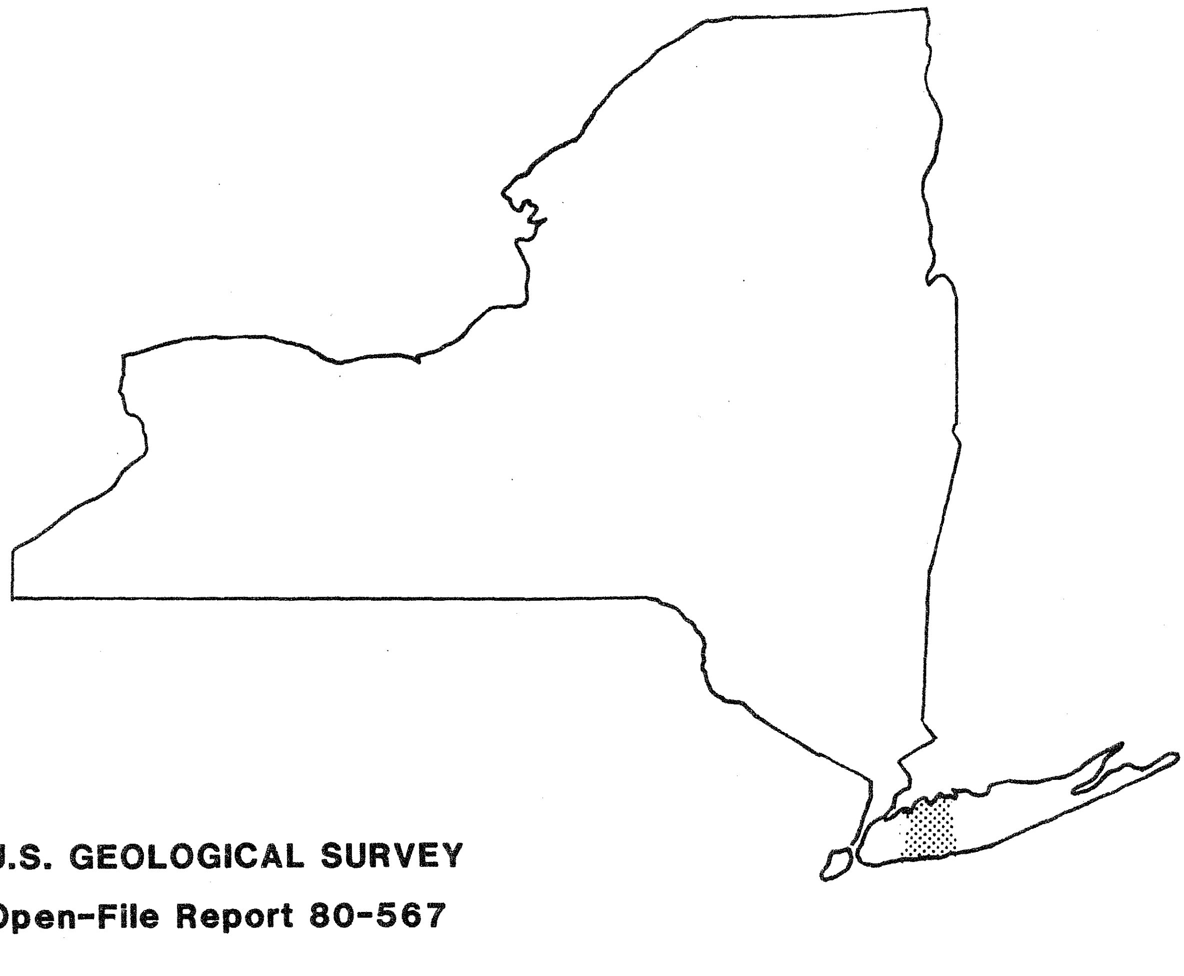
Chemical and Microbiological Monitoring of a Sole-Source Aquifer Intended for Artificial Recharge, Nassau County, New York



U.S. GEOLOGICAL SURVEY

Open-File Report 80-567

Prepared in cooperation with
Nassau County Department of Public Works

ERRATA

"Chemical and Microbiological Monitoring of a Sole-Source Aquifer Intended for Artificial Recharge, Nassau County, New York" by Brian G. Katz and Gail E. Mallard; U.S. Geological Survey Open-File Report 80-567.

Table 4, column 5 (page 15)

Maximum concentration of dieldrin (μg/L) should be as below:

Depth of well screen below land surface (feet)	Maximum concentration (μg/L)
50	0.22
100	1.40
200	0.08

Table 5 (page 16)

The entries for fecal streptococci should include results from the 200-foot wells as below:

Depth of well screen below land surface (feet)	Number of samples with one or more bacteria per 100 mL	Total number of samples	Maximum count per 100 mL
200	0	13	0

UNITED STATES
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

CHEMICAL AND MICROBIOLOGICAL MONITORING OF A SOLE-SOURCE AQUIFER INTENDED FOR ARTIFICIAL RECHARGE, NASSAU COUNTY, NEW YORK

By Brian G. Katz and Gail E. Mallard

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Syosset, New York

1980

UNITED STATES DEPARTMENT OF THE INTERIOR

Cecil D. Andrus, Secretary

GEOLOGICAL SURVEY

H. William Menard, Director

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Syosset, New York 11791

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CONVERSION FACTORS AND ABBREVIATIONS

