Long Island Groundwater Resources

USGS involvement in previous efforts

Public Kickoff Meeting, February 14, 2017
Suffolk County Water Authority Education Center

Chris Schubert—U.S. Geological Survey

U.S. Department of the Interior
U.S. Geological Survey

Outline

- Background
- Selected groundwater studies conducted on Long Island by the USGS since the early 1900’s
- Opportunities and challenges of previous USGS efforts
- Summary

USGS

Background

- The USGS collects and interprets information following nationally standardized procedures

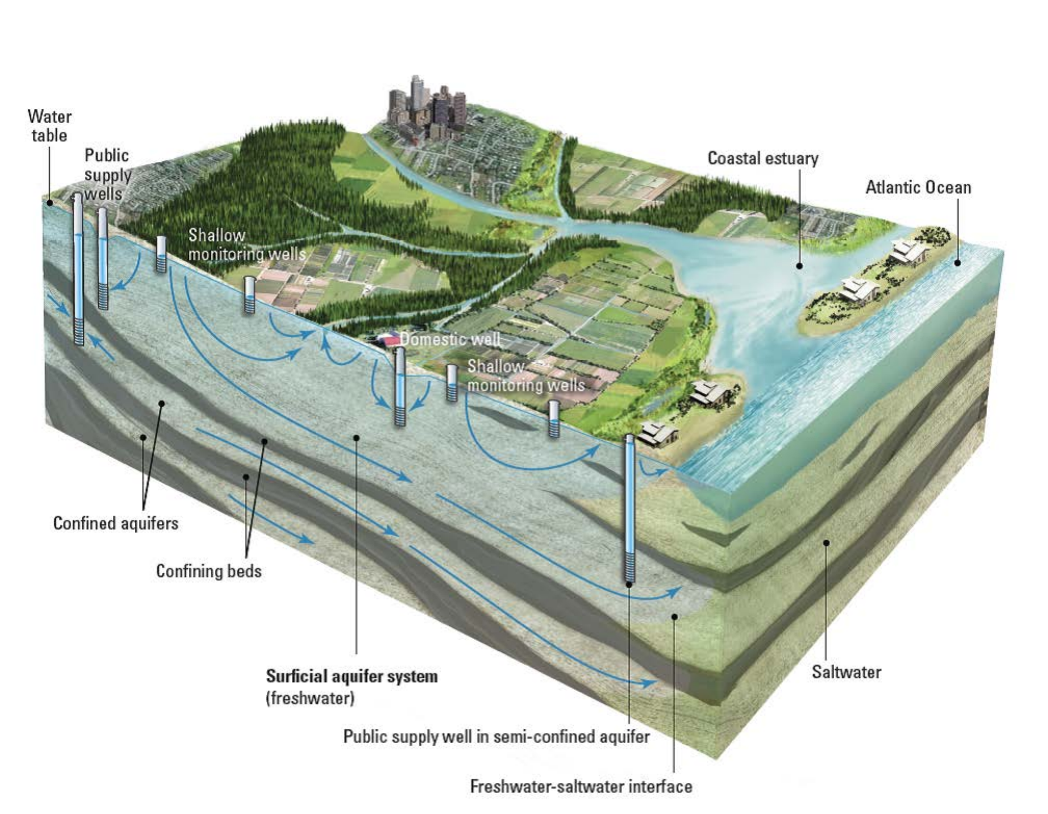
- This builds local knowledge about issues and trends while providing an understanding of regional and national context

- The consistent, multi-scale approach helps to determine if issues are isolated or pervasive

USGS

Background

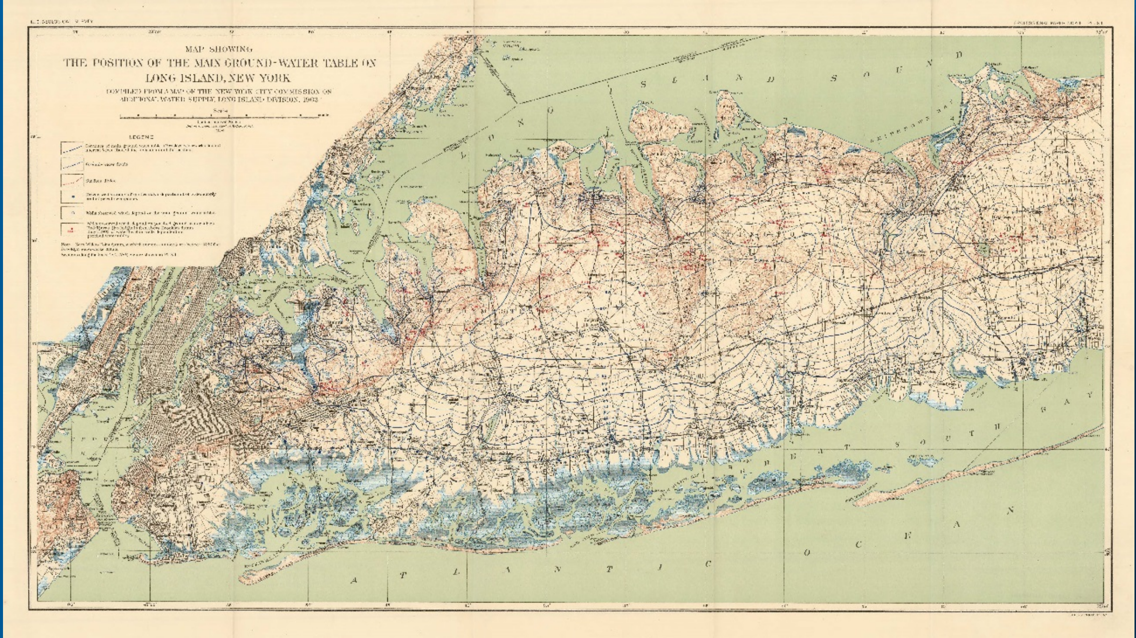
- Federal funding is but one small part of the USGS program on Long Island
- The majority of USGS work is reimbursable projects for funding partners (cooperators)
- Partnerships with cooperators enable our collective knowledge to be leveraged
- Much of what we know today reflects past investments by many thoughtful cooperators



