AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. Village of East Rochester (3 wells)	8,000	0.397
2. Village of Pittsford (2 wells)	3,500	0.392
3. Village of Webster (2 well fields) (includes 16 water districts)	35,000	3.129
Subtotal	46,500	3.918
B. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per person per day is assumed	* 1,000	* 0.10
Total	* 47,500	* 4.018

NOTE: Much of area is served by the Monroe County Water Authority with Lake Ontario water

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
* Estimated

Deglaciation filled a bedrock valley with thick glacial and lake deposits

Irondequoit Bay and Creek occupy a preglacial valley partly filled with glaciofluvial sediments. Proglacial lake waters reworked a till plain and recessional-moraine features, leaving local sand and gravel units interspersed with a mantle of silt and clay.

A preglacial drainage system carved a deep valley in bedrock beneath the present Irondequoit valley and probably developed an alluvium-filled valley floor. During the Ice Age, glaciers covered the area and left a deposit of drift nearly everywhere. Whether the former valley alluvium is still present or whether glaciation removed it is unknown. An ice lobe of one or more glaciations occupied the valley (Fairchild, 1896a) early and prevented complete filling of the valley with meltwater deposits. East and west of the valley, the glacier deposited a mantle of till.

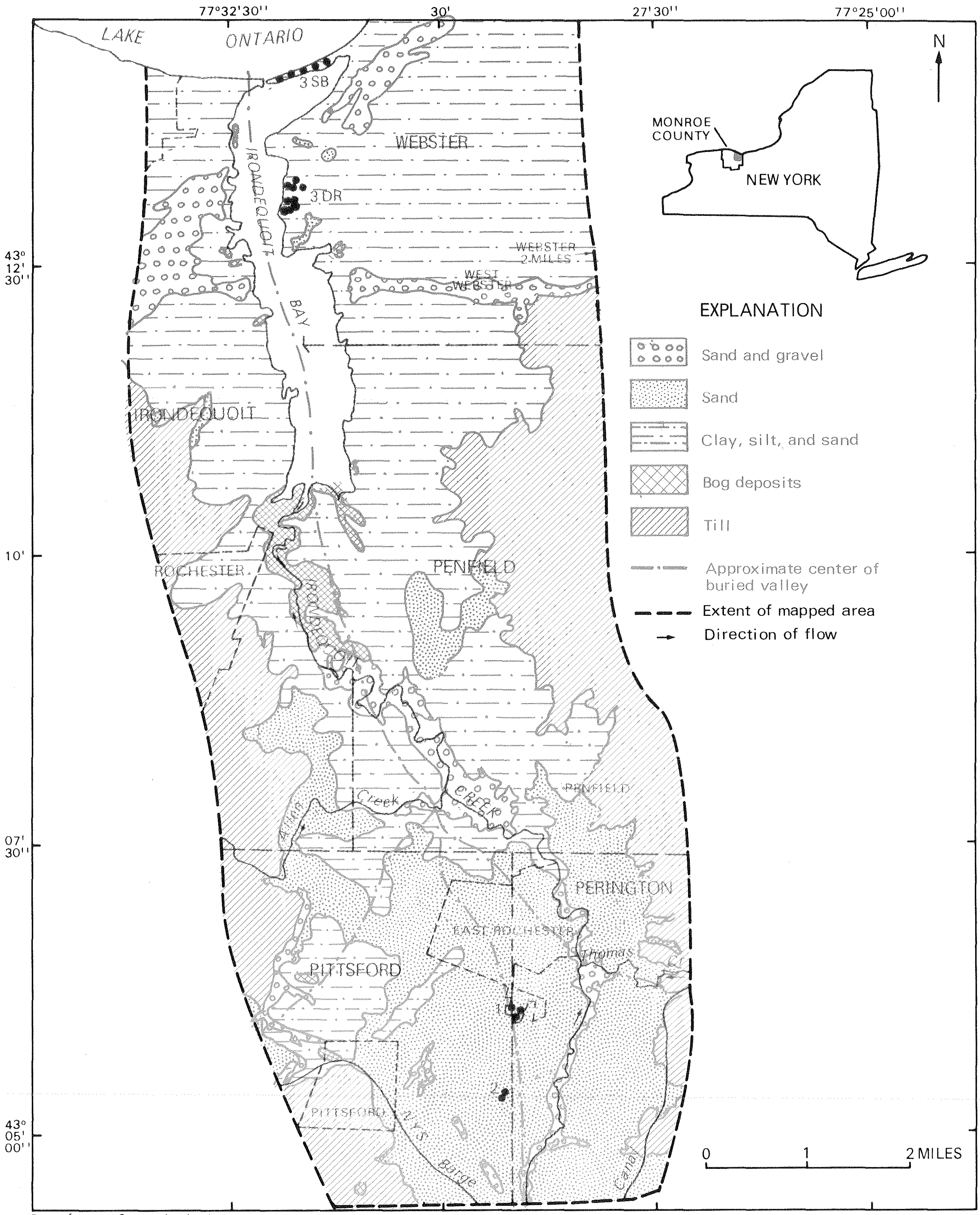
It is generally considered, primarily from Fairchild's numerous publications (1928 in particular), that the last stages of glacial melting produced extensive sand and gravel deposits in the form of kames and outwash. These deposits remain in the southern edge of the mapped area (fig. 5C).

Several lakes formed as the ice front receded (Fairchild, 1928). Wave action on the till plain, on drumlins, and on kames created a layer of fine to medium-grained material of varying thickness that overlies the silt and clay deposits. The last glacial-lake stage (Lake Iroquois) formed the prominent east-west beach line occupied by "ridge roads" on most of the Lake Ontario plain.

Sediments at land surface are mostly silt and clay in the northern two-thirds of this area and are sand and gravel in the southern third (fig. 5C). Thickness of the sediments ranges from a few feet to about 400 feet. The generalized surficial geology map (fig. 5C) was made from a soils map (Sweet and others, 1938) and a map by Young (1980).

FIGURE 5C IRONDOGENESEE AREA

Geologic setting



Base from U.S. Geological Survey, 1968

Modified from Waller and others, 1982

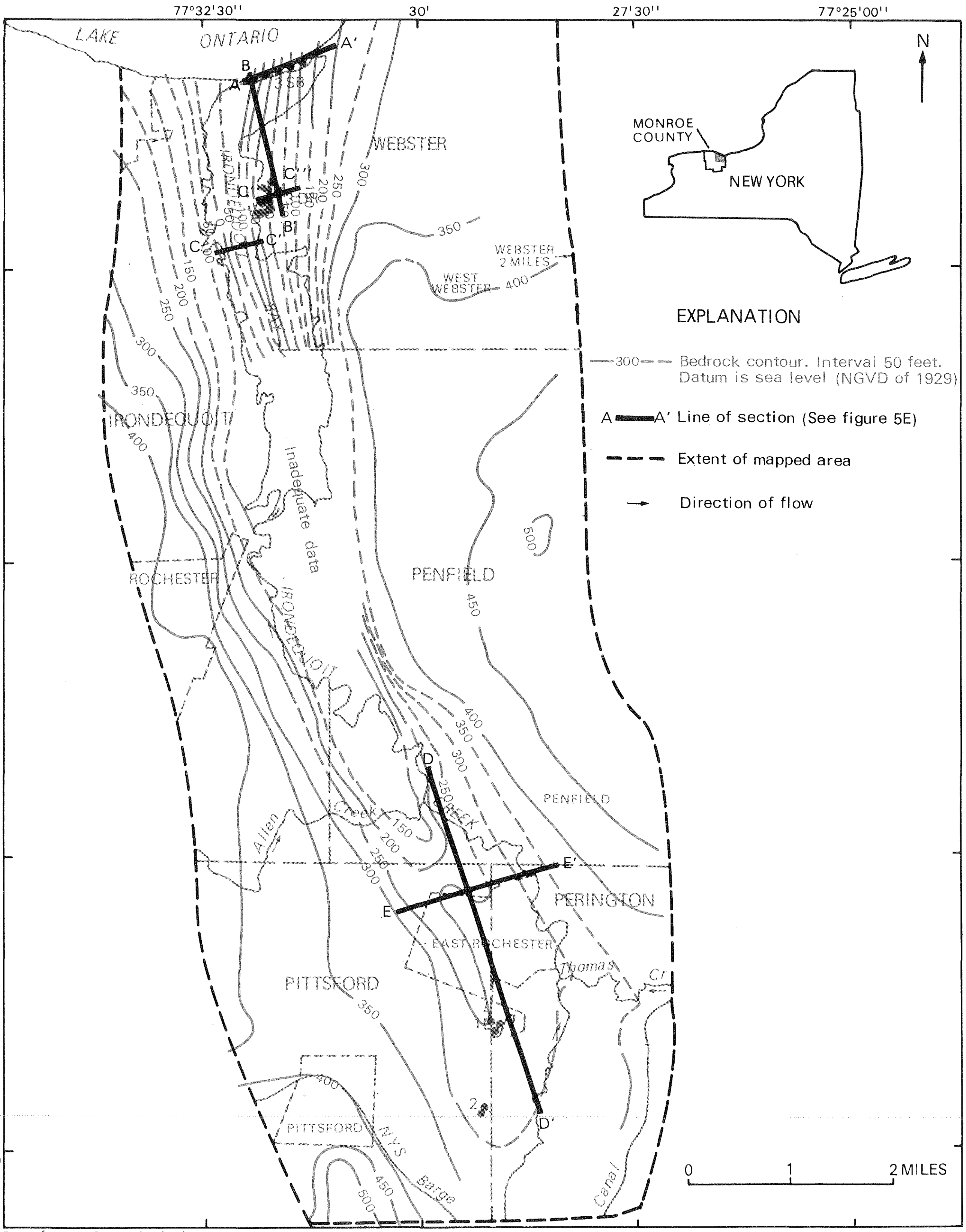
The bedrock-valley configuration controlled distribution of aquifer material

The bedrock valley determined the distribution of glacial sediments in the northeastern part of the area and probably in the southern part as well. An abrupt increase in slope of the valley north-northeast of East Rochester at a dolomite subcrop may have controlled distribution of permeable sediments.

An extensive inventory of wells in the early 1930's provided sufficient data from which to develop the first bedrock-contour map showing the preglacial bedrock valley (Leggette and others, 1935). Young (1980) modified the map. Three sets of additional data, described below, helped further delineate the valley configuration and the limits of the aquifer system; these new data are reflected in figure 5D.

Bridge borings and seismic data (New York State Department of Transportation, unpublished data) at the Route 104 bay crossing (sec. C-C′, fig. 5E), well data and a geologic profile at the mouth of the bay (Morrison, 1974, 1975), and well data from the villages of Pittsford and East Rochester well fields were used to refine the bedrock contours (fig. 5D). Still no data are available from the 5-mile segment from the south end of the bay into the wetlands of lower Irondequoit Creek. Probably the most significant new features are that (1) the centerline of the bedrock valley beneath the bay is east of the general center of the bay, and (2) the subsurface escarpment of dolomite, also exposed in Allen Creek and reportedly also in Irondequoit Creek (Bannister and Bubeck, 1978), creates a steepening of the bedrock (ancient falls or rapids), as indicated by the contours in the valley north-northeast of East Rochester.

FIGURE 5D IRONDOGENESEE AREA
Preglacial bedrock valley



Base from U.S. Geological Survey, 1968

Modified from Waller and others, 1982

This area contains several productive aquifers of varying composition and extent

A water-table aquifer at relatively shallow depth in the south provides high yields; in the north, a water-table aquifer and an underlying confined aquifer both provide high yields. The relationship between the northern and southern systems is unknown.

Unconsolidated deposits within and over the bedrock valley contain several extensive, highly permeable sand and gravel aquifers. The generalized geologic sections in figure 5E indicate the depth and lateral extent of the aquifers in some of the northern and southern parts of the area.

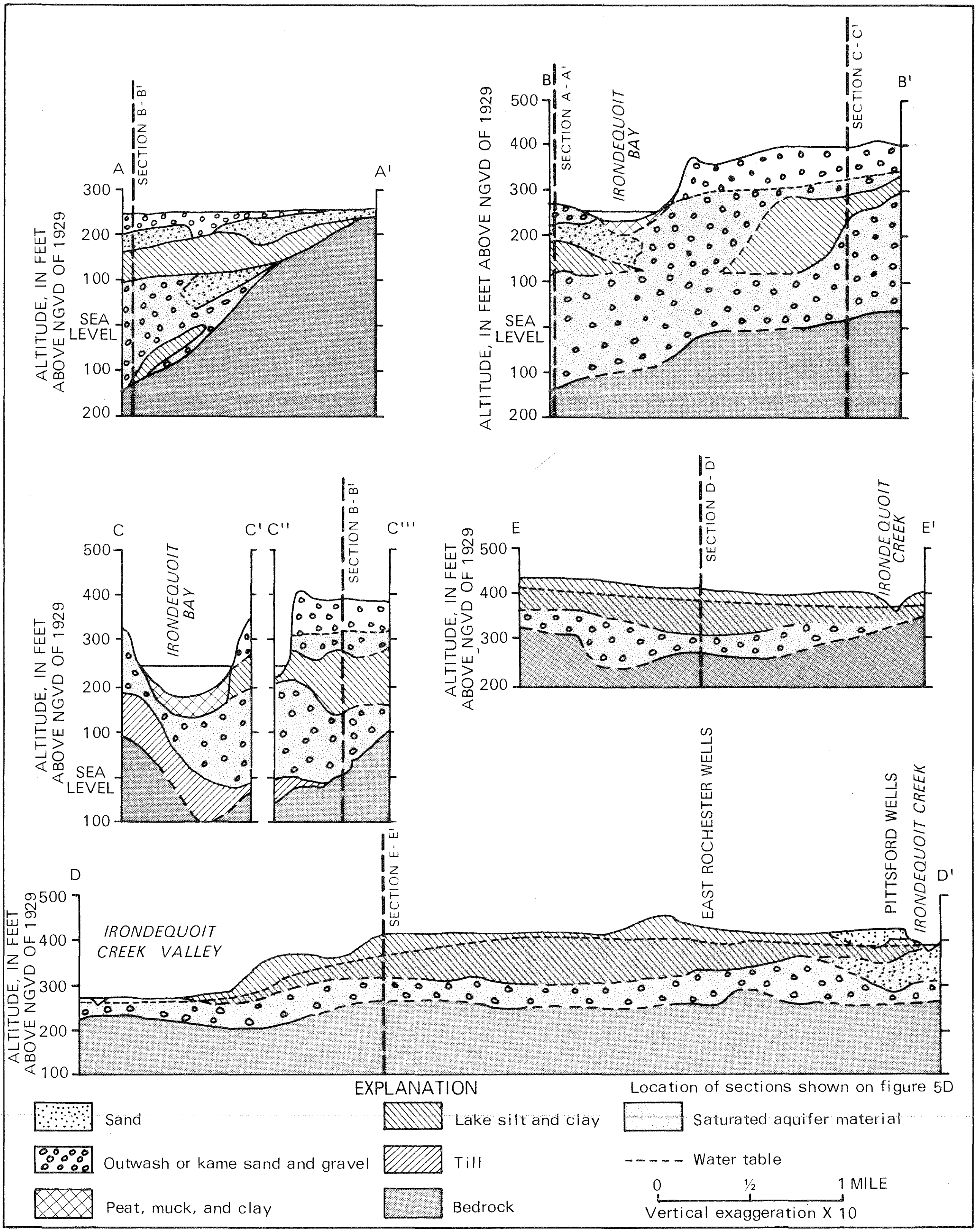
The northern well fields (Dewitt Road and Sand Bar fields of the village of Webster, fig. 5B) have been recently developed and appraised (Larsen, 1973; Morrison, 1974, 1975). The Sand Bar wells tap two prolific water-bearing units (sec. A-A′); but the Dewitt Road field reportedly taps only a lower aquifer (sec. C-C′), which was determined to be hydraulically connected to the lower aquifer at the Sand Bar field (Morrison, 1974, 1975). This relationship is evident in section B-B′. Test-well data north of the Dewitt Road well field indicate an upper aquifer, but well records indicate inadequate yields. Data from the Route 104 bridge, which were used to construct section C-C′, indicate the probable westward extension of the lower aquifer system.

The buried-valley aquifer system in the north is nearly 200 feet thick and provides large quantities of water. The lower aquifer, 60 to 85 feet thick, may extend as far west as the centerline of the valley as it does to the east of it and also extends several hundred feet northward (Morrison, 1974) under Lake Ontario. The presence of compacted sand and gravel at the base of the bedrock valley belies the common belief that the valley contained only fine lake deposits. The basal sand and gravel may be preglacial alluvium, advance outwash from early glaciation, or early kame deposits; Fairchild (1935) implied advance outwash. Sandy deposits above lake deposits, as depicted in sections B-B′ and C-C′, may be related to ice-contact deposition off the east side of an ice lobe (remnant ice) during the waning stages of glaciation.

In the southern part of the mapped area, the aquifer system consists of sand and gravel outwash about 80 feet thick and extending laterally at least 3 miles, as indicated in section E-E′. North of East Rochester, the extent of this sand and gravel is unknown, but it may connect with the lower aquifer of the Dewitt Road well field. As indicated in section D-D′, the system thins to less than 50 feet near the postulated subcrop of dolomite.

Ground water is readily available from the aquifer system of this area; well yields of several hundred gallons per minute are common. Morrison (1974) indicates that the Sand Bar well field can yield 2.8 Mgal/d from the upper aquifer and as much as 10 Mgal/d from the lower aquifer, and that the Dewitt well field can yield as much as 13 Mgal/d. The aquifer system in the south has not been analyzed for potential yield. However, two wells now produce only 0.4 Mgal/d each (about 300 gal/min) but cause very little drawdown. It would seem reasonable to expect yields of at least a few Mgal/d. Individual wells in this area may each produce several hundred gallons per minute.

FIGURE 5E IRONDOGENESEE AREA
Aquifer thickness and well yields



Modified from Waller and others, 1982

Ground water flows toward Irondequoit Bay and Lake Ontario

Ground water moves into the bedrock-valley deposits from surrounding areas and thence to Irondequoit Bay and also directly to Lake Ontario.

Ground water moves from the south, east, and west toward the preglacial valley and from there to Irondequoit Creek and its wetlands, the bay, and Lake Ontario. In the northern half of the valley, the deep confined aquifer system discharges upward through poorly permeable silt and clay beds into the bay as well as laterally to Lake Ontario. The ground-water level at the north end of the valley is about at lake and bay level, with gradients from the east, west, and south that provide a driving force for upward leakage.

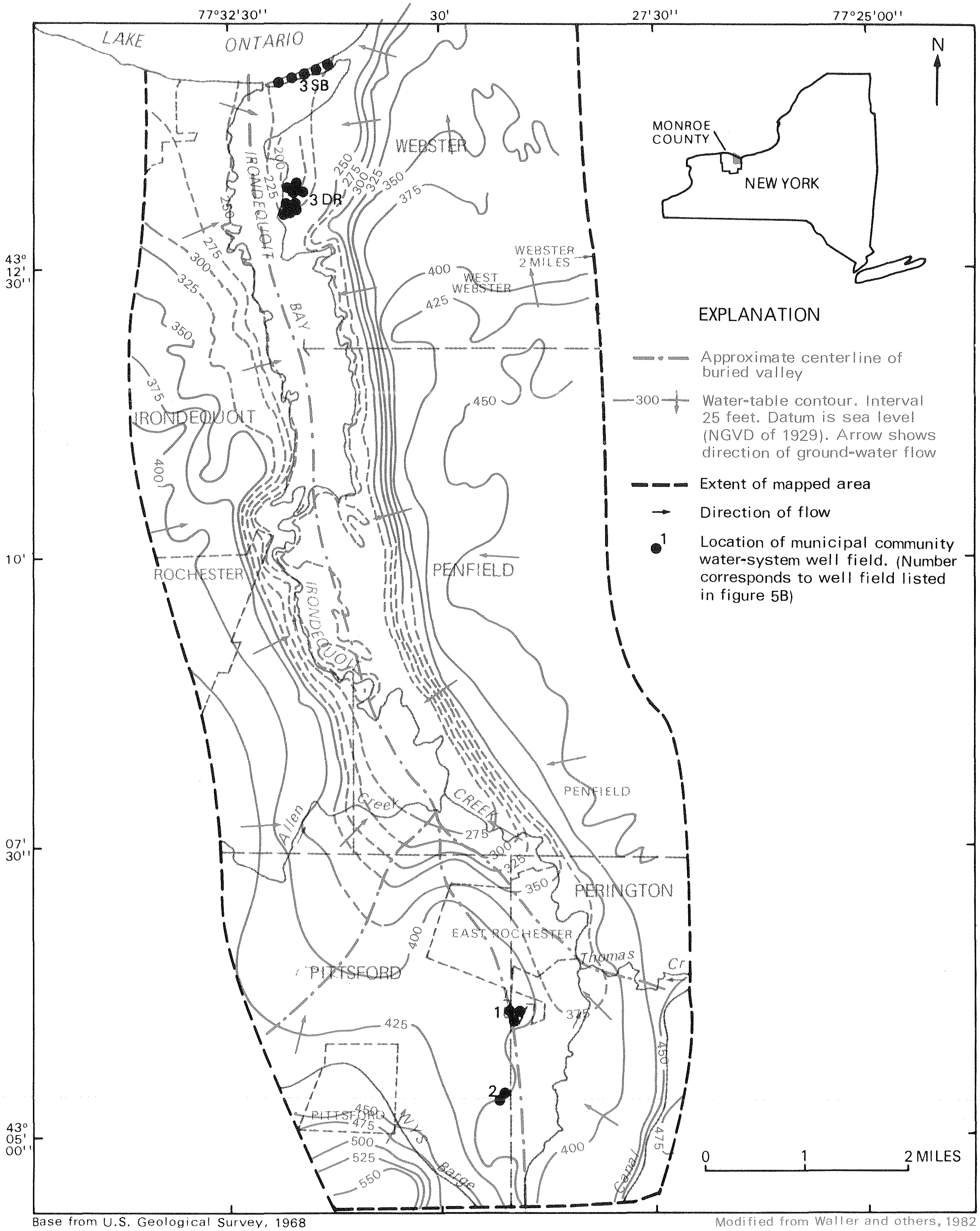
Water levels from a well inventory (Leggette and others, 1935) were used by Young (1980) to construct a potentiometric-surface map of the aquifer system. Data from present well-field operations were used to modify Young's map and show the generalized movement of ground water in the Irondequoit valley (fig. 5F).

According to Morrison (1974), pumping at the two well fields at the north end of the valley produces cones of depression as deep as 70 feet below lake and bay level, so that ground water flowing toward the lake and bay in this area is captured at pumping centers. This also may induce inflow from the lake. Morrison (1974) also indicates that the shallow aquifer at the Sand Bar well field is not affected by pumping of the deep aquifer; this conclusion seems reasonable because the lake and bay are in excellent hydraulic contact with the upper aquifer.

The probable main recharge area for the aquifer system is in the southern part of the area, which contains highly permeable outwash and kame sediments at land surface. Additional recharge probably occurs from the dolomite and sandstone bedrock throughout the valley. Recent urban-runoff studies have noted a mean monthly increase of 10 to 16 Mgal/d in discharge of Irondequoit Creek between East Rochester and the bay during base flow in May-August 1980 (U.S. Geological Survey, 1982), which would support this conclusion.

FIGURE 5F IRONDOGENESEE AREA

Ground-water movement



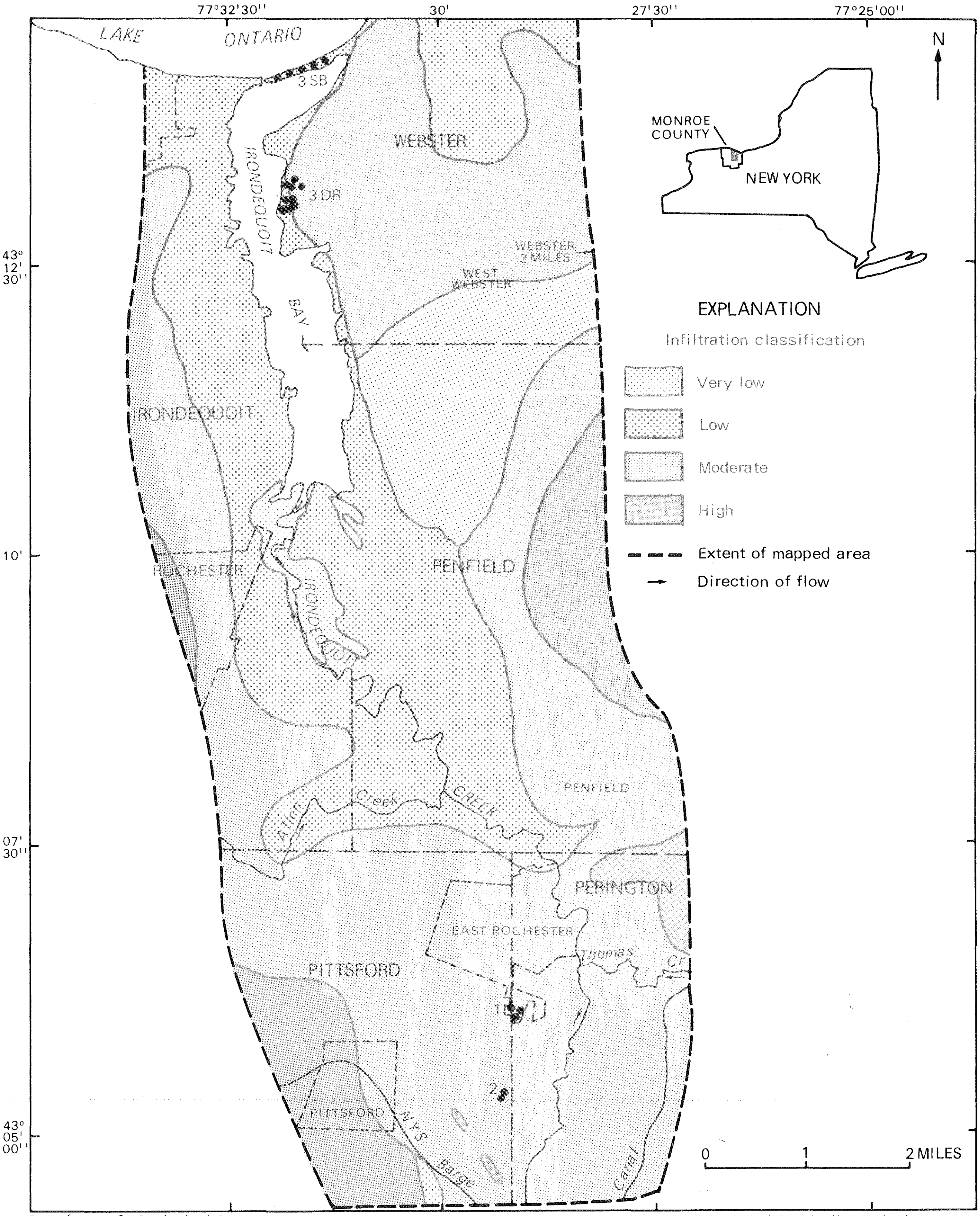
Soils in the northern part of this area are less permeable than in the southern part

Soils overlying the glaciolacustrine deposits in the northern part of the area are thin and have low to moderate permeability. Soils developed in outwash and kames in the southern part have moderate to high permeability.

The glaciolacustrine deposits of the area have developed a relatively thin soil zone. A generalized soil-permeability map, developed from a map by Sweet and others (1938), is given in figure 5G; a more recent soil survey (Heffner and Goodman, 1973) gives more detail for site-specific information. Extensive land development within this area has locally reduced the water-infiltration characteristics of the soil zone.

Figure 5G indicates that the floor of the Irondequoit Creek valley has low permeability. The numerous silt and clay deposits, a high water table, and gentle slopes create ponding and water-logged conditions. On the uplands adjacent to the valley, soils that have developed on sandy lake deposits and till have moderate permeability, but the underlying silt and clay impedes vertical percolation. In the south, soils overlying outwash and kames have moderate to high permeability. This area, and the zone in the northeast in which the infiltration capacity is moderate, provide the greatest potential for recharge to the aquifer system.

FIGURE 5G IRONDOGENESEE AREA
Soil-zone permeability



Base from U.S. Geological Survey, 1968

Modified from Waller and others, 1982

The southern part of this aquifer is vulnerable to contamination from surface sources

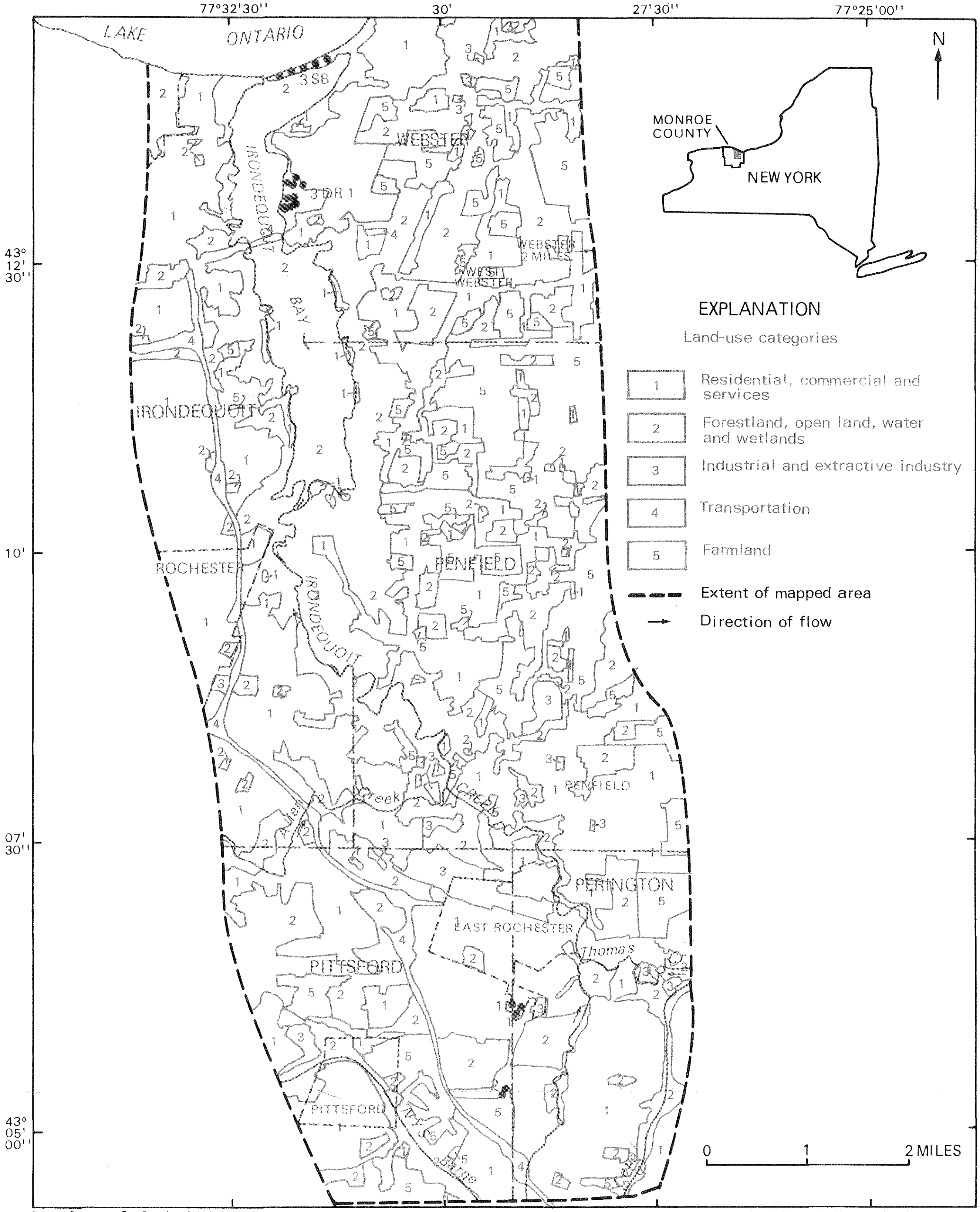
Much of this area is urban and suburban. Farms, forests, and open public land make up most of the remainder. Industry is concentrated in the East Rochester area.

Land use over the buried-valley system is hydrologically important, primarily in the southern part of the area, where the aquifer is close to land surface and under water-table conditions. In this area, where the soil is moderately permeable, wastes and contaminated runoff can readily infiltrate to the aquifer.

Land use over the aquifer system is predominantly urban-suburban (perhaps 60 percent), but the eastern part contains large areas of farmland (estimated 15 percent), and the central valley and the south contain siginificant areas (estimated 15 percent) of open public land and forests (fig. 5H)[1]. Industry is concentrated in the East Rochester area. A major transportation network runs north-south along the west edge of the area. The principal open-water and wetland areas are Irondequoit Bay and the lower reach of Irondequoit Creek.

[1] Figure 5H was compiled from the 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University for the New York State Department of Transportation.

FIGURE 5H IRONDOGENESEE AREA
Land use



Base from U.S. Geological Survey, 1968

Modified from Waller and others, 1982

Elevated concentrations of chloride have been reported with increasing frequency

Chloride concentration at some well fields has increased markedly in recent decades. A lack of knowledge of the extent and potential of the aquifer inhibits further ground-water development.

Although the buried-valley aquifer system has been extensively used for decades, no attempts have been made to appraise either its extent or its potential for additional use. The system seems capable of sustaining large yields, but the water quality has deteriorated locally. Two appraisals of the two well fields in the northern part of the system point out the excellent potential for high well yields but caution about possible deterioration (Morrison, 1974, 1975).

Reported changes in water quality, particularly chloride concentration, have inhibited ground-water development. Early data (Leggette and others, 1935) indicated no problem, in that water from more than 300 wells tapping all types of drift ranged in average chloride concentration from 20 to 101 mg/L. Subsequent sampling at many of the same wells (Grossman and Yarger, 1953) showed a low average chloride concentration (32 mg/L) in those wells tapping sand and gravel. By the 1960's, however, chloride concentrations were clearly rising (fig. 5I).

Chloride concentration in water from community systems from 1930-80 is plotted in figure 5I. Originally, East Rochester water had less than 30 mg/L (1930's), Pittsford water had about 50 mg/L (1950's), and Webster water ranged between 10-140 mg/L (1960's). All have reported increases in some wells to levels near or above recommended health limits of 250 mg/L. Most references on ground water in this area attribute chloride problems to a bedrock source (saline water is verified in bedrock aquifers) or, recently, to road salts.

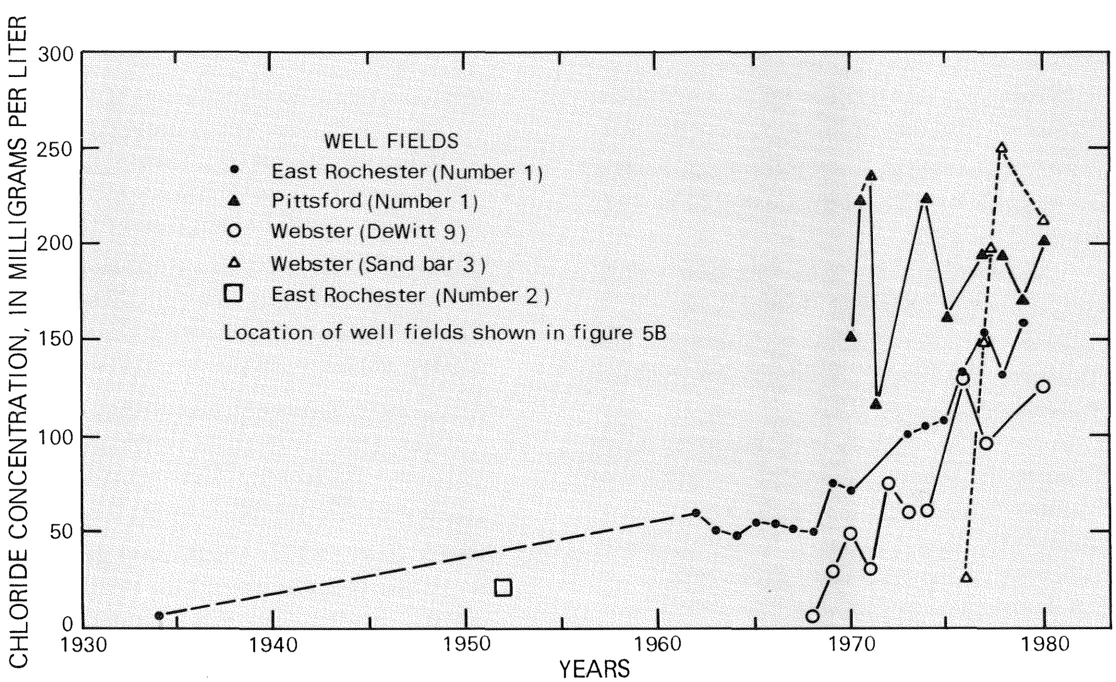
Chloride increases in the Dewitt well field have been attributed to a bedrock source (Larsen, 1973; Morrison, 1974) because some of the wells are screened just above the bedrock contact. The two Sand Bar aquifers differ in chloride levels (Morrison, 1975); the upper aquifer has wells near bedrock surface (sec. A-A′, fig. 5E) that obtain high-chloride water, but continued pumping lowers the concentration. The lower aquifer has concentrations of only 20 to 50 mg/L.

East Rochester wells were affected by a nearby waste-disposal well in the early 1970's (Koral and Burton, 1972). Whether earlier chloride increases were related to disposal is not known. No lowering in chloride concentration or other constituents since then seems apparent (fig. 5I).

Pittsford wells had a serious chloride increase until it was discovered in the 1970's that water-softening wastewater (high in chloride) was being disposed of too close to the well field (Larsen, 1969). Since the cessation of this practice, the chloride levels have declined somewhat (fig. 5I).

Road salt may be a contributing problem in the southern part of the area. An exhaustive study of water quality in Irondequoit Bay by Diment, Bubeck, and Deck (1974) concluded that although Irondequoit Creek and the bay were receiving excessive loads of chloride during winter runoff, infiltration to the deeper water-bearing units had not yet occurred.

Whether the elevated chloride levels are attributable to natural or man-made sources, or both, has not been fully resolved. The southern part of the aquifer, owing to its shallow water table and thin soil cover, seems likely to be affected more by waste-disposal practices than by natural causes. An appraisal of data, plus a systematic sampling study, would be needed to resolve the question.



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6
JAMESTOWN AREA

By Henry R. Anderson

A. Location and major geographic features

B. Population and ground-water use

C. Geologic setting

D. Geohydrology

E. Aquifer thickness

F. Ground-water movement

G. Well yields

H. Soil-zone permeability

I. Land use

J. Present and potential problems

K. Selected references

6 JAMESTOWN AREA

A. Location and major geographic features

This area is largely rural, with southward drainage to the Allegheny River system

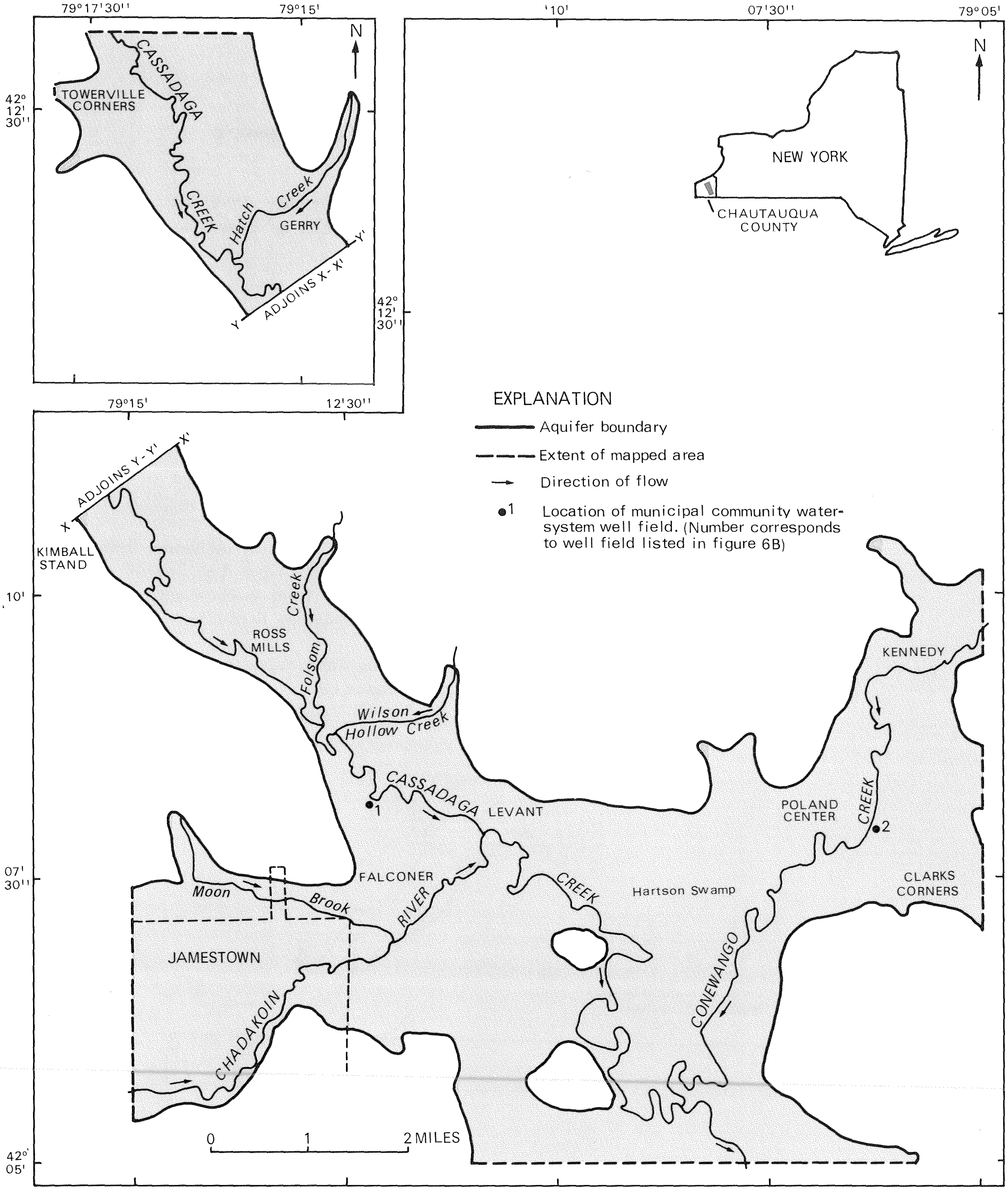
This valley-fill aquifer system underlies Cassadaga and Conewango River valleys in Chautauqua County in the extreme southwestern part of New York. Rolling upland bedrock hills border the valleys. Most of the area is rural.

Jamestown is in the southeastern part of Chautauqua County in the southwestern corner of New York (fig. 6A). The aquifer system encompasses about 34 square miles within the broad Cassadaga and Conewango Creek valleys and Chadakoin River valleys. The valleys drain rolling glaciated uplands of moderate relief.

The area contains many broad, flat-bottomed valleys separated by wide upland areas of rolling, irregularly shaped hills that rise about 700 feet above the valley floors. Lake Chautauqua, about 1 mile west of the area, is at an altitude of about 570 feet.

Conewango Creek, Cassadaga Creek, and Chadakoin River, the outlet of Chautauqua Lake, drain southward into the Allegheny-Ohio-Mississippi River system. The Conewango and Cassadaga Creek valleys are remarkably flat bottomed, and the streams draining these valleys have exceptionally low gradients.

FIGURE 6A JAMESTOWN AREA
Location and major geographic features



Base from U.S. Geological Survey, 1978

This aquifer provides ground water to about 52,000 people

About 52,000 people use ground water from this aquifer. About 8.6 Mgal/d of ground water was pumped in 1980. The City of Jamestown accounts for more than half the pumpage.

The population of the Jamestown aquifer area is about 52,000. About 40,000 live in the urban areas, which are concentrated in the City of Jamestown and vicinity; the remaining 10,000 live in villages and hamlets having less than 2,000 people each.

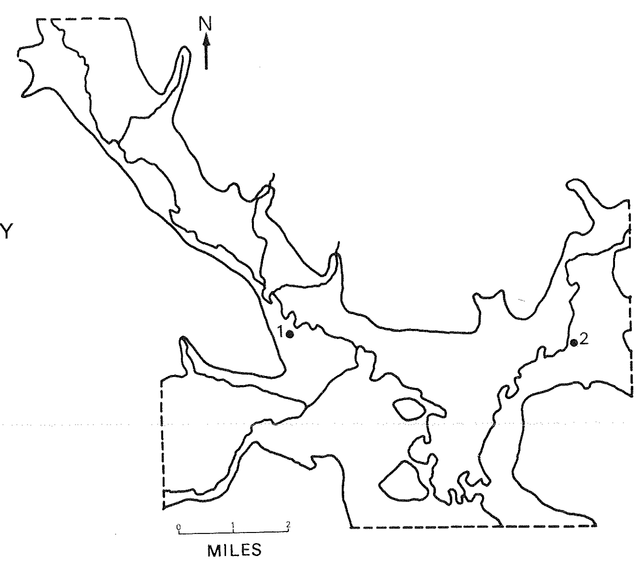
Total ground-water pumpage in the area in 1980 was approximately 8.6 Mgal/d. The City of Jamestown is the largest single user of ground water in the area and accounts for about three-fourths of the total pumpage. Average pumpage by the Jamestown system in 1980 was 6.6 Mgal/d; this pumpage includes water supplied to the Villages of Celoron, Lakewood, Falconer, and three water districts.