Multiply Inch-Pound Unit	by	To obtain SI[1] unit
mile	1.609	kilometer
square mile	2.590	square kilometer
foot	0.3048	meter
million gallons per day	3.785	million liters per day

[1] International System of units

CHEMICAL AND MICROBIOLOGICAL MONITORING OF A SOLE-SOURCE AQUIFER INTENDED FOR ARTIFICIAL RECHARGE, NASSAU COUNTY, NEW YORK

By

Brian G. Katz and Gail E. Mallard

ABSTRACT

In late 1980, approximately 4 million gallons per day of highly treated wastewater will be used to recharge the ground-water reservoir in central Nassau County through a system of 10 recharge basins and 5 shallow injection wells.

To evaluate the impact of large-scale recharge with reclaimed water on ground-water quality, the U.S. Geological Survey, in cooperation with Nassau County Department of Public Works, has collected hydrologic and water-quality data from a 1-square-mile area around the recharge site to provide a basis for future comparison. Extensive chemical and microbiological analyses are being made on samples from 48 wells screened in the upper glacial (water-table) aquifer and the upper part of the underlying Magothy (public-supply) aquifer.

Preliminary results indicate that water from the upper glacial aquifer contains significant concentrations of nitrate and low-molecular-weight chlorinated hydrocarbons and detectable concentrations of organochlorine insecticides and polychlorinated biphenyls. At present, no fecal contamination is evident in either aquifer in the area studied. In the few samples containing fecal indicator bacteria, the numbers were low.

Nonpoint sources provide significant loads of organic and inorganic compounds; major sources include cesspool and septic-tank effluent, cesspool and septic-tank cleaners and other over-the-counter domestic organic solvents, fertilizers, insecticides for termite and other pest control, and stormwater runoff to recharge basins.

The water-table aquifer is composed mainly of stratified, well-sorted sand and gravel and, as a result, is highly permeable. In the 1-square-mile area studied, some contaminants seem to have traveled 200 feet downward to the bottom of the water-table aquifer and into the upper part of the public-supply aquifer.

INTRODUCTION

Ground water is the sole source of fresh water for the nearly 1.5 million residents of Nassau County, one of four counties on Long Island, New York (fig. 1). Rapid population growth in Nassau County over the past 30 years has increased both the demand for fresh water and the amount of domestic wastewater discharged to the ground water through cesspools and septic tanks. Because ground water is the sole source of public supply for Nassau and Suffolk Counties, the U.S. Environmental Protection Agency in 1978 assigned "sole-source" status to the Long Island ground-water reservoir (1). This status prohibits Federally assisted projects from discharging waters that would contaminate the ground-water reservoir.

At present, 1980, about 65 percent of the land in Nassau County is residential, and only 1.8 percent of the area remaining is vacant land. Approximately 60 percent of the population, or 850,000, reside in unsewered areas and discharge 60 Mgal (million gallons per day) of domestic wastes through 150,000 cesspools into the shallow zone of the ground-water reservoir (2).

To prevent further degradation of water quality from domestic wastewaters, a comprehensive sewering program was begun in the 1950's to serve about 85 percent of Nassau County. The work is expected to be completed in 1985.