USGS

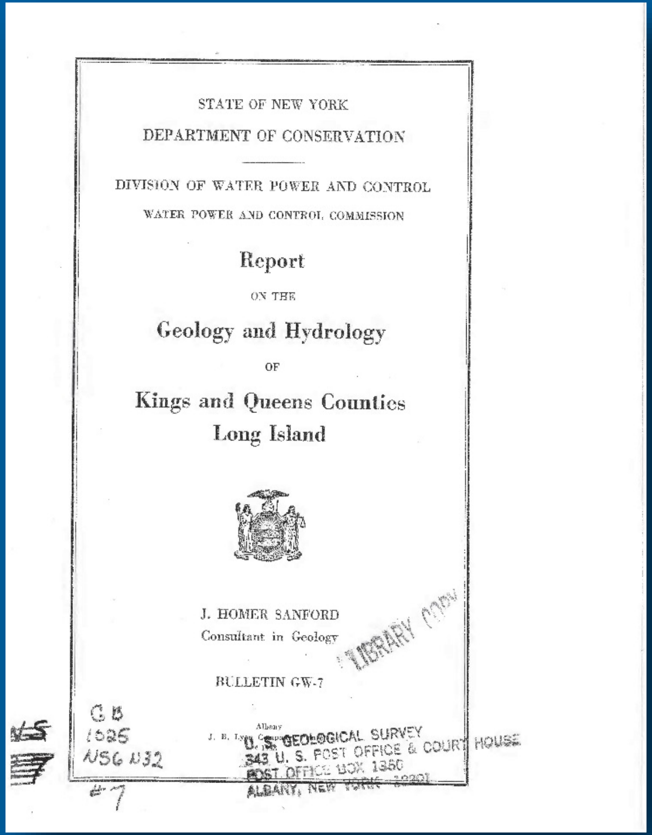
Selected groundwater studies conducted on Long Island by the USGS since the early 1900’s

Historical characterization of the Long Island aquifer system



Underground water resources of Long Island, New York (1906)

Early investigation of water-resources issues in New York City


STATE OF NEW YORK
DEPARTMENT OF CONSERVATION

DIVISION OF WATER POWER AND CONTROL
WATER POWER AND CONTROL COMMISSION

Report
ON THE
Geology and Hydrology
OF
Kings and Queens Counties
Long Island

J. HOMER SANFORD
Consultant in Geology

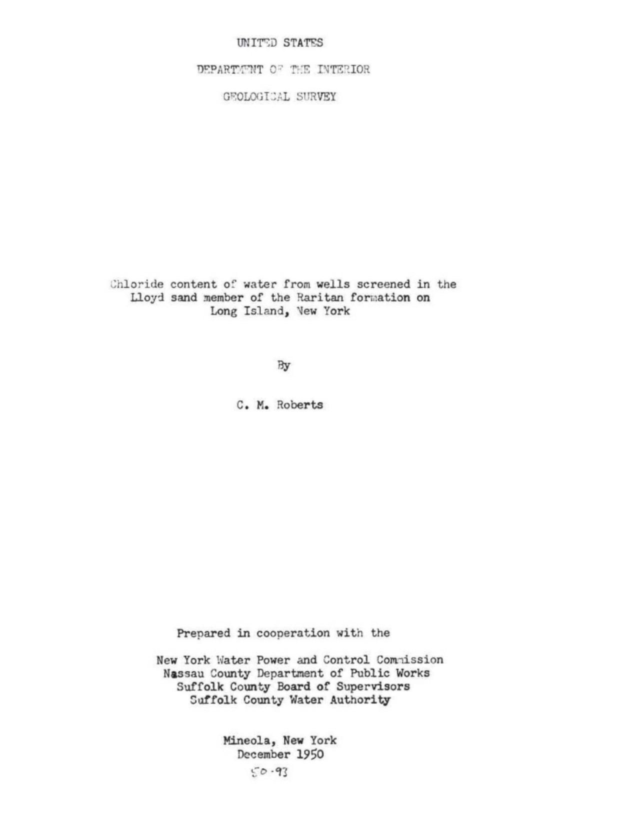
BULLETIN GW-7

Albany

Report on the geology and hydrology of Kings and Queens Counties, Long Island (1938)