Many of the industries in the area obtain water from wells; use by individual firms ranges from a few hundred to hundreds of thousands of gallons per day. Several of these industries also use surface-water sources and water from public supplies to supplement their own systems. Nearly the entire rural population depends on ground water.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 6A.

LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite



POPULATION AND PUMPAGE FROM JAMESTOWN AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
City of Jamestown (2 well fields)	35,775	6.57
Village of Celoron	1,431	—
Ellicott Water District No. 1	250	—
Ellicott Water District No. 2	250	—
Village of Falconer	2,928	—
Village of Lakewood (25% from Jamestown)	1,000	—
Busti Water District No. 1	500	—
Subtotal	42,134	6.57
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer parks (7)	* 1,630	0.16
C. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per person per day is assumed	* 8,575	* .86
D. INDUSTRY	—	[3] 1.00
Total	* 52,339	* 8.59

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
[3] Industrial use from Crain (1966)
* Estimated

The valleys consist of thick unconsolidated deposits overlying shale bedrock

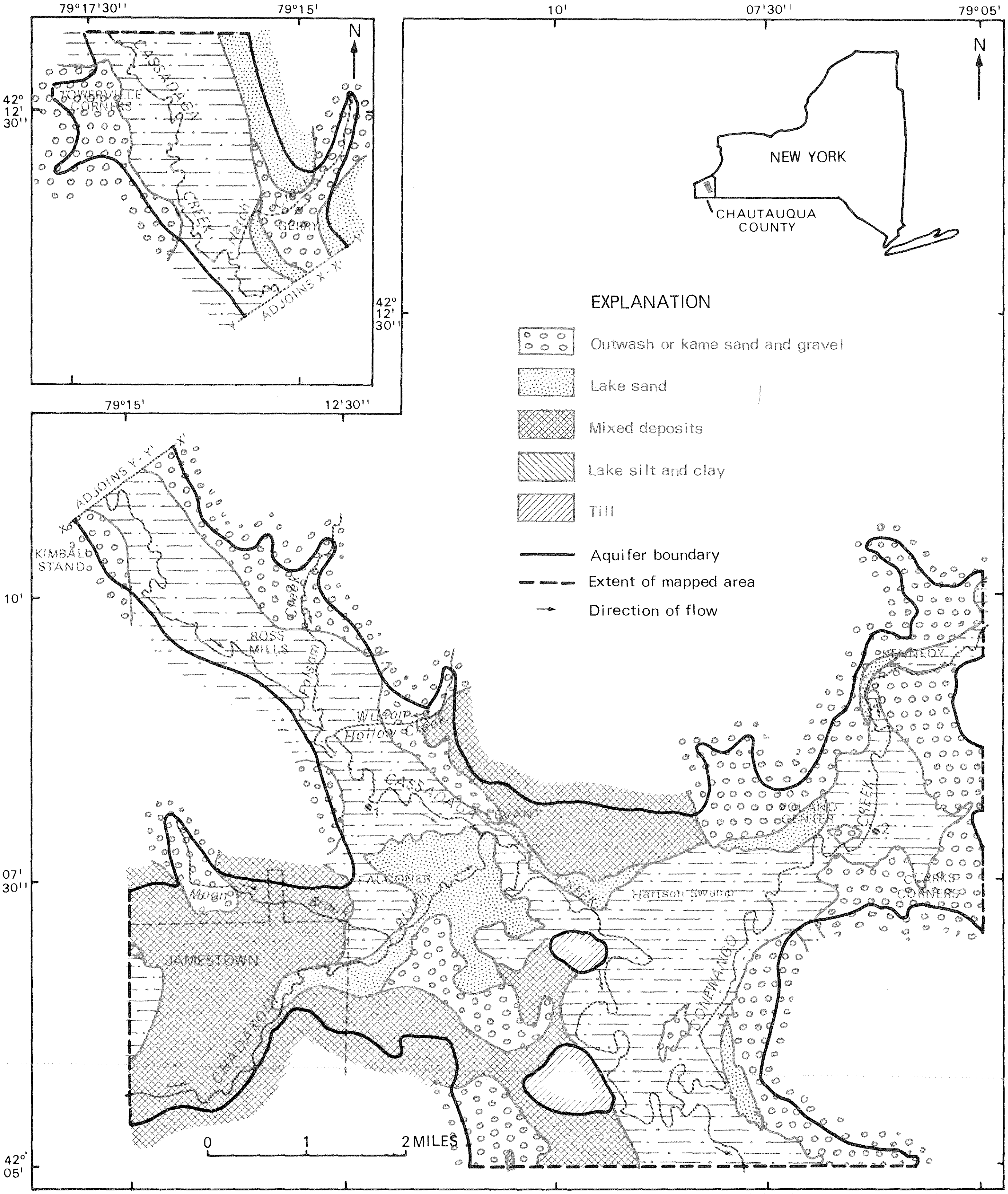
The Jamestown area is a broad valley floor in a shale plateau that has been deeply eroded by continental glaciation. Thick drift and lacustrine deposits fill the bedrock valleys.

This aquifer area encompasses four drift-filled stream valleys that merge in the Jamestown vicinity. In the uplands, thin till covers shale bedrock, and streams have cut through this till. The thick unconsolidated deposits that fill the bottom of the valleys form the aquifers. Figure 6C shows the distribution of surficial deposits within the area.

The valleys were originally formed by preglacial rivers flowing into Lake Erie. During the ice age, glaciers scoured the valleys wider and deeper and effectively blocked the northward drainage, so that lakes formed in the ice-dammed valleys. As the glaciers melted, they deposited large amounts of debris that continued to block many of the valleys. Lake Chautauqua, west of Jamestown, was formed in this manner. Lacustrine deposits of silt and clay as thick as 500 feet formed in many temporary lakes and valleys. Interbedded with the lake deposits are layers of sand and gravel outwash that were intermittently deposited by meltwater streams entering the lakes, probably from tributary deltas or readvances of ice. The tops of the deltas now look like alluvial fans of sand and gravel. These deposits also interfinger with the outwash gravels along the valley margins.

FIGURE 6C JAMESTOWN AREA

Geologic setting



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

This aquifer system contains both water-table and artesian aquifers

Glacial deposits ranging from 200 to 600 feet thick form the valley fill. Discontinuous outwash sand and gravel units within lacustrine clays create an artesian aquifer system. Alluvial-fan (delta) deposits on the east side of the valley form water-table aquifers.

Conewango and Cassadaga valleys contain unconsolidated glacial sediments 200 to 600 feet thick. The deposits are mostly clayey lake sediments. Thin outwash gravels interbedded with the lacustrine deposits form the aquifers. Section A-A′ (fig. 6D) shows a profile of the Cassadaga valley from Gerry to near Jamestown. The so-called Jamestown aquifers can be traced more or less discontinuously down the Cassadaga valley at depths of more than 100 feet. The main aquifer is a thin outwash gravel overlain by silt and clay lake-bed deposits that act as a confining layer, making it an artesian aquifer. Because section A-A′ lacks subsurface data below 200 feet, the profile is only interpretive.

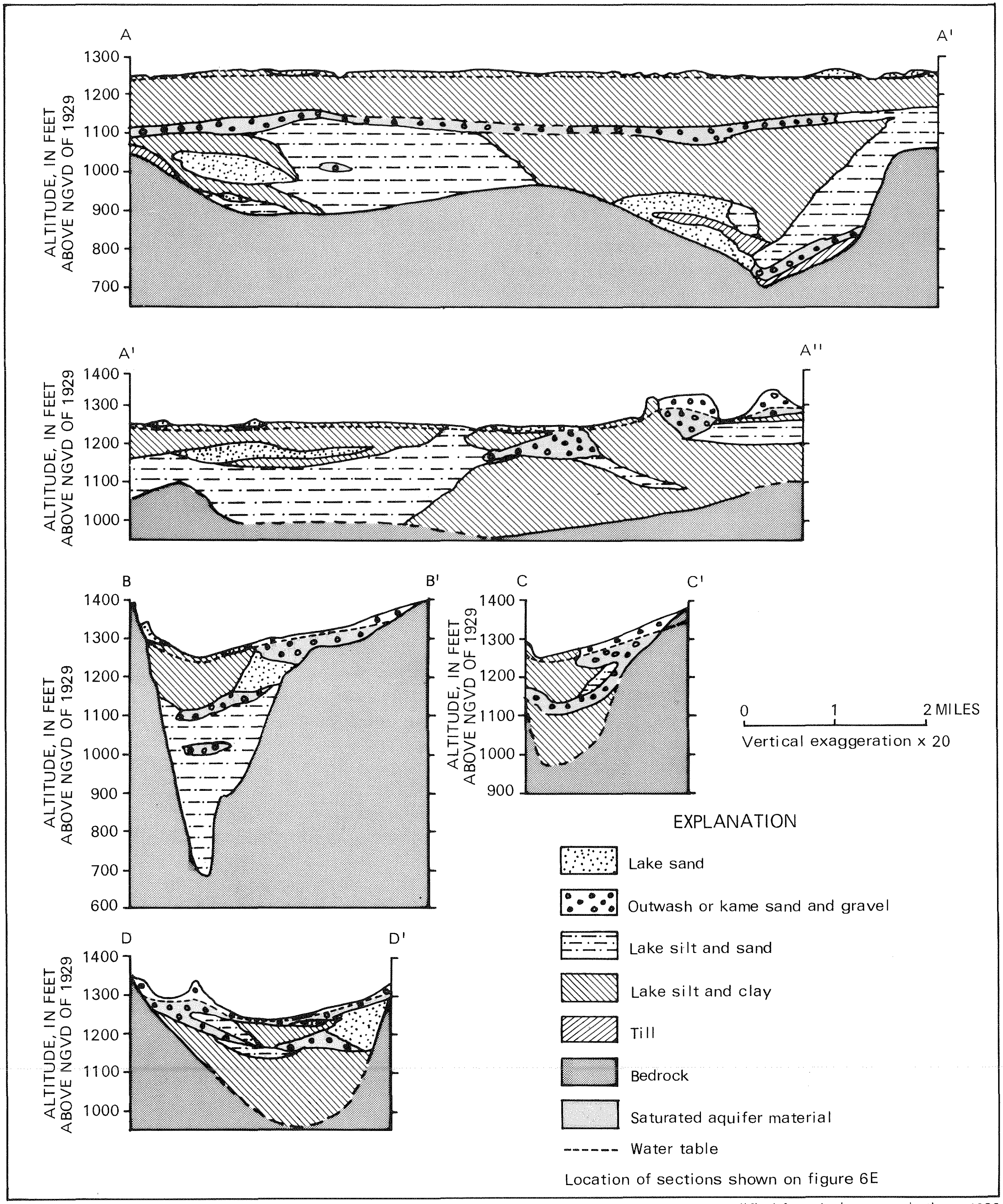
Sand and gravel has been penetrated in wells 300 to 500 feet deep, but the water quality is marginal (185 to 350 mg/L chloride).

The sections at Gerry (B-B′) and Ross Mills (C-C′), transverse to Cassadaga valley, show the probable relation of the thin artesian aquifer under the middle of the valley to the unconfined water-table aquifer on the right flank of the valley. Alluvial-fan (delta) deposits flanking the valley are in contact with the artesian zone.

Between Cassadaga and Conewango valleys is a hydrologic constriction consisting of a high bedrock floor covered with relatively impermeable clayey sediments. Thus, the Jamestown and Poland Center aquifers (A-A′) may be hydrologically separated.

The aquifer near Poland Center (sec. D-D′) is a shallow gravel deposit that crops out and apparently ends just north of the town. The well field there is in hydraulic contact with the Cassadaga River. Section D-D′ indicates continuity between the sand and gravel aquifer and the alluvial-fan deposits.

North of Poland Center, the valley fill is silt and clay, an apparent hydrologic barrier to the terrace gravel deposits at Kennedy.



Modified from Anderson and others, 1982

Several sand and gravel deposits exceed 100 feet in thickness

The aquifer material is thickest (100 feet or more) in low areas of the Cassadaga valley and in the Poland Center area. In these areas, ground water occurs under both unconfined and artesian conditions.

The aquifer-thickness map (fig. 6E) shows the saturated thickness of water-bearing sand and gravel. Most wells penetrate only part of the valley fill (see also fig. 6D), which may be as thick as 600 feet. The thickness contours in most areas represent only the known part of the total section. The aquifer thickness is measured from the water table to clay, till, or bedrock, or the deepest known aquifer.

Near the valley walls, sand and gravel of the alluvial fans crops out at land surface. In the middle of the valley, outwash sand and gravel layers are confined under and interbedded with relatively impermeable lake-clay deposits; these, enclosed by the dashed line on the map, form the large artesian aquifer.

At Gerry, in the north end of Cassadaga valley, total thickness of sand and gravel ranges from 10 to 140 feet within more than 400 feet of valley fill. Toward the south end of the Cassadaga valley, at the Jamestown well field, the artesian aquifer is 20 to 50 feet thick and begins more than 100 feet below land surface. One well encountered an additional 100 feet of sand below the 300-foot depth. Thus, the contour map indicates more than 100 feet of total aquifer thickness in the area. The deep zone is largely unexplored as a source of water supply.

Near Jamestown and Falconer, water-bearing sand and gravel beds thin to less than 25 feet and eventually pinch out, and the valley fill thins to about 200 feet. Between Jamestown and Poland Center, the valley fill is predominantly clay (see sec. A-A′, fig. 6D).

At Poland Center, a gravel aquifer 25 to 40 feet thick lies beneath 40 feet of silt and clay (see fig. 6D) but crops out just north of Poland Center and merges with a thick sand to the east. Silt and clay apparently separate this gravel from the thin, saturated terrace gravels at Kennedy, where the aquifer is less than 25 feet thick in most places and is perched above the river level. Here wells commonly dry up during droughts and summer months, when recharge is at a minimum and pumpage is high.

FIGURE 6E JAMESTOWN AREA
Aquifer thickness

Cones of depression have developed at major pumping centers

This aquifer system is recharged at the valley margins by runoff and by streams crossing tributary stream deltas. Water in both water-table and confined aquifers is being diverted by three major pumping centers. Dewatering is not evident from the 30-year water-level record.

The potentiometric-surface map (fig. 6F) is a composite of both artesian and unconfined water levels. The water-level contours where drawn from measurements of individual wells in different years and seasons; thus, the map indicates average annual altitudes. Ground-water levels vary seasonally, as indicated by the hydrograph below. They are higher in spring, when ground water is recharged, and lower in the fall and winter after the growing season.

Ground-water levels in Cassadaga valley are highest at the north end of the valley, where artesian levels are above land surface. Farther downvalley the potentiometric surface declines toward the cone of depression created by the Jamestown well field. A small cone of depression occurs in the City of Jamestown because of localized industrial pumping.

Ground water in the Conewango valley moves toward the slight cone of depression at the well field near Poland Center, and, in the Hartson Swamp area, ground water flows from the Cassadaga valley toward the 1,240-foot cone of depression. Most ground water from the Conewango valley discharges to land surface in this lowland area.

Recharge occurs mainly from late fall to early spring (see hydrograph). Throughout the growing season, as vegetation depletes soil moisture and pumpage increases, both streamflow and ground-water levels decline.

Before development of the Jamestown well field, ground water discharged upward through silt and clay layers to Cassadaga Creek. With the installation of Jamestown wells, this flow has been captured by pumpage.

The hydrograph gives no indication of dewatering in the last 30 years. However, the potentiometric surface indicates little gradient out of the valley, which suggests that much of the ground water that was formerly discharged is now being pumped.

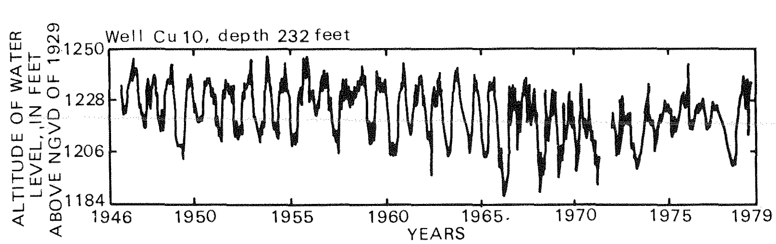
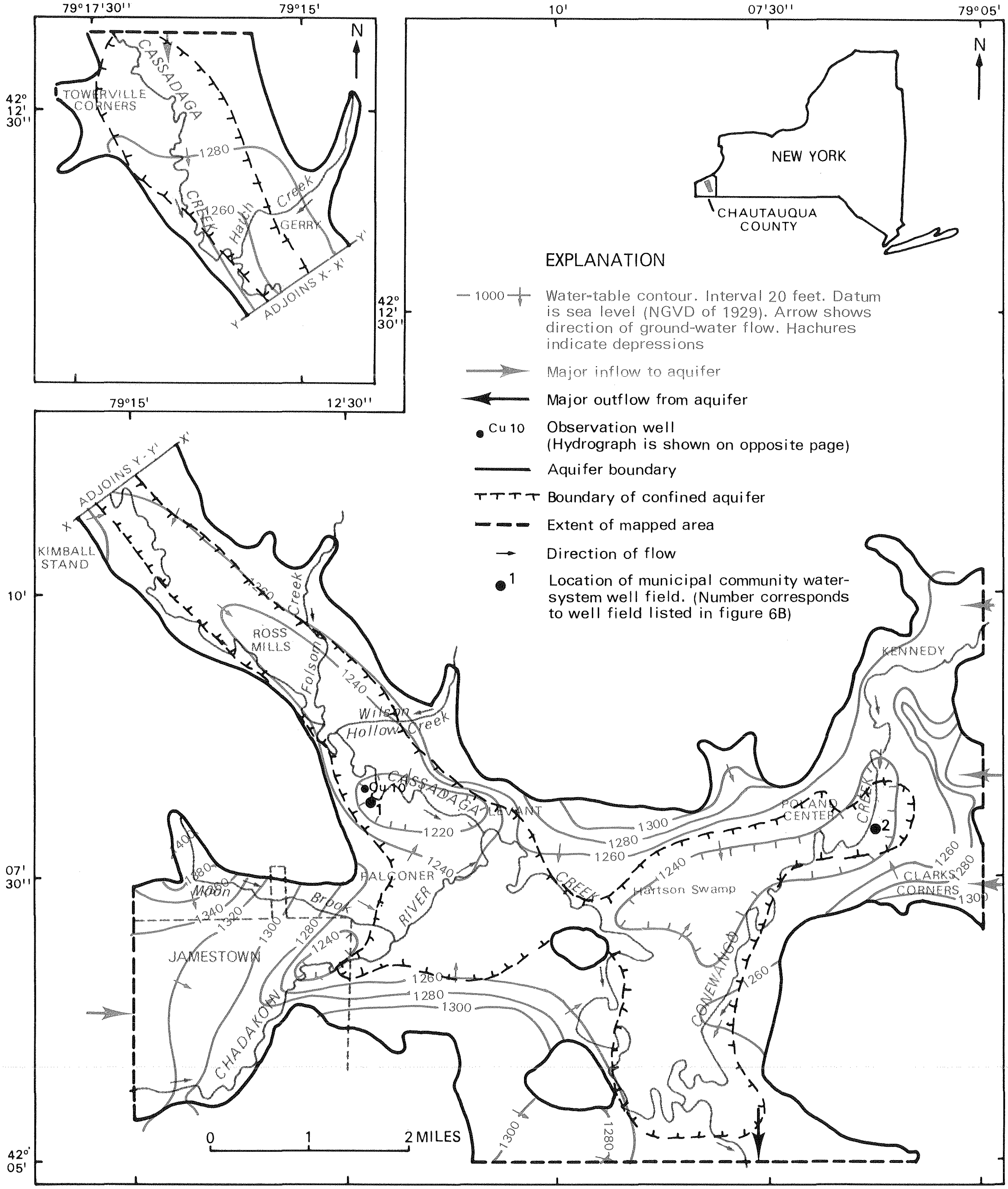


FIGURE 6F JAMESTOWN AREA
Ground-water movement



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

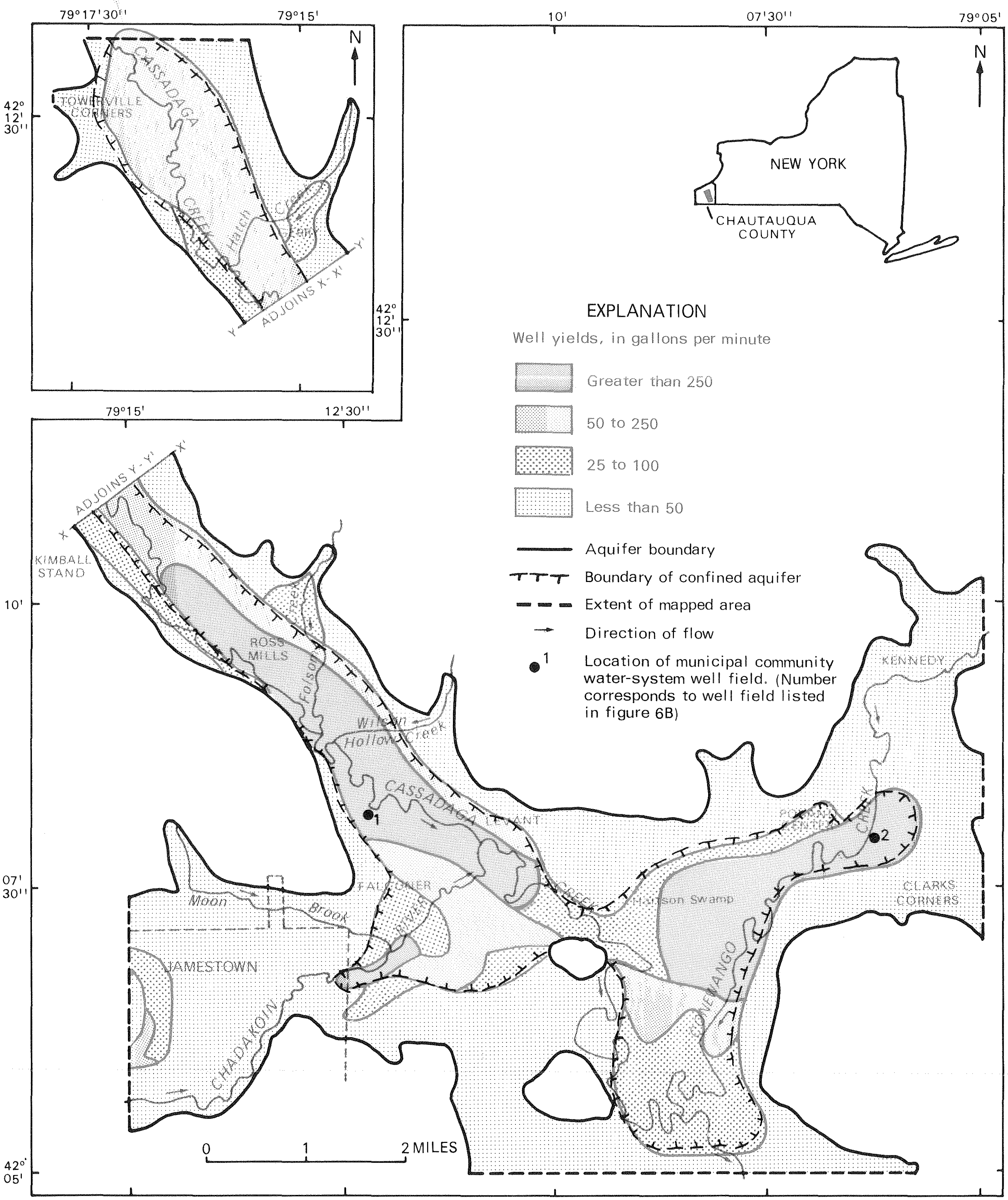
Some wells yield more than 1,000 gallons per minute

Highest yields (250 to 1,000 gallons per minute) are available from confined gravel aquifers near Jamestown and Poland Center. Yields exceeding 50 gallons per minute can be obtained from most areas of Conewango and Cassadaga Creek valleys.

More than half the aquifer area is capable of sustaining high-yield wells (fig. 6G). Highest well yields, ranging from 250 to 1,000 gal/min, have been obtained from the artesian aquifers at Poland Center and the area from Falconer to Ross Mills. Moderate yields ranging from 50 to 250 gal/min are available from sand and gravel confined under silt and clay. Most of these deposits are extensions of the high-yield artesian aquifer that underlies the main axis of the valley. Both artesian and water-table areas may yield from 20 to 100 gal/min. Unconfined deposits less than 25 feet thick along the margin of the valley generally yield less than 50 gal/min.

FIGURE 6G JAMESTOWN AREA

Well yields



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

Soils along the valley flanks are more permeable than along the axis

Deep, well-drained sand and gravel soils along the valley flanks have high permeability. The lake and silt deposits in the center of the valley have very low permeability. Soils of high permeability readily transmit recharge to the water table.

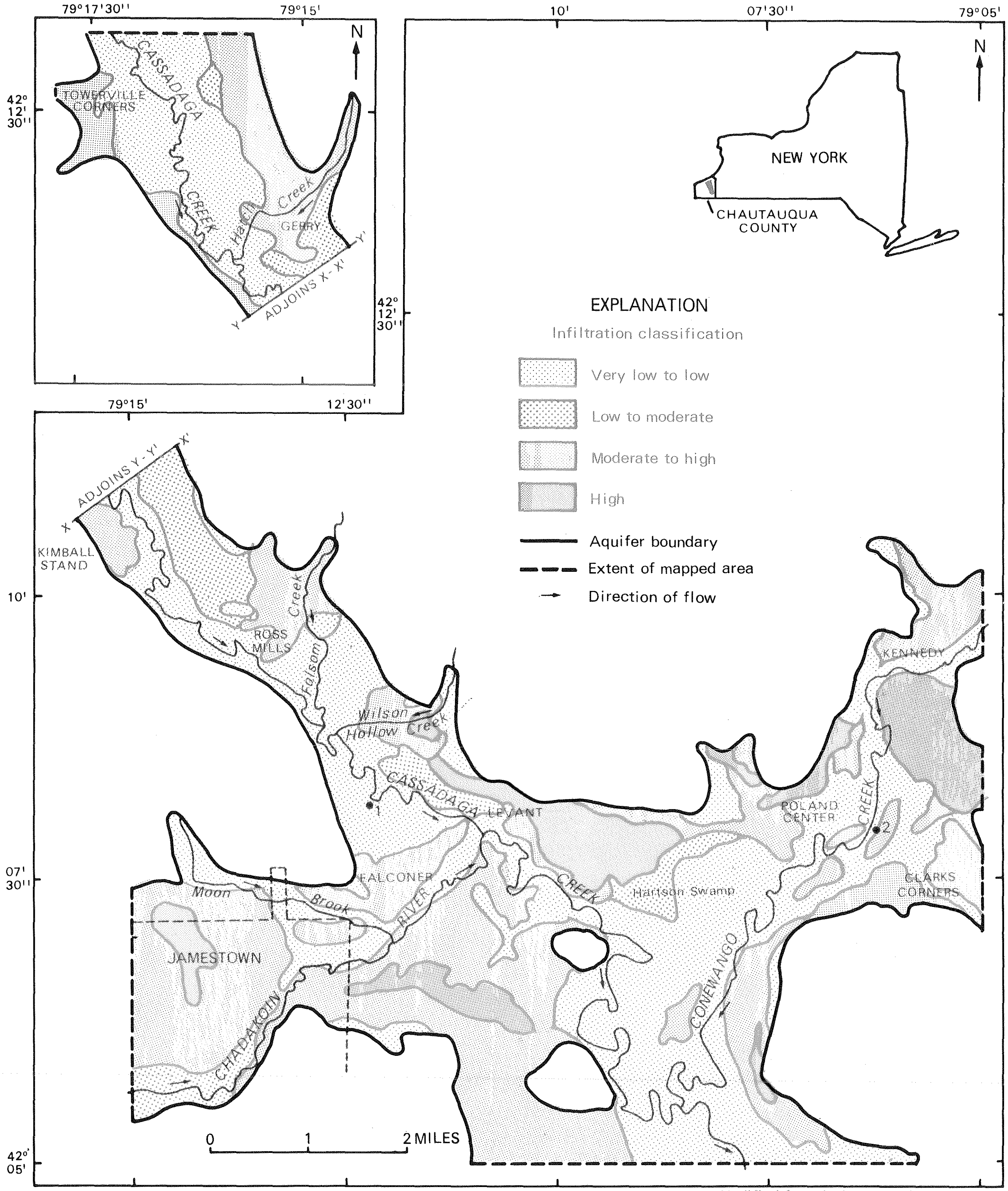
Most of the aquifer area has soil with high permeability and thus high infiltration rates, particularly along the flanks of the valley (fig. 6H). Soils over lake silt and clay in the center of the valley or on till-capped hills have very low infiltration rates. High soil permeability facilitates both recharge and contamination of the aquifer from surface sources.

Soils overlying sand and gravel deposits typically have high permeability; such soils occur also on alluvial-fan deposits where tributary streams enter the valley.

Soils on alluvial deposits of the main streams—Cassadaga and Conewango Creeks and Chadakoin River—have silty and sandy textures and moderate permeability. However, alluvial soils overlying the lake silt and clay deposits in the middle of the valley are richer in clay and therefore of lower permeability.

Soils overlying till-covered bedrock on the valley slopes generally have low permeability. However, a large amount of runoff is funneled from the slopes and hilltops into the valleys and streams, and from there into the alluvial-fan recharge areas.

FIGURE 6H JAMESTOWN AREA
Soil-zone permeability



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

6 JAMESTOWN AREA
I. Land Use

Jamestown is the major urban center; the remaining area is mostly rural

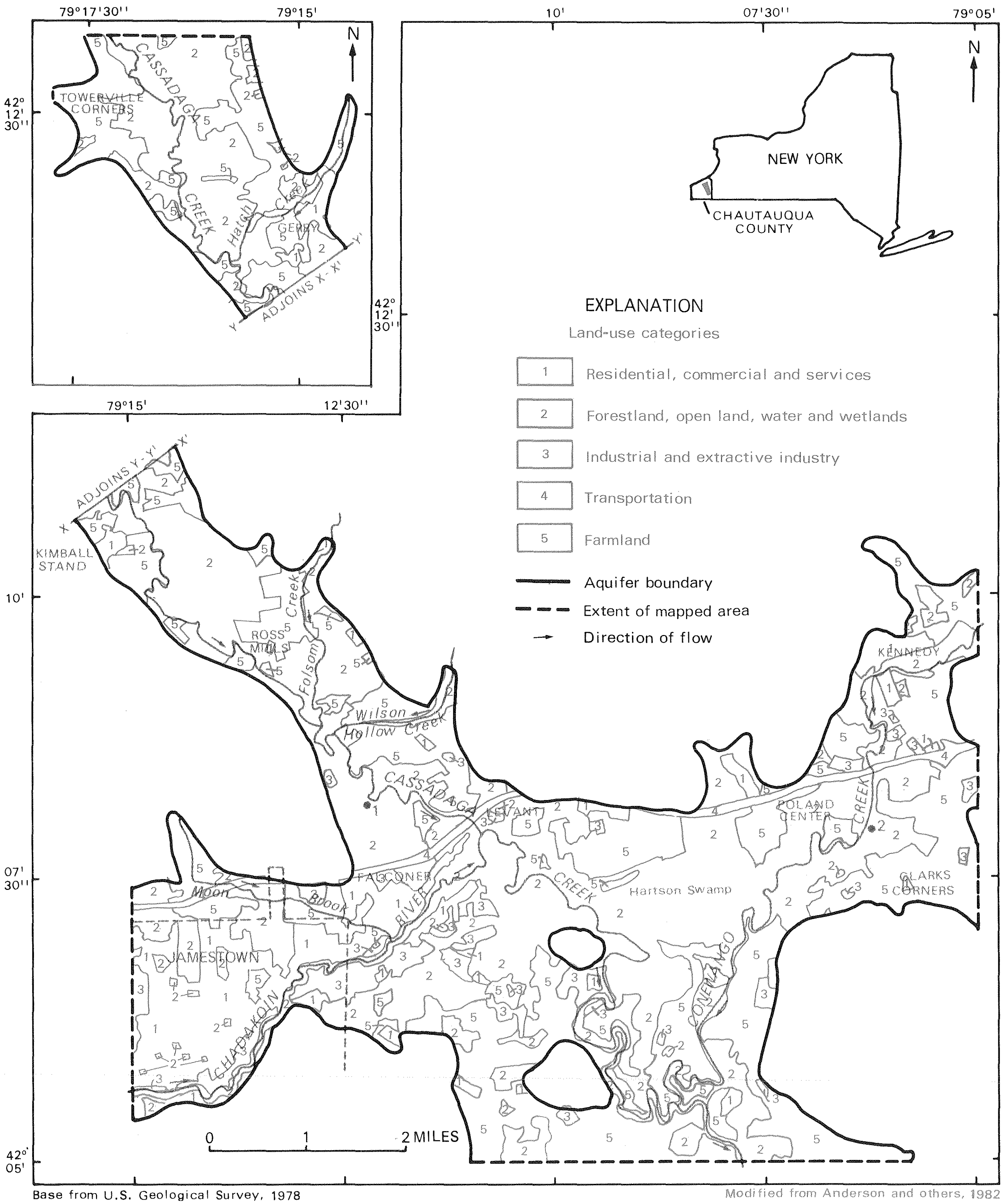
The Jamestown area contains mostly forest, open public land, farms, and wetlands. The principal urban area is Jamestown. A major transportation corridor bisects the area.

Most of the Cassadaga and Conewango valleys are in forest, open public land, farmland, and wetlands (fig. 6I)[1]. Jamestown, the principal residential, commercial, and industrial area, is southwest of the main aquifer area. Smaller communities such as Kennedy, Poland Center, and Gerry are on the alluvial fans, which are recharge areas of the aquifer and susceptible to contamination. The main transportation route is the Southern Tier expressway, which trends east-west and passes near the Poland Center and Jamestown well fields.

Forest and open public lands, along with farmland, cover most of the aquifer area. Wetlands other than Cassadaga and Conewango Creeks include Hartson Swamp and a swampy area at the north end of Cassadaga valley. Hartson Swamp occupies the area just north of the confluence of Cassadaga and Conewango Creeks. Forests, open public land, and wetlands pose the least threat as sources of aquifer contamination. The well fields at Poland Center and Falconer (Jamestown wells) are in rural areas.

[1] Figure 6I was compiled from the 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University in 1968 for the New York State Department of Transportation.

FIGURE 6I JAMESTOWN AREA
Land use



Increasing water consumption has lowered the water table in some areas

Ground-water development since 1935 has caused a water-level decline in this artesian aquifer system. The aquifer may be reaching its perennial yield capacity. A small area of the aquifer east of Jamestown, and another area along the Chadakoin River in the Jamestown-Falconer area, may be chemically polluted.

The City of Jamestown has experienced a steadily rising rate of water consumption since 1935, coupled with a gradual lowering of water levels in the well fields. At present, conditions are stable because pumpage has not increased appreciably in recent years. In the early 1960's, Jamestown pumped about 6 Mgal/d from the well field in the Cassadaga Creek valley northeast of the city (Crain, 1966) and, in 1980, pumped only 6.5 Mgal/d, which included the Poland Center field (see fig. 6B).

The hydraulic head in the aquifer is now below land surface except in the northern reaches of the Cassadaga Creek valley and in certain other areas during spring (see fig. 6G). About 90 percent of the water pumped in the Jamestown well field is derived from the aquifer north of the well field (Crain, 1966). The maximum perennial yield of the Jamestown well field depends on the amount of water stored in the delta deposits to the north (see fig. 6C) during the summer and the gradient available to deliver this water to the well field. From records of pumpage and water levels, the maximum perennial yield of the well field without dewatering the aquifer has been determined to be about 10 Mgal/d (Crain, 1966).

The deltas may be used as sources of recharge (reservoirs) for the aquifer (Crain, 1966). Large-scale withdrawals from the deltas between Wilson Hollow and Hatch Creek (see fig. 6A) could have a detrimental effect on the yield of the Jamestown well field downgradient. It is apparent that the water available to supply the deltas is more than the estimated yield of the Jamestown well field (Crain, 1966). If some of the water that flows during winter and early spring in the streams crossing the deltas could be held until the summer, the yield of the well field could be increased by several million gallons per day (Crain, 1966).

The water quality in the valley-fill aquifer at depths greater than 150 feet below land surface is generally satisfactory for most uses (Crain, 1966). However, the concentration of chloride and dissolved solids generally increases with depth. The sand aquifer below 300 feet under the Jamestown aquifer revealed relatively high chloride concentrations of 184 and 350 mg/L (Crain, 1966).

A survey of the Chadakoin River water by the New York State Department of Health before 1966 reported toxic concentrations of cyanide, lead, zinc, and copper, which probably originated from industries along the river. The concentration of some of these substances, such as cyanide, far exceeded the limit set by the U.S. Public Health Service for human consumption. Therefore, most shallow ground water along the river must be regarded as unsafe or potentially unsafe for domestic use.

The density of dwellings in areas without public water supplies or sanitary sewers, such as around Chautauqua Lake to the west and in the smaller hamlets, poses a threat of ground-water contamination. With the intensive development of suburban areas without sewers, this problem will probably increase and have an important effect on the use of water supplies in many parts of the area.

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7
ELMIRA-HORSEHEADS-BIG FLATS AREA

By Todd S. Miller

7 ELMIRA-HORSEHEADS-BIG FLATS AREA
A. Location and major geographic features

This aquifer underlies the Chemung River valley, a separated valley, and several tributaries

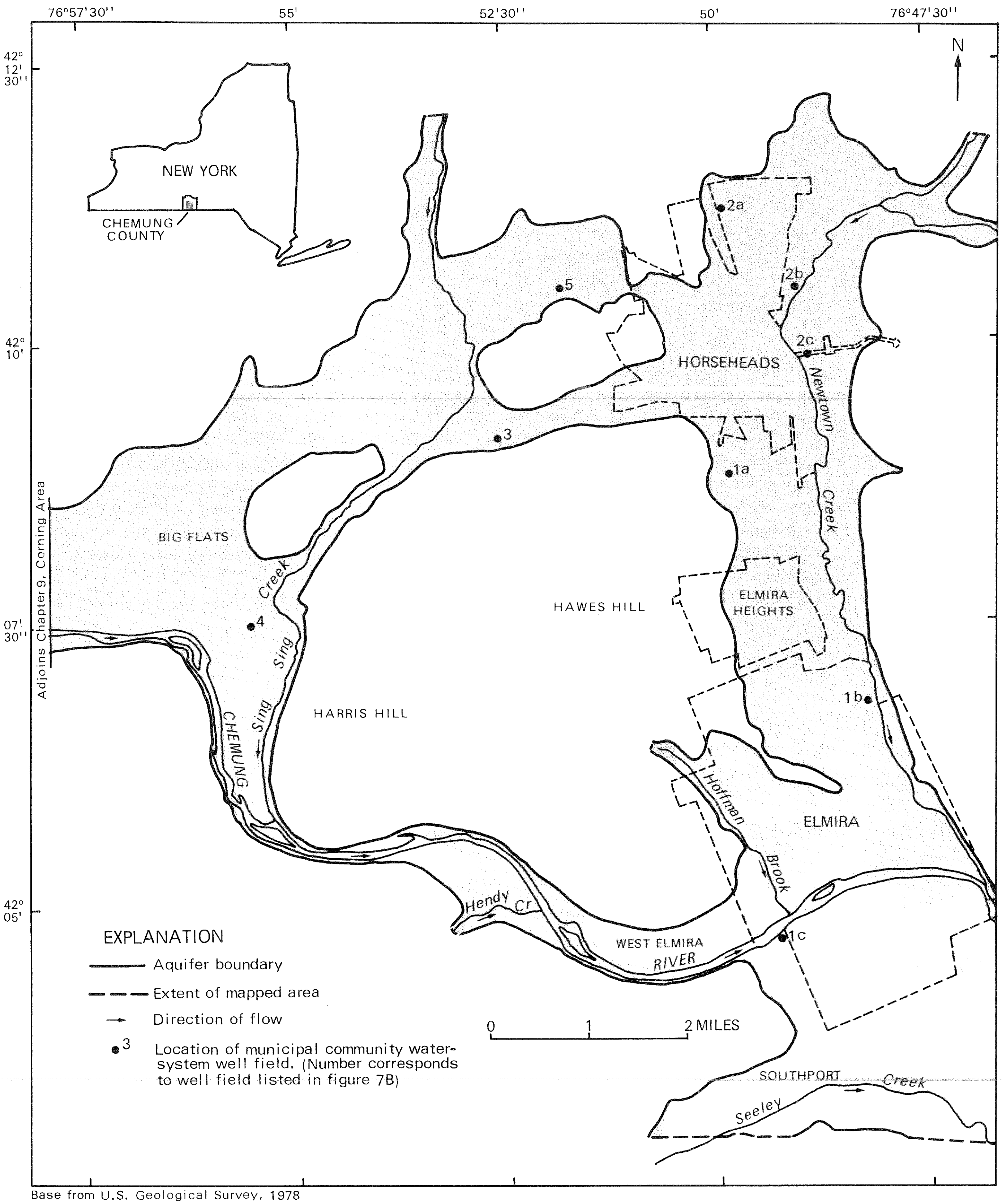
This valley-fill aquifer occupies a broad valley floor bordered by steep bedrock hills in south-central New York. The area is drained by the Chemung River and several tributaries. A large bedrock hill separates much of the aquifer from the river.

The Elmira area, in the Southern Tier region, occupies the western part of Chemung County in the Towns of Elmira, Horseheads, and Big Flats (fig. 7A). The aquifer occupies a valley flat that is bordered by steep bedrock hills that rise a high as 800 feet above the valley floor and range from 1,600 to 1,700 feet in altitude. The triangular valley system is separated by a 9-square-mile bedrock hill, known as Harris Hill, a site of national fame as a sailplane and gliding center.

The northern reach of the aquifer occupies a preglacial valley now filled with sediment. The eastern reach from Elmira to Horseheads, and the northwestern reach from Horseheads to Big Flats, are fairly wide and in most places range from 1.5 to 2.5 miles in width. The reach along the Chemung River between Big Flats and Elmira, however, thins locally to less than 0.25 mile in width where the river passes through a bedrock gorge. The southern part of the aquifer is drained by the Chemung River, which is tributary to the Susquehanna River.

On the west, this aquifer is continuous with the aquifer of the Corning area, discussed in chapter 9.

FIGURE 7A ELMIRA-HORSEHEADS-BIG FLATS AREA
Location and major geographic features



This aquifer provides water to nearly 50,000 people

The area obtains 18.4 million gallons per day from the aquifer. Of the total pumpage, industry uses 53 percent, public supplies use 43 percent, and private wells use 5 percent.

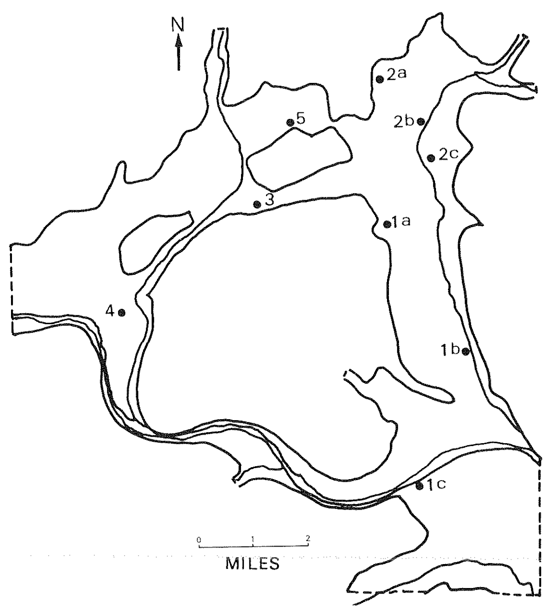
About 80,000 people live in the area underlain by the aquifer. Ground-water supplies serve nearly 50,000 people (fig. 7B); the biggest users are Elmira and Horseheads. About 9,400 of the people obtain water from domestic wells; public surface-water supplies from Chemung River and Hoffman Brook serve another 30,000, so that water use in the area averages 115 gal/d per person (Southern Tier Central Regional Planning and Development Board, 1976a).

Community water systems pump 7.8 Mgal/d (43 percent of the total pumpage), of which industry obtains 3.2 Mgal/d. Private domestic wells withdraw about 1.0 Mgal/d (5 percent of total pumpage), and industry, which consists of 40 private firms, uses an additional 9.6 Mgal/d (53 percent of the total pumpage) and is the largest single ground-water user of the area (Southern Tier Central Regional Planning and Development Board, 1976a).

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 7A.

LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite



POPULATION AND PUMPAGE FROM ELMIRA-HORSEHEADS-BIG FLATS AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. Elmira Water Board (3 well fields)	24,480	3.490
2. Village of Horseheads (3 well fields)	7,348	3.990
Town of Horseheads Water District No. 1	900	—
Town of Horseheads Water District No. 2	210	—
Town of Horseheads Water District No. 3	308	—
3. Big Flats Water District No. 1	4,000	0.065
4. Big Flats Water District No. 2	1,825	0.160
5. Big Flats Water District No. 3	280	0.022
Subtotal	39,351	7.727
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer parks (5)	940	0.048
C. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per day per capita is assumed	* 9,400	* 1.000
D. INDUSTRY (40 systems)	—	[3] 9.6
Total	* 49,691	* 18.375

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
[3] Southern Tier Central Regional Planning and Development Board (1976)
* Estimated

This separated-valley system contains a variety of unconsolidated glacial deposits

Continental glaciation deepened preglacial valleys, steepened valley walls, diverted the preglacial Chemung River southeastward, and partly filled the valleys with drift. Stratified sand and gravel covers most of the valley flats.