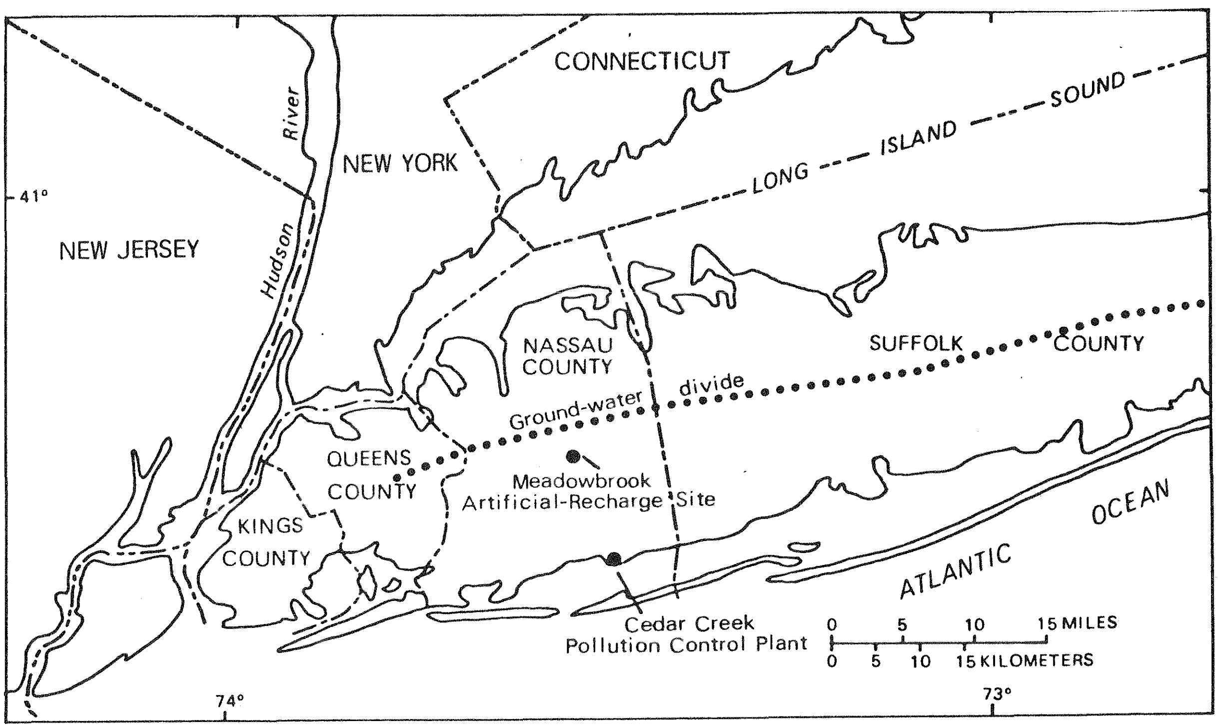

Figure 1.--Location of ground-water divide, Meadowbrook Artificial Recharge Site, and Cedar Creek sewage-treatment plant.

Two of the effects of urbanization--sewering and increased ground-water pumpage--have resulted in a reduction in the quantity of ground water; this reduction has in turn caused a decline in the water table, a corresponding decrease in fresh-water streamflow, increased salinity of the bays, and the landward movement of saline ground water in some areas. To offset this decline in the water table and to alleviate the accompanying problems, highly treated sewage that would otherwise be discharged into the sea can be used to replenish the ground-water reservoir.

Comparison of water-quality data collected before recharge with data collected after recharge begins should reveal whether or not artificial recharge with reclaimed water of high quality will be safe and feasible. This report is a result of an ongoing cooperative program with the Nassau County Department of Public Works. Special analyses for selected organic compounds were performed by the New York State Department of Health Laboratory through the cooperation of Nassau County Department of Health.

Purpose and Scope

In an effort to offset the effects of lowered ground-water levels and declining quantity and quality of ground water, reuse of treated wastewater and methods of replenishing the ground-water reservoir have been under investigation since 1968. The most recent of these studies is the Cedar Creek water-reclamation recharge project, which will study the feasibility of recharge with 4 Mgal/day of tertiary-treated sewage through a system of basins and injection wells. This report describes the role of the U.S. Geological Survey in monitoring the quality of ground water for selected chemical and microbiological constituents before the introduction of reclaimed wastewater to the system and presents the results obtained to date. Data obtained through this study will provide a basis for future comparisons to determine the chemical and biological effects of artificial recharge and to evaluate its safety.

Previous Recharge Studies in Nassau County

Recharge and reuse of water in Nassau County were proposed as early as 1963. In response to concern that a predicted deficit in the quantity of available ground water could lead to the landward movement of salt water in some areas, the U.S. Geological Survey, in cooperation with the Nassau County Department of Public Works, began an experimental deep-well recharge program in 1968. Between 1968 and 1973, 13 recharge tests with tertiary-treated sewage (reclaimed water) were made through a well screened in the Magothy aquifer between depths of 420 and 480 feet below land surface. However, injection into the fine-grained sediments at that particular site (Bay Park) was found to be infeasible because the excessive head buildup of injected water required frequent redevelopment of the well (3).

In a study of storm-water basins in Nassau County, Aronson and others (4) found that large quantities of reclaimed water could be transmitted to the ground-water reservoir through many of the county's stormwater basins, which are excavated in the highly permeable material of the upper glacial aquifer. That study concluded that, under proper conditions, there would be little chance of overflow or excessive water-table buildup during recharge.

HYDROGEOLOGY

The hydrogeology of the major aquifers underlying Long Island is described only in general terms in this paper. More detailed descriptions are given in reports by McClymonds and Franke (5) and Franke and Cohen (6).

Long Island is underlain by a southward-dipping wedge of unconsolidated deposits (fig. 2). The two aquifers of concern include the upper glacial (water-table) aquifer and the underlying Magothy aquifer, which has been given sole-source designation by the U.S. Environmental Protection Agency. Within the 1-square-mile study area these aquifers are hydraulically connected. Here, the upper glacial aquifer is composed of Pleistocene outwash deposits consisting mainly of highly permeable sand and gravel of glacial origin; depth to the water table generally ranges from 29 ft to 32 ft.

The Magothy aquifer, which underlies the upper glacial aquifer in the study area, consists of beds or lenses of fine to medium sand, clay, silt, and gravel. At present, water from the Magothy aquifer is used for public supply for most of Nassau County because the upper glacial aquifer has become widely contaminated.

Precipitation is the source of all fresh ground water in Nassau County; average annual precipitation is 44 inches. Under natural conditions, about half the average annual precipitation percolates to the water table; the rest runs off or evaporates and transpires. Additional recharge to the water table results from infiltration of storm runoff, injection of water used by industry, and discharge of domestic and industrial wastewater from cesspools and septic-tank systems (6). The deeper Magothy aquifer is recharged by downward movement of water from the upper glacial aquifer.