Selected groundwater studies conducted on Long Island by the USGS since the early 1900’s

Early investigation of saltwater encroachment on Long Island


UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Chloride content of water from wells screened in the Lloyd sand member of the Raritan formation on Long Island, New York

By

C. M. Roberts

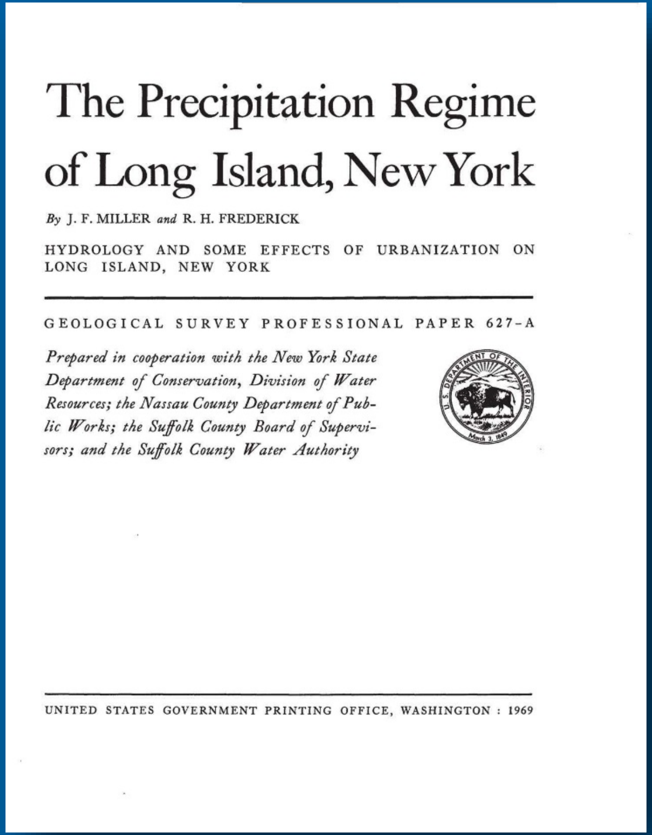
Prepared in cooperation with the

New York Water Power and Control Commission
Nassau County Department of Public Works
Suffolk County Board of Supervisors
Suffolk County Water Authority

Mineola, New York
December 1950
50-93

Chloride content of water from wells screened in the Lloyd sand member of the Raritan formation on Long Island (1950)

Foundational study of Long Island water resources


The Precipitation Regime of Long Island, New York

By J. F. MILLER and R. H. FREDERICK

HYDROLOGY AND SOME EFFECTS OF URBANIZATION ON LONG ISLAND, NEW YORK

GEOLOGICAL SURVEY PROFESSIONAL PAPER 627-A

Prepared in cooperation with the New York State Department of Conservation, Division of Water Resources; the Nassau County Department of Public Works; the Suffolk County Board of Supervisors; and the Suffolk County Water Authority

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1969

The precipitation regime of Long Island, New York (1969)

Selected groundwater studies conducted on Long Island by the USGS since the early 1900’s

Pioneering work on analog-model development

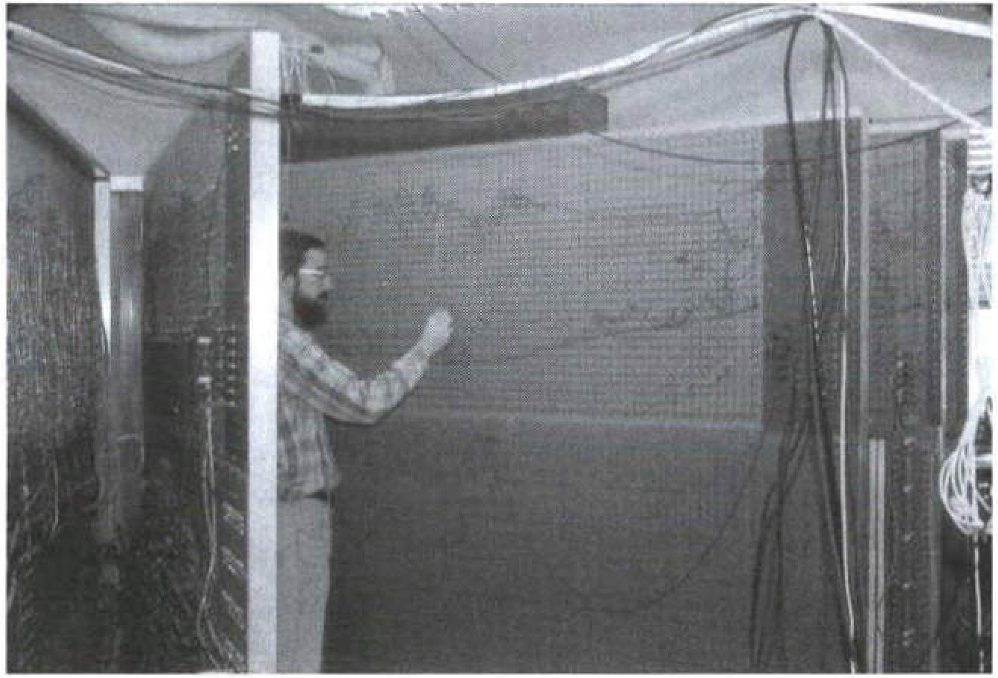
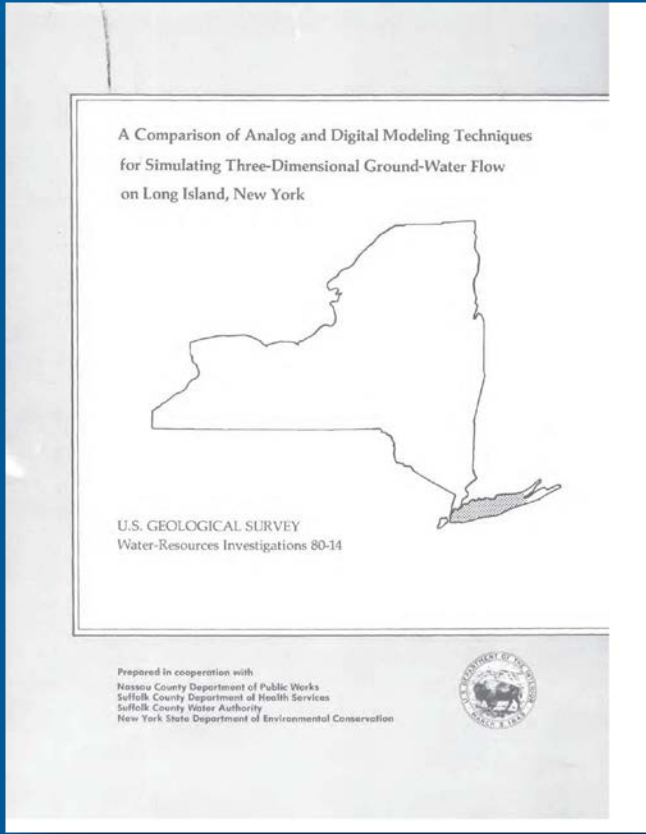