The Elmira area lies in a dissected plateau underlain by nearly flat-lying limestone, shale, siltstone, and fine-grained sandstone. Glacial deposits overlie bedrock everywhere (fig. 7C)[1] except on steep hillsides bordering the aquifer, where ice scoured the slopes, creating truncated spurs.

The last glaciation in the Elmira area resulted in the deposition of glacial sediments such as lodgment till, morainal till, stratified drift (outwash, kames), and lake deposits (fig. 7C). In most places in the uplands, 5 to 25 feet of till mantles the bedrock.

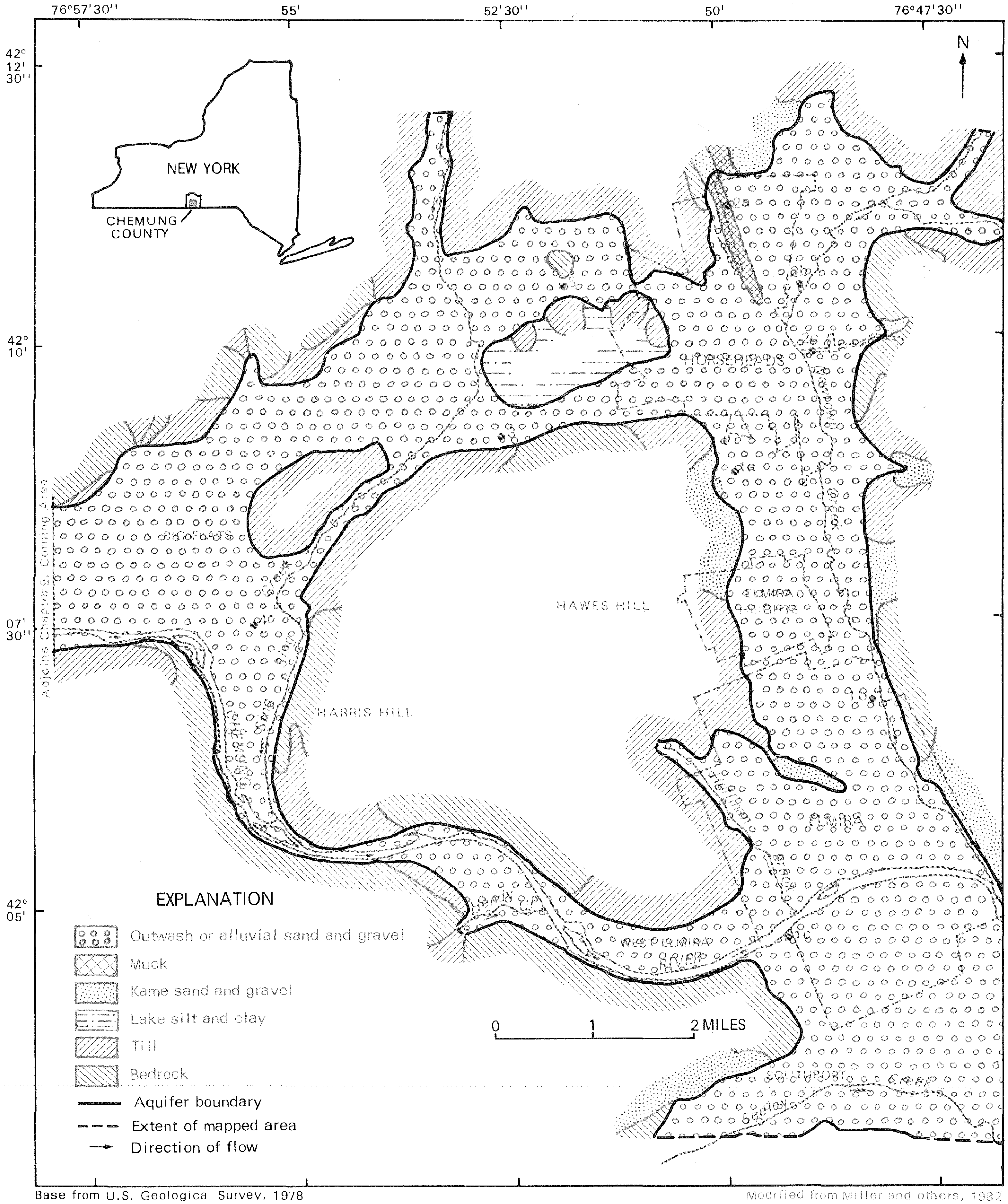
Five types of valley-fill deposits occur in the valley (Randall, 1969): (1) silty lake deposits, overlying morainal till and interspersed with thin sand and gravel layers, that form low, rounded hills within the separated valley between Big Flats and Horseheads; (2) kame terraces and morainal till along the west side of the Elmira-Horseheads valley and also occurring as valley plugs in the Chemung River gorge and in Newtown Creek valley northeast of Horseheads; (3) lateral moraines (morainal till) along the lower flanks of the valley walls in the valley between Big Flats and Horseheads; (4) outwash sand and gravel covering most of the valley flat and, along the flood plains of Newton Creek and Chemung River, commonly covered by 5 to 15 feet of silty sand and alluvium; and (5) alluvial fans consisting of silt, sand, and gravel where upland tributary streams enter the valley. The outwash surface in the Horseheads-Elmira valley slopes southward and in the Big Flats area southwestward.

During deglaciation, the eastward-flowing meltwaters in the valley from Big Flats to Horseheads became blocked by morainal till, lake sediments, and outwash, which diverted flow southeastward and through the present gorge between Big Flats and South Elmira, leaving a separated valley. The source of much of the outwash now present in most of the valley was meltwater streams from the Valley Heads ice readvance north of Horseheads. The outwash also probably contains modern alluvium from Newton and Sing Sing Creeks. In the western part of Big Flats, outwash derived from the Valley Heads ice converged with outwash derived from further west up the Chemung valley.

[1] The geologic map (fig. 7C) was modified from MacNish, Randall, and Ku (1969), Woodward-Clyde-Sherard and Associates (1967), and Denny and Lyford (1963).

FIGURE 7C ELMIRA-HORSEHEADS-BIG FLATS AREA

Geologic setting



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1982

Glacial deposits within this aquifer system locally exceed 500 feet in thickness

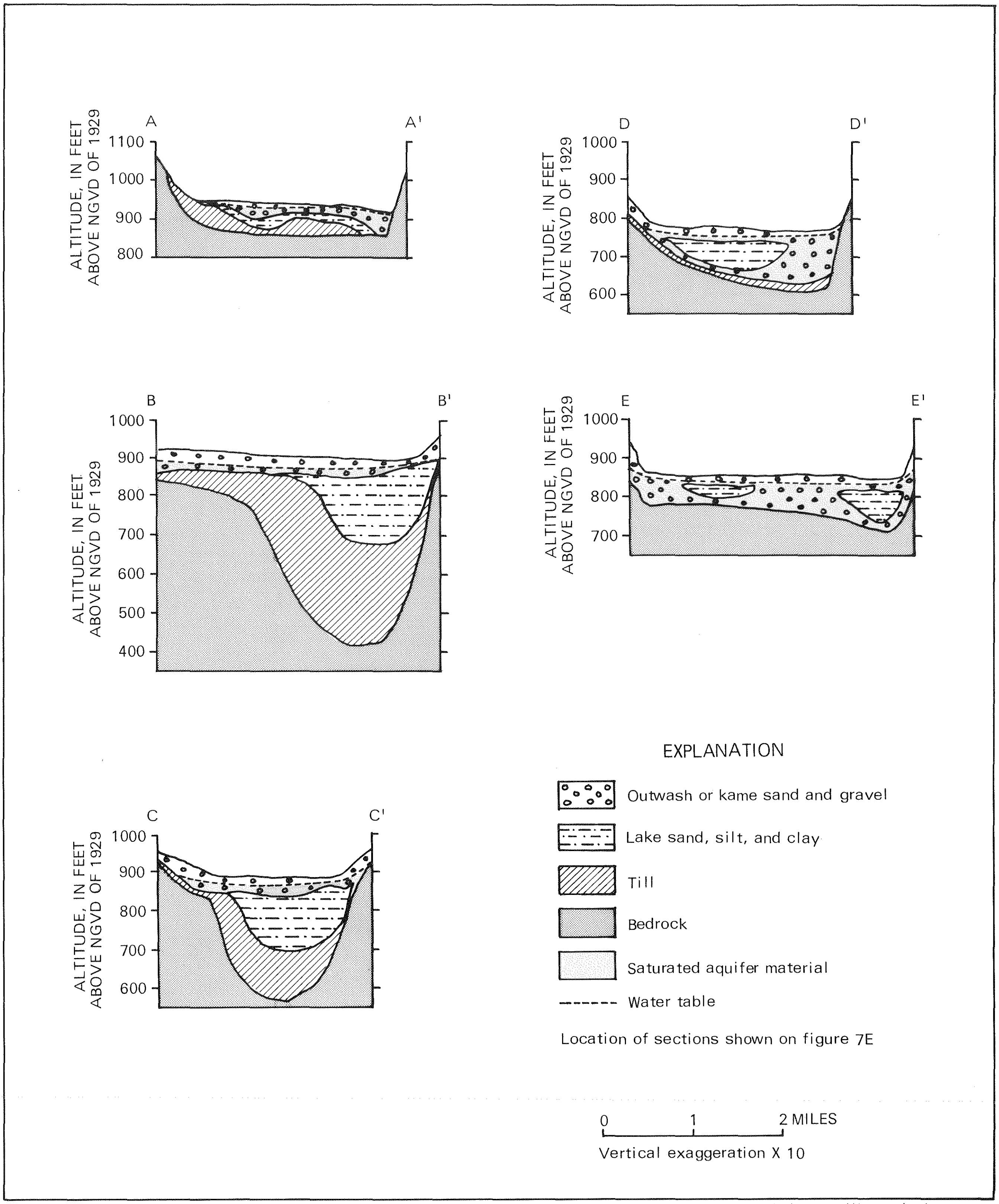
The bedrock valley is partly filled with glacial drift that in places reaches a thickness of 500 feet. The aquifers in the Elmira-Horseheads-Big Flats valley consist of surficial outwash and alluvial sand and gravel deposits 25 to 50 feet thick.

In the Horseheads-Big Flats part of the valley, glacial meltwater and streams deposited sand and gravel in the form of alluvial fans and outwash. Underlying the outwash and alluvium are fine-grained lake deposits overlying morainal till, which is in turn underlain by bedrock (sec. A-A′, fig. 7D). The till deposits have an undulating, irregular surface (sec. A-A′; in two areas within the valley adjacent to section A-A′, they crop out at land surface, forming islandlike mounds. The bedrock surface is fairly shallow, around 65 to 80 feet below land surface (altitude 865-850 feet).

In the deep bedrock valley between Elmira Heights and Horseheads, thick continuous lake deposits underlie outwash (sec. B-B′, C-C′, and D-D′). These deposits consist of fine sand, silt, and clay and are more than 200 feet thick. A sand and gravel unit dips beneath these deposits on the east side (sec. C-C′), but its thickness and continuity are unknown. The western part of the Elmira-Horseheads channel (sec. B-B′) contains a shallow bedrock bench at an altitude of about 840 feet (60 feet below land surface). Above this bench is gravel, separated from the bedrock by a layer of till or dirty gravel.

The bedrock valley from section D-D′ north is much deeper than elsewhere and represents the preglacial northward-draining valley. In Elmira Heights and Horseheads, bedrock dips sharply northward. At Horseheads, bedrock may be as much as 500 feet below land surface (altitude 400 feet). In downtown Elmira and south of Elmira, bedrock is 70 to 100 feet below land surface (altitude 780 feet at west side of valley) and is relatively flat.

In the southernmost part of the valley (sec. E-E′), most wells penetrate sand and gravel; this material could represent outwash and alluvium overlying ice-contact or deltaic outwash deposits.



Modified from Miller and others, 1982

Thickness of sand and gravel deposits ranges from 15 to 40 feet in most places

This aquifer consists of relatively thin outwash and alluvial sand and gravel. Thickness ranges from 10 to 100 feet but is between 15 and 40 feet in most places.

Aquifer material consists of sediments ranging from very fine sand to coarse gravel. The aquifer-thickness map (fig. 7E) represents the saturated thickness from the water table to the top of the first relatively impermeable unit. Because the extent of several buried confining layers (lake deposits) is not well known, thickness values in many areas are only approximate.

In the valley from Big Flats to Horseheads, the outwash is 40 to 50 feet thick in the east and north, but because the water table is relatively deep (20 to 40 feet below land surface), saturated thickness is only 10 to 20 feet. In the western part of the same valley, the outwash varies in thickness where underlain by irregularly shaped lake and morainal till deposits; saturated thickness in this area is estimated to range from 10 to 30 feet.

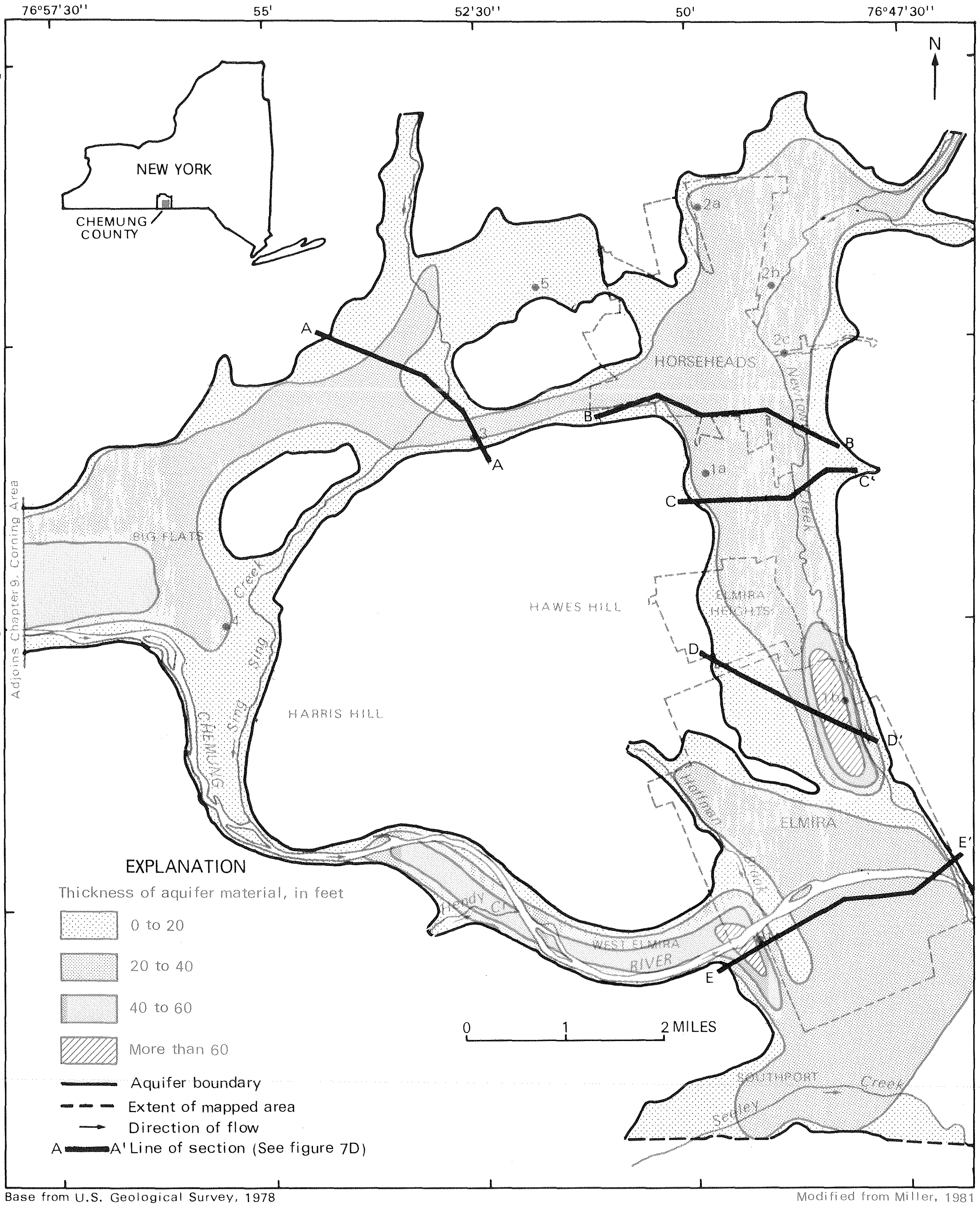
In the eastern part of the valley from Horseheads to Elmira, 10 to 30 feet of saturated thickness of sand and gravel overlie thick lake and till deposits. The western third of the valley contains 30 to 38 feet of saturated sand and gravel.

In downtown Elmira and South Elmira, limited information suggests a thick outwash deposit containing 40 to 50 feet of saturated material. Further south, in the vicinity of the Chemung River, two lenses of lake material interrupt the outwash (see sec. E-E′, fig 7D) and decrease the total aquifer thickness.

Thick deposits of alluvial fan sand and gravel are found in many places along valley sides, but depth to water is generally 20 feet or more. Saturated thickness in these areas ranges from 5 to 35 feet.

MacNish, Randall, and Ku (1969) estimated the volume of ground-water storage in this aquifer to be 33 billion gallons.

FIGURE 7E ELMIRA-HORSEHEADS-BIG FLATS AREA
Aquifer thickness



Ground water moves toward the streams; drawdowns are not significant

Ground water in this aquifer system moves predominantly southward and discharges to the streambeds and as underflow that leaves the area south of Elmira. Recharge is derived from precipitation, from streams, and from bedrock adjacent to and beneath the aquifer. Drawdowns at the largest production wells rarely exceed 10 feet.

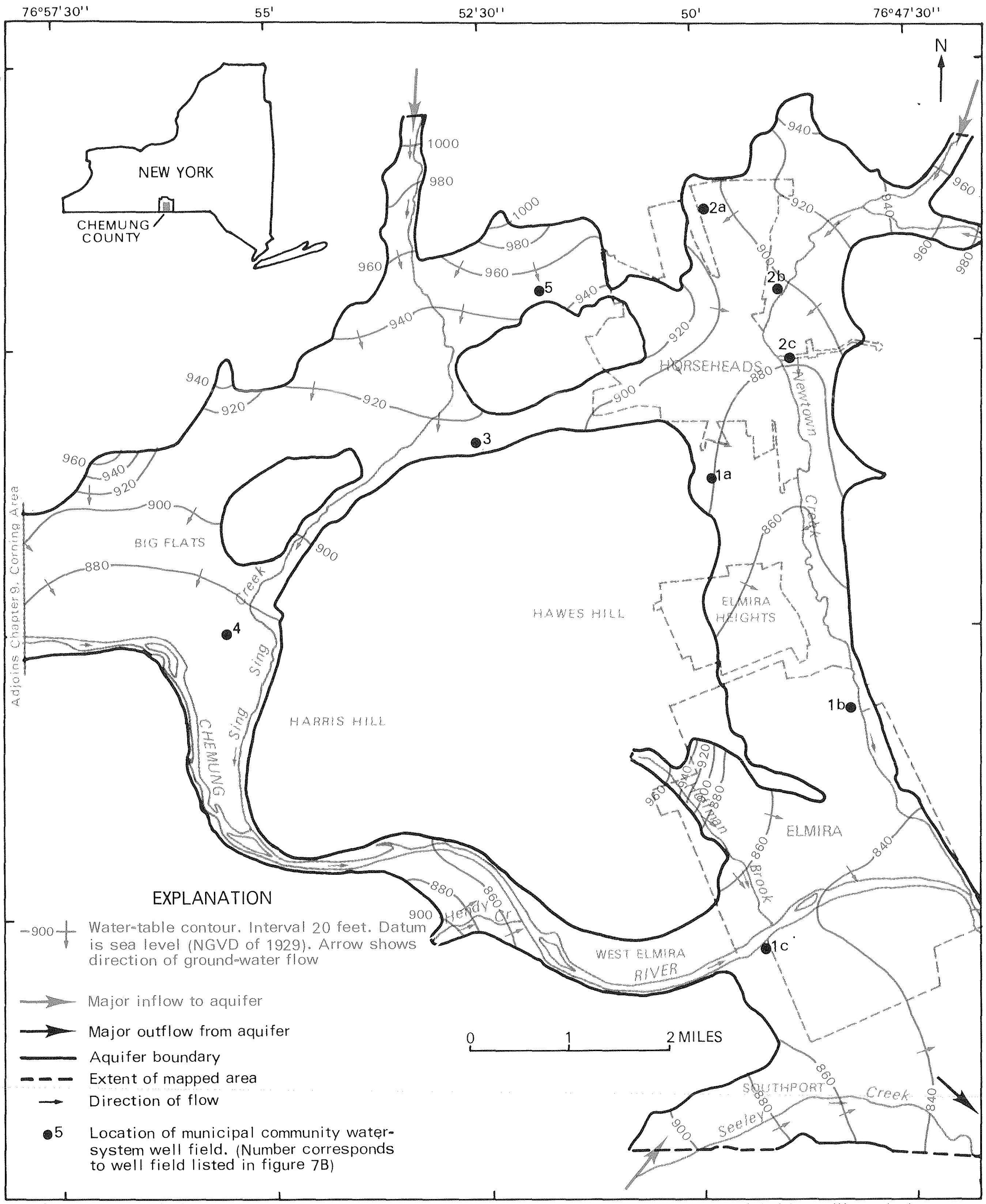
The contours in figure 7F represent the average water-table altitude, in feet above sea level. Most of the aquifer is under water-table conditions, but confined sand and gravel units beneath clay layers have been penetrated by wells in the Newton Creek valley northeast of Horseheads. The water-level map is based on measurements made by U.S. Geological Survey and well drillers from 1932-68; most measurements were made in the late 1950's and early 1960's.

In the Big Flats-Horseheads area, a north-south-trending ground-water divide occurs midway between Sing Sing Creek and Horseheads. West of the divide, ground water moves southwest toward Big Flats; east of the divide, it moves southeast toward Elmira.

Ground water in the Chemung River gorge flows southeast from Big Flats to south of Elmira. Little water-level information about the gorge area is available, however.

Recharge occurs from precipitation directly on the aquifer, from stream infiltration at the aquifer borders, and from the bedrock. From a method described in MacNish, Randall, and Ku (1969), it is estimated that average annual recharge to this aquifer is 18 Mgal/d. Water levels are highest during spring, when recharge from precipitation and snowmelt is significant and water loss from transpiration is low. Water levels decline through summer and fall as the aquifer drains to streams and evapotranspiration diminishes recharge. Ground water continually discharges from the area as streamflow and as underflow in the valley fill south of Elmira.

Water-level records of wells show seasonal fluctuations ranging from 8 to 12 feet. Wells that withdraw large amounts of ground water create cones of depression. However, this aquifer system is relatively permeable, so that only the large production wells such as for public supply and industry cause significant drawdowns. Water-level declines have ranged from 1 to 26 feet, but most are less than 10 feet and hence are not evident on the water-level map. Large producing wells within several hundred feet of a stream may induce water infiltration to the well.



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1982

Well yields of several hundred gallons per minute are available in this area

Most well yields in this area are between 50 and 500 gallons per minute, but yields ranging from 500 to more than 1,000 gallons per minute could be obtained in several areas. Yields are smaller where saturated thickness is thin or the material is of lower permeability.

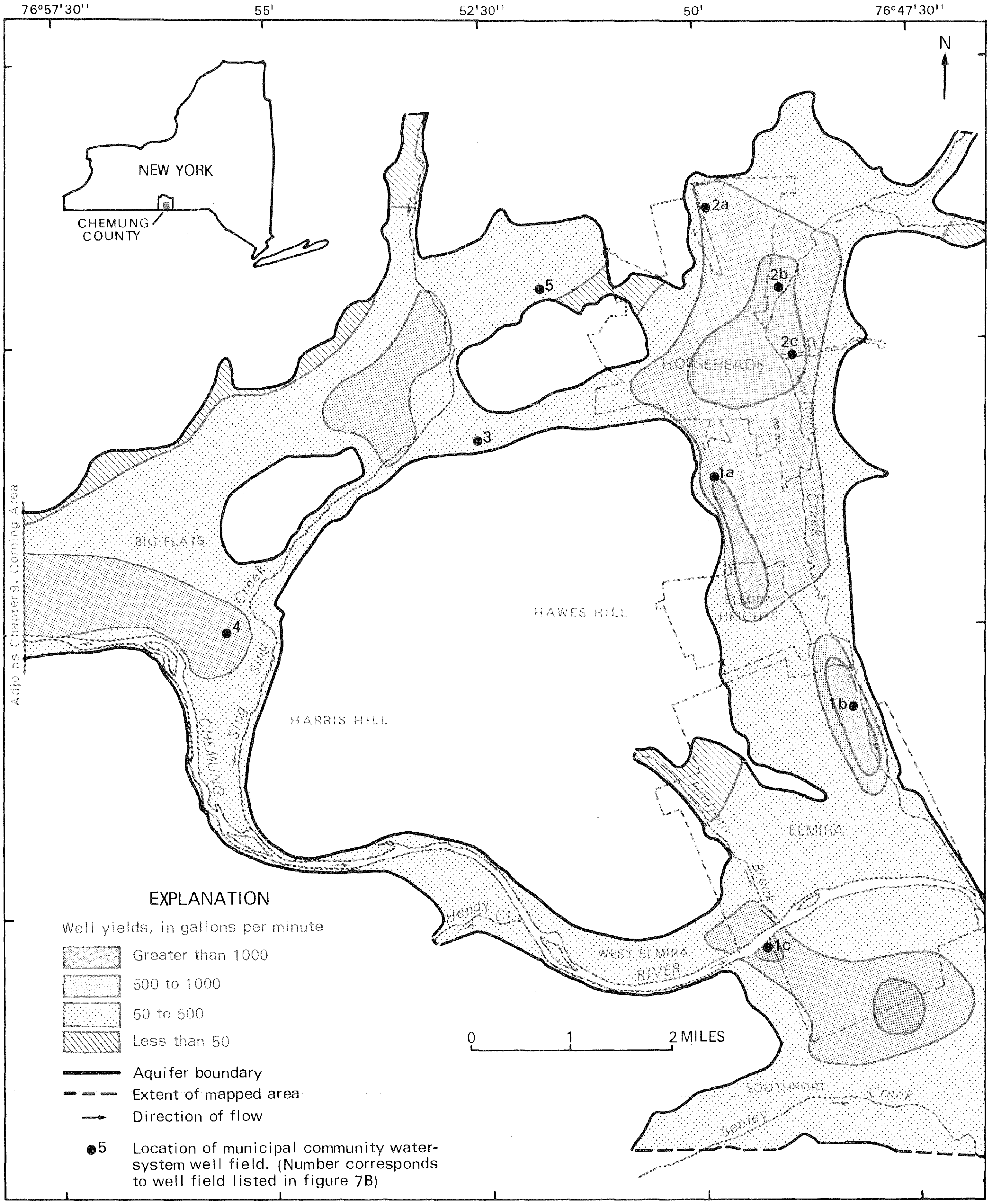
Predicting potential well yield and locating ground-water supplies within narrow limits is difficult in the many areas where the unconsolidated deposits are not homogeneous. Test drilling would be needed to define the extent and hydrologic properties of the various unconsolidated deposits.

The most important factor affecting well yield is the extent and permeability of the surrounding materials through which water must flow to sustain yields. If the permeability of the surrounding material is low, heavy pumping may cause a net loss of storage. Most outwash consists of coarse, well-sorted sand and gravel and is highly permeable, but in some areas outwash may consist of silty sand and gravel, which is less permeable. Wells equipped with screens may obtain large quantities of ground water. Moderate to large yields (500 to more than 1,000 gal/min) may generally be obtained where saturated thickness exceeds 40 feet (see fig. 7G), where streams recharge the aquifer (along Newton Creek in northern Horseheads), and in the area south of Elmira, where exceptionally permeable gravel occurs. (See fig. 7D).

Moderate well yields (500 to 1,000 gal/min) may generally be obtained where saturated thickness is between 20 and 40 feet (see fig. 7E). Low to moderate yields (50 to 500 gal/min) are the most common in this area and generally occur where saturated thickness is less than 20 feet or the aquifer has low permeability. Yields less than 50 gal/min are obtained where the saturated thickness is less than 5 feet, where the sand and gravel pinches out against the valley walls, or where the aquifer material contains a large percentage of till or lake deposits.

FIGURE 7G ELMIRA-HORSEHEADS-BIG FLATS AREA

Well yields



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1982

Soils overlying this aquifer have moderate to high permeability

This aquifer is overlain with soils of moderate to high permeability that readily transmit water to the water table. Soils on adjacent hillsides are less permeable and allow large amounts of runoff to flow onto the valley floor, where infiltration and recharge occur.

The Elmira-Horseheads-Big Flats area is relatively urbanized so that the underlying aquifer is subject to contamination from surface sources. Estimates of soil-zone permeability can guide planners in (1) determining the suitability of specific sites for industrial, commercial, residential, or recreational purposes, and (2) making preliminary estimates as to the rate at which dissolved or suspended pollutants could seep into the underlying ground-water system. The distribution of soil permeability is shown in figure 7H. This classification refers to the B horizon, which is mostly between 10 and 40 inches below land surface.

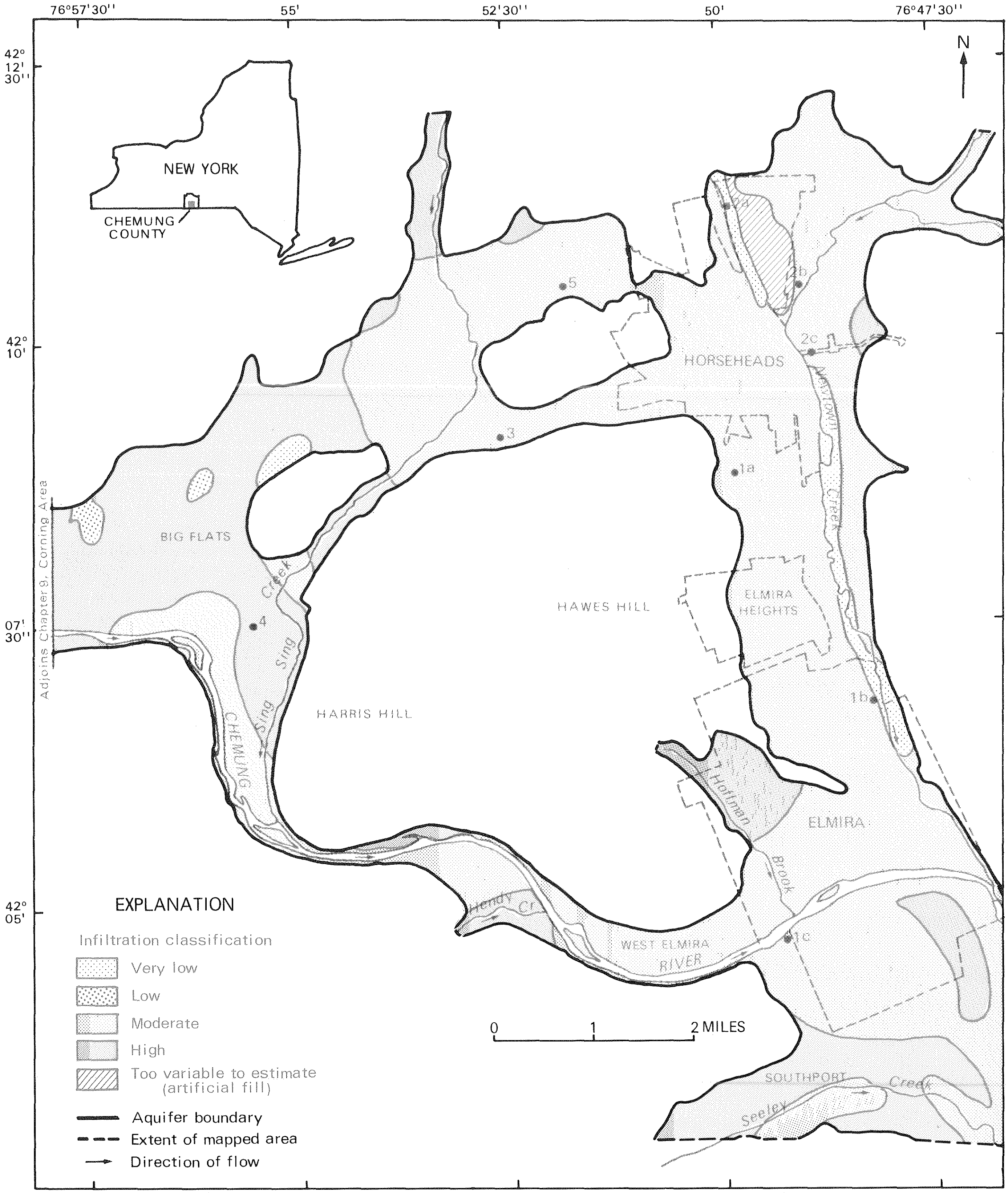
Soils developed in the permeable stratified sand and gravel deposits have moderate to high permeability so that rainfall infiltrates readily. Runoff from these soils would occur only during an extremely intense rain or during winter, when the frozen ground inhibits infiltration.

Near the streams, alluvial flood-plain deposits consisting of sand, silt, and clay overlie the outwash. Where this material contains mostly fine sand, the permeability is high, but where it is predominantly silt with very fine sand, permeability is moderate.

Hillsides adjacent to the aquifer typically have soils of low permeability that are derived from till. On oversteepened hillsides, where bedrock is at or near land surface (mostly 20 to 40 inches below land surface), precipitation is unable to infiltrate in significant amounts and therefore flows overland toward the valley. Thin soils derived from bedrock or till overlying weathered bedrock consist predominantly of coarse, broken rock fragments and silt and therefore have moderate permeability, so that surface runoff is lessened.

FIGURE 7H ELMIRA-HORSEHEADS-BIG FLATS AREA

Soil-zone permeability



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1982

7 ELMIRA-HORSEHEADS-BIG FLATS AREA
I. Land use

Much of the area is urban-suburban, but large open areas remain

Residential and commercial areas occupy more than half the valley flat. Urbanization and industry are most extensive in the Horseheads-Elmira reach.

This aquifer area contains a variety of land uses (fig. 7I)[1]. The major cities are Elmira, Horseheads, and Elmira Heights, and all contain relatively large areas of open public land. The Big Flats area contains equal proportions of farmland, commercial and residential land, forest, wetlands, and open public land.

Residential areas, commerce, and industry have expanded while agriculture has declined. Farmland occupies one-third of the Big Flats area, but virtually none remains in the Horseheads-Elmira area.

Residential and commercial areas occupy more than half the total valley floor (fig. 7I); industrial and extractive land use constitutes approximately 6 percent of the area. Gravel is mined in the northeast part of Horseheads. Industry in this area is extensive, but most of the centers are in Horseheads and the City of Elmira. The major industries include food processing, glass production, metal fabrication, and manufacture of electrical equipment. From 1954-67, the number of manufacturing firms increased by 11 percent (Southern Tier Central Regional Planning and Development Board, 1977).

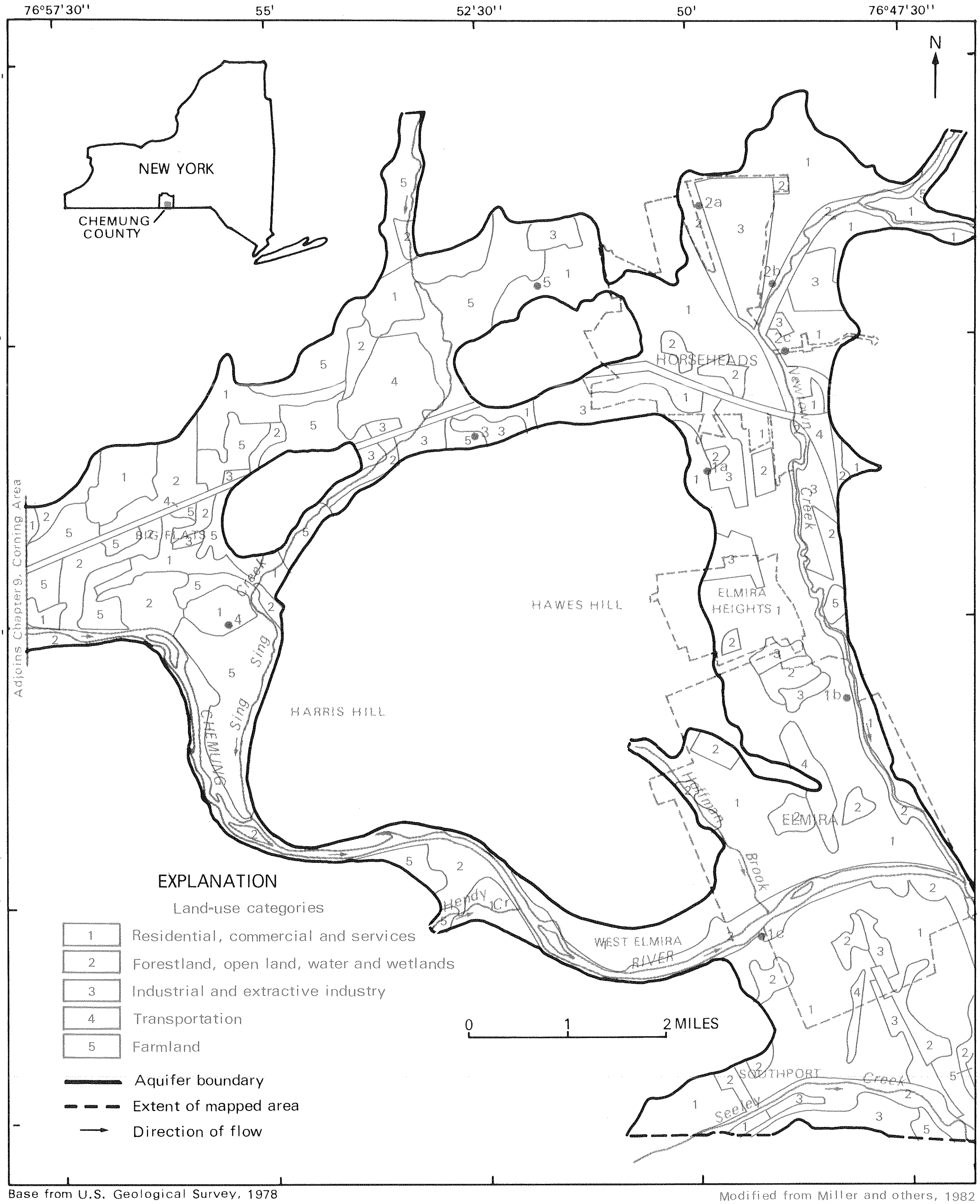
Major transportation facilities, including two railroads, an interstate highway, and an airport, have helped the Elmira area develop into a significant urban area.

Significant tracts of forest and open public land remain only in the Big Flats area and in a few spots near Elmira.

[1] Land use was compiled from maps done under the 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University, for the New York State Department of Transportation and from updates of these maps by the Southern Tier Central Regional Planning and Development Board in 1976.

FIGURE 7I ELMIRA-HORSEHEADS-BIG FLATS AREA

Land use



Elevated concentrations of nitrate and toxic wastes have been reported

Ground-water contamination has been reported in some localities. Long-term well yields are of concern.

The Elmira-Horseheads-Big Flats area lacks a comprehensive regional documentation of ground-water quality. Only community water-supply systems and several industries have analyzed ground-water samples periodically. These analyses have indicated contamination at several wells.

Starting in the early 1970's, nitrate concentrations in ground water in the Big Flats area have been around 10 Mg/L, especially during spring recharge and periods of excessive rainfall. These elevated concentrations have been attributed primarily to fertilization practices in the agricultural areas (Southern Tier Central Regional Planning and Development Board, 1976a). More recently the U.S. Environmental Protection Agency has identified Elmira as an area having toxic wastes in its ground water (Newsweek, 1981).

Long-term well yields are of concern because present pumpage (18.4 Mgal/d) is approximately equal to estimated annual recharge (18 Mgal/d).

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8
CORTLAND-HOMER-PREBLE AREA

By Todd S. Miller

8 CORTLAND-HOMER-PREBLE AREA

A. Location and major geographic features

This aquifer system underlies five converging valleys

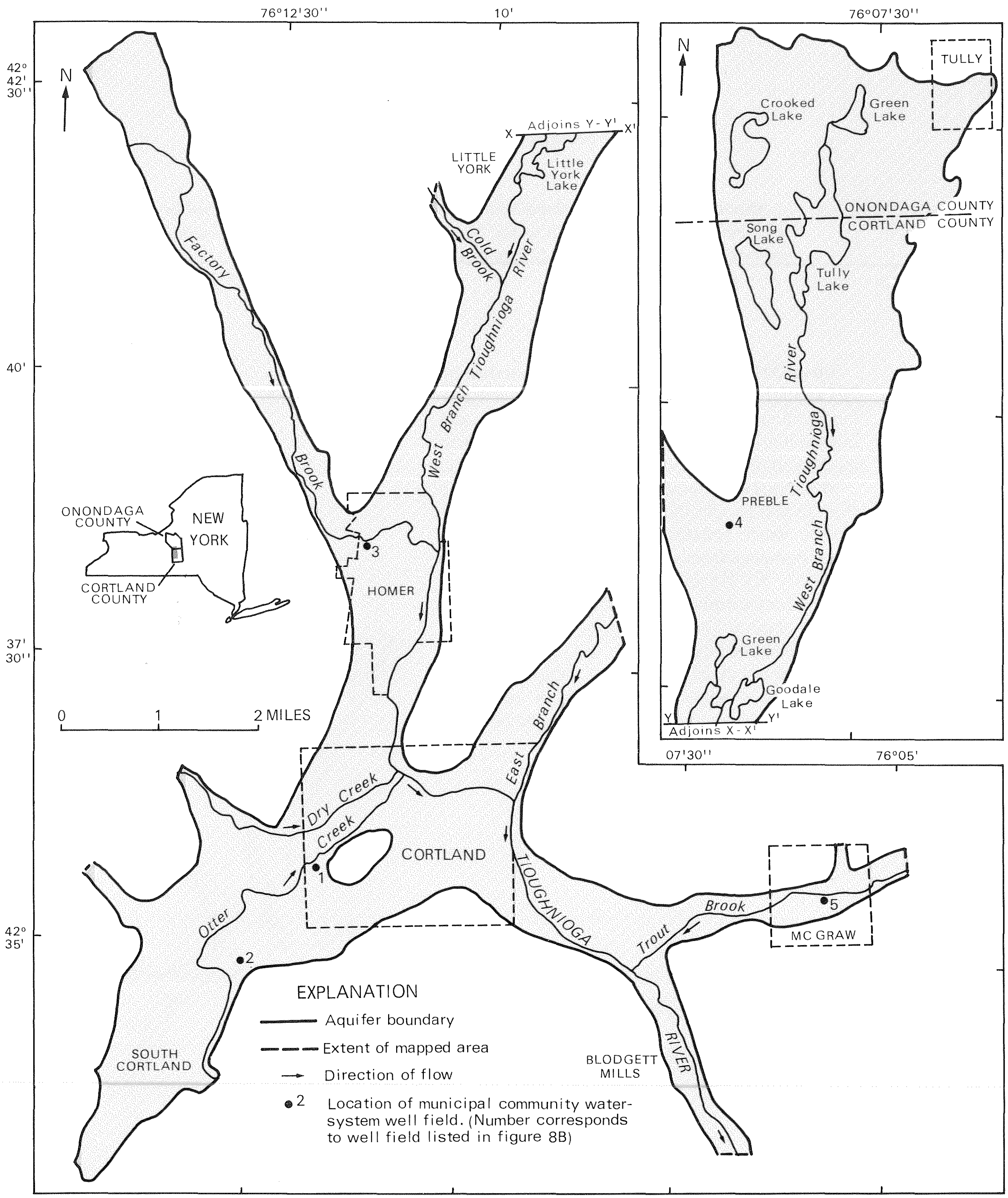
This aquifer occupies five relatively narrow valleys that converge at Cortland. The aquifer is bordered by bedrock hills. The valleys are tributary to the West Branch and Main Branch Tioughnioga River.

The Cortland-Homer-Preble area lies mostly within Cortland County but extends north into Onondaga County (fig. 8A). The aquifer occupies five valleys that meet in the vicinity of the City of Cortland. The valley floors are relatively flat and are surrounded by hills that rise nearly 700 feet above the valley floors. Glacial moraines form the drainage divides of most of the valley heads.

The main valley is the Homer-Preble valley. It is widest (2.3 miles) at its northern extension and narrows southward to a width of less than 1 mile south of Homer. The Homer-Preble valley is drained by West Branch Tioughnioga River, to which Cold Brook and Factory Brook are significant tributaries (fig. 8A). The northern part from Little York to Tully contains several lakes, which are used for recreation and are undergoing increasing housing development.

The South Cortland-Cortland area is drained by Otter Creek and Dry Creek, which flow northeastward into the West Branch Tioughnioga River. The McGraw area is drained by Trout Brook, which flows west into the main branch Tioughnioga River, which in turn flows southeastward out of the mapped area as part of the Susquehanna River system.