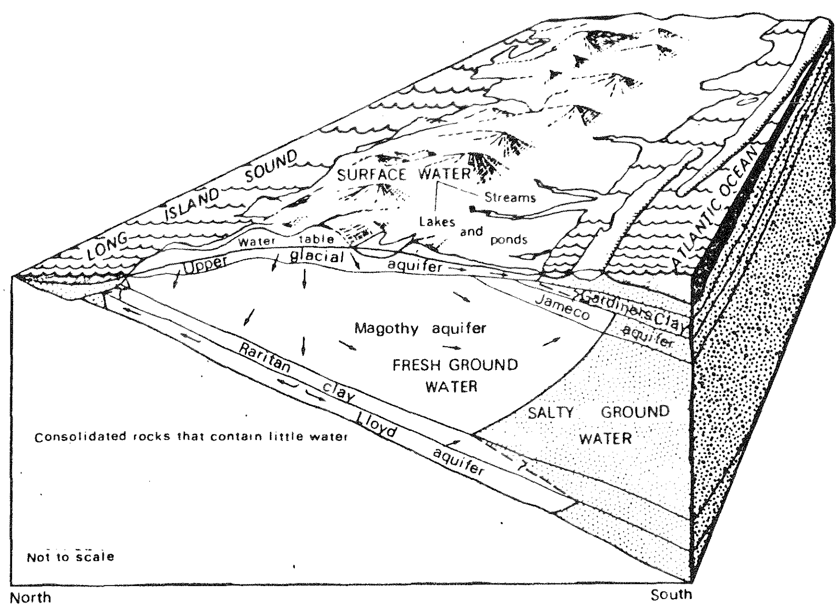

Figure 2.--Generalized cross section of Long Island showing major hydrogeologic units and paths of ground-water flow. (Modified from Cohen and others, 1968, [7].)

In general, ground-water movement north of the regional ground-water divide (fig. 1) is northward toward Long Island Sound; south of this divide, it is generally toward the south shore of Long Island, as indicated by the arrows in figure 2.

DESCRIPTION OF CEDAR CREEK WATER-RECLAMATION RECHARGE PROJECT

The Cedar Creek water-reclamation recharge project was developed in an effort to offset the effects of urbanization, where the quality and quantity of potable ground water have been diminished. The project is a multiagency effort supported by grants from the U.S. Environmental Protection Agency, New York State Department of Environmental Conservation, and Nassau County Department of Public Works. The U.S. Geological Survey entered into a cooperative agreement with Nassau County Department of Public Works in 1977 to study the hydrologic effects of water reclamation and artificial recharge. The artificial-recharge system consists of three main components--the reclamation plant, the transmission-main system, and the recharge facilities.

Reclamation Plant and Transmission-Main System

The Cedar Creek sewage-treatment plant is a conventional activated-sludge facility designed to treat 45 to 50 Mgal/day. Approximately 5 Mgal/day of influent sewage will be diverted to the water-reclamation plant after screening and grit removal; the remaining 40 to 45 Mgal/day will be discharged to the ocean after secondary treatment. The advanced wastewater-treatment process consists of four steps:

(1) chemically aided primary treatment to improve the removal of phosphorous, BOD (biochemical oxygen demand), suspended solids, and heavy metals;

(2) a two-stage biological treatment system consisting of a nitrification-denitrification process to promote biological nitrogen removal in combination with oxidation of remaining carbonaceous material;

(3) filtration and carbon adsorption to reduce organic compounds in the effluent to a few parts per billion; and

(4) chlorination and storage to disinfect and store this effluent to allow for continuous delivery of 4 Mgal/day to the injection wells and basins at the recharge site. A diagram showing the treatment process is included as figure 3.

New York State and Federal drinking-water standards must be met before any water will be transmitted from the Cedar Creek sewage-treatment plant (fig. 1) to the Meadowbrook artificial-recharge site, a distance of 6.25 miles.