Figure 2. Arlen Harbaugh, in about 1975, making a voltage measurement on the three-dimensional electric-analog model of Long Island, New York.

Analog-model analysis of hydrologic effects of sewerage in southeast Nassau and southwest Suffolk Counties, Long Island, New York (1975)

Pioneering work on numerical model development



A Comparison of Analog and Digital Modeling Techniques for Simulating Three-Dimensional Ground-Water Flow on Long Island, New York

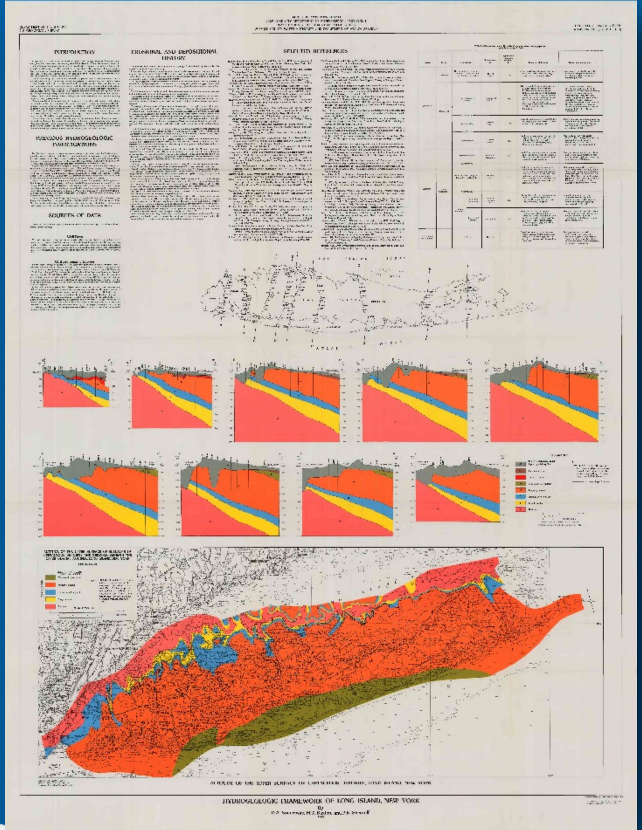
U.S. GEOLOGICAL SURVEY
Water-Resources Investigations 80-14

Prepared in cooperation with
Nassau County Department of Public Works
Suffolk County Department of Health Services
Suffolk County Water Authority
New York State Department of Environmental Conservation

A comparison of analog and digital modeling techniques for simulating three-dimensional ground-water flow on Long Island, New York (1980)

Selected groundwater studies conducted on Long Island by the USGS since the early 1900's

Synthesis and mapping of the Long Island aquifer system



USGS *Hydrogeologic framework of Long Island, New York (1989)*

Refined modeling based on updated hydrogeology for Long Island

Particle Tracking Analysis of Recharge Areas on Long Island, New York

by Herbert T. Buxton[a], Thomas E. Reilly[b], David W. Pollock[b], and Douglas A. Smolensky[c]

Abstract

Protection of ground-water resources from the effects of anthropogenic contamination requires definition of the source of water flowing in developed aquifers. Aquifer recharge areas for the confined Magothy and Lloyd aquifers of Long Island, New York, are estimated by using a three-dimensional model of the Long Island ground-water flow system and a particle-tracking algorithm.