FIGURE 8A CORTLAND-HOMER-PREBLE AREA
Location and major geographic features



Base from U.S. Geological Survey, 1978

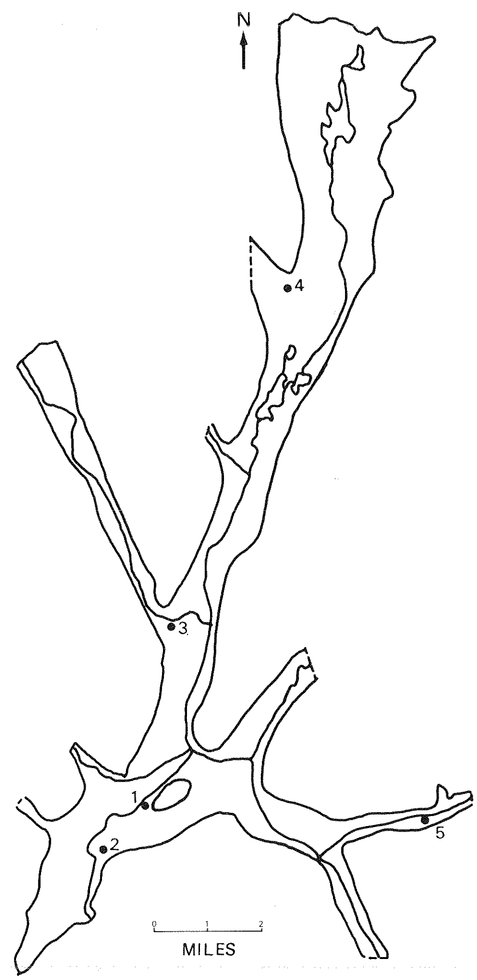
This aquifer provides water to about 39,000 people

About 85 percent of Cortland county's population lives within the aquifer area and depends on ground water. Pumpage in 1980 averaged 6.5 million gallons per day. The City of Cortland is the principal user.

About 39,000 people live in the area underlain by this aquifer, and about half live in the City of Cortland. About 85 percent of the Cortland County population lives in the Cortland area, and nearly all depend on ground water for their water supply.

Municipal community water systems serve more than 28,000 people (fig. 8B), and five other community water systems serve an additional 600. Total pumpage from these systems is estimated to be nearly 5.5 Mgal/d; pumpage from individual systems for the remaining 10,000 people is 1 Mgal/d. Hence, about 6.5 Mgal/d of ground water is withdrawn from the aquifer.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 8A.



LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite

POPULATION AND PUMPAGE FROM CORTLAND-HOMER-PREBLE AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. City of Cortland	20,094	4.073
Cortlandville Water District No. 2	100	—
2. Cortlandville Water District Nos. 1, 3	2,700	0.411
Cortlandville Water District No. 5	100	—
3. Village of Homer (Newton Water Works)	4,242	0.885
4. Preble Water Association	50	0.006
5. Village of McGraw	1,200	0.112
Subtotal	28,486	5.487
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer parks (5)	* 600	0.062
C. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per day per capita is assumed	* 10,000	* 1.0
Total	* 39,086	* 6.549

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
* Estimated

The valleys contain a variety of glacial deposits

Continental glaciers deepened the bedrock valleys and left a mantle of till over most of the upland. Coarse sand and gravel deposited by glacial meltwater blankets the valley floors.

The Cortland-Homer-Preble area lies within the Allegheny Plateaus Province. Bedrock consists of nearly flat-lying shale, siltstone, and fine-grained sandstone. Most summits and valleys of the area were formed before the last glaciation. Glaciation modified the topography by deepening and widening the valleys into the characteristic U-shape and depositing thick layers of drift in the valleys and a veneer of till on the hilltops. Glacial deposits, as shown in figure 8C, overlie bedrock nearly everywhere except on oversteepened hillsides, along some stream channels, and in man-made excavations.

The last glacial readvance had ice fronts that terminated in all major tributary valleys. During glacial recession, a thick terminal moraine was deposited within the valleys and today forms the surface-water drainage divide between the Susquehanna and the St. Lawrence River basins. This moraine (called Valley Heads) is composed of poorly sorted boulders, gravel, sand, and silt. The most prominent moraine deposits shown are the kame and ice-disintegration material west of Tully, northwest of Preble, the head of Factory Brook valley, and southwest of South Cortland.

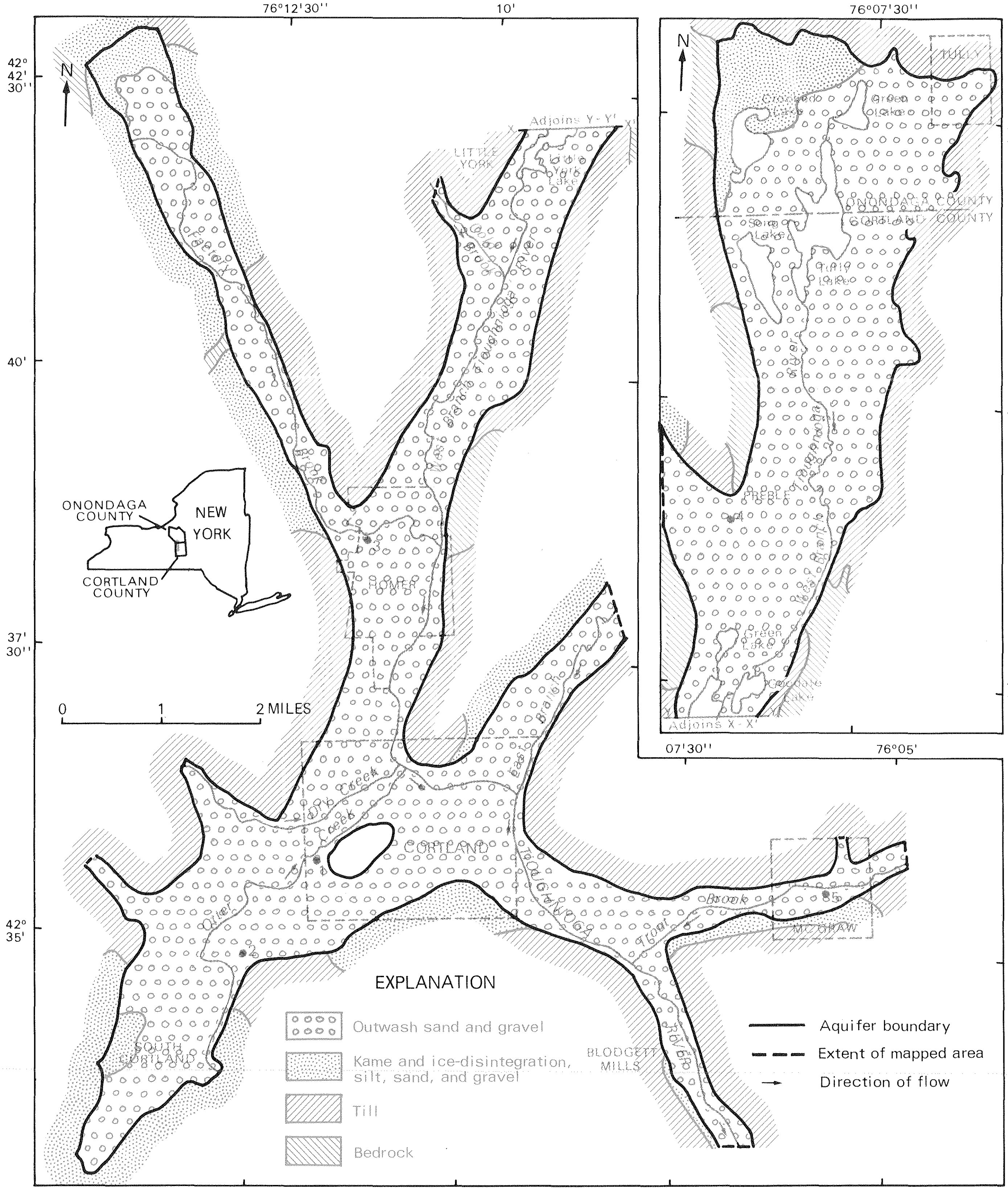
During this period a proglacial lake formed in the deep, U-shaped Homer-Preble valley and in the Tioughnioga valley southeast of Cortland. Within this lake, thick layers of fine sand, silt, and clay accumulated.

Meltwater from the ice fronts flowed down the valleys, depositing coarse outwash. The outwash eventually covered the valley floors and formed a flat, slightly sloping surface that dipped away from the moraines and now coalesces at Cortland around the bedrock knob.

Outwash is thickest and coarsest close to the moraines. As the glaciers stagnated, the ice-borne sediments accumulated, forming kames and ice-disintegration deposits near the moraines (fig. 8C). As the ice front receded north of the Valley Heads Moraine, meltwater drained elsewhere, allowing the valley system south of the moraine to develop a new drainage system. Postglacial streams have reworked the outwash, principally by lateral meandering.

FIGURE 8C CORTLAND-HOMER-PREBLE AREA

Geologic setting



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1981

This aquifer system consists of thick kame and outwash deposits

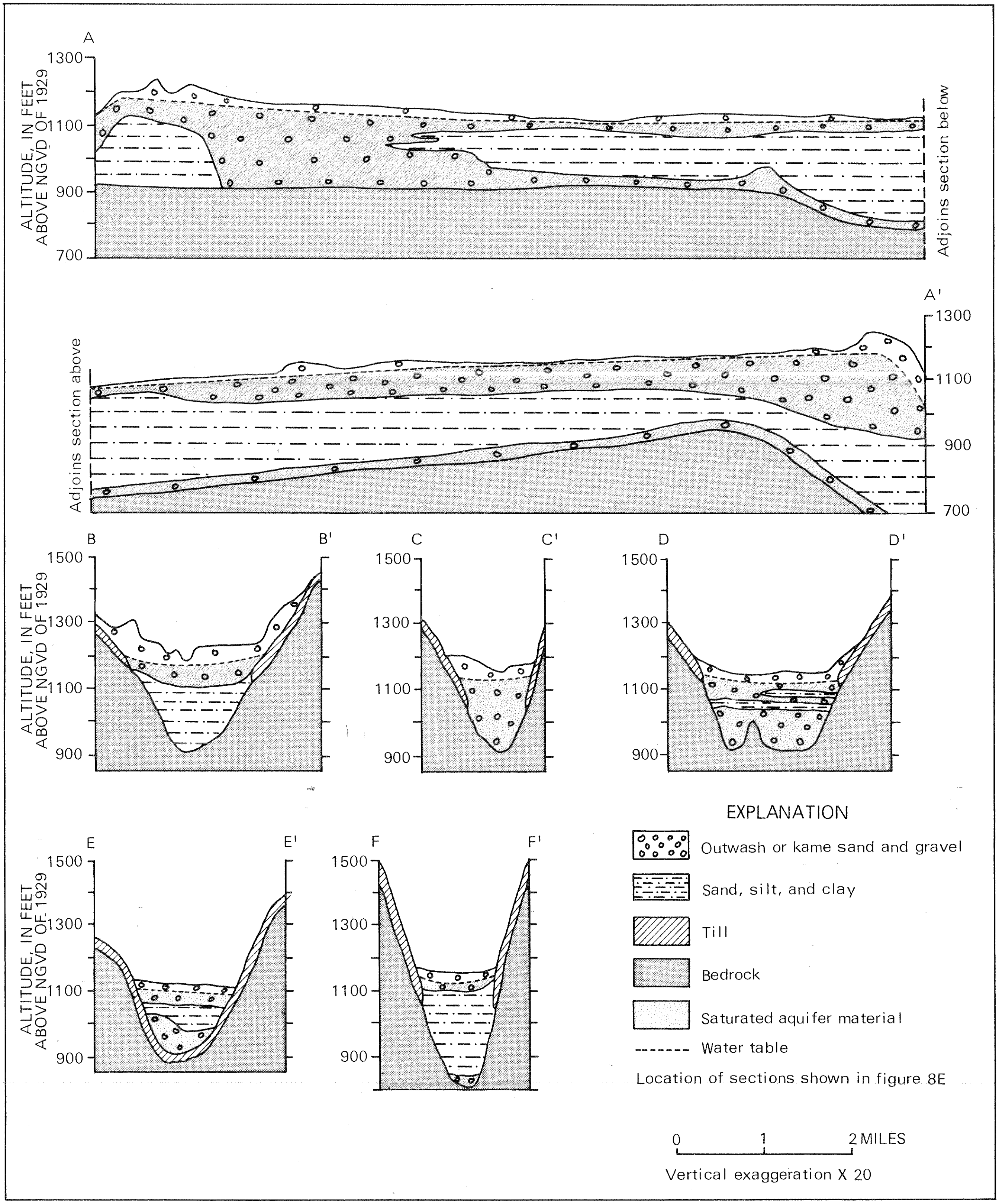
The glacially deepened bedrock valleys contain as much as 500 feet of glaciolacustrine deposits. Permeable sand and gravel in surface outwash and deeper layers forms the aquifers.

The major valleys are partly filled with glacial sediments. These deposits are thickest (about 500 feet) at the head of the Homer-Preble valley in the vicinity of the crest of the Valley Heads Moraine (sec. A-A′, fig. 8D), west of Tully. From here the bedrock floor rises sharply southward to the vicinity of Tully Lake (Durham, 1958), where it slopes gently downward for about 5 miles beneath unconsolidated deposits that reach a thickness of 335 feet. About a mile north of Homer, the bedrock floor again rises sharply, probably where resistant limestone forms a buried escarpment. From Homer southwestward, the bedrock surface remains relatively level. It is overlain by drift that ranges from 200 to 260 feet thick in the vicinity of Homer and Cortland and increases in thickness southward toward the moraine at South Cortland, where it ranges from 267 to 300 feet thick.

In the Homer-Preble valley, the surface outwash consists of coarse sand and gravel and forms the major aquifer. A thin basal sand layer of unknown aquifer potential lies between the lacustrine deposits and bedrock.

Southwest of the City of Cortland (sec. C-C′ and D-D′), the major aquifer consists of kame and ice-disintegration sand and gravel with silty clay and till lenses. This material crops out near the drainage divide.

At Cortland, a lacustrine silt-clay layer that thickens from west to east divides the aquifer into an upper and a lower unit (sec. E-E′). Little information is available on the lower unit, however.


A
A'
B
B'
C
C'
D
D'
E
E'
F
F'
ALTITUDE, IN FEET ABOVE NGVD OF 1929
1300
1100
900
700
1500
Adjoins section below
Adjoins section above
EXPLANATION
Outwash or kame sand and gravel
Sand, silt, and clay
Till
Bedrock
Saturated aquifer material
Water table
Location of sections shown in figure 8E
0
1
2 MILES
Vertical exaggeration X 20

The coarsest, thickest deposits are southwest of Cortland

This aquifer consists of thick sand and gravel extending through several valleys. Saturated thickness ranges from less than 20 feet to more than 200 feet. Coarsest material is in the headwaters areas.

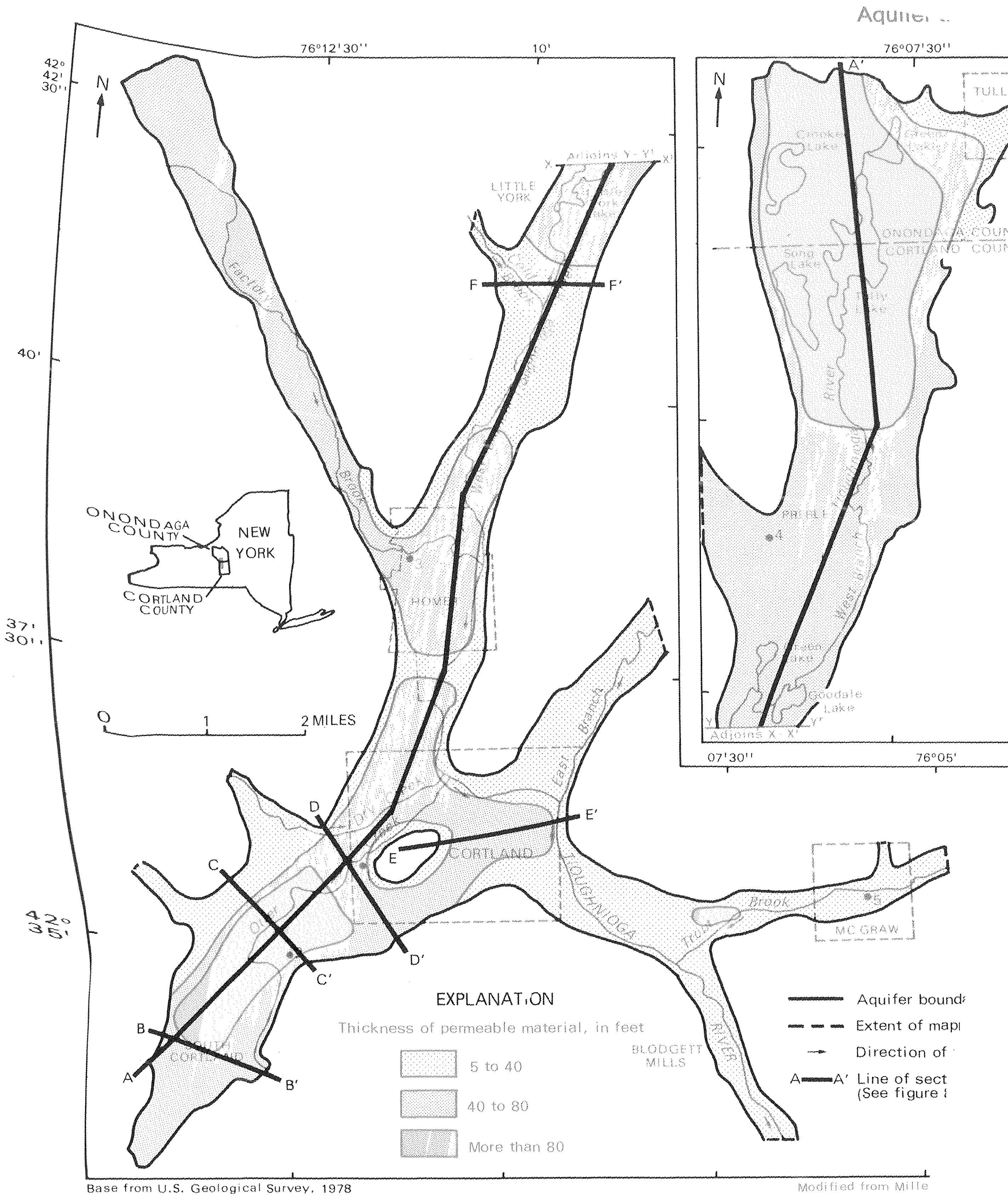
This aquifer is continuous throughout the valleys within the mapped area. Saturated thickness of permeable sediments is indicated in figure 8E. The values represent the thickness from the water table to the top of the first continuous relatively impermeable unit. The saturated material extends nearly to land surface in most of the area, except in the southwest, where the water table is a few tens of feet below land surface.

In the Homer-Preble valley, the aquifer is mostly coarse gravel and sand; it is thickest (60 to 80 feet) in the northern part and thins downvalley to less than 40 feet. At Homer, where an outwash fan from Factory Brook enters the main channel, aquifer thickness increases to more than 40 feet. South of Homer, aquifer thickness decreases.

In the central and eastern Cortland area, the clay layer (surface altitude about 1,005 feet) separates the sand and gravel aquifer into an upper unit 30 to 60 feet thick and a lower unit that may exceed 100 feet in thickness. In the area southwest of Cortland the aquifer contains more than 200 feet of sand and gravel with silt-clay and till lenses.

In the valleys at McGraw, Blodgett Mills, and Factory Brook, where little hydrologic information is available, the aquifer may be from 20 to 40 feet thick

FIGURE 8E CORTLAND-...



Ground water moves toward streams, roughly parallel to land surface

Ground-water flow closely follows the topography of the valley floor. The aquifer is recharged by precipitation, seepage from tributary streams entering the main valleys, and from bedrock. Discharge is to the streams, underflow out of the valley to the southeast, and to wells.

Ground water moves from areas of recharge to the West Branch Tioughnioga and the Tioughnioga Rivers (fig. 8F). Ground-water movement conforms regionally to the land surface. The map in figure 8F is based on water-level measurements made during the last decade by the U.S. Geological Survey (Buller, 1978 and Buller and others, 1978), by drillers, and by the Cortland County Environmental Health Department.

Recharge occurs from precipitation on the valley floor, from streams near the valley walls as they emerge from the hills, and from bedrock. Principal discharge occurs as ground-water seepage to the streams, and some also leaves the valley as underflow at Blodgett Mills. Recharge also occurs from upgradient parts of the aquifers beyond the mapped area (fig. 8F). Recharge from precipitation is greatest in winter; a significant amount is lost by evaporation and transpiration in summer.

Wells that withdraw large amounts of ground water create cones of depression and cause radial flow of ground water to the well. However, most of this aquifer system is highly permeable, so that only large-yield wells such as public-supply and industrial wells produce a significant drawdown. Most cones of depression in this area are less than 10 feet and are therefore not reflected in the water-table contours.

Seasonal fluctuation of the water table is usually less than 15 feet and, at most wells, less than 10 feet. The hydrograph shows both seasonal fluctuations and the long-term trend in water-table altitude at the Cortland well field, the area of greatest pumpage. The greater summer declines in recent years are probably due to drier summers and increased pumpage.

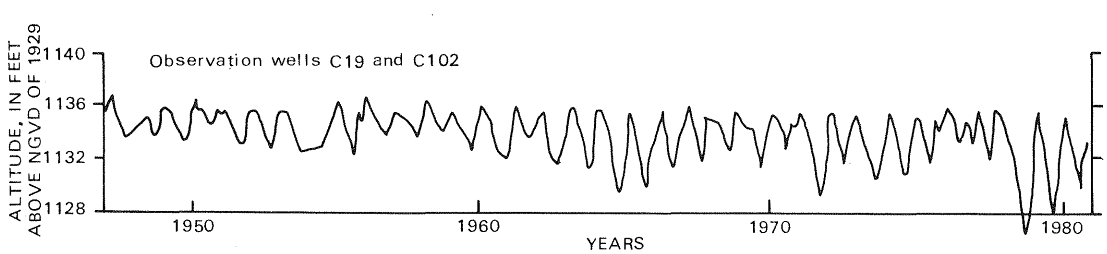
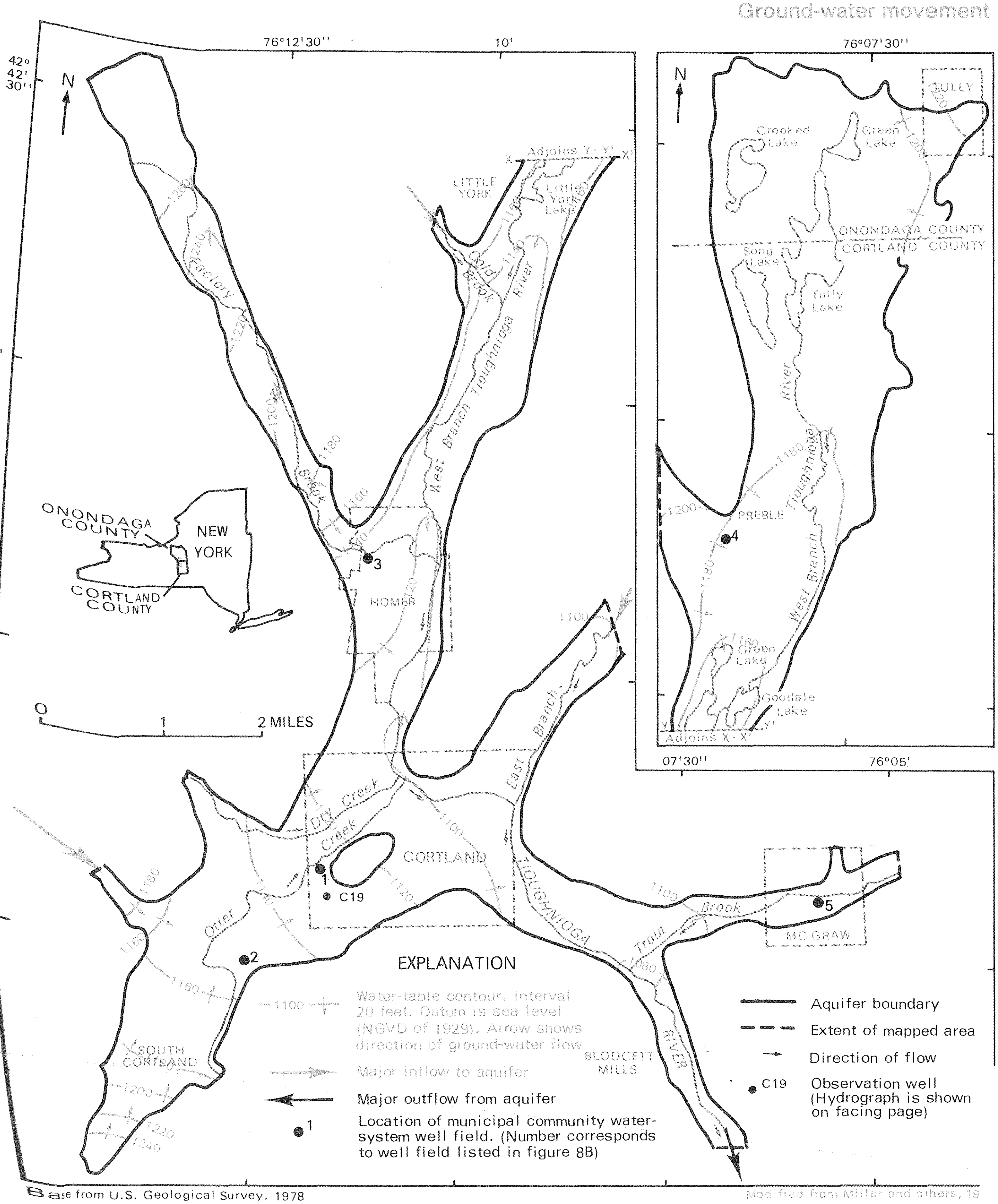


FIGURE 8F CORTLAND-HOMER-PREBLE AREA
Ground-water movement



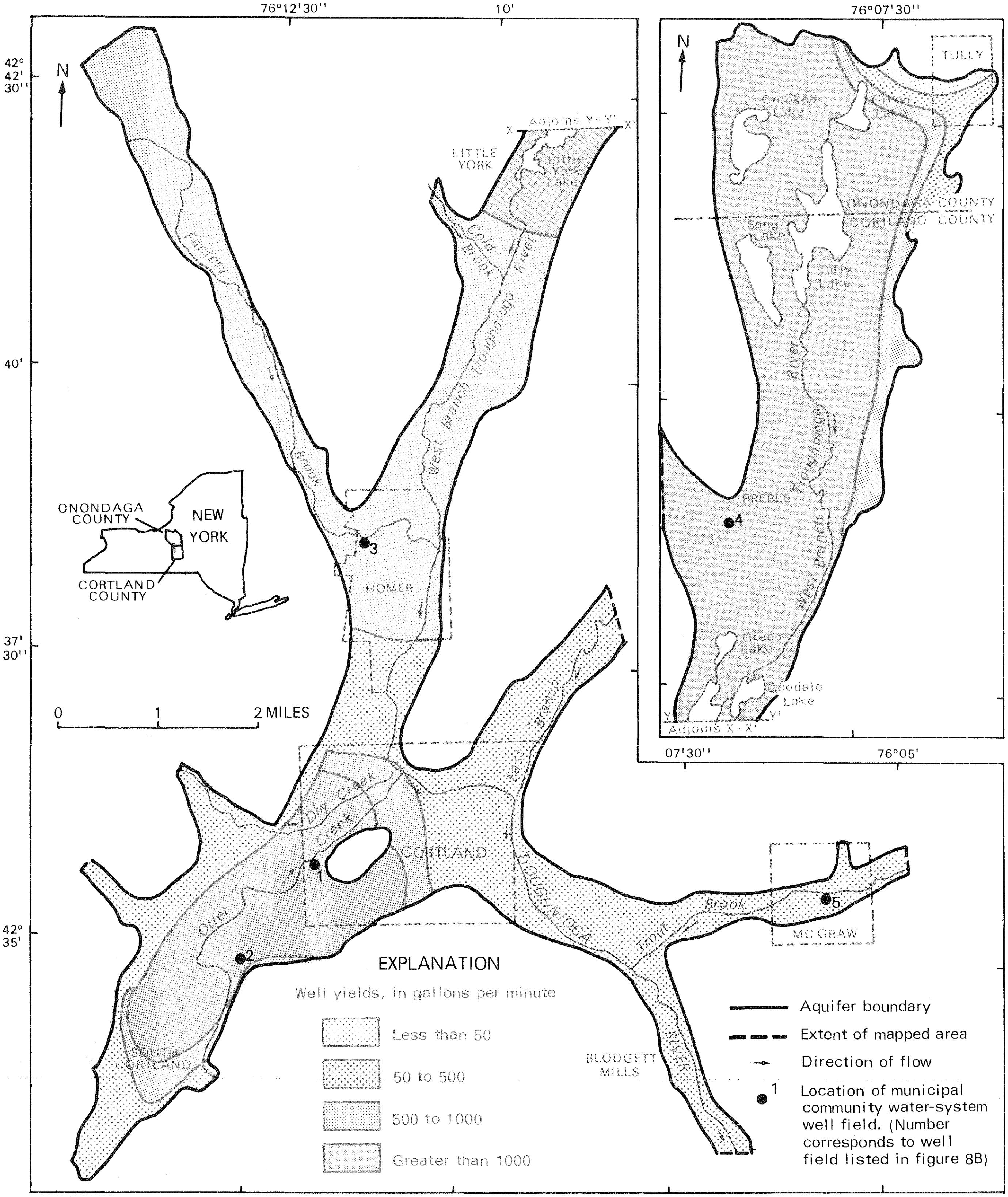
Yields may exceed 500 gallons per minute in many places

Yields to properly constructed wells may exceed 500 gallons per minute in much of this valley-fill aquifer. Near the fringes of the aquifer and where the aquifer is thinnest, yields are smaller.

Both the availability of ground water to large-capacity wells, and aquifer yield over the long term, are of vital interest to communities that depend on ground water. As water use increases with population growth, or new sources are needed because of water-quality deterioration, the areas in which supplementary supplies are available become important. Figure 8G gives estimated yields available to wells tapping this valley-fill aquifer.

Large yields (greater than 1,000 gal/min) can be obtained in much of the valley where the saturated thickness of outwash exceeds 40 feet (see fig. 8E). Yields between 500 and 1,000 gal/min are available where outwash has a saturated thickness of about 40 feet. In the lower reaches of the valley, where outwash has a saturated thickness generally less than 40 feet, yields between 50 and 500 gal/min may be expected. Along the edges of the aquifer, where the sand and gravel pinches out as it meets the till-mantled bedrock valley walls, yields are generally less than 50 gal/min. Such areas are generally narrow and are therefore not shown on the map.

FIGURE 8G CORTLAND-HOMER-PREBLE AREA
Well yields



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1981

Soils overlying most of this aquifer are highly permeable

This aquifer is overlain with highly permeable soils. Adjacent hillsides are mantled with till and soils of low to moderate permeability that allow substantial amounts of runoff to drain onto the valley floor.

Permeability of the soil zone within an area determines recharge and also can serve as a guide to planners concerned about where and at what rate surface contaminants could infiltrate into the ground-water system. Soil maps for Cortland County (Seay, 1961) were used to evaluate the permeability and infiltration potential, as depicted in figure 8H.

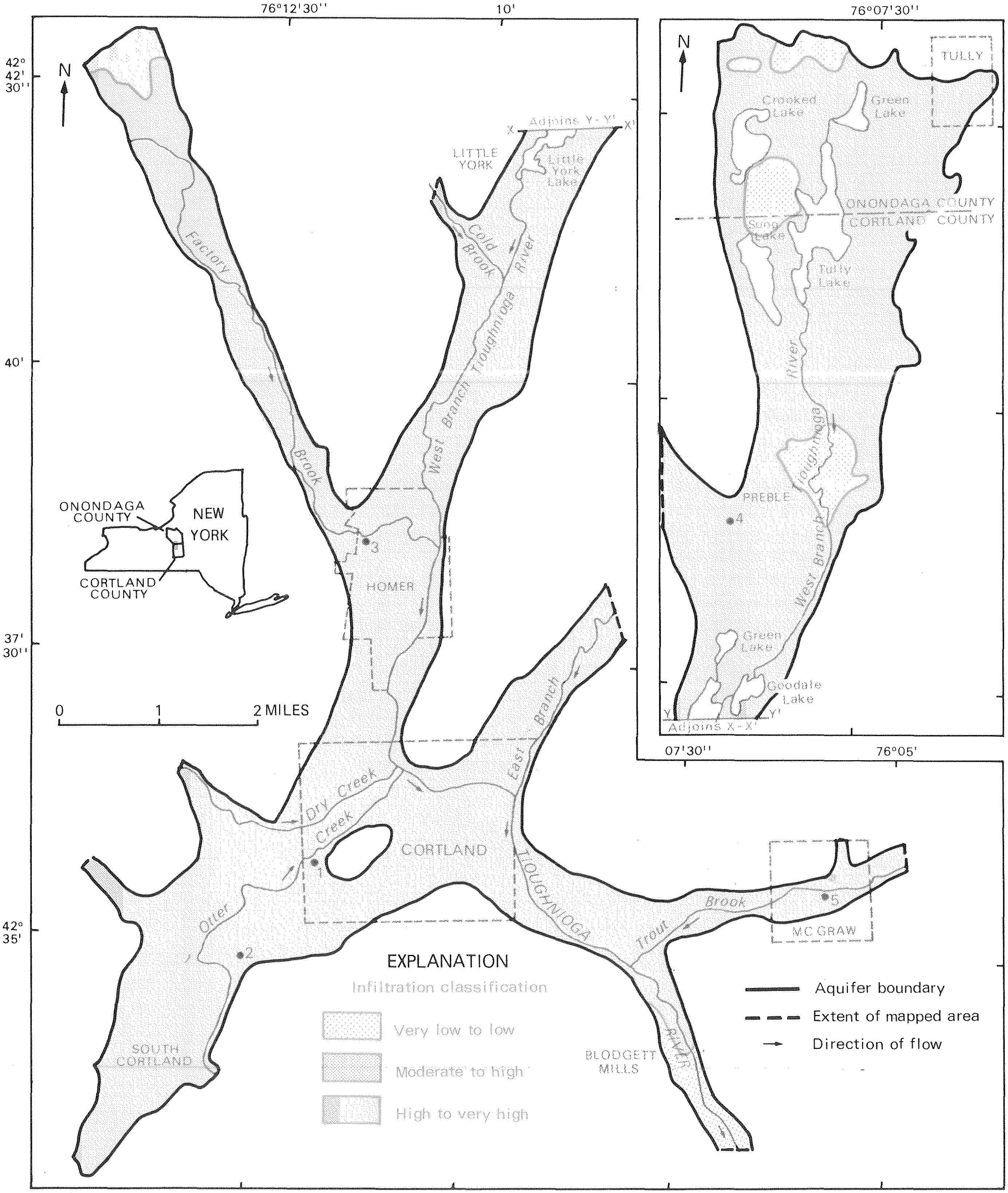
Soils that have developed in the sediments over this aquifer are well drained and have high to very high permeability. The most productive farms in the region are in areas containing these soils. Soils developed in ice-disintegration deposits, kames, and kame terraces are moderately well drained and exhibit moderate to high permeability. Some soils, however, may contain fragipans that inhibit infiltration locally.

The hills adjacent to the aquifer are covered with till having clayey soils of low permeability, so that precipitation on the hillsides readily runs off onto the valley floor. Wetlands generally have muck soils, which are poorly drained.

Where floodwaters of the Tioughnioga River have inundated areas southeast of Cortland, silty loam soils have formed on the sandy silt alluvium. These soils are poorly drained and have very low permeability.

FIGURE 8H CORTLAND-HOMER-PREBLE AREA

Soil-zone permeability



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1981

8 CORTLAND-HOMER-PREBLE AREA
I. Land use

Much of this area remains agricultural

Cortland and Homer, the two major urban centers, are surrounded mostly by farmland. The area contains several extensive transportation corridors and scattered areas of residential and commercial development and light industry.

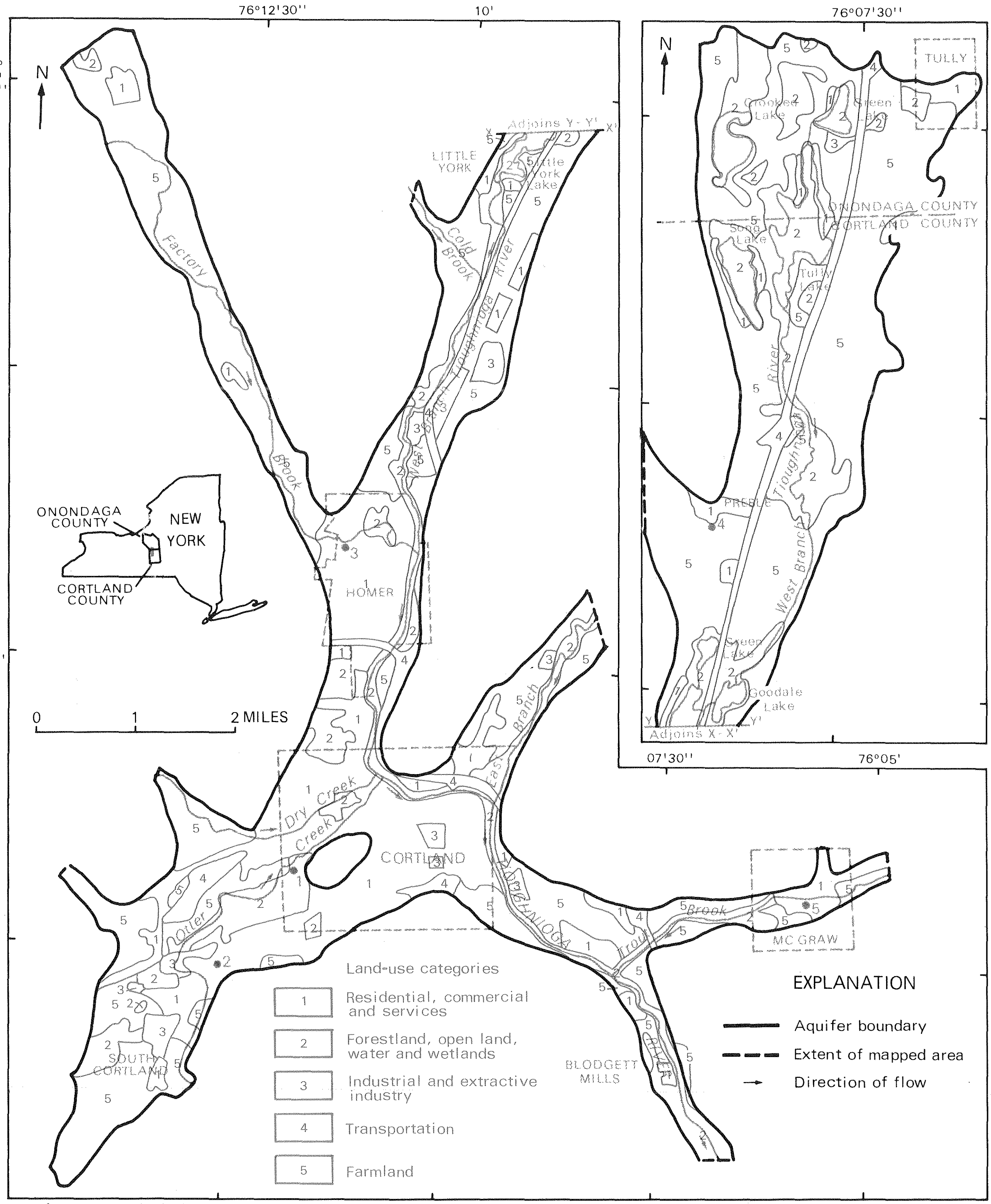
Most of this area is rural except for the City of Cortland and the Village of Homer. The major categories of land use are depicted in figure 8I[1]. The predominant land use over the aquifer is agriculture. Approximately half the area is active farmland, but residential, industrial, extractive, and commercial growth are encroaching into the farming areas. Several small population centers having light industry and commerce are scattered along transportation corridors throughout the aquifer area, but most of the commercial facilities are in Cortland and Homer. Forest and open public land constitute only about 3 percent of the area overlying the aquifer.

Industrial and extractive land use constitutes about 2 percent of the area within the aquifer boundary. Extractive land use consists of two types of sand and gravel mining — excavation of kame sand and gravel along the hillsides (above the water table), and dredging of well-sorted outwash gravel within the valley flat (mostly below the water table). The depletion of easily mined aggregate in areas surrounding Cortland County, and the presence of a high-grade gravel in the Homer-Preble valley, have resulted in competition for land use between the extractive industry (gravel mining) and agriculture.

The transportation network is extensive, but only the largest facilities — Cortland County Airport and Interstate Highway 81 — are shown in figure 8I.

[1] Figure 8I was compiled from 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University for the New York State Department of Transportation. Major developments since 1968 were field checked in 1981.

FIGURE 8I CORTLAND-HOMER-PREBLE AREA
Land use



Base from U.S. Geological Survey, 1978

Modified from Miller and others, 1981

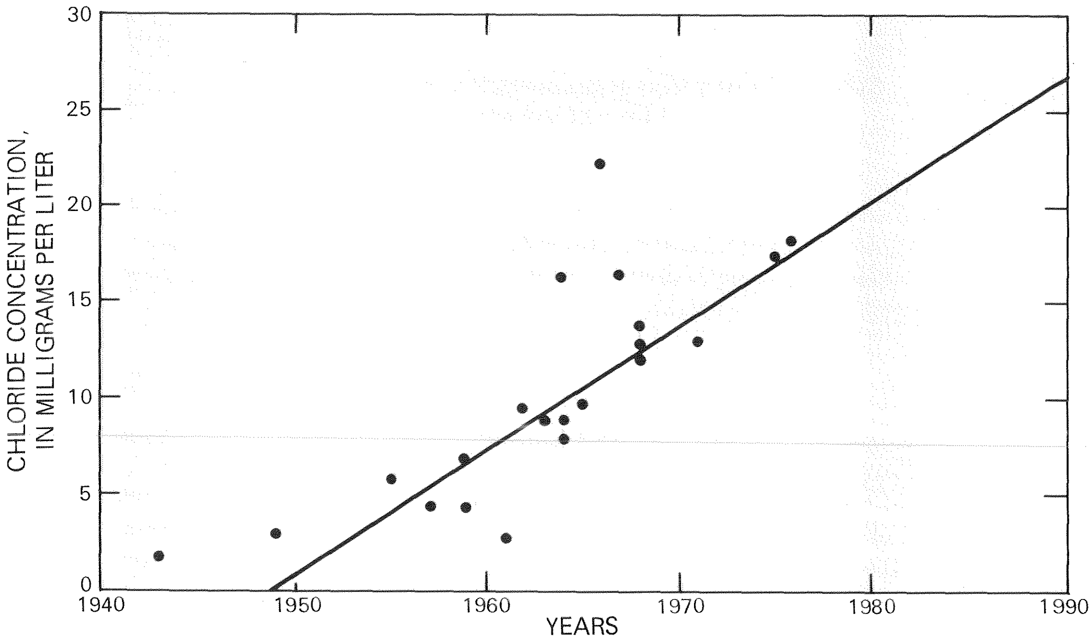
Shallow ground water contains elevated concentrations of chloride and nitrate

Ground-water quality in the upper part of this aquifer is changing as man alters the land surface and discharges wastes. Although chloride and nitrate concentrations have been rising since 1930, ground-water quality in 1980 met State standards for drinking water.

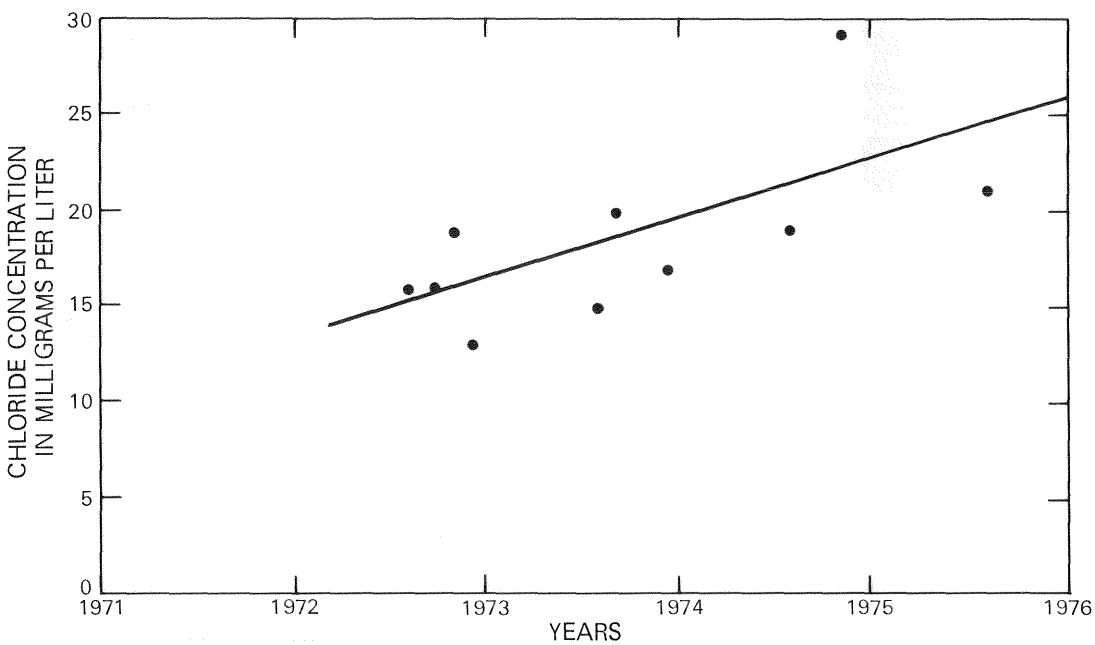
A progressive increase of chloride and nitrate in ground water from the City of Cortland well field was confirmed in the early 1960's (fig. 8J). Chemical analyses of community systems in the early 1970's (U.S. Geological Survey, 1980) confirmed elevated chloride levels in two of the four systems sampled from the valley-fill aquifer. Chloride concentration in the upper part of the aquifer had generally increased from 2 mg/L in 1930 to 20 mg/L in 1976, and nitrate had increased from 1 mg/L in 1930 to an average of 4 mg/L in 1976 (Buller, Nichols, and Harsh, 1978). In a study of ground water in the southwest part of the valley-fill aquifer, Buller, Nichols, and Harsh (1978, p. 43) attributed chloride increases to road salting, septic systems, and dairy farming.