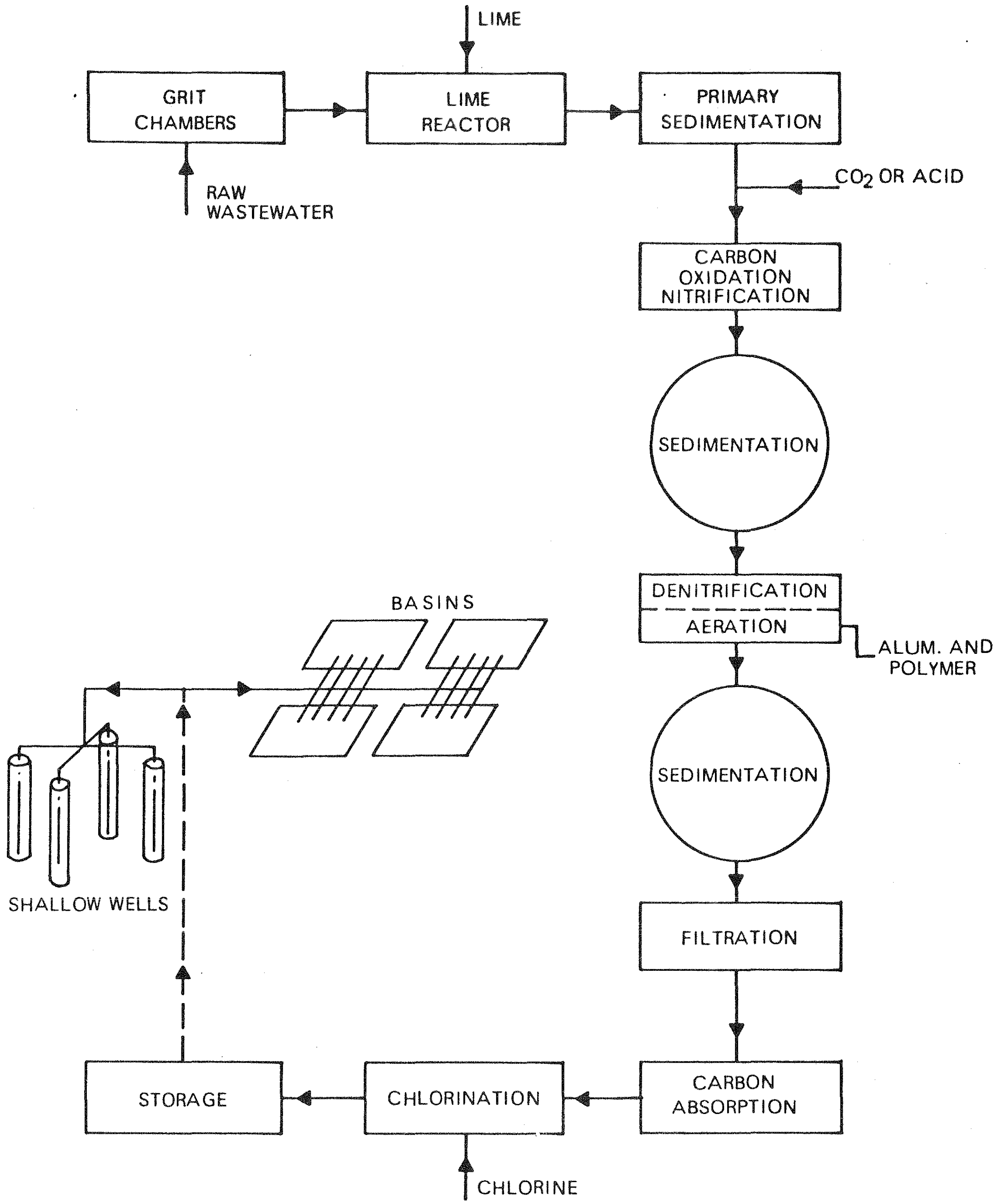

Figure 3.--Schematic diagram of water-reclamation recharge project facilities (from Beckman and Avendt, 1973 [8]).

Recharge Facilities

At the Meadowbrook artificial-recharge site (fig. 1), a system of 5 injection wells and 10 basins will be used to return 4 Mgal/day of reclaimed water to the ground-water system. This site, near the geographic center of Nassau County, includes approximately 35 acres. Two major goals of the project (9) are to (a) determine the most efficient methods of artificial recharge; and (b) monitor and evaluate the chemical, biological, and physical effects of artificial recharge on the ground-water reservoir at and downgradient from the recharge site. An observation-well network, which will be used to monitor changes in ground-water quality before and after recharge begins, is discussed in the following section.

METHODS OF SAMPLING GROUND WATER FOR SELECTED CHEMICAL AND MICROBIOLOGICAL CONSTITUENTS

A monitoring network of 48 observation wells at 22 sites (fig. 4) was established within the 1-square-mile area surrounding the recharge site. The well sites contain either one, two, or three wells screened at depths of from 45 to 50 ft, 95 to 100 ft, and 195 to 200 ft below land surface. Hereafter, these screened depths are referred to as 50, 100, and 200 feet.

Construction of Observation Wells

All holes for the observation wells were drilled with rotary drilling equipment. Bentonite or fine sand, free of added organic substances, was used as a drilling mud. The wells were cased with 6-inch diameter noncorrosive fiberglass pipe. Five feet of stainless-steel 6-inch diameter well screen was attached to the bottom of each casing. The well screen was surrounded by clean washed gravel-size material. A layer of cement grout was used to fill the annular space above the gravel pack to reduce the possibility of contamination from above; the remainder of the hole was backfilled with the original aquifer material. After construction was completed, the well was developed by surging and pumping until the water was substantially free of suspended material and the turbidity was less than 5 Jackson turbidity units (JTU).

Chemical and Microbiological Constituents

To provide a basis for future comparison, the quality of water from these wells before artificial recharge is being evaluated in terms of major cations and anions, nutrients (nitrogen, phosphorous, and carbon), selected low-molecular-weight halogenated hydrocarbons, selected organochlorine and organophosphorus insecticides, polychlorinated biphenyls, selected herbicides, several groups of bacteria including pollution indicator organisms, and organisms important in the nitrogen cycle. A list of all chemical and microbiological constituents is provided in table 1.

Table 1.--Selected chemical and microbiological constituents routinely analyzed in samples of ground water from study area.