Aquifer recharge areas under predevelopment conditions are consistent with an understanding of the ground-water flow system operation. A budget comparison indicated that the recharge occurring in each area as calculated by particle tracking was within one percent of the flow entering that aquifer, according to the water budget computed from the flow model.

Aquifer recharge areas for two stressed conditions, one at the present time and the other an estimate for the year 2020, are more difficult to define because of numerous pumped wells. Maximum and minimum recharge areas for each aquifer are presented for both present conditions and the year 2020 to bracket the actual aquifer recharge areas. These results also are consistent with the water budgets computed from the flow model.

Results indicate that development causes large-scale changes in flow patterns and the size and shape of aquifer recharge areas. The accuracy of defining recharge areas is limited by the model's representation of local-scale characteristics of the flow system and the wells.

Introduction

To assess the effects of anthropogenic contamination on a ground-water system, it is necessary to understand the pattern and rate of ground-water movement through the system. Federal programs are attempting to assess the status of ground-water resources and define wellhead-protection and aquifer-protection areas with only a qualitative understanding of flow patterns in the systems under study. Quantitative estimates of the flow paths of water recharging ground-water systems under both natural and stressed conditions would enable better definition of the extent and movement of contaminants within the system and their effects on water supply. These estimates of flow paths would indicate areas at the water table which are the source of water to aquifers and allow for consideration of the fact that the land use overlying these areas could eventually affect the quality of water in the aquifers and in wells which withdraw water from them. Quantitative estimates of recharge areas can be particularly valuable for confined aquifers where water that enters these aquifers may have flowed great distances in an overlying unconfined aquifer and recharge areas may be great distances from where the water actually enters the confined aquifer.

A computer program has recently been developed (Pollock, 1988 and 1989) that computes flow lines in three-dimensional finite-difference ground-water models using a particle-tracking method. The particle-tracking method provides the quantitative means to define the pathway from source to discharge of ground water, and under many circumstances will enhance the ability to understand flow paths and contaminant distributions within the system. However, as with all numerical methods, it is based on limiting assumptions. The effects of these assumptions depend on the scale of discretization and the distribution of internal and boundary sources and sinks.

The purpose of this report is to evaluate the potential of using the particle-tracking method and a numerical ground-water flow model to determine aquifer recharge areas in regional multiaquifer ground-water systems. The ground-water system on Long Island, New York (Figure 1), is used as an example to illustrate the calculation of recharge areas, to discuss the variability and complexities of these areas in actual flow systems, and to discuss the limitations of such an analysis caused by the use of a numerical representation of the flow system.

[a]Hydrologist, U.S. Geological Survey, 810 Bear Tavern Road, West Trenton, New Jersey 08628.
[b]Hydrologists, U.S. Geological Survey, 411 National Center, 12201 Sunrise Valley Drive, Reston, Virginia 22092.
[c]Hydrologist, U.S. Geological Survey, 5 Aerial Way, Syosset, New York 11791.

Received October 1989, revised May 1990, accepted May 1990.
Discussion open until July 1, 1991.

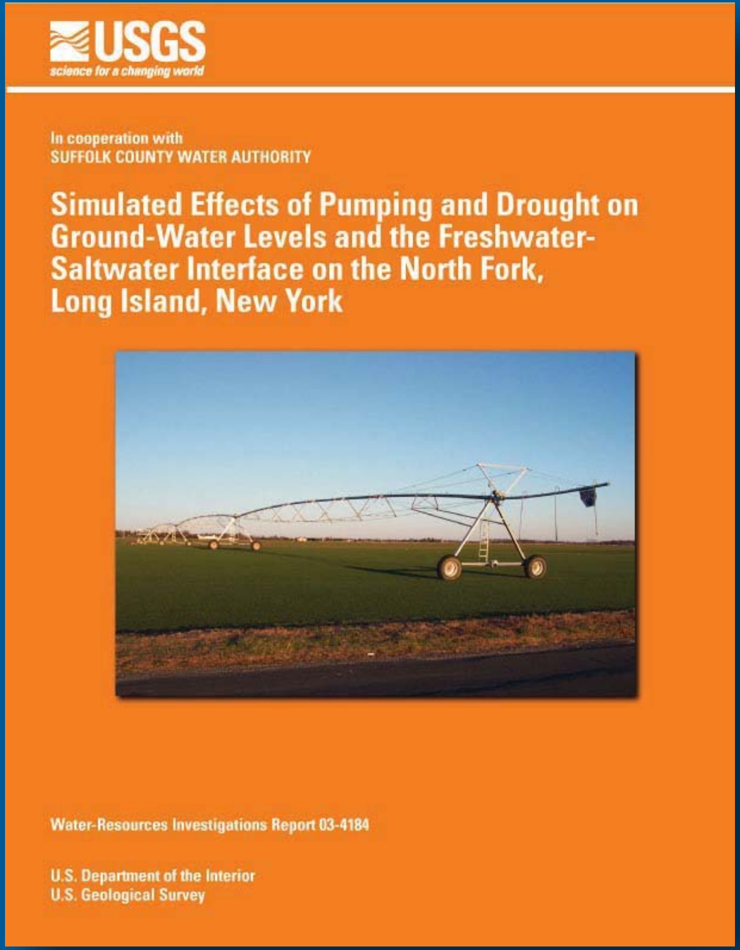
Particle tracking analysis of recharge areas on Long Island, New York (1991)