Chloride concentration has also increased in the Homer-Preble area (Sterns and Wheler, 1970, Buller, 1978). Figure 8J indicates a progressive increase during 1972-76; Buller (1978, p. 16) relates the chloride contamination to road salt and septic-system effluent. Several instances of elevated nitrate in the Homer-Preble valley have been reported; Buller (1978, p. 15) relates them to agricultural fertilizer and septic systems.

Buller, Nichols, and Harsh (1978) noted the distribution of chloride and nitrate in ground water from the Otter Creek area and determined areas of significant nitrate (2 to 5 mg/L) and chloride (30 to 70 mg/L) to be near high-density residential septic systems. The areas evaluated in that report are upgradient from public water systems. They also found chloride and nitrate in deeper zones of the aquifer (60 to 200 feet) but at concentrations much less than near the surface; they state that nitrate has diffused through the upper 60 feet of the aquifer from combined sources, chiefly agriculture, septic systems, and lawn and garden fertilizers.



Chloride concentration of ground water at City of Cortland well field



Chloride concentration of ground water in Homer-Preble area

Contaminants have been detected, but concentrations are not yet serious

Past studies on parts of this aquifer have revealed water-quality problems for future development and management. An adequate data base and better knowledge of the aquifer dimensions and properties can aid in planning and management of ground-water resources.

The preceding page highlights problems of chloride and nitrate in ground-water. Chemical analyses of the City of Cortland's water (U.S. Geological Survey, 1980) also indicated higher concentration of heavy metals and phenols than in other community water-supply systems tapping the aquifer. Consequently, sampling and analyses for "priority pollutants"[1] in Cortland's ground-water supply was done in 1978 in a statewide program by the New York State Department of Health (Kim and Stone, 1979). Three systems contained detectable concentrations of benzenes, phthalates, and halocarbons, but these were not considered significant (Schroeder and Snavely, 1981).

Water quality changes with time, as noted in figure 8J, and future monitoring would provide warning of potentially dangerous trends. Although the known contaminants had not reached serious levels as of 1980, a rising trend is evident, which suggests that other contaminants that have not been appraised may also be increasing.

To predict the quality of water in this aquifer, the known sources of contaminants and their rate of infiltration to the aquifer need to be evaluated. In addition, analysis for other suspected cotaminants would be advisable.

[1] Toxic organic chemicals designated by the U.S. Environmental Protection Agency.

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9
CORNING AREA

By Todd S. Miller

A. Location and major geographic features

B. Population and ground-water use

C. Geologic setting

D. Geohydrology

E. Aquifer thickness

F. Ground-water movement

G. Well yields

H. Soil-zone permeability

I. Land use

J. Present and potential problems

K. Selected references

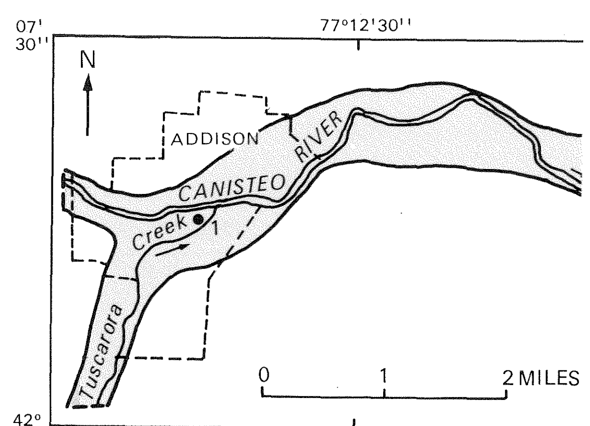
This aquifer underlies four intersecting river valleys

This aquifer forms the valley flat of four convergent river valleys in south-central New York. The City of Corning is the only major urban area. The rivers are tributary to the Susquehanna River basin.

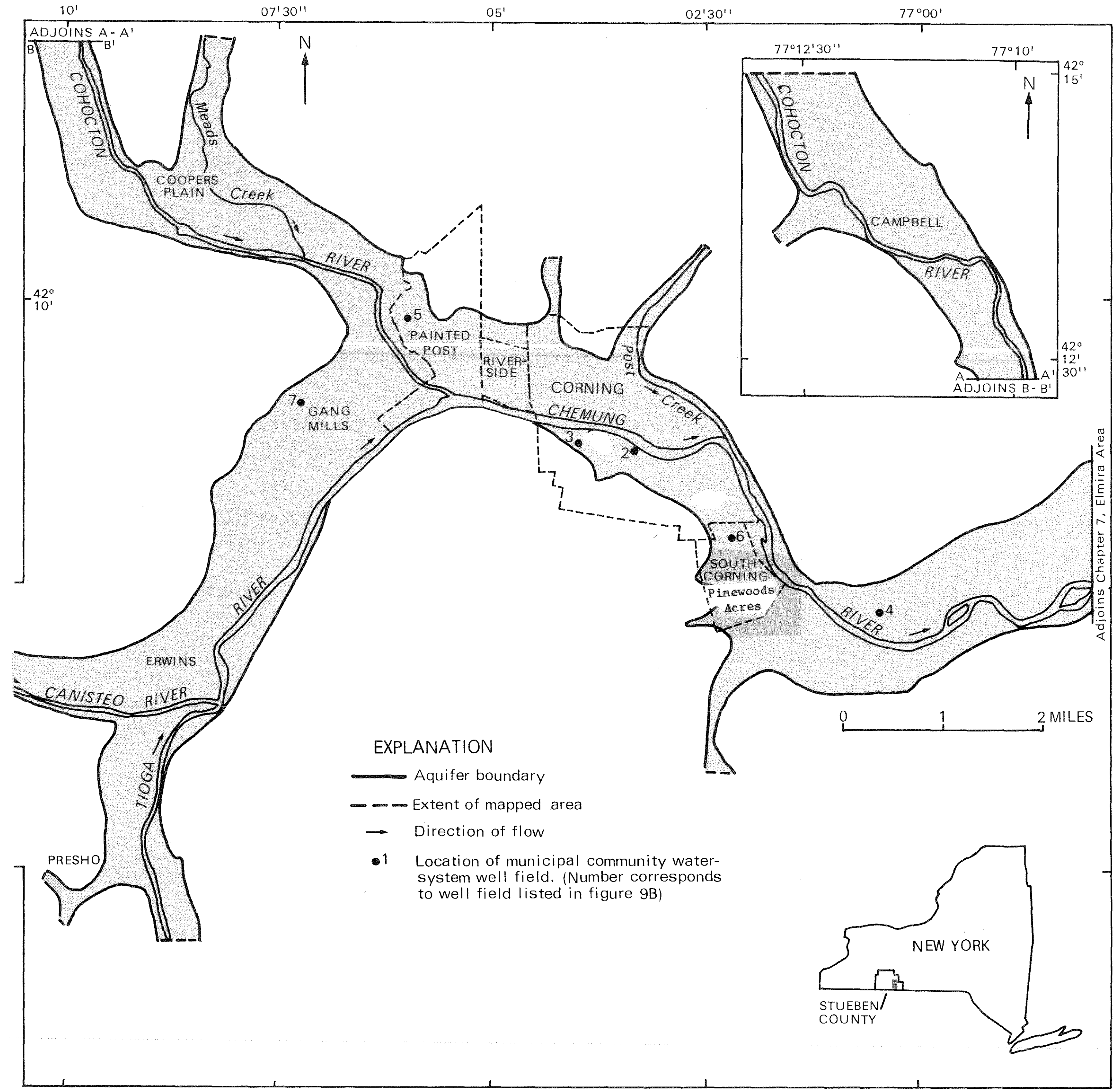
The Corning area is in the southeastern part of Steuben County (fig. 9A). This aquifer underlies the floors of the Canisteo, Tioga, Cohocton, and Chemung Rivers valleys and extends partway upstream into tributary valleys of each. The aquifer underlies approximately 28 square miles of relatively flat valley floor 0.5 to 1.0 mile wide. The aquifer is bordered by steep, rounded hills that rise 800 feet from the valley floor and reach altitudes as high as 1,800 feet.

The Chemung River and its major tributaries — the Canisteo, Tioga, and Cohocton Rivers — drain into the Susquehanna River in Pennsylvania.

Corning is the area's major industrial center. Several small communities are scattered along the main valleys. On the east, this aquifer is continuous with the aquifer of the Elmira-Horseheads-Big Flats area, discussed in chapter 7.



Base from U.S. Geological Survey, 1978



EXPLANATION

- Aquifer boundary
- Extent of mapped area
- Direction of flow
- •1 Location of municipal community water-system well field. (Number corresponds to well field listed in figure 9B)

9 CORNING AREA
B. Population and ground-water use

This aquifer provides water to about 29,000 people

Approximately 16.6 million gallons a day of ground water is pumped from this aquifer. The most extensive withdrawals are in the vicinity of the City of Corning. Of the total water withdrawn, industry uses 61 percent, community supplies use 34 percent, and private individual wells use an estimated 5 percent.

This aquifer provides 16.6 Mgal/d of ground water to a population of approximately 29,000. Municipal community water systems provide 7.5 Mgal/d to 23,000 people; this includes 1.8 Mgal/d to industry. About 6,000 people use a total of 0.8 Mgal/d from individual domestic wells, and six industrial wells pump 9.1 Mgal/d (Southern Tier Central Regional Planning and Development Board, 1976). The most extensive withdrawals are in the vicinity of the City of Corning.

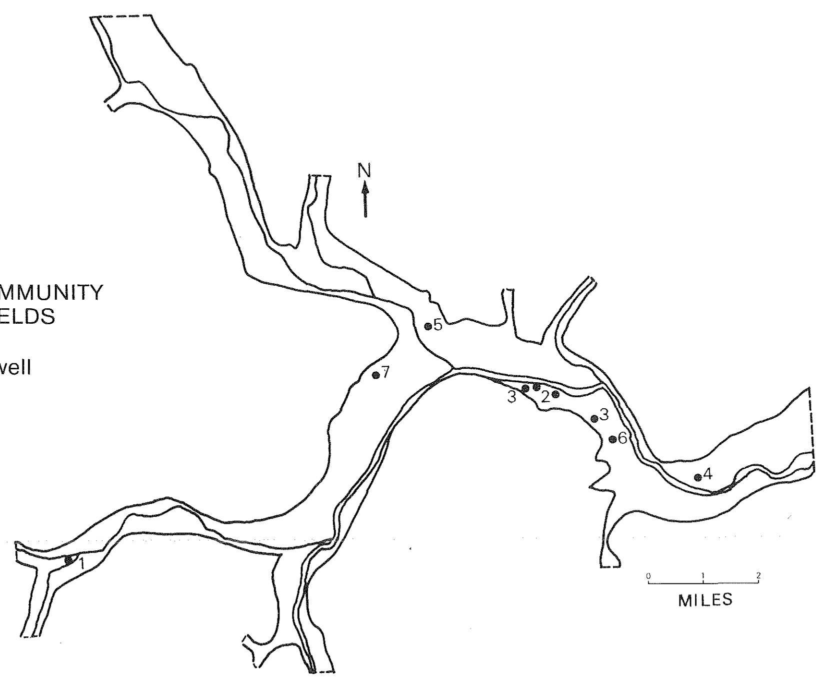
The well field supplying the Corning urban area is the largest municipal water user and pumps 5.5 Mgal/d. The remaining water systems belong to six other villages and 17 trailer parks. A glass company uses 90 percent of the ground water used by industry and is the largest single user in the area.

Average daily per-capita use in the area in 1976 was reported to be 131 Mgal/d, and ground-water pumpage, in Mgal/d, was reported as follows (Southern Tier Central Regional Planning and Development Board, 1976): industry, 10.1 (61 percent); public water supplies, 5.5 (34 percent); and private domestic supplies, about 0.8 (5 percent).

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 9A.

LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite



POPULATION AND PUMPAGE FROM CORNING AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. Village of Addison	2,100	0.350
2. City of Corning	12,953	5.500
3. Corning Manor Water District	300	0.20
4. Gibson Water District	500	0.35
5. Painted Post	2,700	1.000
Riverside	1,050	—
6. Village of South Corning	1,400	.200
Pinewood Acres	160	—
7. Morningside Heights Water District	600	.175
Subtotal	21,763	7.280
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer parks (17)	1,400	.178
C. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per day per capita is assumed	[3]6,000	[3] .800
D. INDUSTRY	—	[3]8.3
Total	29,163	16.558

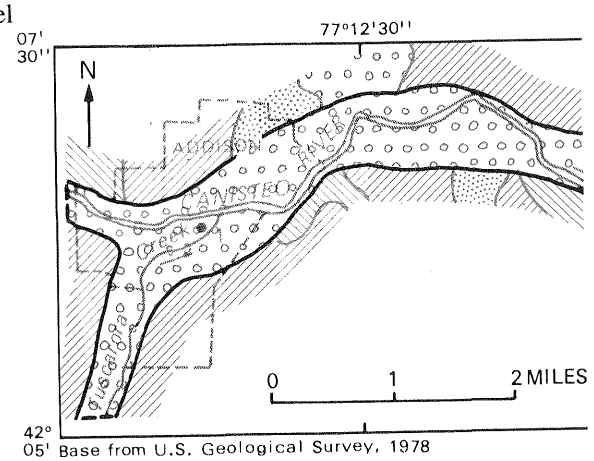
[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
[3] Southern Tier Central Regional Planning and Development Board (1976)

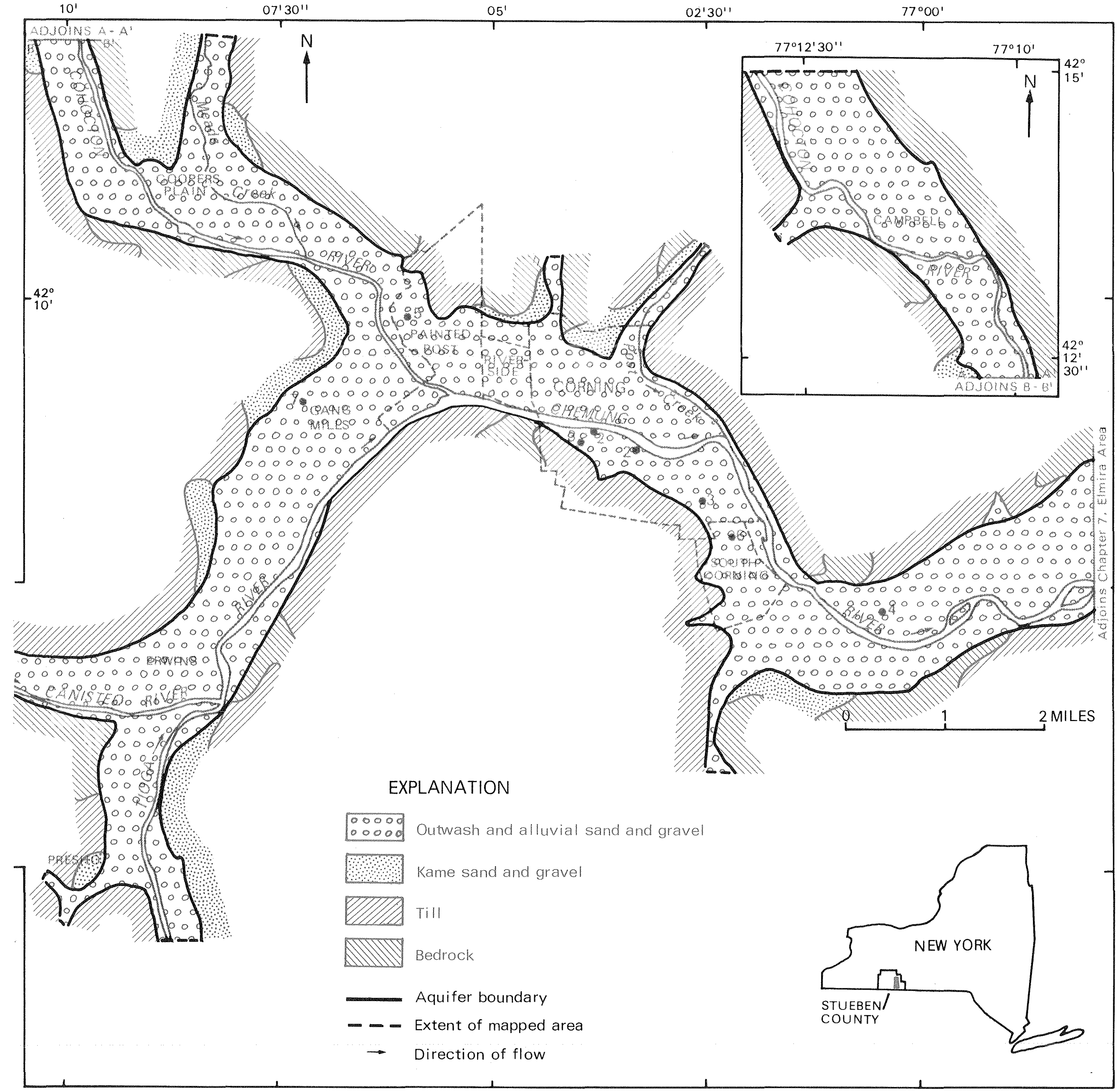
The valley floors contain drift and reworked alluvium

Glaciation scoured the valleys and hilltops and deposited drift almost everywhere. The thickest deposits are in the valleys, where stratified outwash sand and gravel predominate. Postglacial streams have partly reworked the outwash deposits.

The Corning area lies within the northern, glaciated part of the Allegheny Plateau. Bedrock consists of nearly flat-lying shale, siltstone, and sandstone. During periods of glacial advance, ice scoured the preglacial topography and widened and deepened the valleys, oversteepened hillside slopes, and rounded off hilltops. During glacial recession, the melting ice deposited drift within the valleys, partly filling them, and mantled bedrock hills with 5 to 25 feet of till. Figure 9C is a generalized surficial geology map of the Corning area.

The valleys now contain several kinds of drift. Kame terraces flank the west valley walls of Meads and Post Creeks, the north valley wall of Canisteo River, and the east valley wall of Tioga River. Lateral or end-moraine till covers the lower slopes of hillsides and is in places buried beneath or interbedded with lake deposits and surficial outwash. Layers of lacustrine sand, silt, and clay occur irregularly throughout the drift, and outwash sand and gravel form most of the valley flat. Since the retreat of ice, streams have reworked the sediments and deposited fine sand and silt 5 to 15 feet thick in low areas adjacent to streams and as alluvial fans of sand and gravel where upland streams meet the valley flat.





Modified from Miller and others, 1982

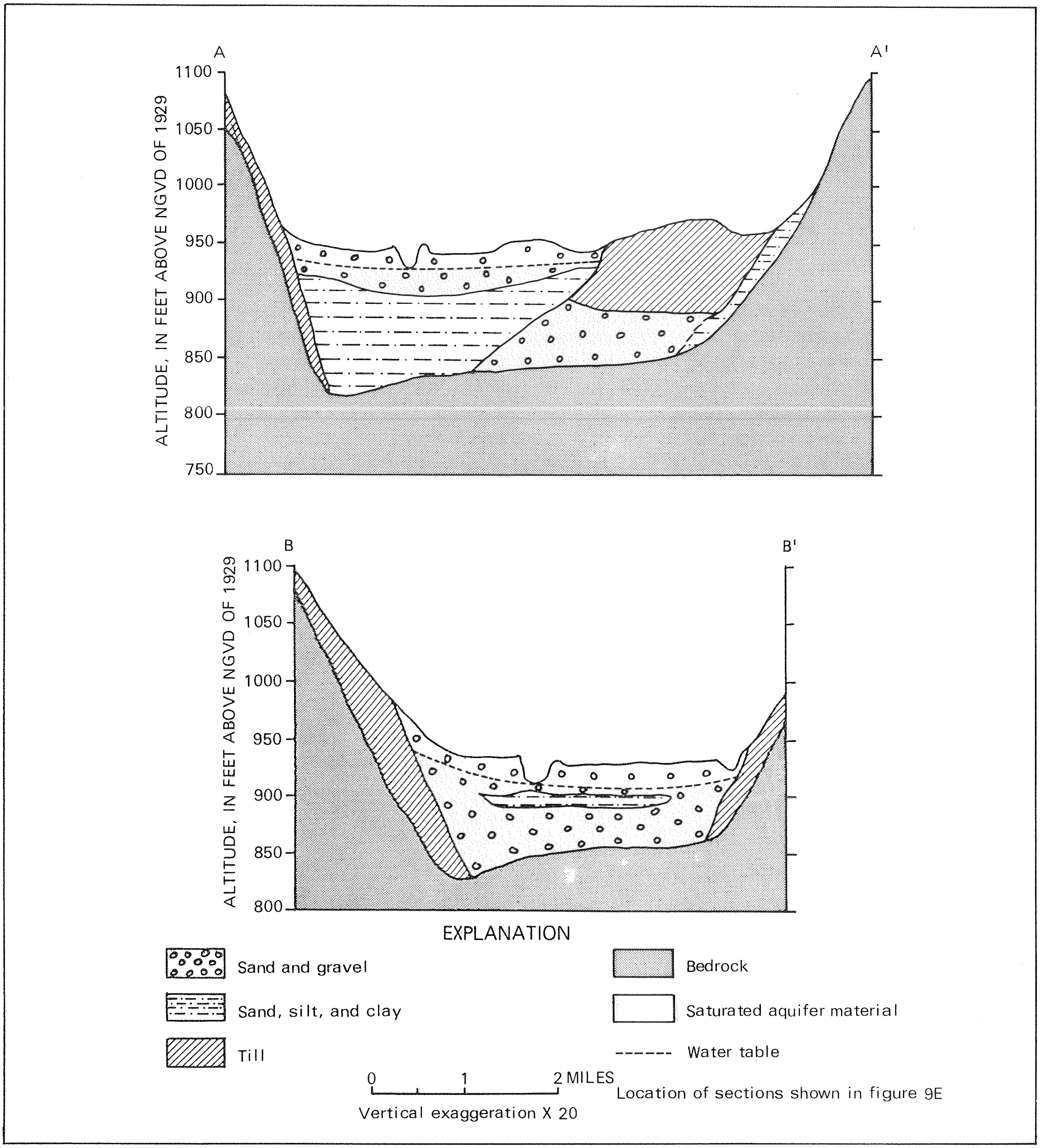
This aquifer consists of outwash sand and gravel

The widened and deepened valleys are party filled with drift, lake deposits, and alluvium containing highly permeable sand and gravel outwash. Thickness of valley fill ranges from 60 to 130 feet.

The valleys are partly filled with drift and postglacial alluvium ranging in thickness from 60 to 130 feet, typically 90 feet. The drift consists of sand and gravel (outwash) deposited by meltwater streams flowing from the ice, lacustrine fine sand, silt, and clay that underlies or is interbedded within the outwash, and morainal till that may be buried or at land surface. Generalized sections showing the position of drift deposits are shown in figure 9D. Only saturated sediments coarser than very fine sand are considered to be aquifer material.

Outwash and kame sand and gravel is widespread. Cohocton valley from Campbell to Coopers Plain has a surficial outwash deposit overlying lake beds or till. Total depth to bedrock here ranges from 90 to 129 feet. The Meads Creek valley also contains surficial outwash or alluvium; one well penetrated a clay layer at 40 feet, but little other information is available.

In the Corning-Painted Post-Gang Mills area, borings and well logs near the south wall of the valley penetrate mostly sand and gravel (70 to 90 feet thick), some of it silty and containing some till (MacNish, Randall, and Ku, 1969). In Painted Post is a thick section of lake beds along the west and north sides of the valleys, underlain by more gravel, possibly kames (sec. A-A′, fig. 9D). Here depth to bedrock ranges from 63 to 90 feet.


A
A'
1100
1050
1000
950
900
850
800
750
ALTITUDE, IN FEET ABOVE NGVD OF 1929
B
B'
1100
1050
1000
950
900
850
800
ALTITUDE, IN FEET ABOVE NGVD OF 1929
EXPLANATION
Sand and gravel
Sand, silt, and clay
Till
Bedrock
Saturated aquifer material
------ Water table
0 1 2 MILES
Vertical exaggeration X 20
Location of sections shown in figure 9E

**Most deposits are about 40 feet thick;
a few exceed 50 feet**

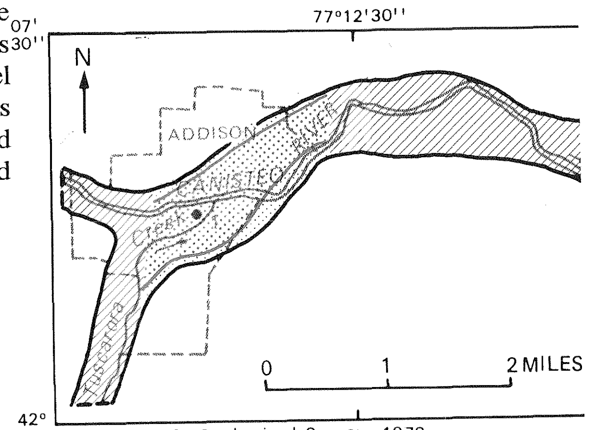
Outwash, kame, and alluvial sand and gravel is extensive within the main valleys and ranges from 5 to 80 feet in saturated thickness. Most deposits are approximately 40 feet thick.

The aquifer-thickness map (fig. 9E) indicates the saturated thickness of unconsolidated sediments coarser than very fine sand. The bottom of the aquifer is regarded as the first extensive impermeable unit — this may be till, lacustrine silt and clay, or bedrock. Because of the irregular occurrence of buried lake deposits, the thickness contours in many areas are only approximate values.

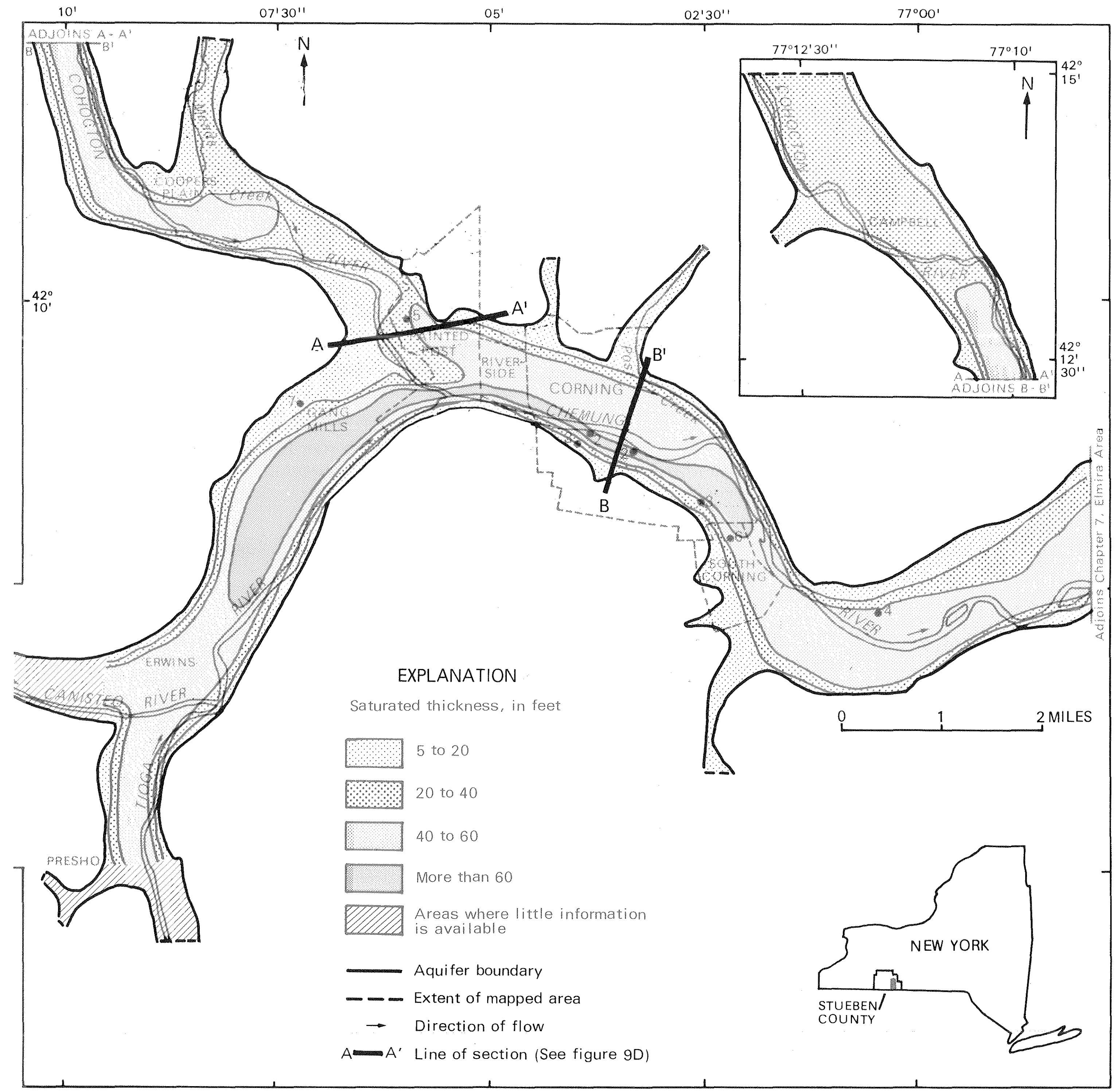
In the reach from Campbell to Coopers Plains, the aquifer is generally 30 to 40 feet thick. In the Meads Creek valley, borings penetrating the upper 50 feet indicate a surficial aquifer approximately 30 feet thick. Little information is available about deeper deposits. From Coopers Plains to the western part of Painted Post, the surficial aquifer thins to 15 to 30 feet.

In the southern part of the Corning-Painted Post area, borings and well logs penetrate a thick (85 to 95 feet) section of mostly sand and gravel. On the north side of Painted Post, a till deposit (probably a lateral moraine) on the inside bend of the valley overlies a buried sand and gravel aquifer 75 feet thick (sec. A-A', fig. 9D).

In the Chemung River valley from South Corning to the Chemung-Steuben County border, lake silt and clay lenses and till that are interbedded within the sand and gravel are included in the saturated thickness. In the Gang Mills and Erwin area, the Tioga valley contains a sand and gravel aquifer 40 to 100 feet thick that also has interlayered lake sediments and till.



Base from U.S. Geological Survey, 1978



Modified from Miller and others, 1982

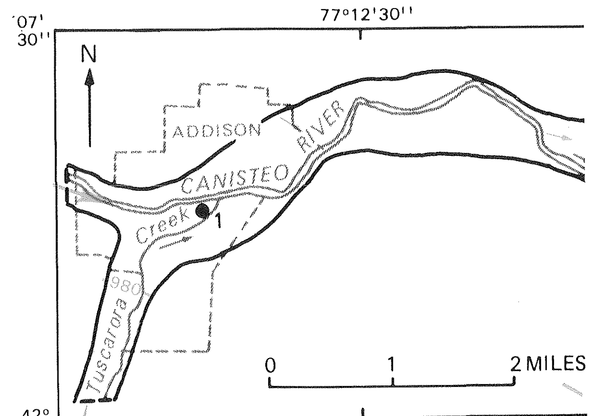
Ground water flows toward streams and southward toward Elmira

Ground-water movement is downvalley except where tributary streams enter the main valley; there water movement is generally transverse to the valley. Discharge is to streams in the valley and also occurs as underflow that leaves the valley east of East Corning.

The potentiometric-surface map[1] (fig. 9F) represents the average altitude of the water table in the surficial sand and gravel aquifer.

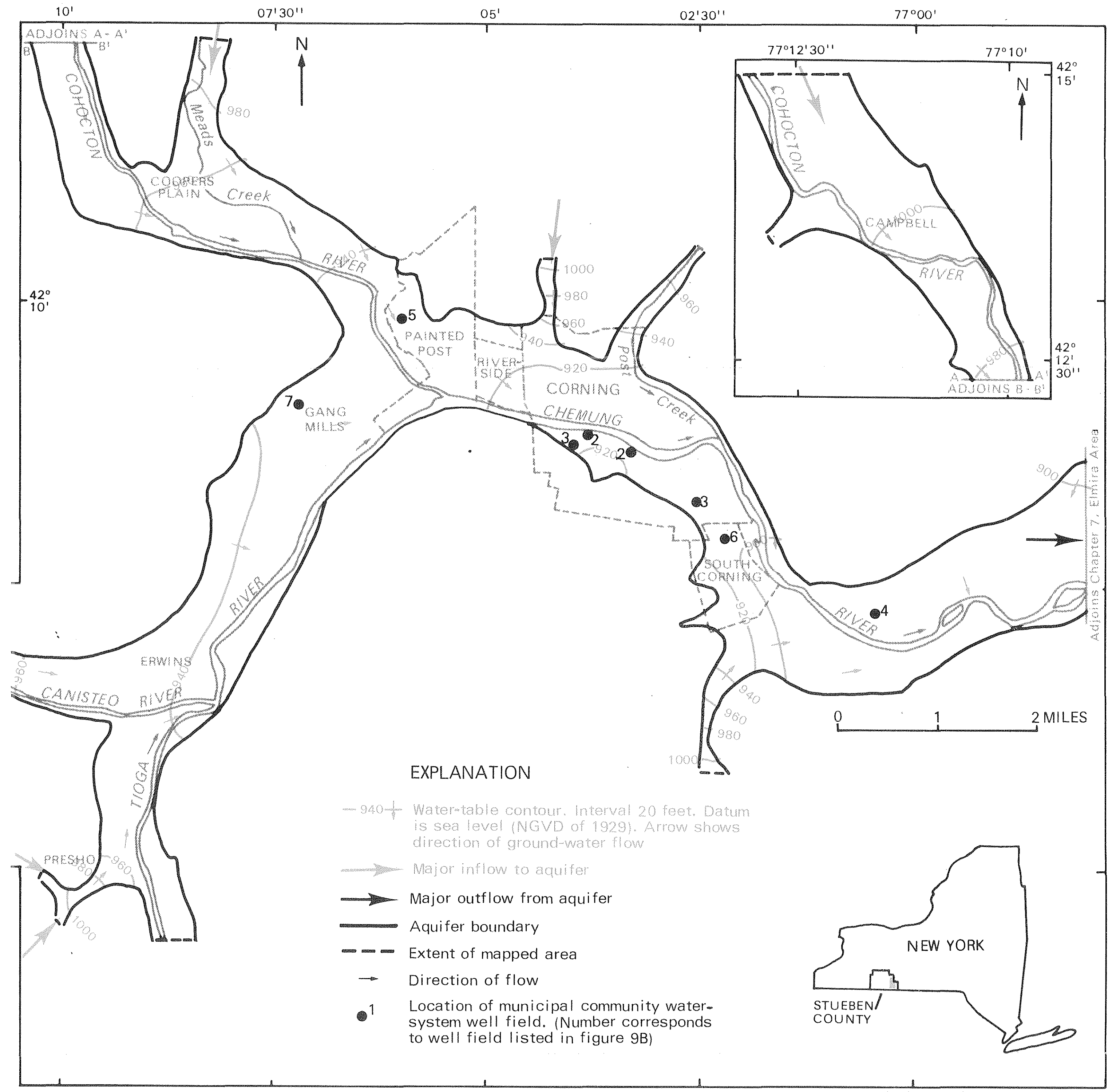
Ground water moves generally downvalley and discharges into the streams, except where tributary streams enter the main valley. At such intersections, ground water is recharged by the streams and forms fan-shaped ground-water mounds in which movement is generally transverse to the valley. Ground water also leaves the valley as underflow toward the Elmira area.

Recharge results from rainfall over most of the valley floor, from seepage along some stream reaches, from the underlying bedrock, and through streambanks during periods of high runoff. Where streambeds are above the ground-water level, stream water may recharge the aquifer; this is common where small streams draining uplands flow onto the permeable sand and gravel valley floor.



Base from U.S. Geological Survey, 1978

[1] The map was compiled from water-level measurements made by U.S. Geological Survey, well drillers, and engineering consultants from 1932-68; most measurements were made in the later 1950's and early 1960's.



Modified from Miller and others, 1982

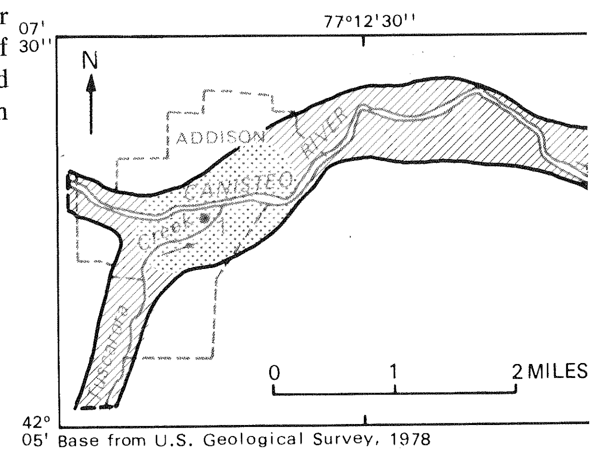
Thick sand and gravel deposits may yield several hundred gallons per minute to wells

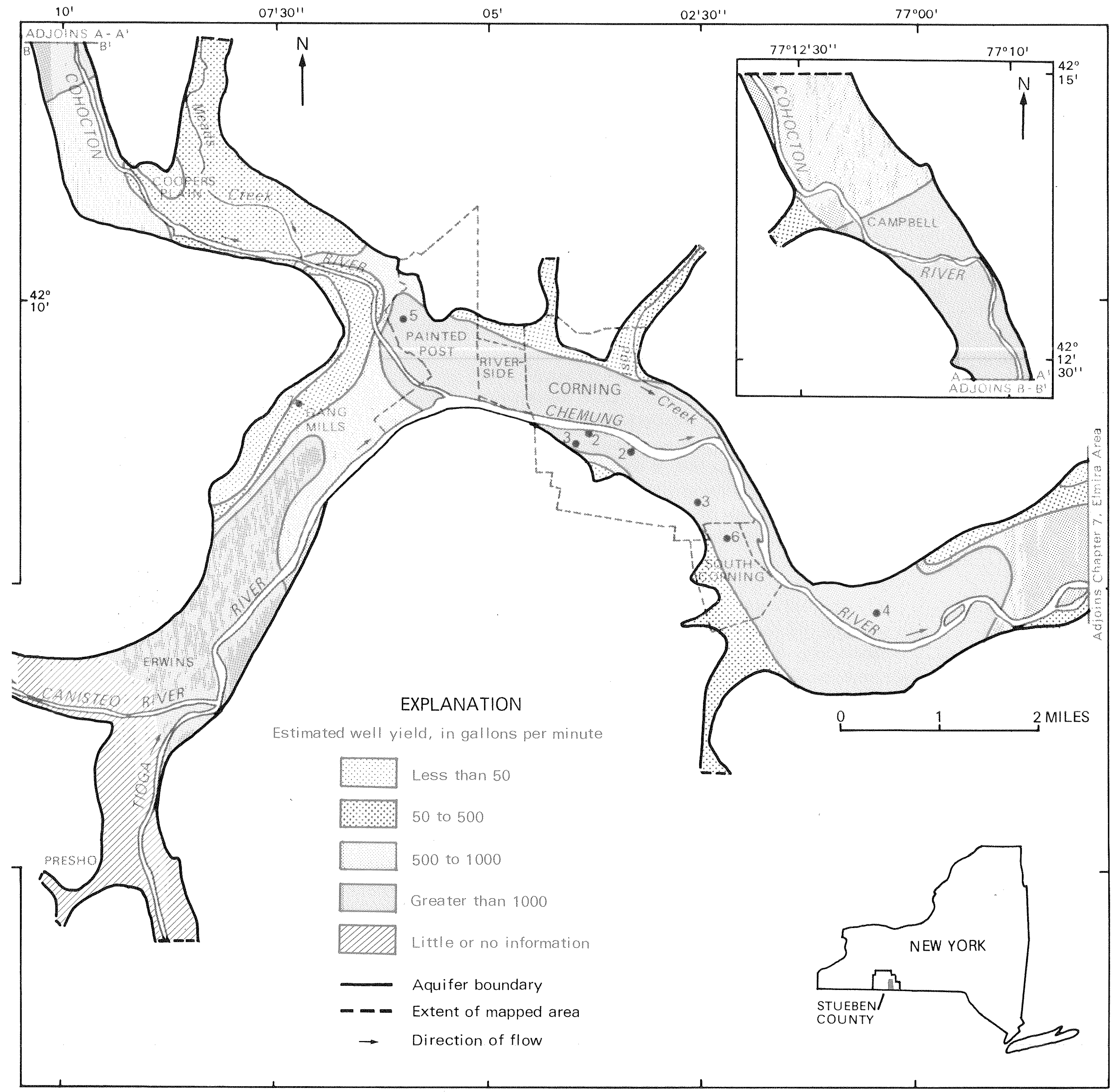
Yields of 500 to more than 1,000 gallons per minute can commonly be obtained from wells tapping the thick stratified sand and gravel deposits in the Cohocton and Chemung River valleys. Little information is available on well yields in the Tioga and Canisteo valleys.

Ground water is being used extensively in the Corning area and is of vital interest to growing communities and industries. As water use increases, or replacement sources are needed because of quality deterioration, alternative areas of high yield need to be located. The map in figure 9G indicates the estimated well yield that can be expected from municipal-type wells. Yield information is most reliable in the Corning area (from Painted Post to the City of Corning) but is scant outside the populous areas.

Large water yields to wells (500 to more than 1,000 gal/min) are common where the saturated thickness of permeable sand and gravel exceeds 40 feet and also near streams, where water can be induced to move from the streambed into the aquifer toward the pumping well. Large yields can generally be obtained in most parts of the Cohocton and Chemung River valleys except in the reach between Coopers Plain and Painted Post, where the aquifer is thin. In Corning, large yields are available from the thick deposits (greater than 60 feet) of saturated permeable sand and gravel.

Little information is available on the Canisteo River valley, except that a municipal well in the Village of Addison is reported to yield 350 gal/min. No well-yield information was available on the Tioga River valley south of Erwin.





Modified from Miller and others, 1982

Soils in the valley flat have moderate to high permeability

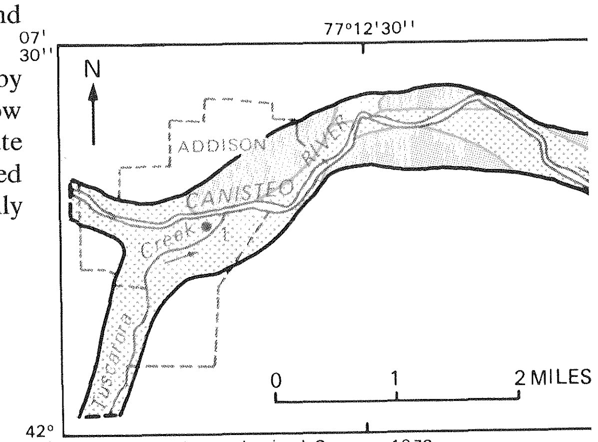
The surficial stratified sand and gravel in the valley has developed a soil zone of moderate to high permeability. Soils on the till-mantled bedrock slopes of the surrounding hills have very low to low permeability, which produces rapid runoff to the valley.

The soil-permeability map (fig. 9H) of the Corning area provides estimates of water-infiltration rate when the soil zone is saturated, as determined by the U.S. Department of Agriculture (French and others, 1978). The character of the soil zone is an important factor in assessing the vulnerability of the underlying aquifer to contamination from certain land-use or waste-disposal practices.