Major inorganic cations and anions:
- calcium, magnesium, potassium, sodium
- chloride, fluoride, sulfate

Nutrients
- nitrogen species
- phosphorus species

Metals
- aluminum, chromium, iron, manganese, zinc

Low-molecular-weight organic chemicals:
- bromodichloromethane
- carbon tetrachloride
- chloroform
- tetrachloroethylene
- trichloroethylene
- 1,1,1 trichloroethane
- 1,1,2 trifluorotrichloroethane

Insecticides:
- Organochlorine:
  - aldrin, chlordane, DDD, DDE, DDT, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, lindane, methoxychlor, mirex, perthane, toxaphene

Insecticides:
- Organophosphorus
  - diazinon, ethion, malathion methylparathion, methlytrithion, parathion, trithion

Herbicides:
- 2,4-D
- 2,4-DP
- Silvex
- 2,4,5-T

Polychlorinated biphenyls

Bacteria:
- total aerobic heterotrophs
- total coliforms
- fecal coliforms
- fecal streptococci
- denitrifying bacteria
- nitrifying bacteria

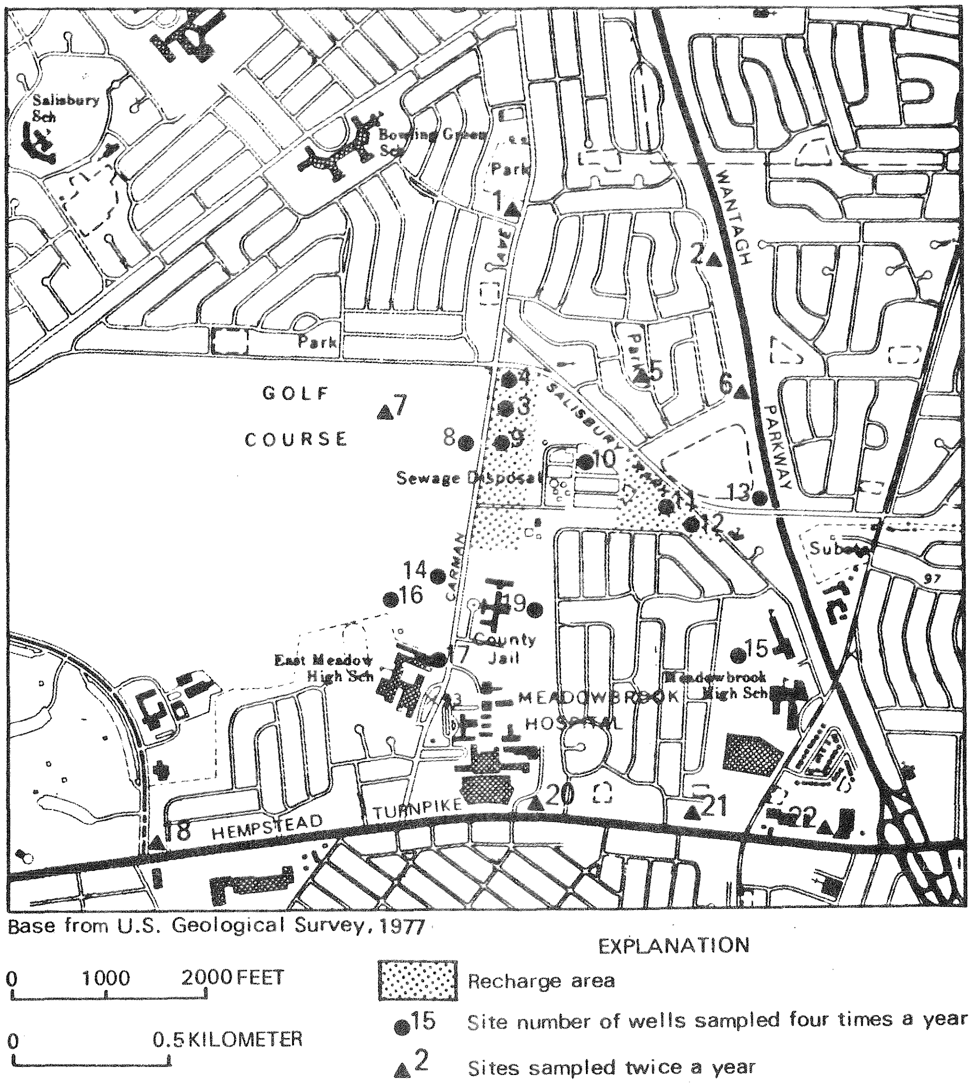

Figure 4.--Location of observation wells at Meadowbrook artificial recharge site.

Sampling Procedures

Samples of water from observation wells near and downgradient from the basins and injection wells to be used for artificial recharge were collected four times per year; observation wells farther from the recharge area were sampled twice a year.

All wells were sampled by submersible pump lowered down the casing to 10 ft or less below water level. Three times the volume of water in the well casing was cleared before the samples were taken for analysis. The pump was then removed from the well and disinfected for 30 minutes by recirculating a solution of calcium hypochlorite containing 25-30 mg/L free chlorine. This is the procedure recommended by "Standard Methods" (10) for sterilizing virus-concentrating equipment that cannot be autoclaved.

After disinfection, the pump was again lowered into the casing, and at least the volume of water in the well casing was removed from the well. In practice, more than the volume of water in the well casing was cleared from the shallowest wells sampled. This practice allowed any chlorine solution remaining on the inside or outside of the pump to be removed. Water to be analyzed for bacteria was collected in sterile bottles and processed within 2 hours.