Opportunities and challenges of previous USGS efforts

Modeling saltwater encroachment on Long Island

- **Computing resources have previously limited ability to model effects at island-wide scale**

- **Insights have been gained from modeling effects at local and subregional scales**

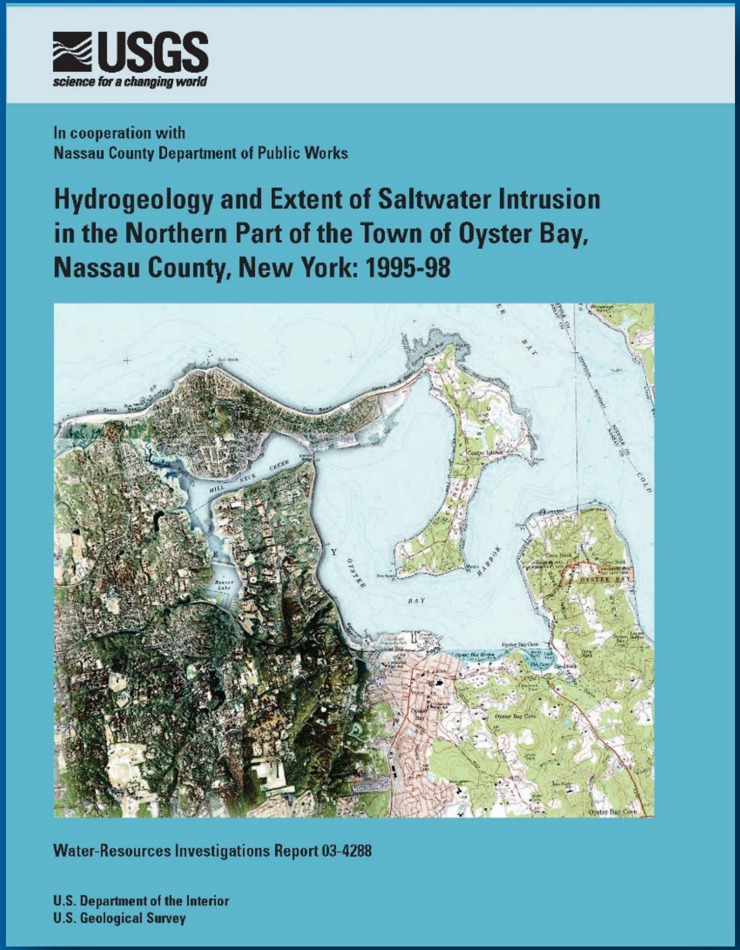


Simulated effects of pumping and drought on ground-water levels and the freshwater-saltwater interface on the North Fork of Long Island, New York (2004)

Opportunities and challenges of previous USGS efforts

Field investigations of saltwater encroachment on Long Island

- **Detailed information is available for water-supply aquifers in some coastal areas**
- **Knowledge is lacking elsewhere, especially along South Shore due to increased depth of water-supply aquifers**



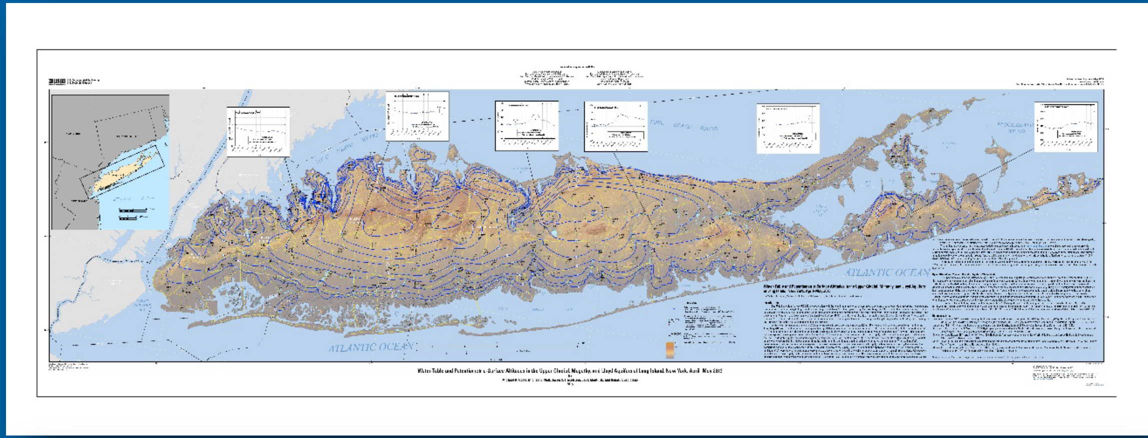
Hydrogeology and extent of saltwater intrusion in the northern part of the Town of Oyster Bay, Nassau County, New York: 1995-98 (2004)