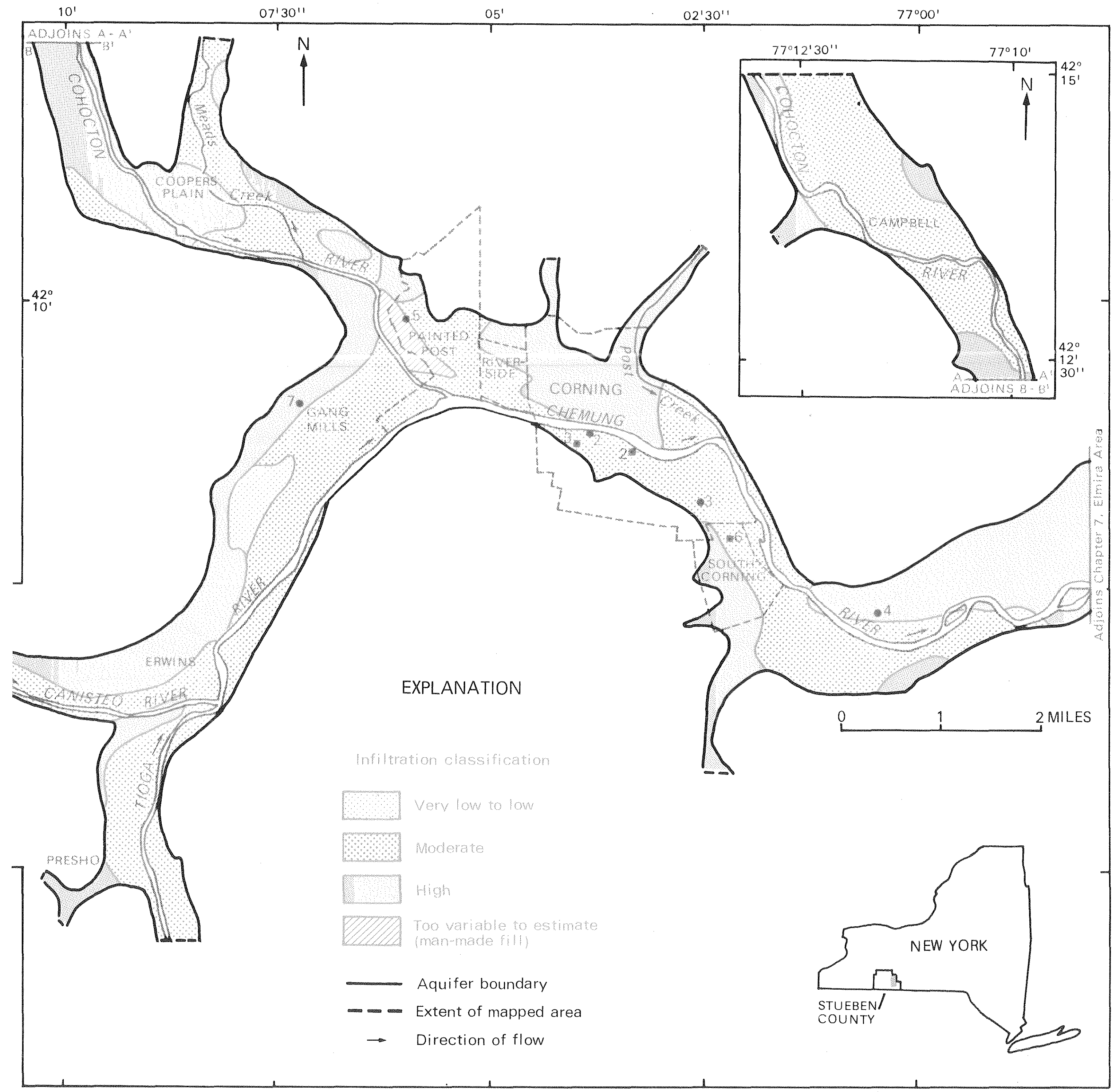
Soils developed from sand and gravel are generally permeable, although accumulations of clay, humus, or precipitated salts in the B horizon reduce permeability somewhat. Precipitation on these soils generally infiltrates readily into the underlying ground-water system, and runoff occurs only during long, high-intensity storms in which the rate of precipitation exceeds the infiltration rate of the soil.

This valley-fill aquifer system is overlain by moderately to highly permeable soils that are derived from alluvial or outwash sand and gravel and are 4 feet or more thick. Alluvial flood-plain soils developed in finer sediments flank the rivers and streams; these are moderately permeable and range in thickness from 40 to 60 inches.

The bedrock hills surrounding the valleys are overlain by a veneer of till. Soils derived from till have very low to low permeability. Even though precipitation can infiltrate through the soil zone at a moderate rate, most of it is stopped by underlying unweathered till and is diverted horizontally or flows downslope as runoff to the valley floor.



Base from U.S. Geological Survey, 1978



Modified from Miller and others, 1982

Much of the area is urban; the rest is mainly agricultural

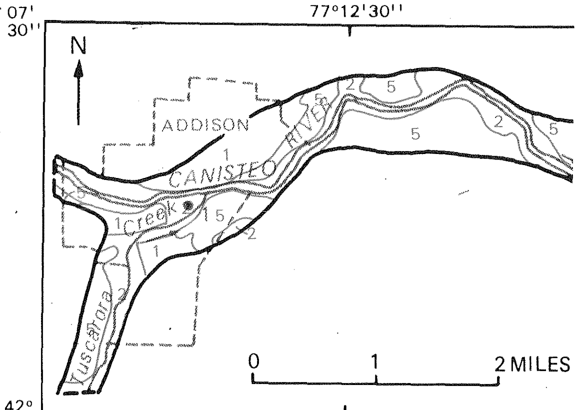
Land use in the Corning area is diversified among agriculture, industry, residential areas, and commerce. An urban core extends along the valley from Gang Mills to the City of Corning. The outlying areas of the valley system are predominantly agricultural but are interspersed with several industries and small residential communities.

The Corning-Painted Post-Gang Mills area has become urbanized and contains extensive industry and commerce (fig. 9I)[1]. The rest of the valley system, which is predominantly agricultural, contains smaller communities and several industries. Farm acreage has declined since 1954 (Southern Tier Central Regional Planning and Development Board, 1977).

Industrial and extractive land use constitutes approximately 2 percent of the Corning area. From 1954-67, the number of industries decreased, but the number of people employed increased slightly (Southern Tier Central Regional Planning and Development Board, 1977). Most of the extractive land use is gravel mining in the valley flat east of Coopers Plain and East Corning, and also in kame terraces along hillsides throughout the area.

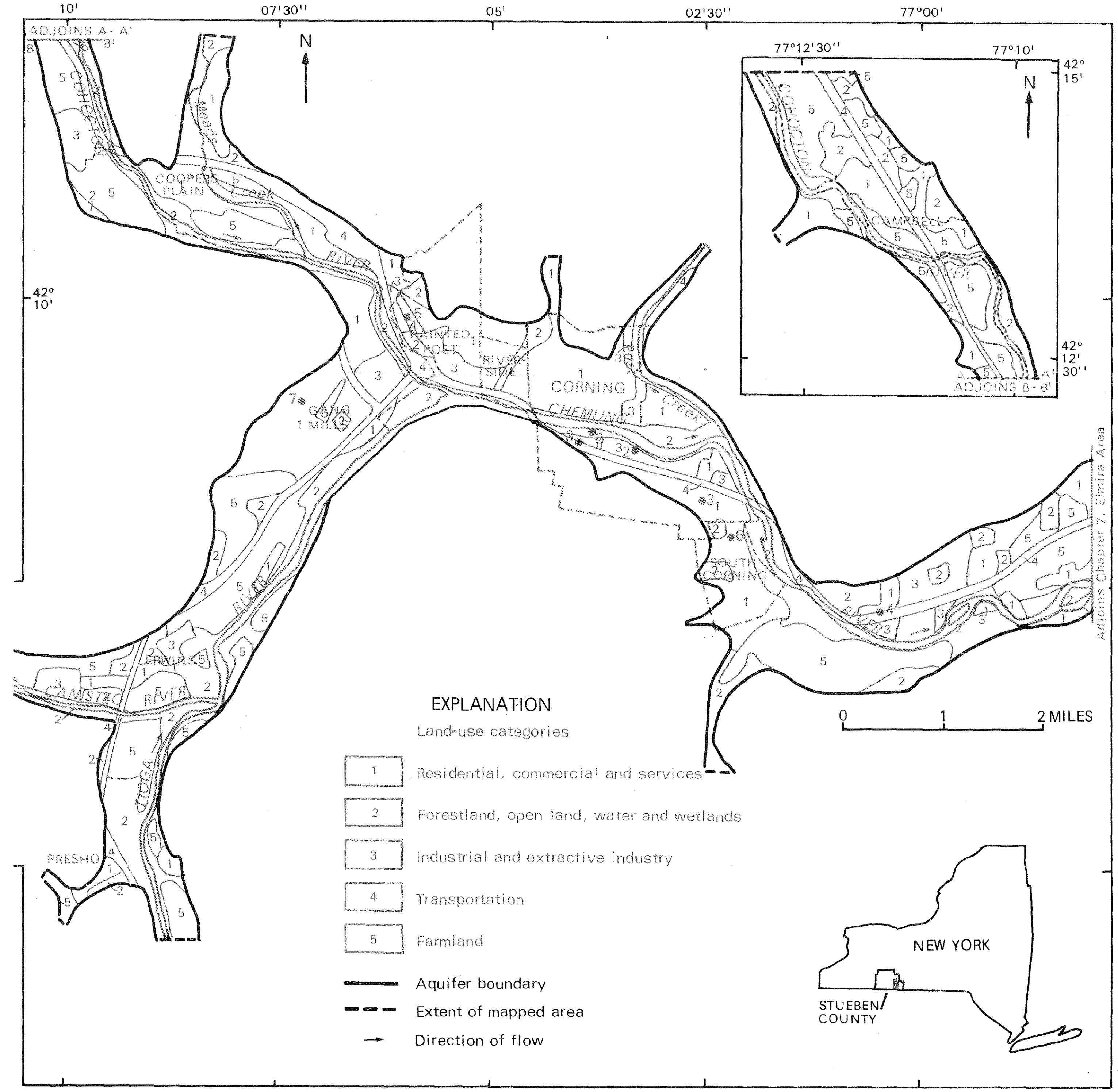
Most of the residential and commercial land is in the urban area from Gang Mills to the City of Corning. Several small communities are dispersed throughout the valleys; residential and commercial areas occupy about 20 percent of the Corning vicinity. From 1960-70, the population decreased; this trend is reported to have continued through the 1970's (Southern Tier Central Regional Planning and Development Board, 1977).

Major transportation routes include railroads through the larger valleys and an interstate highway in the Chemung and Cohocton valleys. Water, wetlands, forest, and open public land occupy about 20 percent of the mapped region.



Base from U.S. Geological Survey, 1978

[1] Figure 9I was compiled from the 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University for the New York State Department of Transportation and from updates of these maps completed by the Southern Tier Central Regional Planning and Development Board in 1976.



Modified from Miller and others, 1982

Concentrated pumping and contamination are the principal concerns

Ground-water use has increased steadily from the mid-1940's to the present. A ground-water model has been developed to predict the regional effects of additional pumpage to determine traveltime and to evaluate the hydraulics relating to point-source disposal of wastes.

Since the 1970's, the Corning area has undergone increased demand for water, and ground-water quality has deteriorated locally (Southern Tier Central Regional Planning Board, 1977). One element of that study was the development of a ground-water model by Battelle Pacific Northwest Laboratories (Reisenauer, 1977) to (1) gather, develop, and evaluate methods for protecting ground water from contamination, (2) identify areas of high water yield, and (3) determine the traveltime of ground water from one location to another.

Information is needed on the locations and extent of ground-water deterioration as well as whether riverside wells induce significant recharge from the respective river. The Southern Tier Central Regional Planning and Development Board (1976, 1977), the U.S. Geological Survey (1980), and the New York State Department of Health (1981) have inventoried most of the significant pumping wells and have documented the quality of some of the ground water.

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10
SPROUT CREEK-FISHKILL CREEK AREA

By Richard B. Moore

A. Location and major geographic features

B. Population and ground-water use

C. Geologic setting

D. Geohydrology

E. Aquifer thickness and well yields

F. Ground-water movement

G. Soil-zone permeability

H. Land use

I. Present and potential problems

J. Selected references

10 SPROUT CREEK-FISHKILL CREEK AREA

A. Location and major geographic features

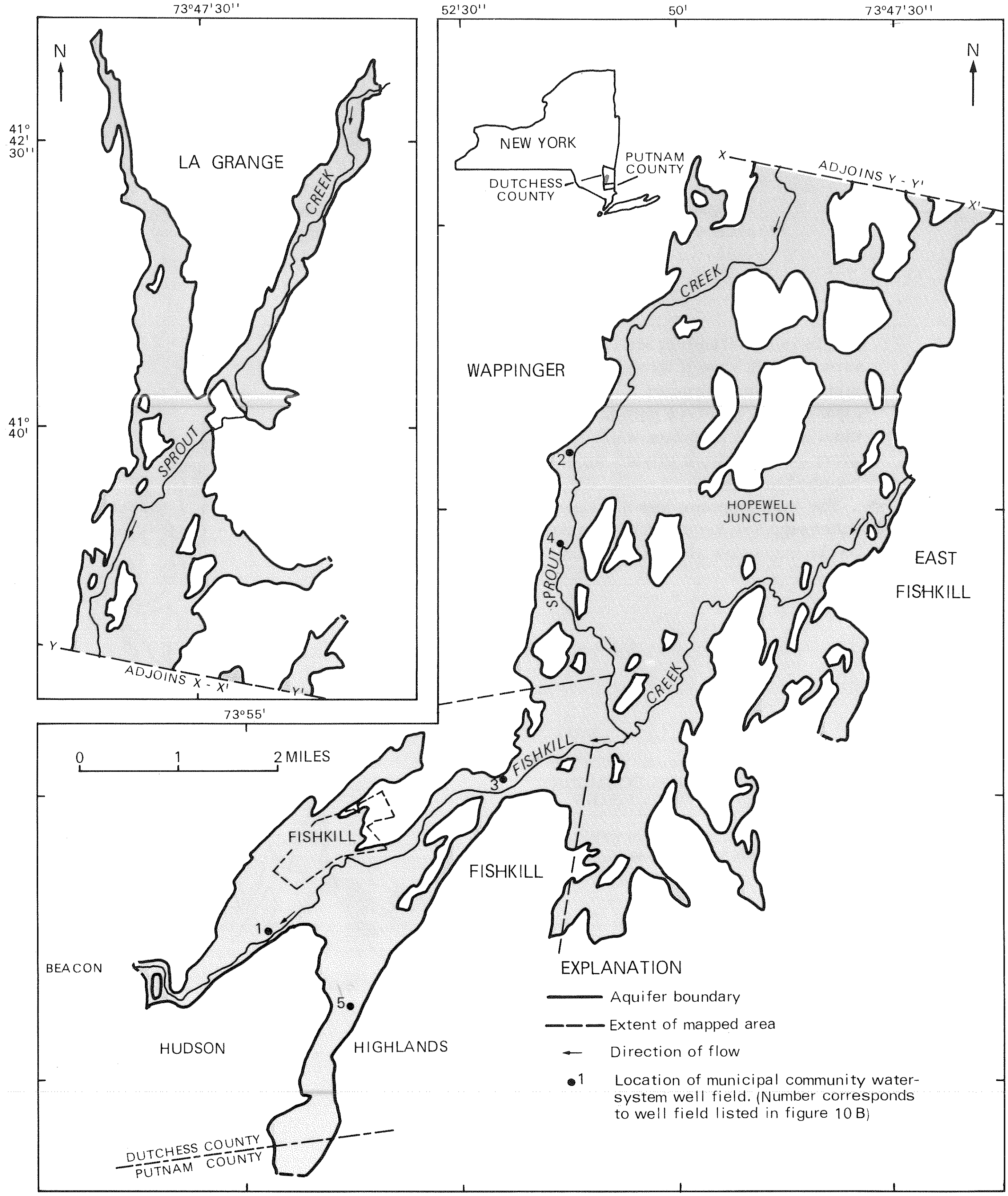
This aquifer underlies two converging stream valleys

The valley-fill aquifer of the Sprout Creek-Fishkill Creek area underlies the valley floor. The area is bounded on the north, east, and west by gently sloping hills and on the south by the Hudson Highlands.

This valley-fill aquifer underlies a 30-square-mile area extending southwest from central Dutchess County into the northwest corner of Putnam County (fig. 10A). Sprout Creek joins Fishkill Creek 2.5 miles northeast of the village of Fishkill. The area adjacent to the aquifer drains a 188-square-mile surface-drainage area.

The valley floor descends southwestward from an altitude of about 300 feet at its northern limit to an altitude of 200 feet at its southern end. The valley is bounded on the east, west, and north by low hills and on the south by the Hudson Highlands, a range of hills extending 500 to 1,600 feet above the valley floor. The valley floor is interspersed with several small bedrock hills.

FIGURE 10A SPROUT CREEK—FISHKILL CREEK AREA
Location and major geographic features



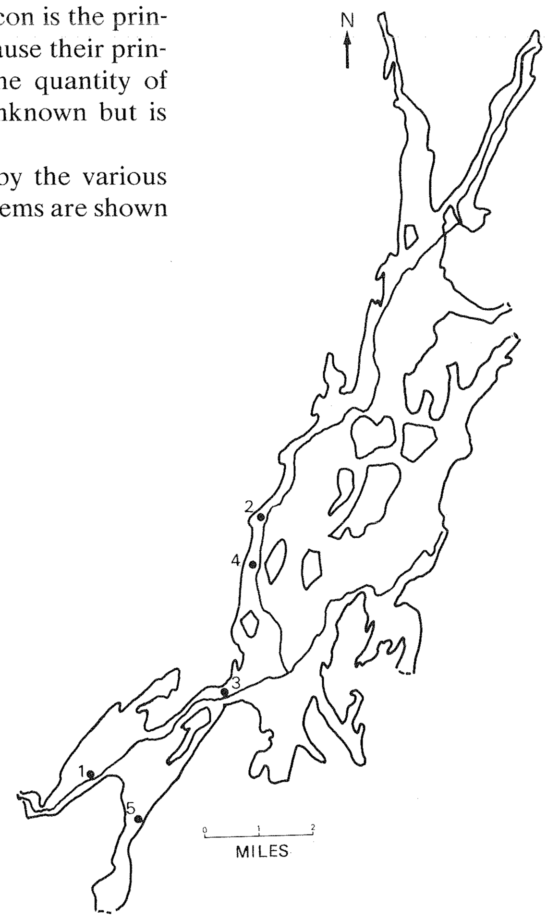
Base from U.S. Geological Survey, 1973

This aquifer provides water to about 23,000 people

The aquifer is a major source of supply for many community systems in the area. About 3 million gallons per day supplies 23,000 people.

This valley-fill aquifer serves a population of 23,000 and provides 3.01 Mgal/d for municipal, industrial, domestic, and agricultural purposes. The City of Beacon is the principal user but only on a part-time basis because their principal supply is a surface-water source. The quantity of water obtained from private supplies is unknown but is assumed to be minor.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown on the map below and in figure 10A.



LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite

POPULATION AND PUMPAGE FROM SPROUT CREEK-FISHKILL CREEK AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. City of Beacon	6,300	[3]1.10
2. Central Wappinger Improvement Area	1,800	* .30
3. Brinkerhoff Company	3,500	.30
4. Rockingham Farms	3,000	.30
5. Village of Fishkill	6,000	* .75
Glenham Water District	—	—
Beacon Hills Water District	—	—
6. Brettview Acres Water Company	920	* .09
7. Hopewell Services	900	.044
8. Revere Park	560	*. .05
9. Dogwood Knolls	600	.07
10. Hopegard Inc.	275	.011
11. Kensington Park Water Company	65	* .01
12. LaGrange Club Estates	120	.008
Subtotal	24,040	* 3.03
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer parks, apartments, and others (4)	490	.05
Total	24,530	* 3.08

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
[3] Pumpage occurred only 140 days per year in 1979. Water is derived partly from a bedrock aquifer.
* Estimated

Glacial deposits occupy a preglacial bedrock channel that follows a fault

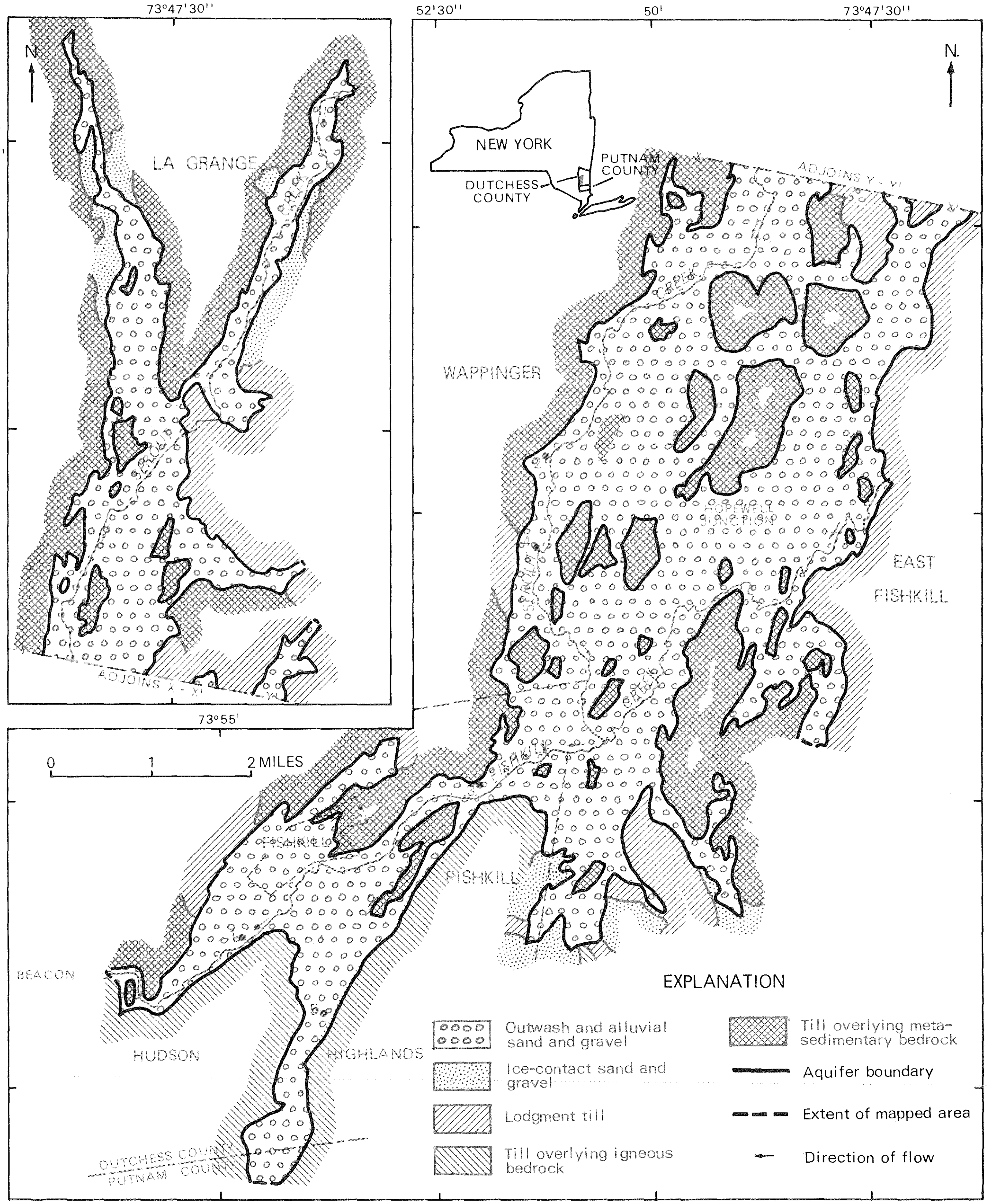
The aquifer area and surrounding hills are blanketed by unconsolidated material deposited by glaciers. Postglacial streams have reworked some of the material into well-sorted deposits of gravel, sand, silt, and clay. Granite and gneiss bedrock forms the highlands south of the area; the region to the north is underlain by metasedimentary rock. A bedrock fault separates the two regions.

The Sprout Creek-Fishkill Creek area has undergone repeated glaciation. During the most recent ice age, the glacier deposited across the area an irregular blanket of till consisting of poorly sorted clay, silt, sand, cobbles, and boulders derived mainly from the local bedrock. Lodgment till was deposited and compacted beneath the glacier; elongate hills (drumlins) of lodgment till are common in the lowlands (fig. 10C). As the glaciers receded, meltwater streams deposited stratified beds of gravel, sand, silt, and clay along their course. Postglacial and modern streams have reworked some of the deposits into sheets of alluvium overlying the outwash.

Bedrock beneath the glacial drift consists of two general rock types — granite and gneiss at the southern edge, and younger metasedimentary rocks (quartzite, marble, phyllite, and schist) from there north (Simmons, Grossman, and Heath, 1961). The contact between the two bedrock groups is a fault zone that zigzags across the southern edge of the area and trends northeast near the Town of Fishkill. The fault is significant in that it directed the development of the present valley system and associated sediment deposition through erosion by streams and glaciation. South of the fault, the land surface has high, steep ridges; north of the fault it is low and gently rolling. Both conditions reflect the types of bedrock and their degree of resistance to erosion.

FIGURE 10C SPROUT CREEK—FISHKILL CREEK AREA

Geologic setting



Base from U.S. Geological Survey, 1973

Modified from Moore and others, 1982

This aquifer consists of outwash and alluvium

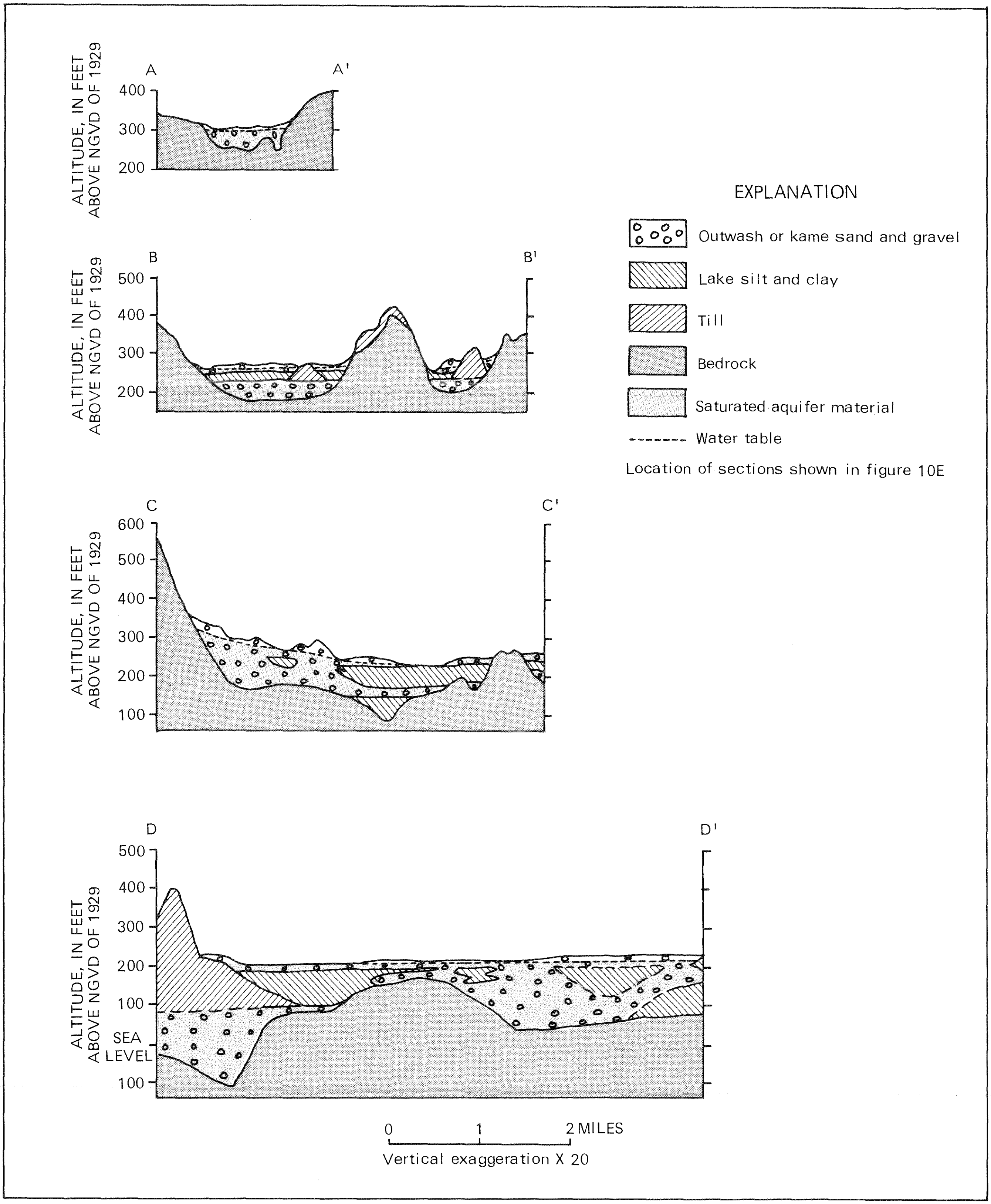
Glacial deposits fill a bedrock channel that follows a major buried fault. The complex stratigraphy of surficial deposits includes permeable water-bearing sediments and indicates at least two glacial advances and recessions.

A deep, narrow bedrock channel that extends northeast-southwest along a fault zone through the Town of Fishkill has been a major influence on the deposition patterns and thickness of glacial deposits in the Fishkill area. The channel was probably incised by a stream flowing along the fault before glaciation. The deepest part of the channel is at least 120 feet below sea level, as indicated in section D-D′ (fig. 10D). Limited data[1] on the channel indicate that its deepest parts are filled with sand.

Overlying the bedrock throughout this area are deposits of lodgment till and outwash sediments. The distribution of deposits indicates two glacial advances, which produced a complex stratigraphy. For example, drumlins that formed during a readvance overlie outwash sand deposits. The drumlins depicted in section B-B′ blocked the valley, forming a temporary pond or lake to the north in which silt and clay accumulated. At the former edge of this pond, deltaic sands and gravels interfinger with the silt and clay.

Overlying the mixed layers of ice-contact, outwash, and lake deposits is a layer of outwash from the final ice recession that has been reworked by modern streams. This outwash consists of cobble gravel in the north, which grades to sand in the south.

[1] Dineen, R.J., Seismic refraction data: Unpublished data on file with New York State Geological Survey, Albany, N.Y. Also New York State Department of Transportation, Borehole data: Unpublished data on file with New York State Geological Survey, Albany, N.Y.



Modified from Moore and others, 1982

Aquifer thickness is generally less than 40 feet

The aquifer thickness is largely unknown because the saturated outwash is interspersed with overlapping layers of clay, silt, sand, and gravel, each differing in thickness and extent. Thickness is generally less than 40 feet. Potential well yields vary greatly but probably average less than 200 gallons per minute in most places.

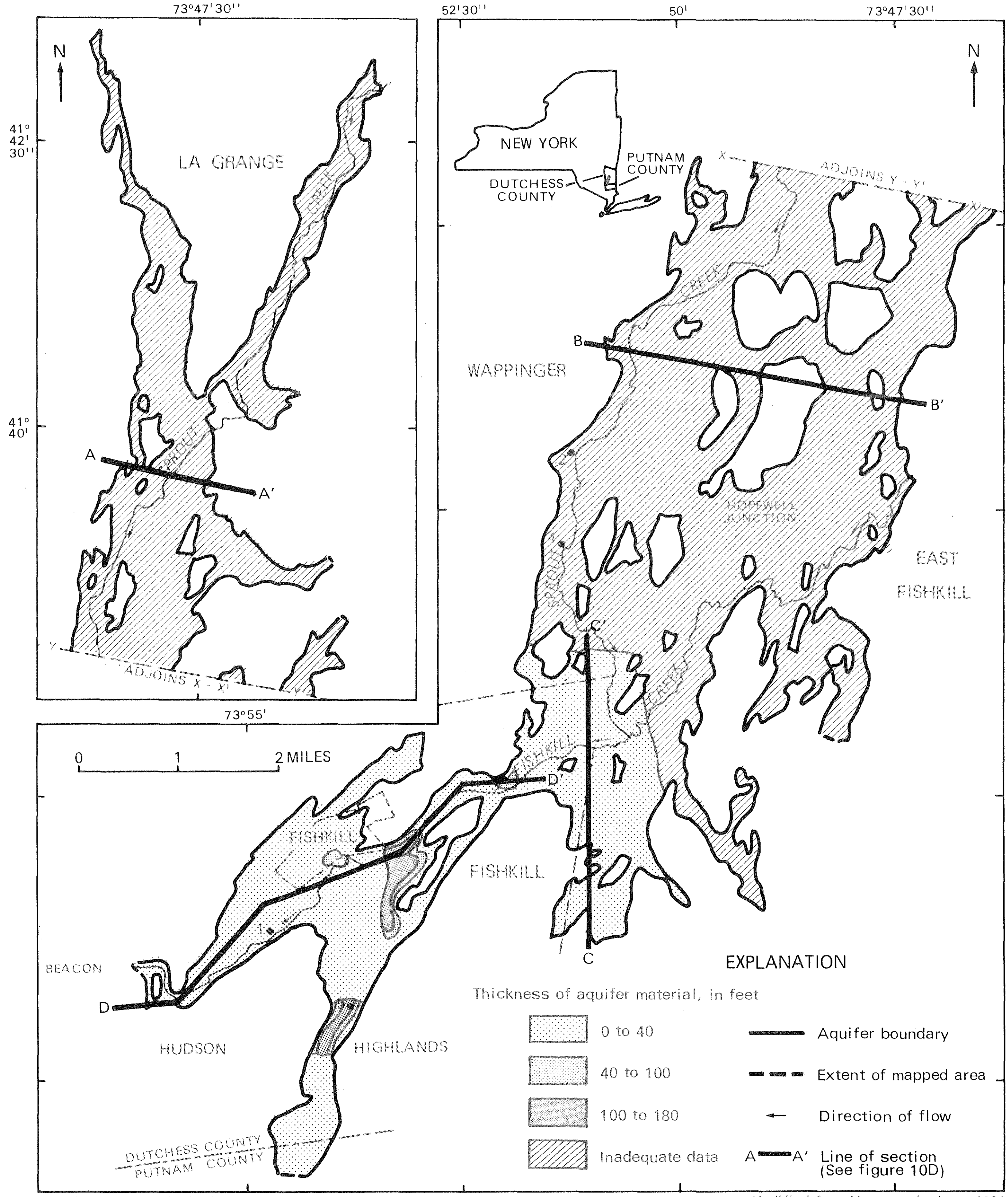
The Sprout Creek-Fishkill Creek valley-fill aquifer contains permeable sand and gravel interbedded with relatively impermeable silt and clay. Local variation is undoubtedly considerable, but data are insufficient to enable mapping of their thickness or distribution.

The saturated-thickness values in figure 10E represent the inferred thickness of sand and gravel from the water table to the top of the first unit of low permeability. The lower limit of the sand and gravel in most places is a silt or clay layer but may be bedrock locally.

The thickest aquifer layers are deltaic sand and gravel or ice-contact deposits, although some of the unmapped lower layers may be thicker and have larger potential well yields.

Potential well yields in most places cannot be derived from the present data because aquifer thickness is insufficiently known, but high yields can be expected wherever sand and gravel layers are thick or in contact with surface-water bodies. Snavely (1980) reports yields from 16 wells within the Town of Fishkill to range from 4 to 660 gal/min with an average yield of 189 gal/min. High-yielding municipal-supply wells may be feasible at several sites within the area, but the suitability of each site would need to be evaluated on an individual basis through detailed aquifer analysis and pumping tests.

FIGURE 10E SPROUT CREEK—FISHKILL CREEK AREA
Aquifer thickness and well yields



Base from U.S. Geological Survey, 1973

Modified from Moore and others, 1982

Ground water moves generally toward the main stream

The water table is shallow and closely parallels the land surface. Aquifer recharge is from precipitation; discharge is to streams, wells, and evapotranspiration. Seasonal water-table fluctuations are smallest near surface-water bodies with which they are in hydraulic contact.

Ground water is in constant movement from areas of high water table toward areas of lower water table. The rate of flow depends chiefly on the gradient and the permeability of the aquifer. This water-table map (fig. 10F) was derived from measurements taken in several wells at different seasons and from altitudes of surface-water bodies and therefore represents the average altitude.

Recharge occurs over the entire land surface from precipitation. It is largest where the soil is unsaturated, flat, and permeable; it is also significant along valley margins, where runoff from hillsides is concentrated. Recharge is greatest from late fall to mid-spring and is smallest during the growing season, when evapotranspiration occurs.

Ground water discharges principally through evapotranspiration, seepage to streams, and pumping wells. Additional loss occurs as underflow through the permeable layers in the bedrock channel in the southwest corner of the aquifer (see sec. D-D′ in fig. 10D).

Seasonal water-table fluctuations are greatest along the aquifer margins and are least along major streams and lakes, where ground water discharges to surface water. The 10-year hydrograph below shows the range of seasonal fluctuations within the northern part of the aquifer. No trends are apparent in the 10-year record.

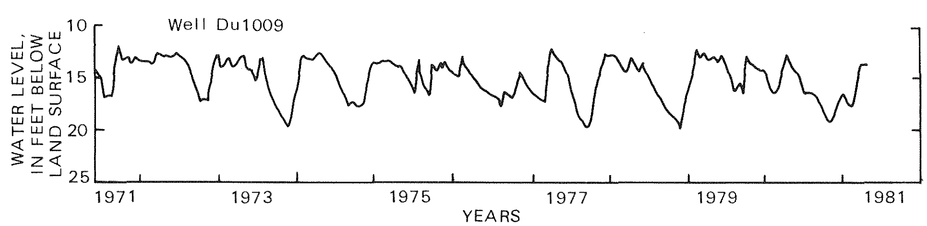
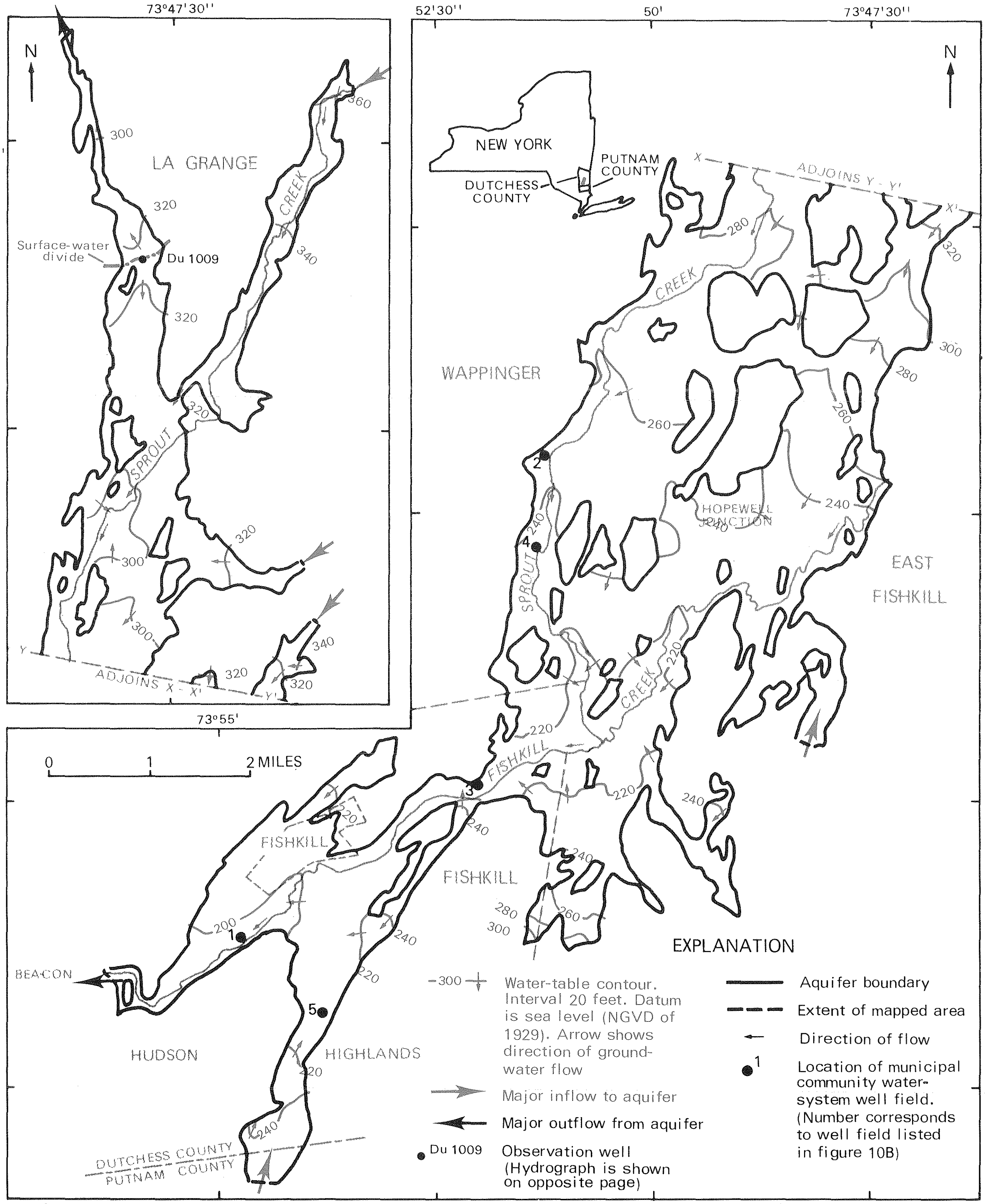


FIGURE 10F SPROUT CREEK—FISHKILL CREEK AREA

Ground-water movement



Base from U.S. Geological Survey, 1973

Modified from Moore and others, 1982

Infiltration rate varies considerably within this area

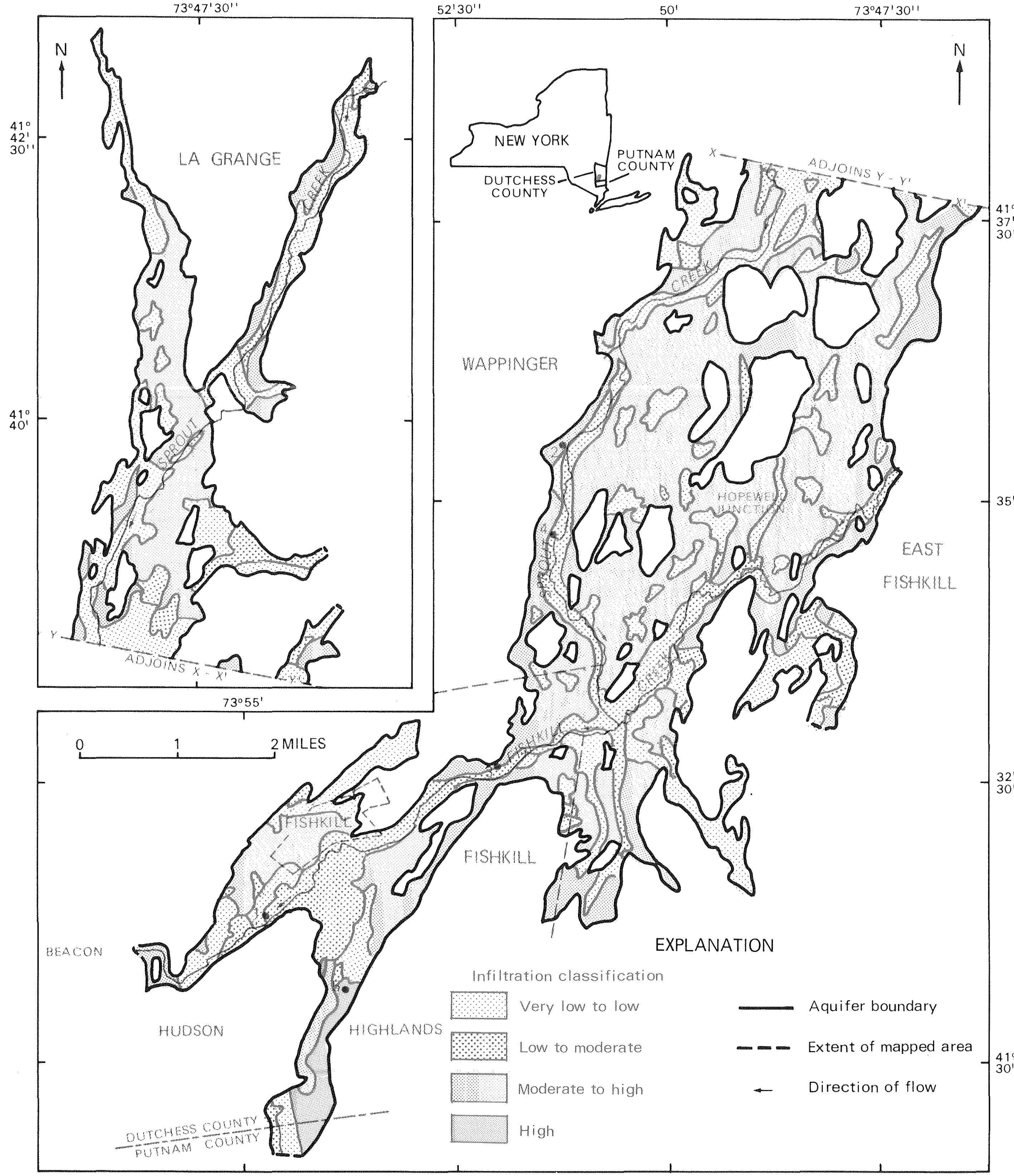
Water-infiltration potential of soils in the Sprout Creek-Fishkill Creek area ranges from very low to very high. Till and clayey soils have the lowest potential; sandy and gravelly soils have the highest. Some of the most permeable soils in the area are in the Town of Fishkill.

Infiltration rate is a general estimate of the permeability of the soil zone and may help determine the susceptibility of an aquifer to contamination from surface sources. Soils having highest infiltration rates are those with a high sand or gravel content; those of lowest permeability are rich in till, clay, and silt.

Infiltration rate varies locally and seasonally, depending on several factors. The soil zone in this area ranges from 18 to 30 inches in thickness and is considered to be only the upper, weathered strata (A and B horizons) overlying unweathered material. The Sprout Creek-Fishkill Creek area contains a variety of soil types and infiltration rates. Soils of high permeability overlie most of the aquifer but do not form a continuous layer and commonly occur adjacent to soils having low permeability.

Some of the most permeable soils are in the southwest part of the aquifer in the Town of Fishkill. Those of lowest permeability include some of the flood-plain deposits on the valley floor.