Analytical Methods

Inorganic substances in samples of ground water are being analyzed at a U.S. Geological Survey Laboratory by methods developed by Skougstad and others (11). Seven selected low-molecular-weight halogenated hydrocarbons are being analyzed by the New York State Department of Health Laboratory with a modified Beller-Lichtenburg technique (12). The organophosphorous and organochlorine insecticides, along with the polychlorinated biphenyls and selected herbicides are being analyzed by the U.S. Geological Survey by gas chromatography-mass spectroscopy techniques developed and modified by Goerlitz and Brown (13). Identification and enumeration of bacteria in all water samples were done according to standard procedures of the U.S. Geological Survey (14). Total aerobic heterotrophs, total coliforms, fecal coliforms, and fecal streptococci were analyzed by membrane filter techniques. A multiple-tube most probable number method was used to enumerate nitrifying and denitrifying bacteria.

QUALITY OF GROUND WATER BEFORE RECHARGE

The quality of ground water before recharge was determined by analyzing samples from 48 observation wells at 22 sites in the recharge area. Data from the observation-well network could be grouped either by depth of the well screen or location within the recharge area. In this report, the data are grouped according to screen depth to allow comparison among 50-, 100-, and 200-ft levels. It would not be useful at this time to examine areal differences in water quality. Water at any given depth is likely to be uniform within the area because there is no readily identifiable point source for a plume of ground-water contamination.

The alteration of ground-water quality in Nassau County results mainly from nonpoint sources, which include effluent from cesspools, septic tanks, stormwater discharge sumps, and sewers as well as salts for road deicing and chemicals used on lawns, in agriculture, and in industry. Precipitation and stormwater runoff are the principal agents in moving dissolved substances from these sources through the ground to the water table. Ground water in the study area moves southward at approximately half a foot per day (15).

Alteration of Ground-Water Quality by Inorganic Chemicals

Chloride, nitrate, sulfate, and ammonium were selected for analysis because they are the major inorganic ions that can indicate contamination. In general, the mean concentration of all four ions decreases with depth (table 2), as would be expected, because water from the 100-and 200-foot wells is being withdrawn from the deeper regional flow systems, in which water contains lower concentrations of dissolved ions. This decrease in concentration with depth is most evident for ammonium-N; it is due in part to chemical reactions such as ion exchange, sorption, and oxidation-reduction.

Table 2.--Mean, median, and range of nitrate-N, chloride, sulfate, and ammonium-N in water from wells in study area.

Chemical	Depth of well screen below land surface (feet)	Mean (mg/L)	Median (mg/L)	Range (mg/L)	No. of analyses
NO_3-N	50	11	11	0.93 - 26	45
	100	8.9	8.7	0.26 - 20	34
	200	9.2	7.9	0.07 - 25	17
Cl	50	39	33	2.8 - 220	52
	100	36	34	7.3 - 67	46
	200	22	21	7.0 - 46	20
SO_4	50	36	38	6.4 - 52	53
	100	32	30	2.6 - 56	46
	200	17	16	0.0 - 44	20
NH_4-N	50	0.18	0.02	0.0 - 1.9	50
	100	0.12	0.0	0.0 - 2.0	41
	200	0.01	0.01	0.0 - 0.03	20

Alteration of Ground-Water Quality by Organic Chemicals

Low-molecular-weight halogenated hydrocarbons are widespread in the ground water beneath Long Island. Trichloroethylene, chloroform, 1, 1, 1-trichloroethane, and tetrachloroethylene have all been observed in concentrations greater than 50 µg/L in the upper glacial and Magothy aquifers during a recent islandwide study (2). In the study area, at least one of these four compounds was detected in water from most wells and from both aquifers (table 3). Concentrations of trichloroethylene and tetrachloroethylene increase with depth below land surface; the highest percentage of samples that exceeded 20 µg/L was in the 100-foot level (table 3). In contrast, both the maximum concentration of 1,1,1-trichloroethane and the percentage of samples exceeding 20 µg/L of this compound decrease with increasing depth.

Table 3.--Low-molecular-weight halogenated hydrocarbons detected in water from wells in study area.

Chemical	Depth of well screen below land surface (feet)	Number of wells sampled	Number of wells where concentration equals or exceeds 20 µg/L	Maximum concentration in ground water (µg/L)
Trichloroethylene	50	21	3	173
	100	15	5	270
	200	9	1	290
Tetrachloroethylene	50	21	5	580
	100	15	5	1500
	200	9	2	1000
Chloroform	50	21	1	21
	100	15	1	20
	200	9	0	17
1,1,1 Trichloroethane	50	21	14	208
	100	15	4	87
	200	9	0	16

The health risk (16) associated with the presence of these compounds in ground water has prompted the Nassau County Department of Health to undertake a comprehensive survey of industrial sites that use organic solvents and consumer products that contain organic chemicals. The above-mentioned low-molecular-weight organic solvents were the most heavily used organic chemicals in 641 industrial plants surveyed. Dry cleaners use large quantities of tetrachloroethylene, and a large aerospace manufacturer uses much 1, 1, 1-trichloroethane and tetrachloroethylene (17).

Results of a consumer-products survey by the Nassau County Department of Health showed that the major source of these low-molecular-weight compounds was cesspool cleaners (16). In 1977, it was estimated that 18,600 gallons of 1, 1, 1-trichloroethane and 17,600 gallons of other halogenated compounds were sold and presumably used for cleaning cesspools in Nassau County.