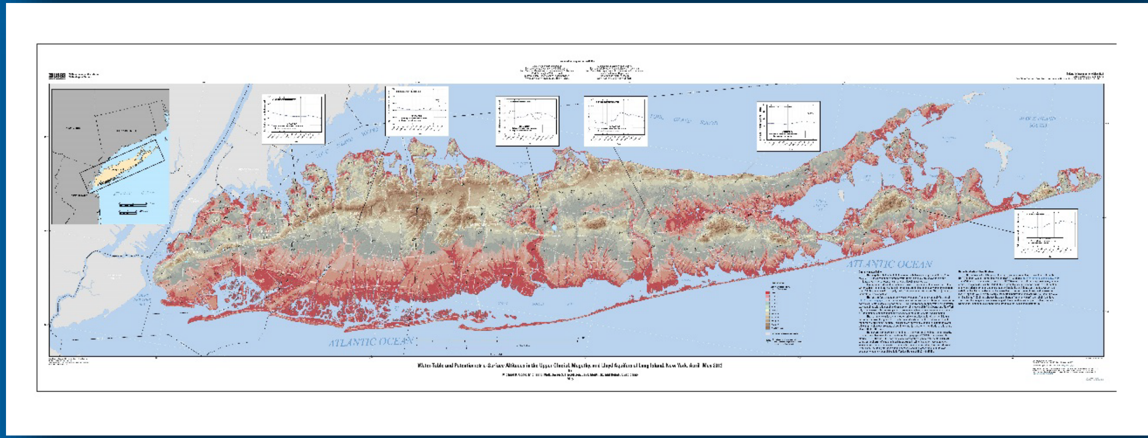
USGS

Opportunities and challenges of previous USGS efforts

Hydrologic data collection on Long Island

- **Monitoring has focused on groundwater levels and streamflows**
- **Records at some sites extend back more than 75 years**
- **Information underpins all interpretive studies by the USGS and others**





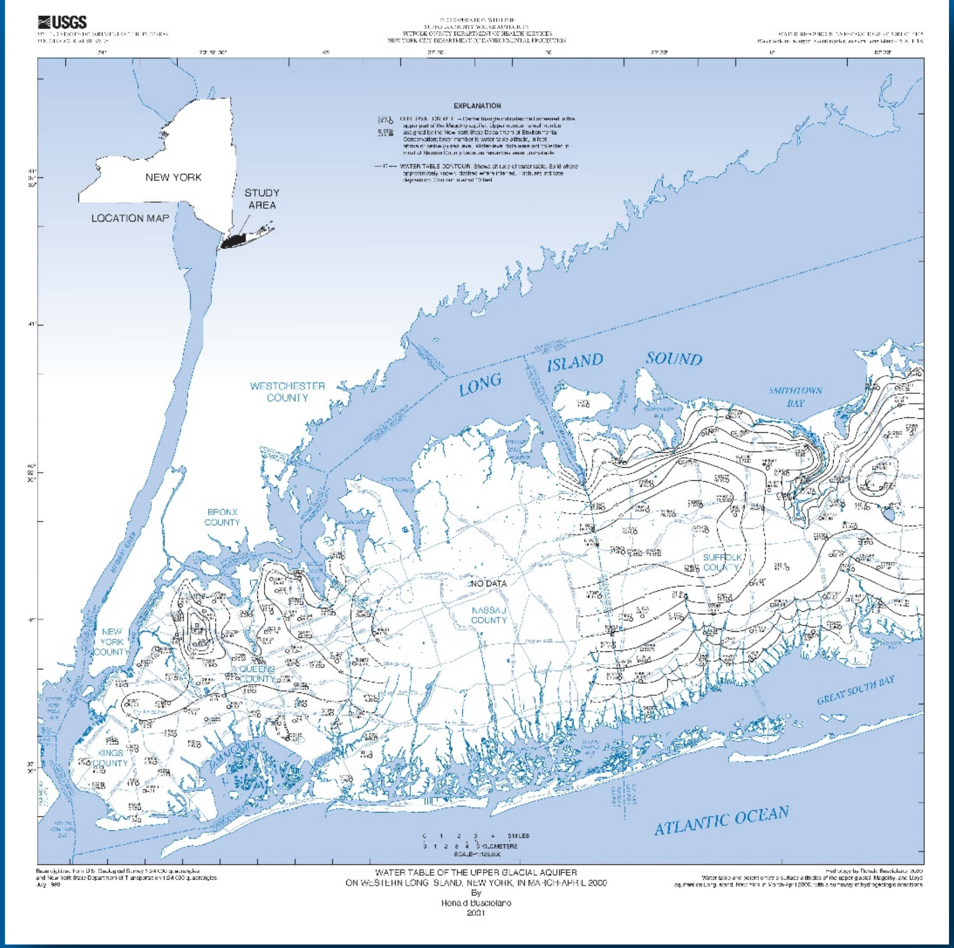
Water-table and potentiometric-surface altitudes in the Upper Glacial, Magothy, and Lloyd aquifers of Long Island, New York, April–May 2013

USGS

Opportunities and challenges of previous USGS efforts

Hydrologic data collection on Long Island

- **Long-term records document effects of natural and manmade stresses on the aquifer system**
- **Fluctuations in funding have made it difficult to maintain uninterrupted, island-wide records**