FIGURE 10G SPROUT CREEK—FISHKILL CREEK AREA
Soil-zone permeability



Base from U.S. Geological Survey, 1973

Modified from Moore and others, 1982

This area is undergoing rapid commercial development and population growth

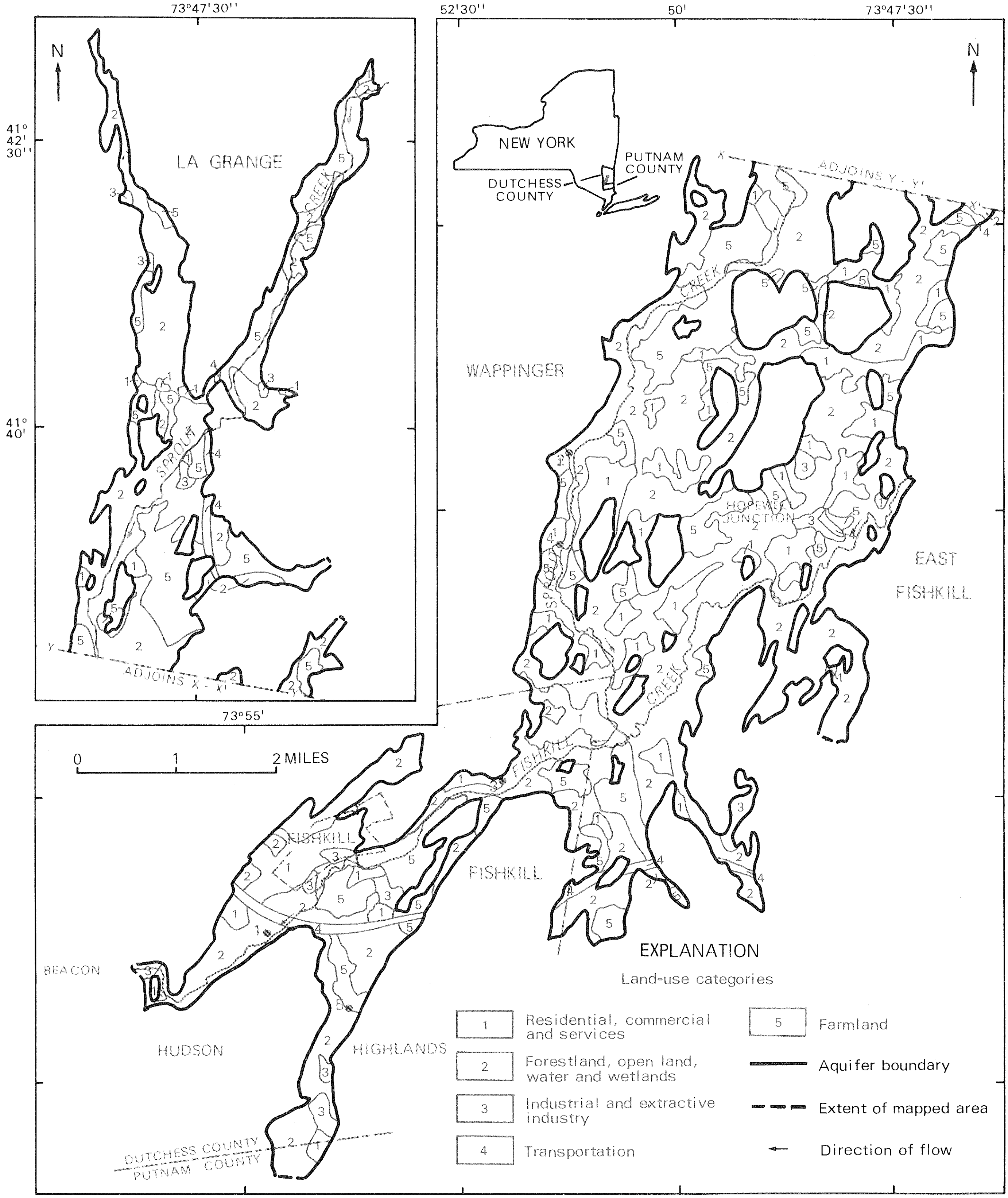
This area contains a diversity of land uses. Commercial, industrial, and residential development over the aquifer are increasing steadily; the remaining land is mostly forest, wetland, open public land, and farms.

Land use may affect the quality of water within the underlying aquifer in a variety of ways, depending upon the soil's ability to transmit water or fluid containing dissolved or suspended contaminants. As indicated in figure 10H, residential, commercial, and industrial land uses are predominant in the Town of Wappinger and, to a smaller extent, in the Town of Fishkill. The rest of the area consists mainly of wetlands, forest, and open public land. Interstate I-84 traverses the southern part of the area; the Taconic Highway traverses a small segment in the north.

This map[1] depicts the six land-use categories most pertinent to the aquifer system: industrial and extractive, residential and commercial, agriculture, forest and open public land, water and wetlands, and major transportation corridors. Since 1968, the area has undergone moderate increases in residential and commercial development.

[1] Figure 10H was compiled from the 1968 Land Use and Natural Resources Inventory (LUNR) by Cornell University for the New York State Department of Transportation

FIGURE 10H SPROUT CREEK—FISHKILL CREEK AREA
Land use



Base from U.S. Geological Survey, 1973

Modified from Moore and others, 1982

Both quantity and quality of ground water are adequate at present

Currently there are few problems in this aquifer system. Industry is a potential source of contamination, and increased growth will require aquifer analysis to determine the extent of contamination and maximum potential yield.

The Sprout Creek-Fishkill Creek area is fortunate in that demands on the aquifer have not as yet caused any water shortages. The residents are aware that continued land development, generally in the adjacent uplands, will cause water demands that may exceed the ground-water supplies. An area in the southeast part of the aquifer has a contamination source from industry that may threaten the aquifer quality (New York State Department of Environmental Conservation, written commun., 1982.)

The Town of Fishkill, which is undergoing a continued expansion of housing, purchases water from the Village of Fishkill. Because the village is not sure the supply will be adequate, the town has sponsored a ground-water investigation as to water needs. Snavely (1980) appraised the town's ground-water resources as a first step in determining ultimate yield of the system. A more detailed appraisal would be needed before additional suppplies could be safely obtained from the aquifer system.

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11
FULTON AREA

By Henry A. Anderson

A. Location and major geographic features

B. Population and ground-water use

C. Geologic setting

D. Geohydrology

E. Aquifer thickness

F. Ground-water movement

G. Well yields

H. Soil-zone permeability

I. Land use

J. Present and potential problems

K. Selected references

A. Location and major geographic features

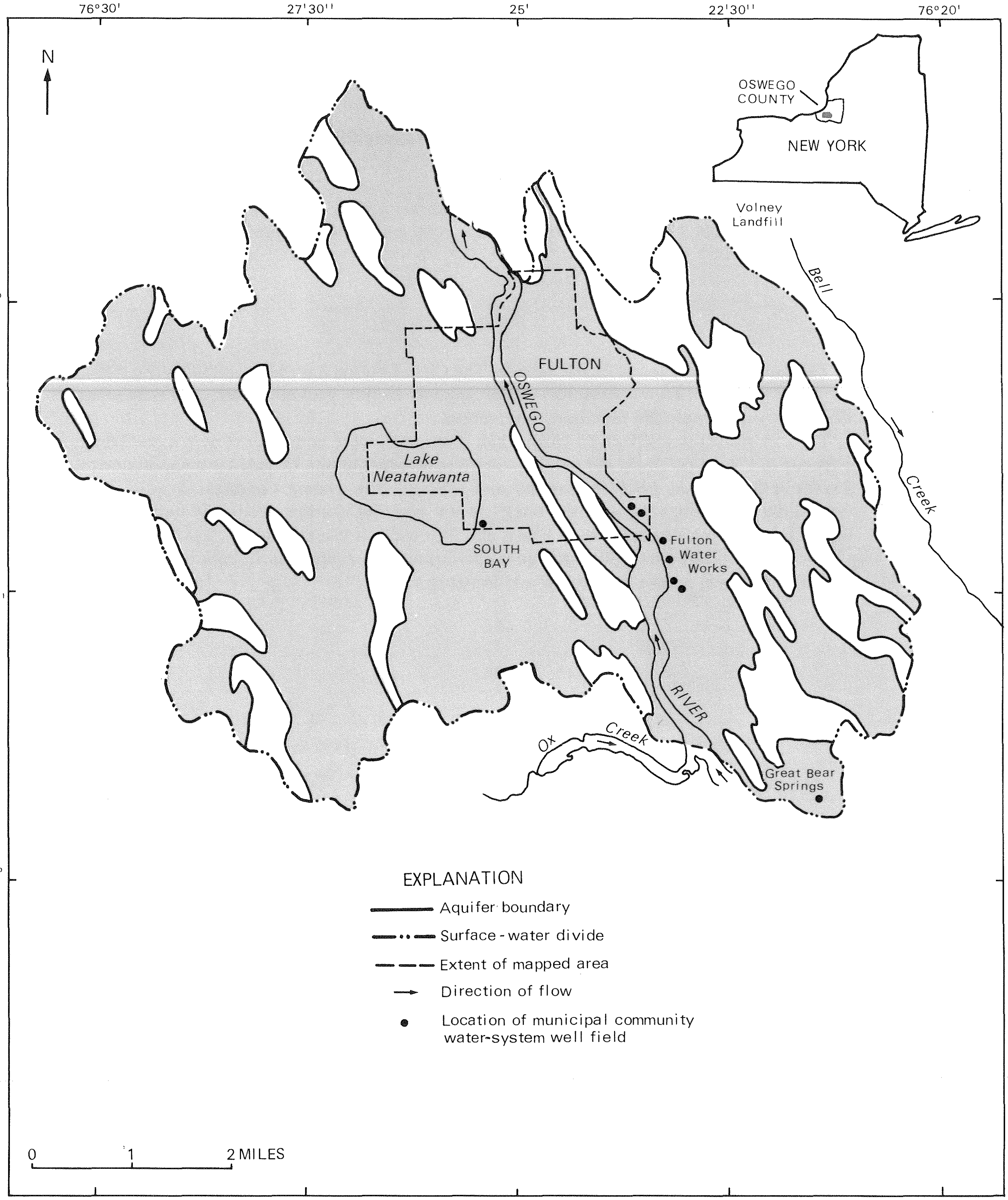
This aquifer lies along the Oswego River on the Lake Ontario Plain

The Fulton area is in southwestern Oswego County, along the Oswego River near Lake Ontario. The principal community is Fulton, an industrial town, in the glaciated hummocky lowlands of the Lake Ontario Plain.

The Fulton area lies in the southwestern corner of Oswego County along the Oswego River, about 10 miles upstream from Lake Ontario (fig. 11A). The aquifer area is arbitrarily defined because the relatively flat Ontario Lake plain contains no bedrock boundaries. Surface-drainage divides were used to delineate the area having a direct hydraulic influence on the aquifer used by the City of Fulton.

Land-surface altitudes range from 308 feet north of the Oswego canal lock in Fulton to more than 500 feet several miles southwest of town. The area covers about 50 square miles. Lake Neatahwanta, a shallow lake having a 1.17-square-mile area, borders the west edge of the city. Small streams in the area drain into the Oswego River-Barge Canal, which in turn receives drainage through canal waterways from as far as the Finger Lakes and Lake Erie.

FIGURE 11A FULTON AREA
Location and major geographic features



Base from U.S. Geological Survey, 1978

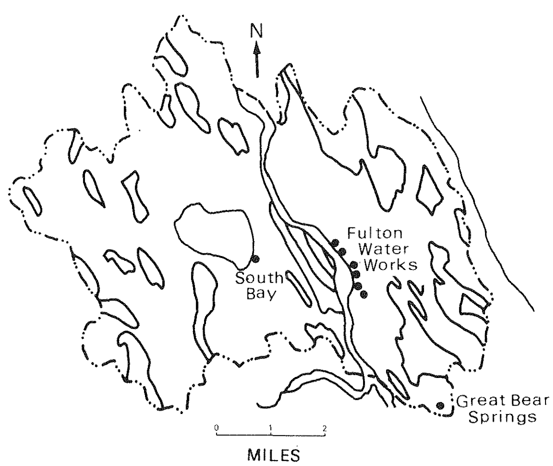
This aquifer provides water to nearly 22,000 people

The entire area depends on ground water. About 22,000 people use an estimated 4 million gallons per day, principally from community water systems.

This aquifer serves nearly 22,000 people. The City of Fulton has three well fields (fig. 11B). In addition, nine other community water systems supply ground water, and numerous domestic wells supply the remaining population.

The city system dates back to 1884, when three wells were constructed with a combined capacity of 1 Mgal/d. Today the municipal system provides about 3 Mgal/d to a population of 15,000 in Fulton and 1,000 in Granby and Volney. The system contains 12 wells, one near Lake Neatahwanta (South Bay); seven river-infiltration wells (Water Works) along the east bank of the Oswego River, and four wells at Great Bear Springs.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of pumping centers are shown on the map below and in figure 11A.



LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite

POPULATION AND PUMPAGE FROM FULTON AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
Fulton City (3 well fields)	15,000	2.90
West River Road Water District	550	—
East River Road Water District	400	—
Subtotal	15,950	2.90
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer parks (9)	* 1,000	0.70
C. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per day per capita is assumed	* 5,000	* 0.50
Total	* 21,950	* 4.10

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
* Estimated

The shallow bedrock is overlain by a variety of glacial and lacustrine sediments

Most of the sediments in the Fulton area are derived from glaciation and associated lakes. Till, fine-grained lake deposits, and coarse-grained kame and beach deposits are scattered across the nearly flat-lying sedimentary bedrock.

The Lake Ontario lowland is covered by glacial and lake deposits and is underlain by a series of sandstone-shale formations that slope gently southward at about 50 feet per mile. Elongate deposits of lodgment till of varying thickness predominate in the eastern part and occur to a lesser extent in the western part. Scattered deposits of kame sand and gravel, laid down by meltwaters flowing away from the ice front, are interspersed throughout the area.

As the ice front receded northward, a proglacial lake (Glacial Lake Iroquois) formed at its front. Wave action winnowed the fine material out of some of the till hills that protruded at or above the lake surface and created permeable beach zones. A mantle of lake silt and clay then formed over the glacial deposits and filled in many of the depressions (fig. 11C). As the lake level receded and became what is now Lake Ontario, streams flowing over the former lake bed formed shallow channels and deposited sand and gravel along them.

Postglacial streams belonging principally to the Oswego River system reworked some of the glacial deposits. Today's landscape is much as it was soon after the glacial lake receded.

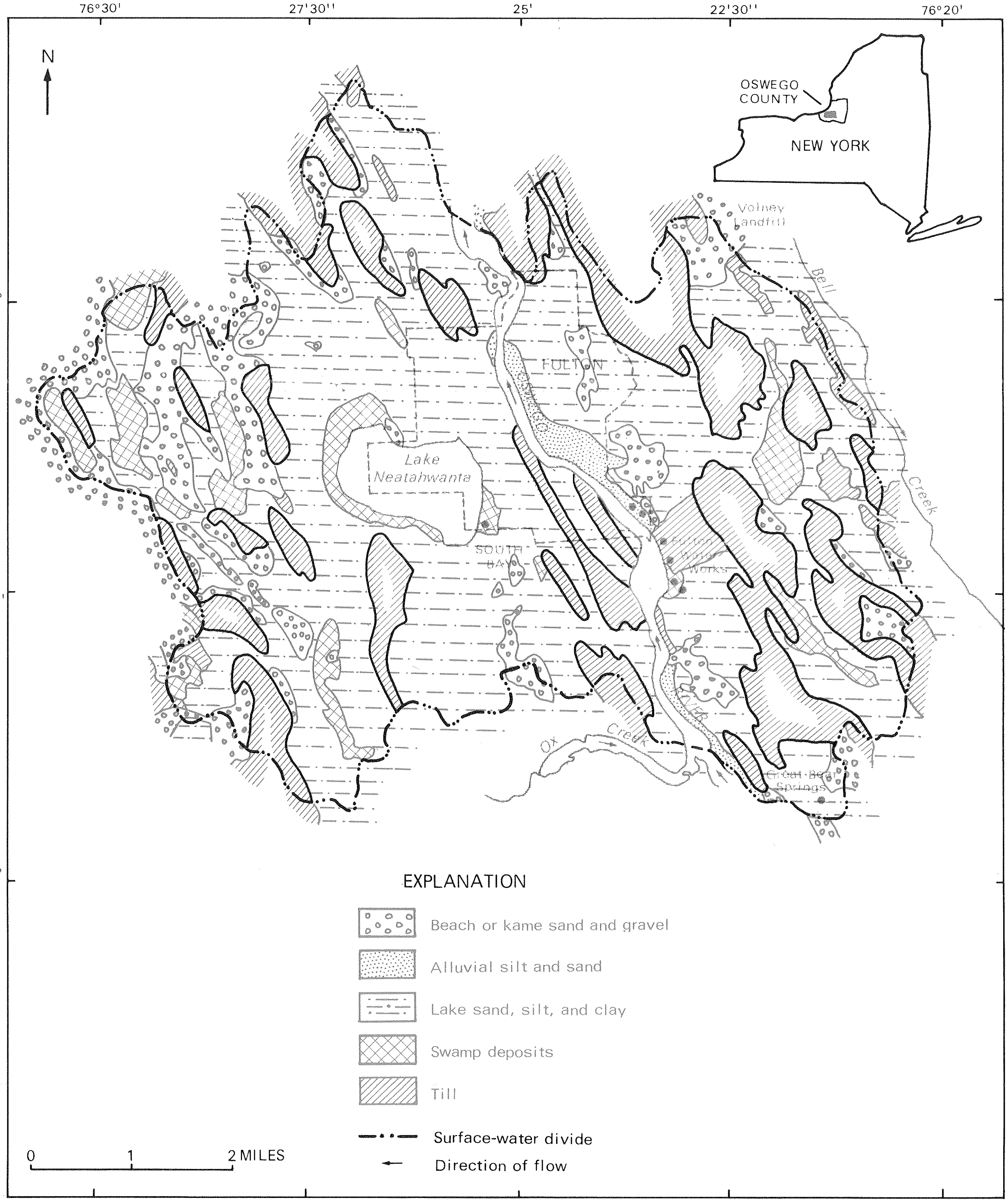
Glaciolacustrine deposits cover the bedrock with as much as 150 feet of silt, clay, sand, and gravel (fig. 11C). Till may be more than 100 feet thick beneath the northwest-southeast trending hills (drumlins), but the average thickness is 30 feet.

As the glaciers stagnated and disintegrated, their sediment load settled out as ablation till consisting of unsorted and loosely consolidated clay, silt, sand, and boulders. Ablation till is exposed in the eastern part of the Fulton area and may overlie either lodgment till or bedrock.

Beach and wave currents in the glacial lake deposited sand and gravel as irregular patches along once-active shores. These deposits are prevalent in the western part of the area.

Scattered mounds of sand and gravel (kames) a few tens of feet thick lie on top of till or lake-bed deposits throughout the area.

FIGURE 11C FULTON AREA
Geologic setting



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

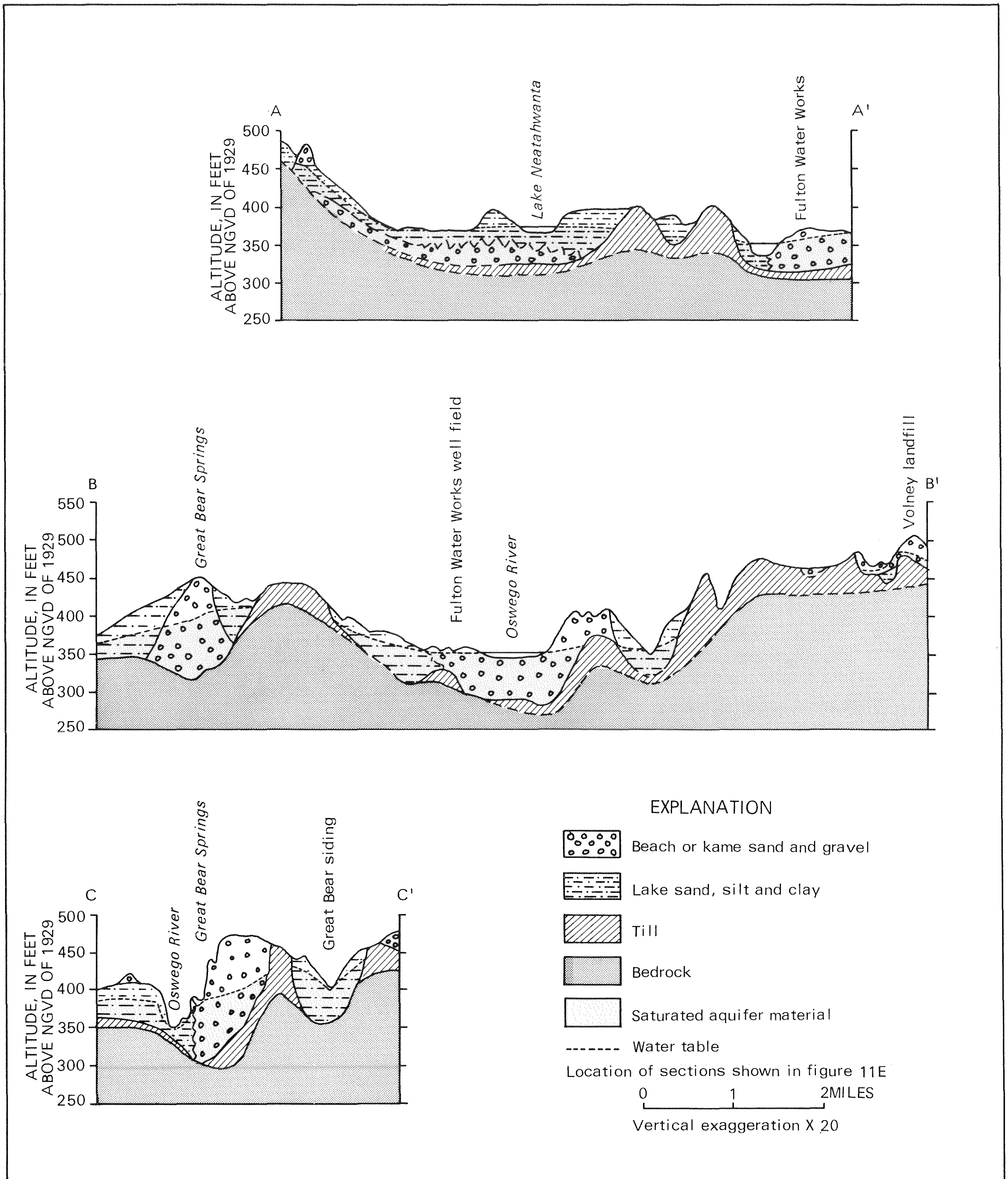
The principal aquifers are overlain mostly by lacustrine sediments

Proglacial lake deposits cover the more permeable water-bearing beach and ice-contact deposits, which are interspersed with lodgment till. The coarse deposits are relatively thin and overlie a subdued undulating bedrock topography.

The geologic sections in figure 11D show the principal water-bearing sand and gravel aquifers in the Fulton area. Section A-A′ (fig. 11D) is a hydrologic interpretation of the subsurface from Lake Neatahwanta to the Fulton Water Works. Glacial deposits generally less than 100 feet thick mantle the sandstone-shale bedrock. They consist of relatively impermeable till directly overlying the bedrock surface throughout the area, and a sand and gravel aquifer system that overlies the till in the Lake Neatahwanta area. This aquifer is in turn overlain by fine-grained, relatively impermeable lake-bed deposits.

Section B-B′ shows a profile between the well fields at Great Bear Springs, Fulton Water Works, and the Volney landfill. The aquifer at Great Bear consists of kame sand and gravel separated from the Water Works gravel aquifer by an impermeable till unit. The Fulton Water Works well field is hydraulically separated from the Volney landfill by lodgment-till terrane.

Section C-C′ shows a profile from the Great Bear Farm well field to the Oswego River. The municipal wells tap kame sand and gravel under a gravel cap. A ridge of lake silt forms a hydraulic barrier between the river and the aquifer so that pumping does not draw river water into the aquifer.



Modified from Anderson and others, 1982

Most water-bearing units are less than 60 feet thick

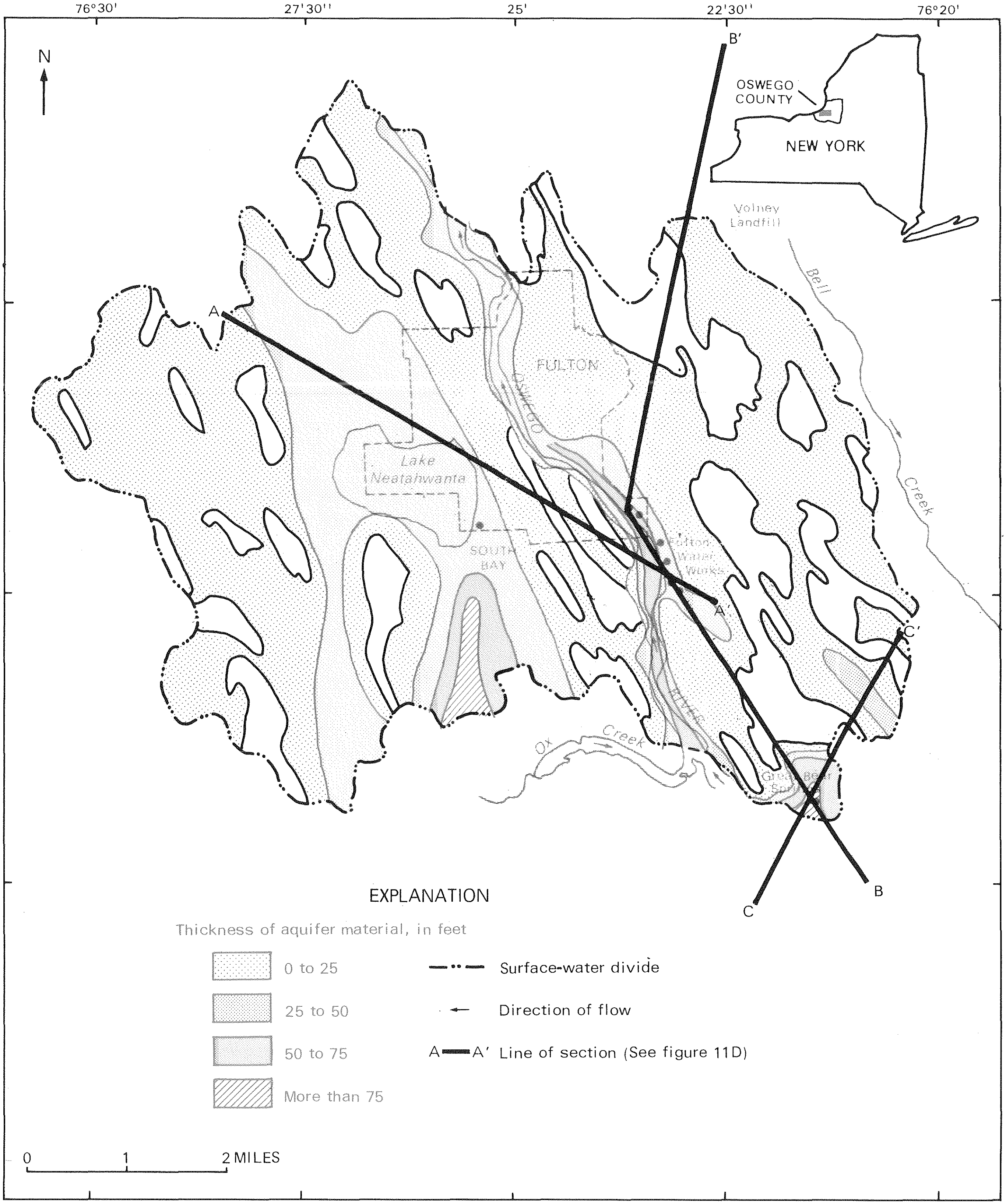
The Fulton area aquifer system consists of relatively thin, discontinuous deposits of stratified glacial-lake sands. Coarse sand and gravel units less than 60 feet thick are the principal aquifers.

The aquifer-thickness map (fig. 11E) represents saturated thickness of stratified gravel and sand deposits as well as that of lake clay, silt, and sand. Although the extensive lake clay, silt, and sand layers are not highly permeable, they are saturated and contribute water to underlying or adjoining aquifers. The gravel and sand deposits are discontinuous. Because their extent is unknown, they are not mapped individually.

The saturated thickness of stratified drift in most areas is less than 50 feet. About 15 percent of the Fulton area probably has more than 50 feet of aquifer. The thickest highly permeable gravels known in the area are at the well fields. The aquifer at the Fulton Water Works is a gravel deposit several hundred feet wide and about a mile long on the east side of the Oswego River (fig. 11E). It ranges from 30 to 60 feet in thickness and is hydraulically connected to the river. Several wells drilled around Lake Neatahwanta indicated gravels from 25 to 50 feet deep along the north and southeast shore of the lake.

The Great Bear Springs well field taps a small beach-kame sand and gravel complex with a maximum saturated thickness of about 80 feet. About 1 mile northeast of the well field, four test wells were drilled and encountered a sand and gravel aquifer about 30 feet thick (Wolfert and Isbister, 1975).

FIGURE 11E FULTON AREA
Aquifer thickness



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

Ground water moves northward and toward the Oswego River

Ground water moves toward the Oswego River roughly parallel to land surface. The water table is relatively flat, but its altitude fluctuates locally and seasonally in response to fluctuations in recharge or discharge.

Figure 11F shows the general potentiometric-surface (water-table) configuration as derived from surface-water altitudes and sparse well data. The water-table surface essentially reflects the land-surface topography, and the drainage divide of the water table is assumed to coincide with the surface-water drainage divide. Ground-water flow essentially parallels the direction of surface runoff; both ultimately flow into streams and the Oswego River.

In the Fulton area, the aquifers are recharged mostly through the kame sand and gravels on the east and west sides of the area (see fig. 11C). Ground water discharges into Lake Neatahwanta, into streams, and into the Oswego River. The two dam and lock sites in Fulton maintain relatively constant river-surface levels at 308 and 353 feet; ground-water levels adjacent to the river are approximately the same as the river levels except at the Fulton Water Works, where pumping lowers the water level and induces river water flow to the wells.

The water table fluctuates in response to seasonal recharge and discharge, as shown in the hydrograph. In general, ground-water levels rise from recharge from late fall to spring and generally decline after April, as temperatures rise and evapotranspiration increases. Of the 35 inches of precipitation that falls annually, net recharge to the water table has been estimated to be about 8.5 inches (Kantrowitz, 1970). The rest is evaporated, transpired by plants, or absorbed in the soil zone.

Water-table fluctuations from season to season may range from 25 feet under hills to less than a few feet in lowlands. Locally water levels may be affected by pumping. Ground-water storage from year to year remains relatively constant.

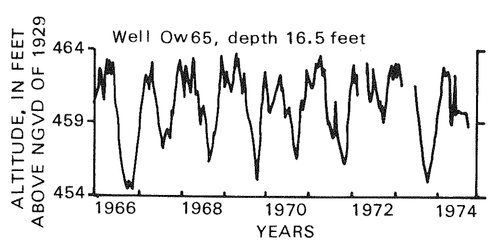
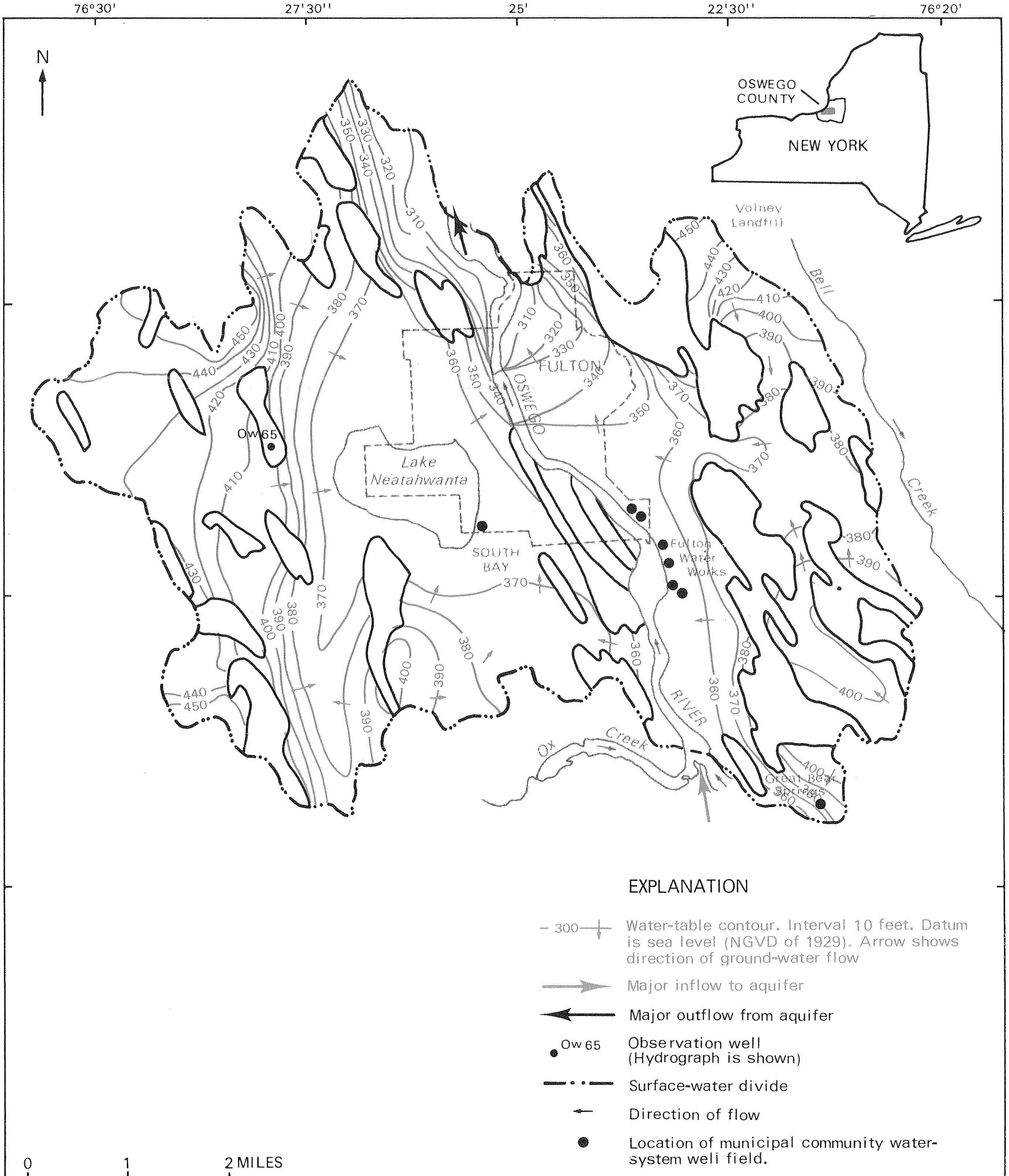


FIGURE 11F FULTON AREA
Ground-water movement



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

Most deposits produce less than 50 gallons per minute

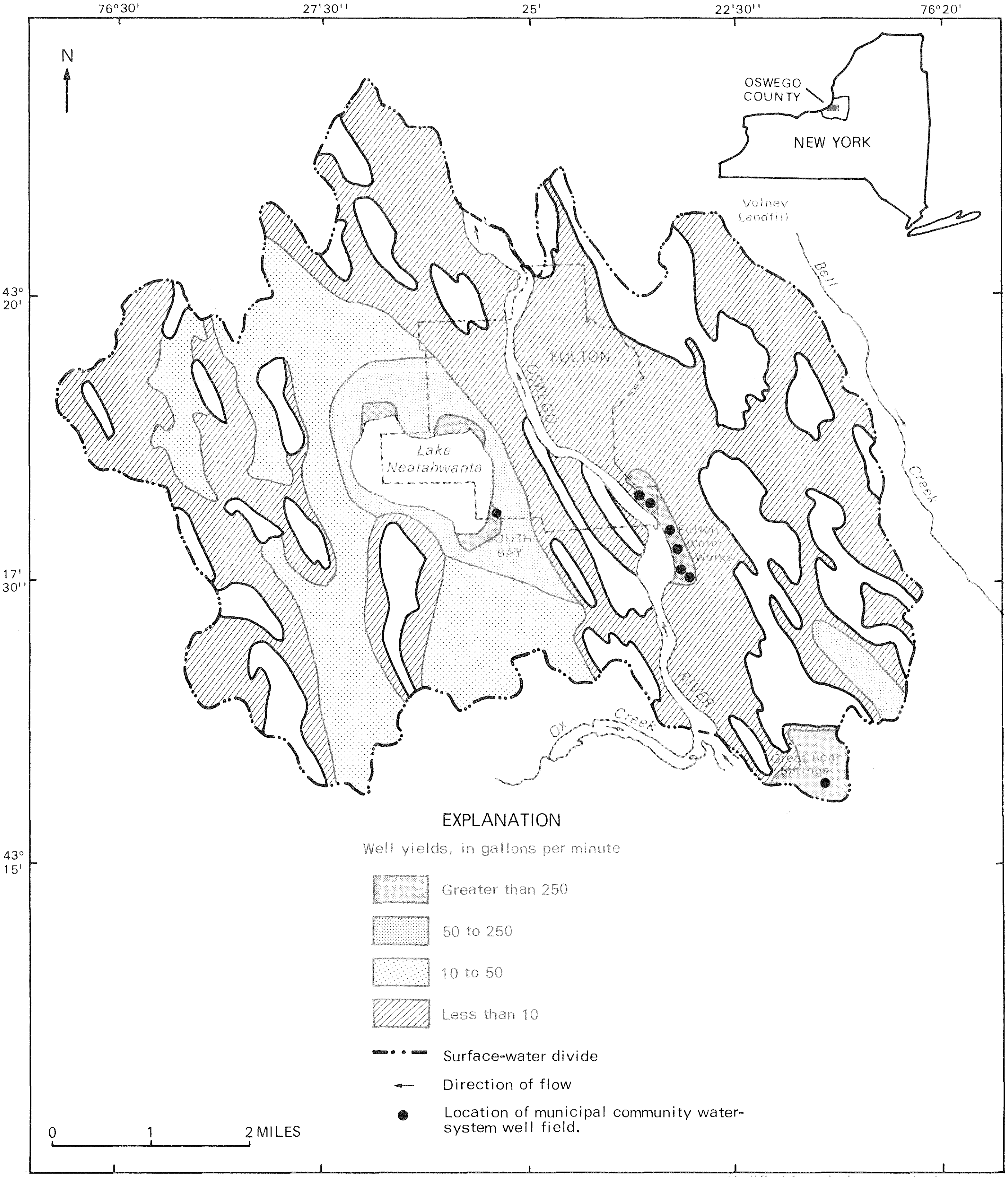
Well yields in the Fulton area are generally less than 50 gallons per minute. However, three small areas containing highly permeable gravel produce more than 250 gallons per minute.

The well-yield map (fig. 11G) indicates the maximum yield that individual wells in a given area may be expected to obtain. The data are based on hydrologic interpretation of well logs and the map of saturated thickness of aquifer material (fig. 11E). Except for the known high-yield areas, the data are meager. In most of the Fulton area, wells will not yield more than 50 gal/min.

Sand and gravel aquifers are highly productive but localized in areal extent and thickness. Some may yield as much as 1,000 gal/min to wells. Known areas yielding more than 250 gal/min are in the well fields. Wells in the Water Works well field yield from 150 to 450 gal/min and average 260 gal/min. The area around the north and southeast shore of Lake Neatahwanta has two wells — the North Bay well (350 gal/min) and South Bay (500 gal/min). Layne (1966) estimated that 2 Mgal/d could be developed from the South Bay area. These areas all receive recharge from the adjacent surface-water body and provide large well yields.

The Great Bear Springs sand and gravel aquifer has well yields ranging from 150 to 1,000 gal/min and averaging 570 gal/min. Deluca and Miller (1967) estimate that 2 Mgal/d could be developed from the aquifer. An aquifer test 1 mile northeast of the springs yielded 260 gal/min (Wolfert and Isbister, 1975). In most other areas of Fulton, the stratified drift is fine grained and not very permeable but is suitable for low-yield domestic wells.

FIGURE 11G FULTON AREA
Well yields



Base from U.S. Geological Survey, 1978

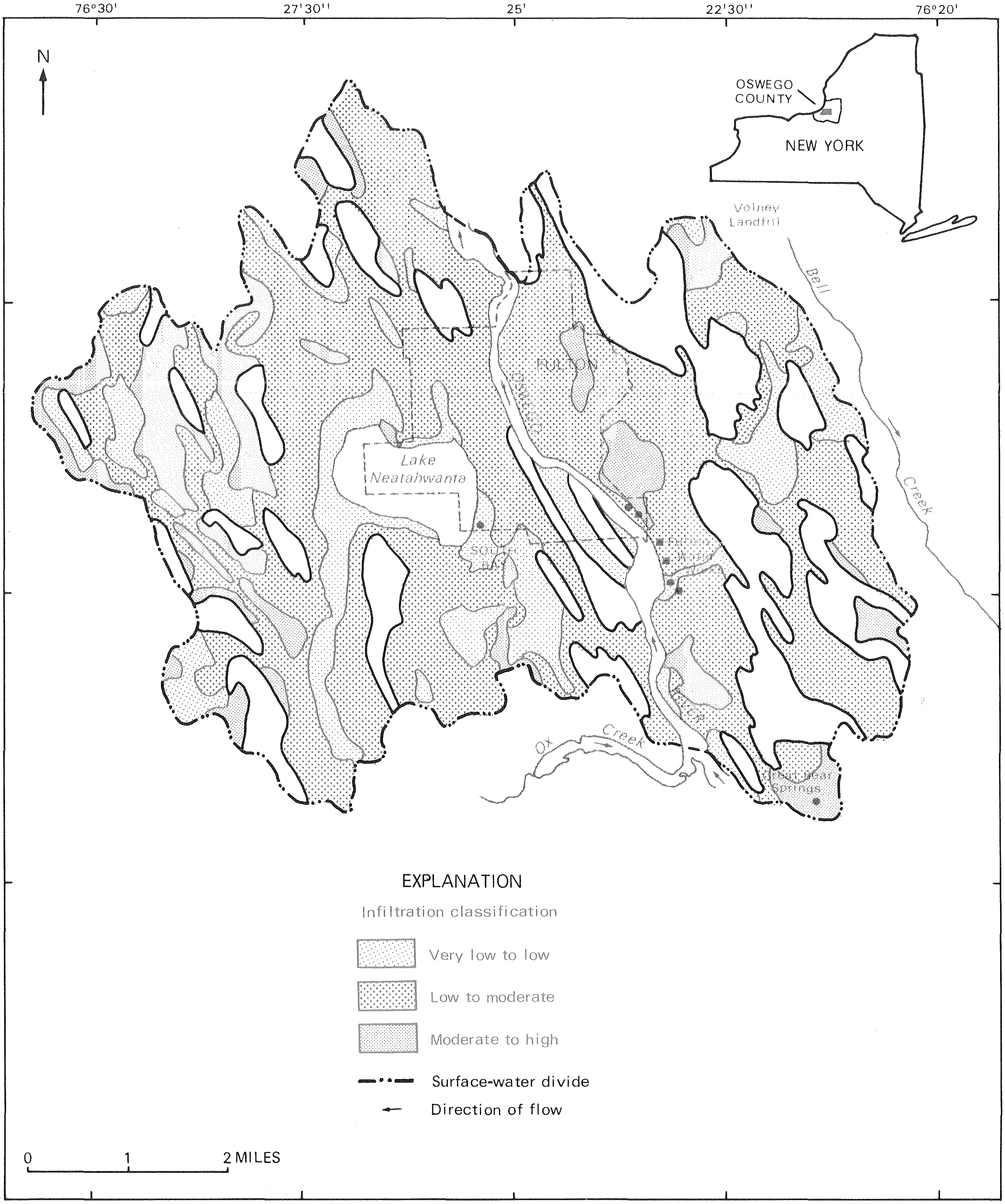
Modified from Anderson and others, 1982

Soils overlying this area have low to moderate permeability

Soil permeability is low to moderate over most of the Fulton area. Fine-grained glacial lake deposits and till cause very low to moderate soil permeability. Sand and gravel deposits have moderate to high infiltration rates and serve as recharge areas.

The Fulton area exhibits a complex pattern of soil associations (Mooney and others, 1919) with varying ranges of permeability (fig. 11H). The most permeable soils are those that are developed in the stratified sand and gravel deposits of kames, beach, and wave deltas; these soil groups have moderate to high permeability. The areas with the least permeable soils are those containing swamps, bogs, lake silt and clay, and till. Soils on lake sand and silt deposits have low to moderate permeability.