In addition to the low-molecular-weight halogenated hydrocarbons, insecticides have been detected in ground water at all three sampling zones (table 4), and polychlorinated biphenyls (PCB's) have been detected at the two upper (50-and 100-foot) zones. As depth below land surface increases, the number of wells containing detectable concentrations of dieldrin and polychlorinated biphenyls decreases (table 4). However, the maximum concentration of dieldrin was not in the shallowest zone but at the 100-ft depth.

Heavy rates of application of dieldrin, aldrin (which is oxidized to form dieldrin), and heptachlor (which is converted to heptachlor epoxide) are used to control termites in Nassau County. In 1975, it was estimated that more than 150,000 pounds of aldrin and dieldrin was applied for termite control (18). Apparently these insecticides travel downward through the nonreactive aquifer material without being removed or altered, as indicated by their presence at the 200-ft depth (table 4).

Microbiological Characteristics

Most public-supply wells that obtain water from the deeper parts of the Magothy aquifer are free of coliform bacteria (19). The shallow water sampled was also relatively free of coliform bacteria; only 5 samples out of 81 analyzed had any fecal coliform bacteria in 100 mL (table 5), and the numbers of fecal coliforms in those samples were low. Similar results were obtained for fecal streptococci.

Bacteria that are important in the geochemical transformation of nitrogen were observed regularly at all three levels sampled. Denitrifying bacteria were observed in all samples; nitrifying bacteria were observed in much lower numbers and in only approximately 50 percent of the samples at all levels. Substantial variation in numbers was observed among well sites and over time at the same location. No relationship between concentration of nitrogen species and number of nitrogen-metabolizing bacteria in any given water sample was noted.

Table 4.--Presence of dieldrin, heptachlor epoxide, and polychlorinated biphenyls at or above detection limits in water from wells in study area.

Chemical	Depth of well screen below land surface (feet)	Detection limit (µg/L)	Percentage of water samples from wells at or above detection limit	Maximum concentration (µg/L)
Dieldrin	50	0.01	80	0.022
	100		56	0.140
	200		22	0.080
Heptachlor epoxide	50	0.01	15	0.03
	100		6	0.01
	200		11	0.02
Polychlorinated biphenyls	50	0.1	35	0.6
	100		13	0.6
	200		0	0.0

In general, the total number of bacteria (total aerobic heterotrophs) in the water samples was low, and the mean number of bacteria per milliliter decreased with depth below land surface. A statistically significant difference was noted between the counts obtained at the 50-foot level and those obtained at the 200-foot level, but interpretation is difficult because the numbers within the samples from all three depths ranged over almost two orders of magnitude. This scatter suggests the need for caution in interpretation of data and also points out the importance of collecting several samples over time and at several sites to obtain adequate information.

Table 5.--Bacterial indicators of fecal contamination in ground water from selected depths.

Bacteria	Depth of well screen below land surface (feet)	Number of samples with one or more bacteria per 100 mL	Total number of samples	Maximum count per 100 mL
Fecal coliforms	50	3	34	23
	100	1	32	4
	200	1	15	1
Fecal streptococci	50	6	33	27
	100	7	31	6

SUMMARY AND CONCLUSIONS

One of the main effects of urbanization in Nassau County has been a net reduction in the quantity and quality of potable ground water. The Cedar Creek water-reclamation project was designed to determine the feasibility of recharging the ground-water reservoir with reclaimed water to replenish the supply and improve its quality. Starting in late 1980, approximately 4 Mgal/day of tertiary-treated sewage will be used to recharge the ground-water reservoir in central Nassau County through a system of 10 recharge basins and 5 shallow injection wells.

To evaluate the hydrologic and water-quality impact of large-scale recharge with reclaimed water, the U.S. Geological Survey has collected data on ground-water quality in a 1-square-mile area around the recharge site to provide a basis for comparison after recharge has begun. Water from observation wells screened at depths of 50, 100, and 200 ft below land surface is being analyzed for major cations, major anions, nutrients, selected metals, and several groups of bacteria, including pollution-indicator organisms and organisms important in the nitrogen cycle. Samples are also being analyzed for selected low-molecular-weight halogenated hydrocarbons, organochlorine and organophosphorus insecticides, chlorinated phenoxy and acid herbicides, and polychlorinated biphenyls.

Preliminary results indicate that ground water at the recharge site contains elevated concentrations of nitrate, chloride, sulfate, and ammonium ions; however, the concentrations of these ions generally decrease with depth below land surface. Water from the upper glacial aquifer and Magothy aquifer contains significant concentrations of low-molecular-weight chlorinated hydrocarbons and detectable concentrations of organochlorine insecticides and polychlorinated biphenyls. At present no fecal contamination of the aquifers is evident. In the few cases where fecal indicator bacteria were present, numbers were low.

Nonpoint sources provide significant loads of organic and inorganic compounds. Major sources include cesspool and septic tank effluent, cesspool and septic-tank cleaners and other over-the-counter domestic organic solvents, fertilizers, insecticides for termite and other pest control, and stormwater runoff to recharge basins.

The feasibility of artificial recharge on Long Island depends upon whether it will adversely affect the supply of potable water. Any change in the water quality during recharge with reclaimed water should be apparent upon comparison with the background data collected during this study.

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