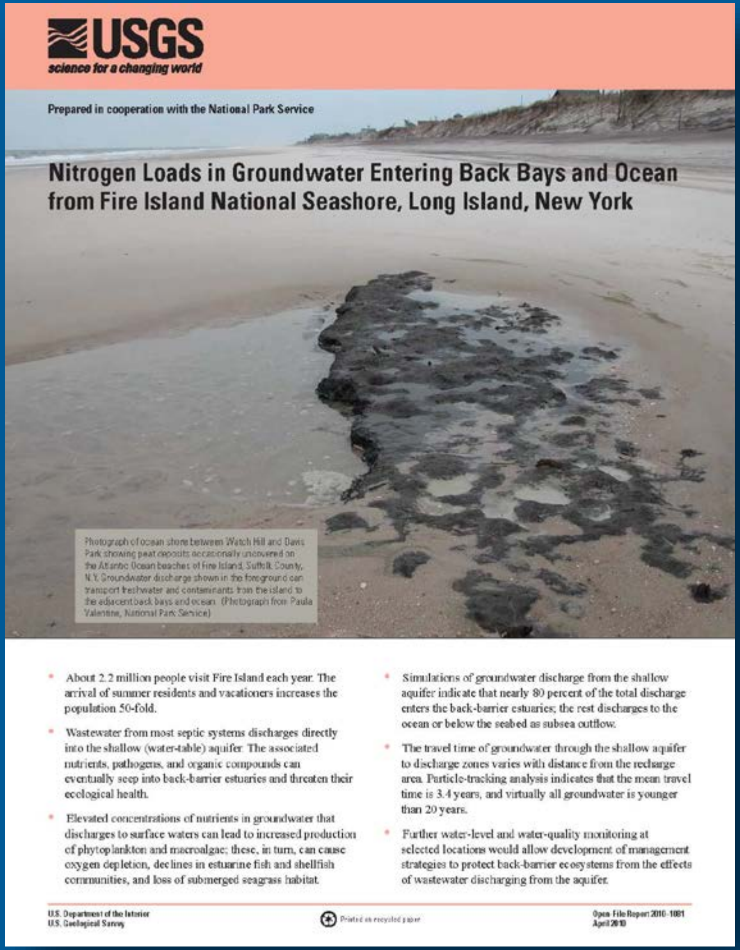
Water-table and potentiometric-surface altitudes of the upper glacial, Magothy, and Lloyd aquifers on Long Island, New York, in March-April 2000, with a summary of hydrogeologic conditions

Opportunities and challenges of previous USGS efforts

Other assessments to meet evolving cooperator needs

- **Contaminants of emerging concern in groundwaters (and surface waters)**

- **Loading of freshwater and dissolved constituents (nutrients, contaminants, etc) to surface waters**


USGS
science for a changing world

Prepared in cooperation with the National Park Service

Nitrogen Loads in Groundwater Entering Back Bays and Ocean from Fire Island National Seashore, Long Island, New York

Photograph of ocean shore between Watch Hill and Davis Park showing peat deposits occasionally uncovered on the Atlantic Ocean beaches of Fire Island, Suffolk County, N.Y. Groundwater discharge shown in the foreground can transport freshwater and contaminants from the island to the adjacent back bays and ocean. (Photograph from Paula Valentine, National Park Service)

- About 2.2 million people visit Fire Island each year. The arrival of summer residents and vacationers increases the population 50-fold.
- Wastewater from most septic systems discharges directly into the shallow (water-table) aquifer. The associated nutrients, pathogens, and organic compounds can eventually seep into back-barrier estuaries and threaten their ecological health.
- Elevated concentrations of nutrients in groundwater that discharges to surface waters can lead to increased production of phytoplankton and macroalgae; these, in turn, can cause oxygen depletion, declines in estuarine fish and shellfish communities, and loss of submerged seagrass habitat.
- Simulations of groundwater discharge from the shallow aquifer indicate that nearly 80 percent of the total discharge enters the back-barrier estuaries; the rest discharges to the ocean or below the seabed as subsea outflow.
- The travel time of groundwater through the shallow aquifer to discharge zones varies with distance from the recharge area. Particle-tracking analysis indicates that the mean travel time is 3.4 years, and virtually all groundwater is younger than 20 years.
- Further water-level and water-quality monitoring at selected locations would allow development of management strategies to protect back-barrier ecosystems from the effects of wastewater discharging from the aquifer.

U.S. Department of the Interior
U.S. Geological Survey

Printed on recycled paper

Open-File Report 2010-1081
April 2010

Nitrogen loads in groundwater entering back bays and ocean from Fire Island National Seashore, Long Island, New York (2010)

USGS

Summary

- **Results benefit not only our cooperators, but also the consulting and NGO communities, by providing the credible science needed to address local-scale issues**

- **Ultimately, all work strives to be responsive to society's changing needs, while supplying the long-term benchmarks against which future changes can be assessed**

For more information

U.S. Geological Survey
N.Y. Water Science Center
(631) 736-0783, -4283 fax
http://ny.water.usgs.gov

- Chris Schubert
  schubert@usgs.gov

USGS