FIGURE 11H FULTON AREA
Soil-zone permeability



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

11 FULTON AREA
I. Land use

Except for Fulton, the area is suburban and rural

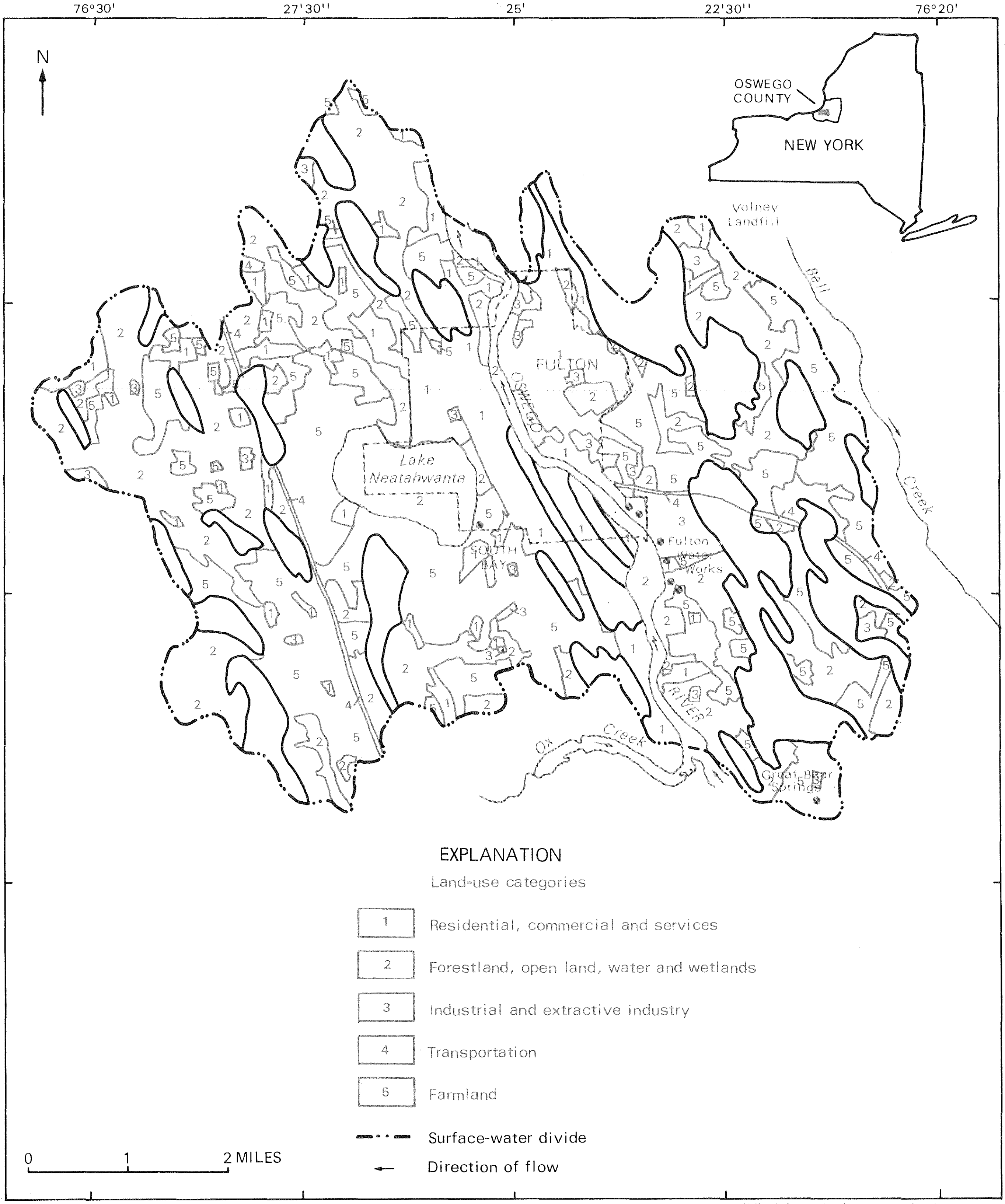
This aquifer area is predominantly rural forest, farm, and wetlands. The Fulton well field is in an urban-industrial area; the other major well fields are in rural and forest areas.

Land use in the Fulton area[1] is over 50 percent forest, farm, and wetlands, with scattered industrial and commercial use centralized around the predominantly residential City of Fulton (fig. 11I). The city is bisected by the Oswego River and is bordered on the west by Lake Neatahwanta. Local wetlands are scattered throughout the Fulton area. Rural sections of the aquifer area are predominantly agricultural with some forest sections.

The Fulton Water Works well field adjoins industrial, transportation, and commercial property, all of which are potential sources of pollution to the shallow gravel aquifer. The South Bay well (Lake Neatahwanta) is in a farm and wetland area where fertilizers could reach the aquifer. The Great Bear Springs well field is in open public forestland that is relatively free of any contamination threat.

[1] The Fulton area land-use map (fig.11I) was compiled from the 1968 Land Use and Natural Resources Inventory (LUNR) conducted by Cornell University for the New York State Department of Transportation. Updates of the LUNR maps were completed by the Oswego County Planning Board in 1978-79.

FIGURE 11I FULTON AREA
Land use



Base from U.S. Geological Survey, 1978

Modified from Anderson and others, 1982

Chemical waste dumps in Oswego River drainage area are a major concern

Contaminants migrating from chemical waste dumps and landfills pose a threat to some aquifers in the area. Septic systems, fertilizers, and induced infiltration of poor-quality river water or brackish water from bedrock may also be detrimental.

A recent survey of organic chemicals in public-supply waters showed that some wells in the Fulton area may be contaminated by benzene and toluene (Kim and Stone, 1979; Schroeder and Snavely, 1981).

Also of concern is the discovery and documentation of chemical-waste dumps in Oswego County (Scrudato and others, 1980). The Volney landfill, 4 miles north of the Fulton well field (fig. 11A), contains 8,000 barrels of buried chemical waste. Although leachate has contaminated the local gravel aquifer adjacent to the dump, the extent of migration is not known. Bedrock is the source of water for most domestic and farm wells in the area. The landfill offers no apparent threat to Fulton municipal wells except possibly through leachate migration to Bell Creek, which flows into the Oswego River upstream from the well field. As pointed out earlier, pumping the well field induces recharge from the river.

The Clothier dump site, 4 miles southwest of Fulton, contains 1,500 barrels of chemicals that are leaking into Ox Creek (see fig. 11A) wetlands. Soil samples from below the barrels contain 92 mg/L of PCB's (Scrudato and others, 1980). If Ox Creek contains pollutants, they will flow into the Oswego River, thereby endangering the Water Works wells downstream.

The expanding surburban population brings with it the potential for septic pollution of ground water. Other potential sources of ground-water pollution are fertilizers used on farms and lawns, and also road salting.

Water-quality deterioration may also result from heavy pumping of aquifers lying directly on bedrock because the bedrock beneath the lake Ontario plain is known to contain brackish water (Kantrowitz, 1970). The rather high chloride concentrations (100 to 200 mg/L) in the Fulton city wells along the river may be due to brackish water discharging into the Oswego River from bedrock or, possibly, from sewage and industry effluent discharged into the river upstream from Fulton. Although Oswego River quality has improved from the past, it still contains substances that are undesirable in drinking water.

The quantity of ground water in storage has been little affected by pumpage of 2 to 4 Mgal/d over the years, and the water table has remained relatively stable. River water has sustained the heavy pumpage of the Water Works wells. The Great Bear Farm aquifer is, however, susceptible to water-table declines if overpumped unless infiltration of river water can be induced.

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12
SOUTH FALLSBURG-WOODBOURNE AREA

By Henry R. Anderson

12 SOUTH FALLSBURG-WOODBOURNE AREA
A. Location and major geographic features

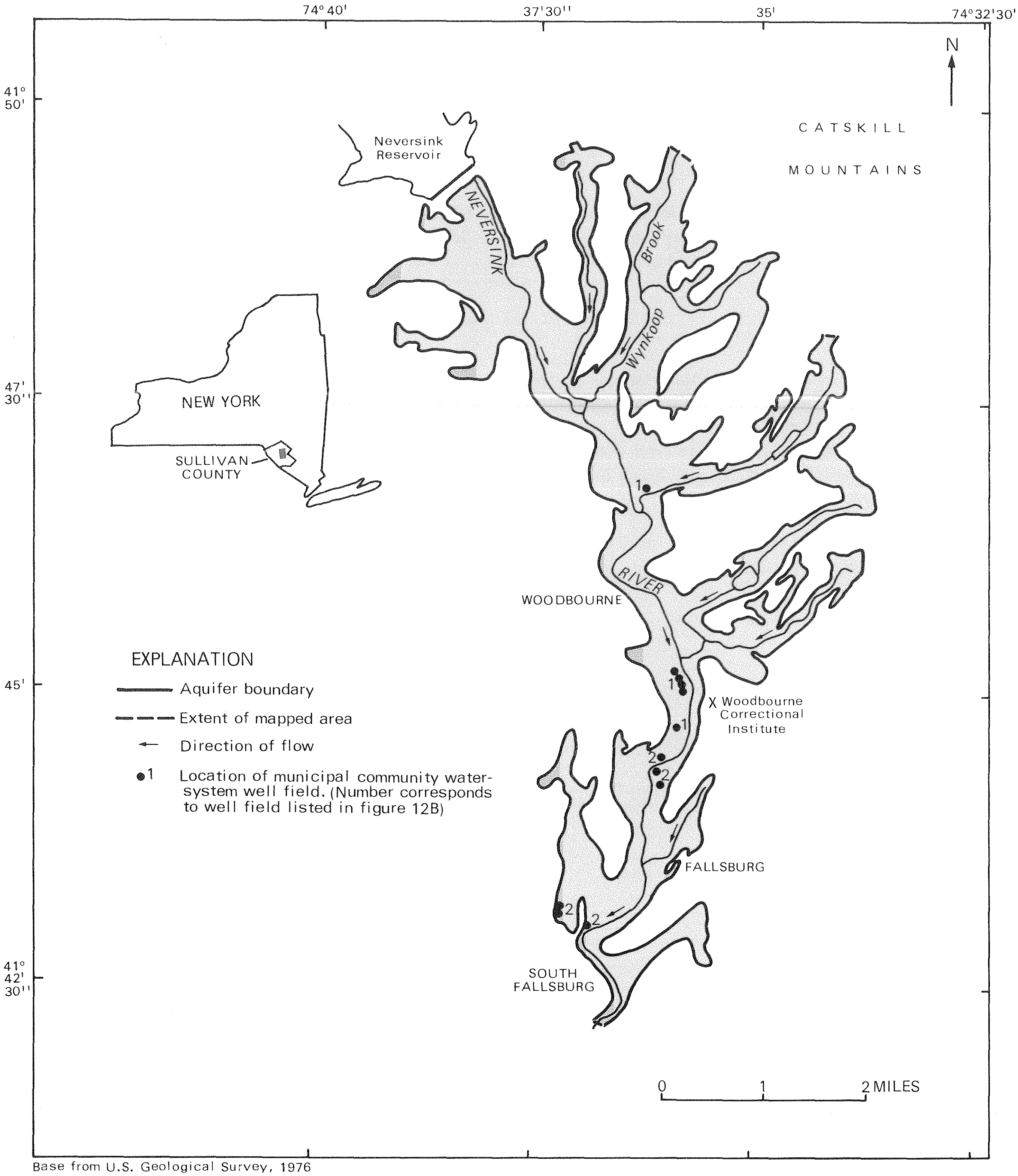
This aquifer underlies a narrow valley in the Catskill Mountains

The valley-fill aquifer of the South Fallsburg-Woodbourne area underlies a 10-mile reach of the Neversink River in the southern Catskill Mountains. The floor of the main valley and its many tributaries is bordered by steep hills and numerous rock exposures.

The South Fallsburg-Woodbourne area encompasses the southern half of the narrow Neversink Valley at the south edge of the Catskill Mountains in Sullivan County, southeastern New York (fig. 12A). The drainage system is part of the Delaware River basin. The aquifer area extends from the Neversink Reservoir (altitude 1,440 feet) about 10 miles downstream to South Fallsburg (altitude 1,100 feet) and encompasses the valleys of several tributaries. The reservoir is part of the New York City water supply. The terrain is hummocky with bedrock exposures and a mantle of unconsolidated deposits.

The small communities of Fallsburg and Woodbourne lie on the valley floor, and South Fallsburg lies just off the south end of the aquifer area. The area receives a large influx of summer residents.

FIGURE 12A SOUTH FALLSBURG-WOODBOURNE AREA
Location and major geographic features



B. Population and ground-water use

Summer vacationers increase the water demand

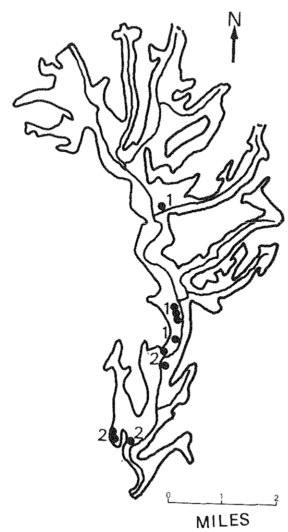
Ground water supplies a peak population of about 19,000 with about 3 million gallons per day. Summer daily demands are many times that of winter because of vacationers.

Ground water is the principal source of water supply for 19,000 people in the area. Wells tapping the stratified-drift aquifer furnish about 3 Mgal/d for public supply, industrial, and large-farm use. Resorts in the area increase the demand during the summer.

The table opposite lists 1980 pumpage by the various water suppliers. Locations of municipal systems are shown in the map below and in figure 12A.

LOCATION OF MUNICIPAL COMMUNITY WATER-SYSTEM WELL FIELDS

Numbers correspond to well fields listed opposite



POPULATION AND PUMPAGE FROM SOUTH FALLSBURG-WOODBOURNE AREA, 1980

Source	Population served[1]	Average pumpage[2] (Mgal/d)
A. MUNICIPAL COMMUNITY WATER SYSTEMS		
1. South Fallsburg Water District (6 wells)	[3]12,500	2.000
2. Woodbourne (2 wells)	1,000	.200
Subtotal	[3]13,500	2.200
B. OTHER COMMUNITY WATER SYSTEMS		
Trailer parks (2) and rehabilitation center	*1,400	.257
C. PRIVATE WATER SUPPLIES		
Home use of 100 gallons per day per capita is assumed	*4,000	* .400
Total	[3]*18,900	*2.857

[1] Revised from New York State Department of Health (1981)
[2] Unpublished data from New York State Department of Health
[3] Peak summer population
* Estimated

The valley system contains outwash and alluvium

The narrow Neversink valley contains more than 200 feet of glacial material partly reworked by modern streams. Surrounding hills are mantled with till overlying sedimentary rocks.

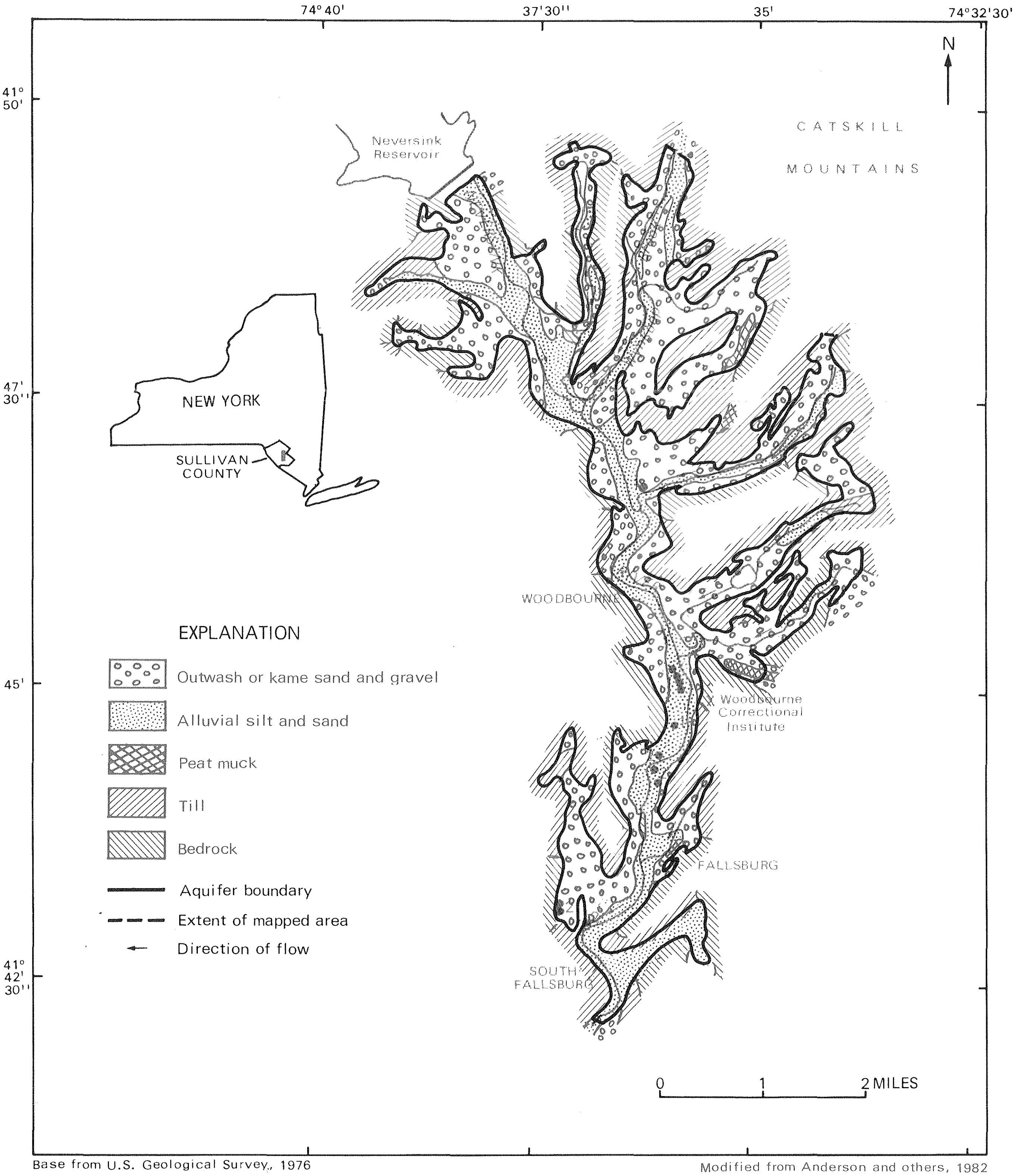
The Neversink basin has been glaciated and left with a mantle of deposits of till and stratified sand and gravel over bedrock (fig. 12C). In river valleys and lowlands near Woodbourne and Fallsburg, the stratified deposits are more than 100 feet thick. These deposits include outwash, kames, and delta deposits. In tributary valleys in which glacial lakes formed, meltwater streams formed delta deposits. In non-turbulent areas of the lakes, fine sand and silt deposits formed.

Nonstratified lodgment till and ablation till were deposited directly by ice, mostly on bedrock in the surrounding upland. In some areas of the valley, till has been deposited over stratified deposits by a glacial readvance. These materials consist mostly of clay and rock fragments.

The remaining terrain, which occupies about 25 percent of the area, consists of bedrock shale, sandstone, and conglomerate with little or no till cover. These sedimentary units dip slightly toward the northwest. The bedrock provides significant quantities of water to rural homes (Soren, 1961).

FIGURE 12C SOUTH FALLSBURG-WOODBOURNE AREA

Geologic setting



This aquifer system contains an upper and a lower unit generally separated by clay

The valley fill contains an upper, highly permeable layer about 80 feet thick and a lower, confined system of lesser permeability ranging in thickness from 80 to 180 feet. More than half the main valley contains saturated sand and gravel exceeding 50 feet in thickness in either unit.

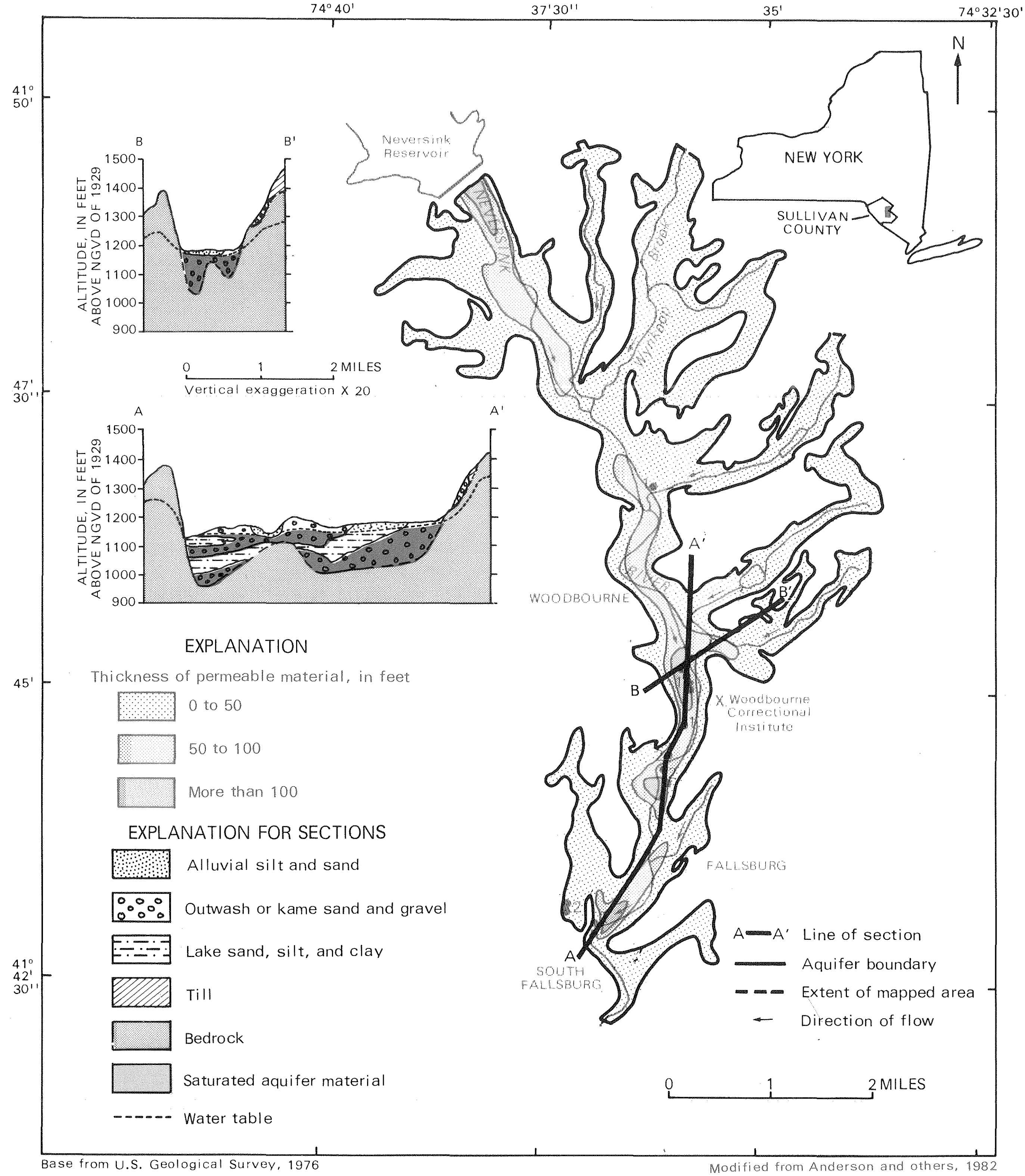
The aquifer system is part of a long, narrow deposit of valley fill, about 10 miles long and a half mile wide, within the upper end of the Neversink River valley (fig. 12D). Saturated sand and gravel layers that make up the aquifer are thickest (more than 100 feet) between Woodbourne and South Fallsburg. The geologic sections in figure 12D depict the makeup of the aquifer system in this area.

At Woodbourne, the principal aquifer is in the upper 80 feet of the valley fill. The lower 80 to 180 feet, according to seismic studies (New York State Geological Survey, unpublished data), consists of highly compact gravel and clay that is less permeable and therefore less favorable for aquifer development. A moderately thick layer of lake sediment separates the upper and lower units in most places. A 1982 drilling program for the Woodbourne Correctional Institute may delineate the potential of the deeper aquifer more closely (New York Department of Transportation, written commun., 1982).

Southward toward Fallsburg and South Fallsburg, the deeper aquifer is highly permeable. The north-south section A-A′ (fig. 12D) depicts the possible connection of the upper gravels from Woodbourne southward. At Fallsburg the valley becomes constricted, which inhibits some of the ground-water underflow southward and increases the aquifer discharge to the Neversink River.

Stream valleys tributary to the Neversink River lack subsurface data but probably contain less than 50 feet of drift, which may not have sufficient saturated sand and gravel for large yields. Although these deposits are largely unsaturated, they act as catchment areas for recharge to the valley floor.

FIGURE 12D SOUTH FALLSBURG-WOODBOURNE AREA
Geohydrology and aquifer thickness



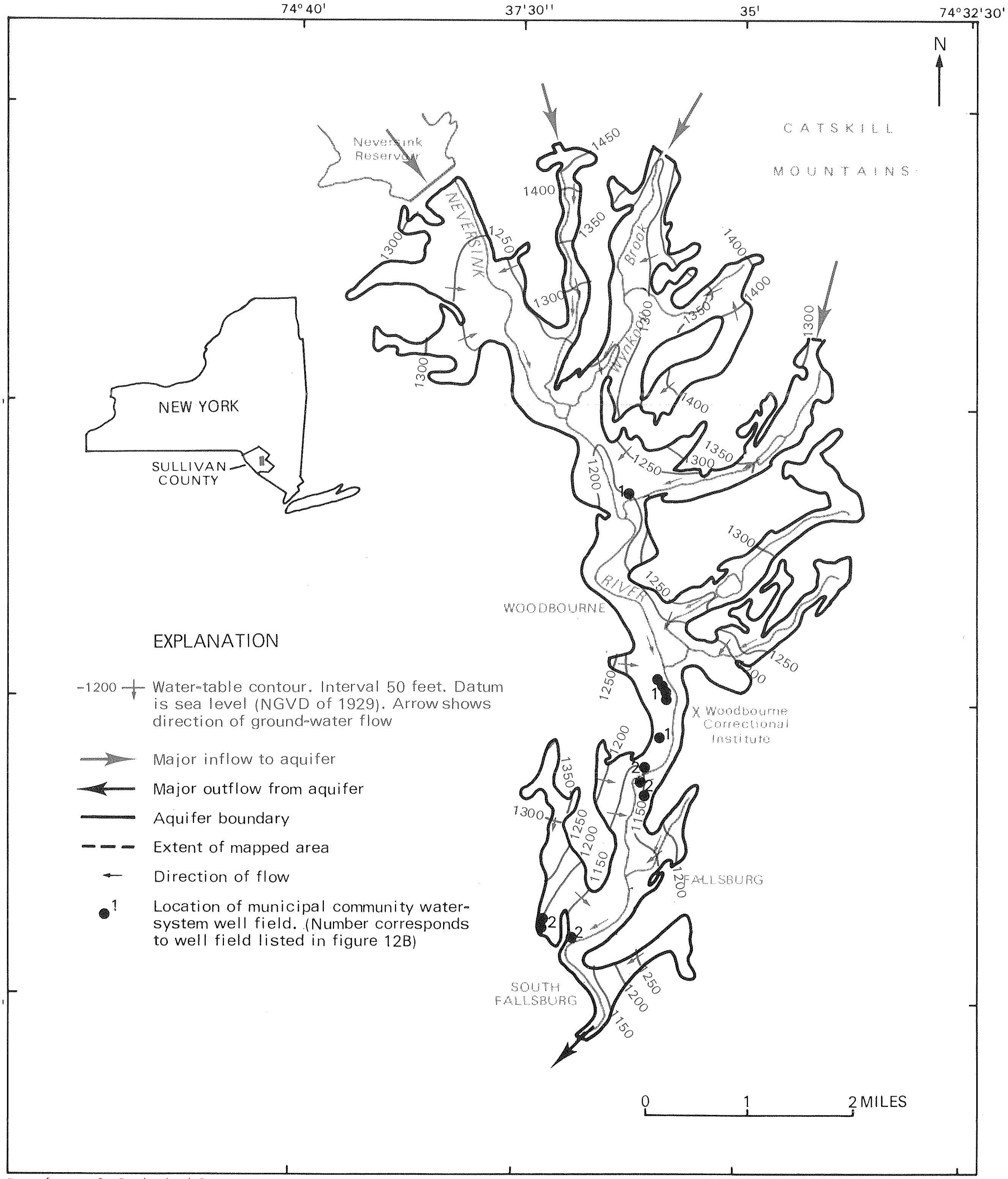
Ground water moves toward the main stream

The ground water in this valley-fill aquifer system moves under a low gradient downvalley and to the master stream. Recharge results from precipitation on the valley floor, from hillslope runoff, and from seepage from bedrock.

The map in figure 12E indicates the average water-table altitude within this aquifer system. The map was constructed mainly from the water-surface altitude of perennial water bodies such as streams, ponds, and swamps. Wells tapping deep gravels may have lower water levels than indicated by the contours, especially in summer, when heavy pumpage lowers the water levels. The water-table gradient slopes downvalley so that ground water moves as underflow through the valley-fill deposits beneath the stream. The gradient in the main valley is nearly flat and averages about 10 feet per mile.

Recharge results from rainfall and snowmelt infiltrating the valley fill and alluvial deposits in the stream valleys, and also from runoff and seepage from upland silt, clay, till, and bedrock that adjoin the valley floor. Recharge is greatest during spring after frost melt and before vegetation begins to grow. Thereafter, ground-water levels decline and reach a low in late summer or early fall, when ground-water pumpage remains high and evapotranspiration is at a peak. The lower aquifer in the southern part of the valley is probably recharged continuously from the bedrock; recharge may also be induced from the upper zones when the lower zone is heavily pumped.

FIGURE 12E SOUTH FALLSBURG-WOODBOURNE AREA
Ground-water movement



Base from U.S. Geological Survey, 1976

Modified from Anderson and others, 1982

The largest yields exceed 400 gallons per minute

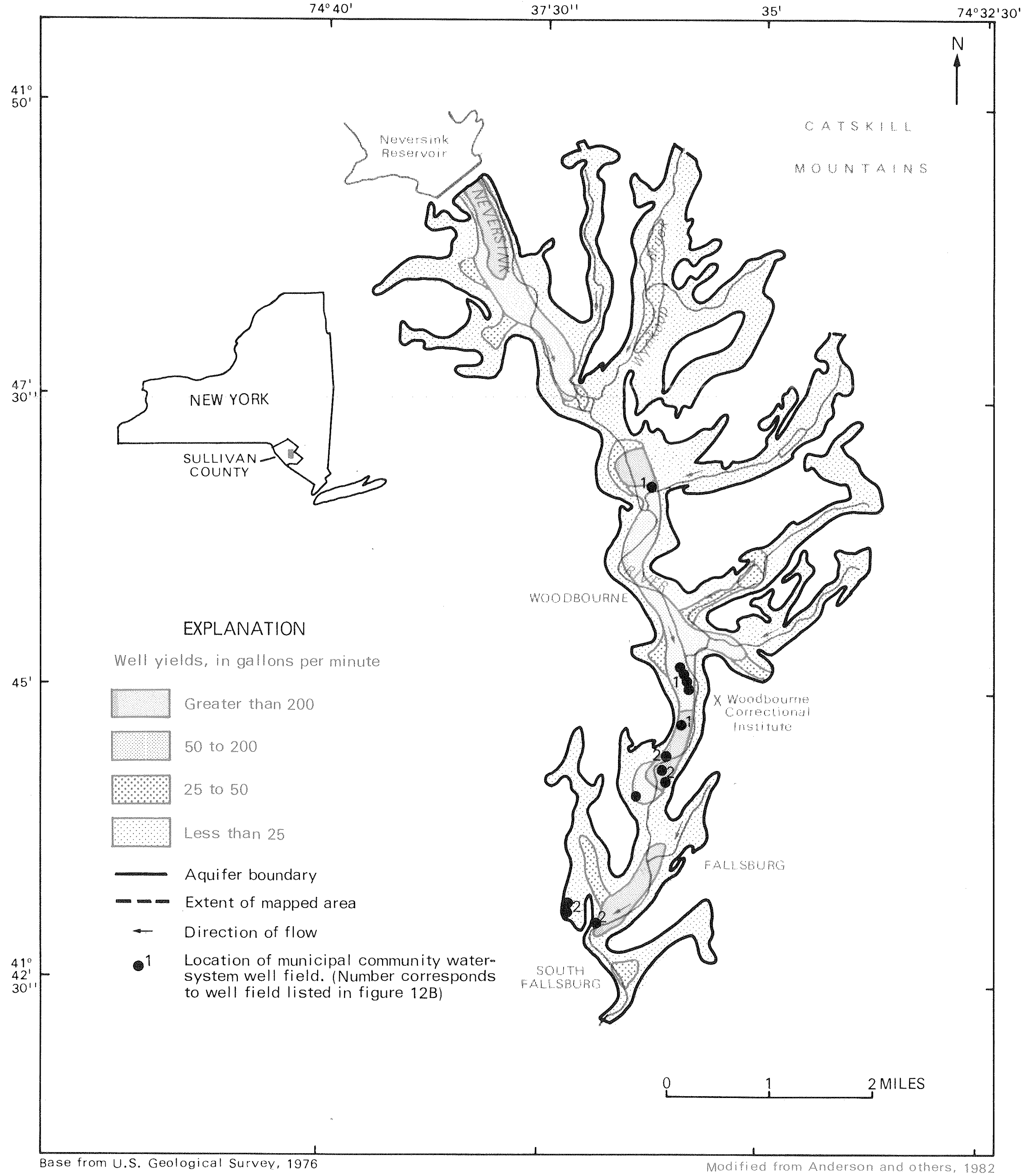
Well yields vary within this aquifer system. Highest yields, up to 400 gallons per minute, are obtained from the lower aquifer in the southern part. The narrowness of the aquifer limits wide spacing of wells.

Well yields in this part of the valley may be as large as 400 gal/min. The highest known yields are obtained from wells tapping the lower gravel aquifer between Fallsburg and South Fallsburg (fig. 12F). However, this deeper aquifer does not have a good hydraulic connection with the river, which results in variable yields depending upon river stage and extent of pumping. The shallow aquifer, which is in hydraulic contact with the river, probably has more consistent yields throughout the year.

Well yields decrease as sand and gravel deposits thin out in tributary streams and near the valley walls. Also, the narrowness of the valleys limits the number of large-capacity wells.

Wells tapping sedimentary bedrock in the upland area beyond the aquifer produce significant yields also. Drilled wells in Sullivan County produce an average yield of 21 gal/min, although yields as high as 120 gal/min have been recorded (Soren, 1961).

FIGURE 12F SOUTH FALLSBURG-WOODBOURNE AREA
Well yields



Most soil overlying the area is highly permeable

Highly permeable soils overlie this sand and gravel aquifer. Most soils in the lowlands are highly permeable also, which enables rapid recharge to the aquifer.

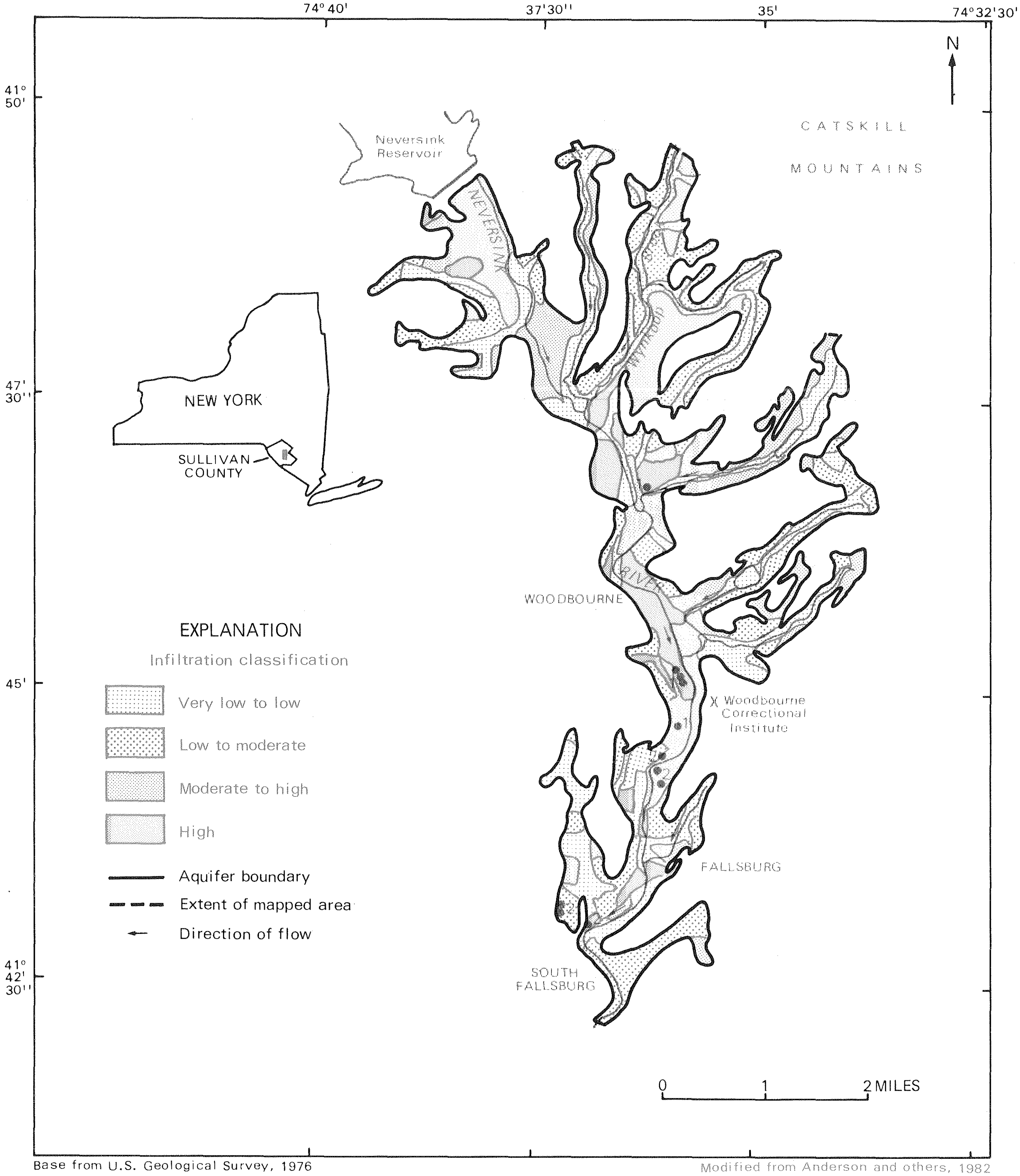
The soil-zone permeability in this area forms a complex pattern. The soil-zone permeability classification in figure 12G[1] was estimated primarily from infiltration characteristics described in Secor and others (1946). The most permeable soils are those derived from stratified sand and gravel deposited in the form of kames and outwash; these soil groups have moderate to high permeability. Soils with the lowest permeability are those overlying silt, clay, and till deposits. Soils overlying lake sand and silt deposits have low to moderate permeability.

Most soils on the hilltops are moderately permeable, whether they are underlain by bedrock, till, or more permeable sand and gravel. Most soils on the slopes are poorly permeable; soils on rock-terrain slopes vary considerably in permeability.

Soils in the bottomlands of the smaller tributary stream valleys are generally clayey, high in organic matter, and poorly drained and thus have very low to low permeability (fig. 12G). Several small areas contain soil of high permeability; these soils may cap sand and gravel kame terraces in hilly areas or the outwash gravel in the Neversink River bottomland (fig. 12E). Soils in the Neversink River valley, where the aquifer is widest and thickest, are highly permeable so that recharge from rainfall, snowmelt, and river flooding readily infiltrates to at least the upper layers of gravel in the aquifer.

[1] The soil-permeability map was constructed from interpretations of the 1938 soil survey of Sullivan County (Secor and others, 1946).

FIGURE 12G SOUTH FALLSBURG-WOODBOURNE AREA
Soil-zone permeability



Most of the area remains rural, although commerce is increasing

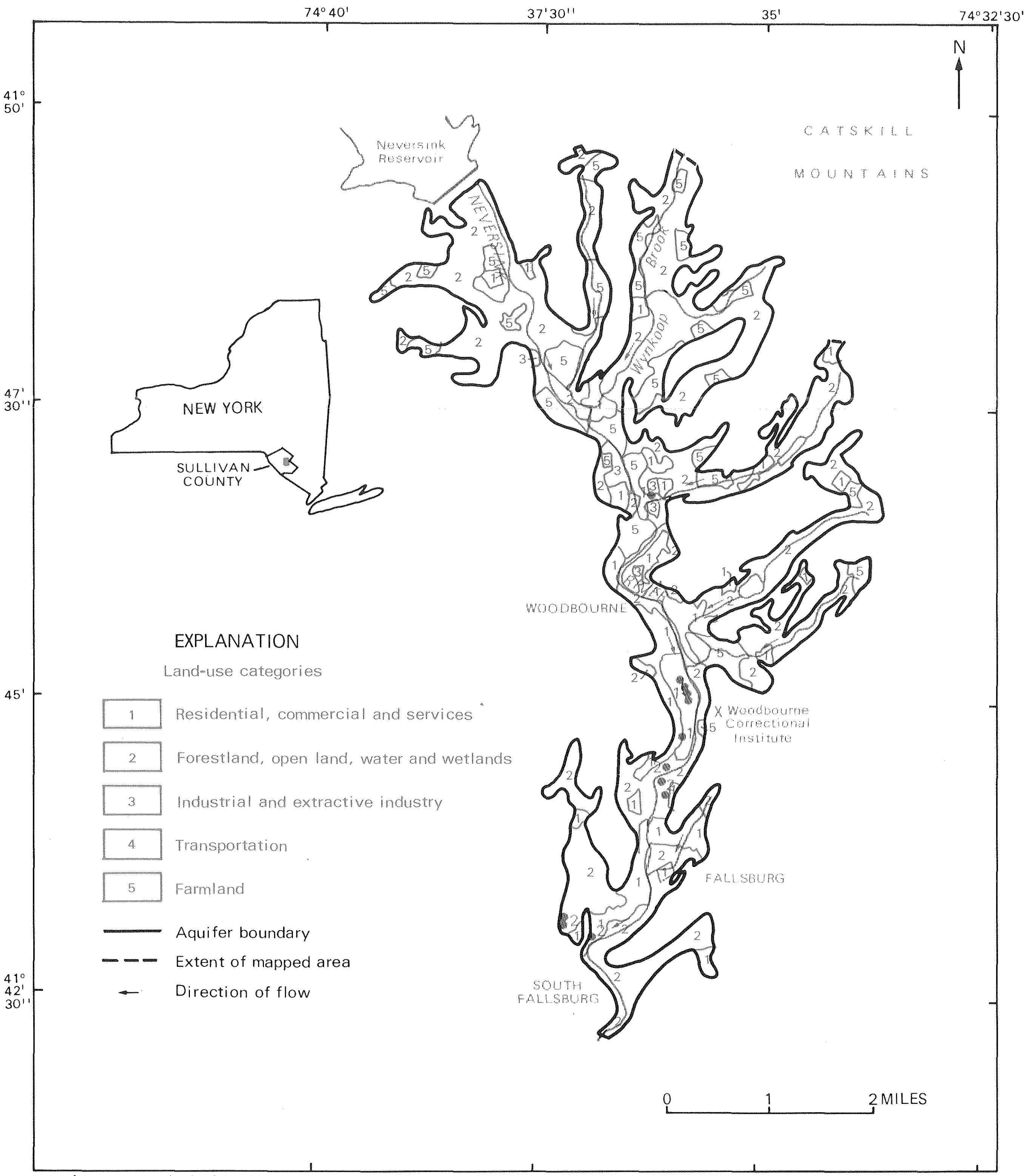
Forestland, farmland, and wetlands dominate the valley-fill aquifer area. Farms, residential areas, and the relatively sparse commerce and industrial areas produce wastes that may enter the aquifer. Extensive pavement in urban areas reduces recharge to the aquifer and increases storm runoff to streams.

Forestland occupies the greatest area in the Neversink basin, followed by farmland and wetlands (fig. 12H)[1]. Commercial and industrial zones occupy a relatively small percentage of the valley flat.

Farms as well as commercial, residential, and industrial use can contribute to aquifer and stream pollution. Fertilizers from farms, sewage from residential areas, and sludge and wastes from industrial areas may readily infiltrate to the water table if improperly disposed of. Urbanization causes a reduction in recharge to the aquifer and increases runoff to streams by paving areas that formerly absorbed precipitation.

[1] Figure 12H was compiled from the 1968 Land Use and National Resources Inventory (LUNR) by Cornell University for the New York State Department of Transportation.

FIGURE 12H SOUTH FALLSBURG-WOODBOURNE AREA
Land use



Base from U.S. Geological Survey, 1976

Modified from Anderson and others, 1982

This aquifer's small size limits its potential yield

Overpumping this aquifer and potential contamination from improper disposal of wastes are the most serious management concerns.

The present use and further development of the valley-fill aquifer may give rise to potential problems. The aquifer is relatively small and receives recharge from the river under pumping stress. Also, the narrowness of the aquifer limits its storage capacity as a water reservoir. Recharge from the headwaters is now controlled by the use of the Neversink Reservoir for exporting water.

When a well field with closely spaced wells, such at at Woodbourne, is pumped heavily, water levels decline and yields decrease. The incomplete hydraulic connection with the river limits the rate at which river water can replenish the aquifer. At times of peak demand, usually in the summer, ground water is pumped excessively, and well yields decrease as a result. Also, the river is at its lowest stage in summer, so that little recharge occurs. For example, at a South Fallsburg well screened in deep gravel, the normal yield is 319 gal/min with 82 feet of drawdown during normal use. In summer, however, the yield decreases to 90 gal/min. These effects are caused not only by low seasonal recharge, but from interference by extensive pumping nearby.

A potential threat to water quality may be a series of industrial sludge pits on the west side of the Neversink valley north of Woodbourne. The pits are excavated in kame sand and gravel deposits but are separated from the bedrock aquifer by a till and rock ridge. Contaminants leaking from this site could seep toward the Neversink River and thence to the aquifer, and from there would flow downgradient to the pumping center at Woodbourne.

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