Appraisal of Operating Efficiency of Recharge Basins on Long Island, New York, in 1969

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 2001–D

Prepared in cooperation with the Nassau County Department of Public Works, New York State Department of Environmental Conservation, Suffolk County Department of Environmental Control, and Suffolk County Water Authority

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By D. A. ARONSON *and* G. E. SEABURN

WATER IN THE URBAN ENVIRONMENT

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APPRAISAL OF OPERATING EFFICIENCY OF RECHARGE BASINS ON LONG ISLAND, NEW YORK, IN 1969

By D. A. Aronson and G. E. Seaburn

ABSTRACT

Recharge basins on Long Island are unlined pits of various shapes and sizes excavated in surficial deposits of mainly glacial origin. Of the 2,124 recharge basins on Long Island in 1969, approximately 9 percent (194) contain water 5 or more days after a 1-inch rainfall. Basins on Long Island contain water because (1) they intersect the regional water table or a perched water table, (2) they are excavated in material of low hydraulic conductivity, (3) layers of sediment and debris of low hydraulic conductivity accumulate on the basin floor, or (4) a combination of these factors exists.

Data obtained as part of this study show that (1) 22 basins contain water because they intersect the regional water table, (2) a larger percentage of the basins excavated in the Harbor Hill and the Ronkonkoma morainal deposits contain water than basins excavated in the outwash deposits, (3) a larger percentage of the basins that drain industrial and commercial areas contain water than basins that drain highways and residential areas, (4) storm runoff from commercial and industrial areas and highways generally contains high concentrations of asphalt, grease, oil, tar, and rubber particles, whereas runoff from residential areas mainly contains leaves, grass cuttings, and other plant material, and (5) differences in composition of the soils within the drainage areas of the basins on Long Island apparently are not major factors in causing water retention.

Water-containing basins dispose of an undetermined amount of storm runoff primarily by the slow infiltration of water through the bottoms and the sides of the basins. The low average specific conductance of water in most such basins suggests that evaporation does not significantly concentrate the chemical constituents and, therefore, that evaporation is not a major mechanism of water disposal from these basins.

INTRODUCTION

Recharge basins in Nassau and Suffolk Counties, Long Island, N.Y., are used primarily to dispose of storm runoff from urban and suburban areas (fig. 1). Precipitation on impervious areas, such as roofs, sidwalks, and streets, commonly drains into recharge basins, where the water generally infiltrates moderately to highly permeable deposits of glacial origin to the underlying ground-water reservoir. Because of generally favorable geologic conditions, most basins on Long Island dispose of storm water within a few hours and almost always within a day or so after a storm. However, some basins contain water for long periods after a storm; a few contain water perennially.

PURPOSE AND SCOPE OF STUDY

The purpose of this report is to review the factors that cause water retention in basins on Long Island. Specifically, this report discusses (1) the factors that cause low infiltration rates in some basins on Long Island (2) methods of disposal of water in such basins, and (3) methods used to improve present or restore previous infiltration rates in some of these basins.

This report is one of several that summarize the results of a detailed study of recharge basins on Long Island. The study was made by the U.S. Geological Survey in cooperation with the Nassau County Department of Public Works, the New York State Department of Environmental Conservation (formerly the Department of Conservation, Water Resources Division), the Suffolk County Department of Environmental Control, and the Suffolk County Water Authority. The major overall objectives of the study were (1) to catalog basic physical data pertaining to recharge basins on Long Island, (2) to make quantitative and qualitative measurements of rainfall, inflow, and infiltration rates at selected basins, and (3) to evaluate the regional effects of recharge basins on the hydrologic system of Long Island.

LOCATION AND EXTENT OF STUDY AREA

Long Island extends east-northeast from the southernmost part of New York State about 120 miles into the Atlantic Ocean. It consists of four counties, has a total land area of about 1,400 square miles, and had a population in 1970 of about 7 million. Recharge basins are used on Long Island only in the two easterly counties—Nassau and Suffolk. However, together these two counties comprise almost 90 percent of the land area of Long Island (fig. 1).

The other two counties on Long Island—Kings and Queens—are boroughs of New York City. Storm runoff from these areas is routed directly to tidewater; therefore, these counties were not included in this study.

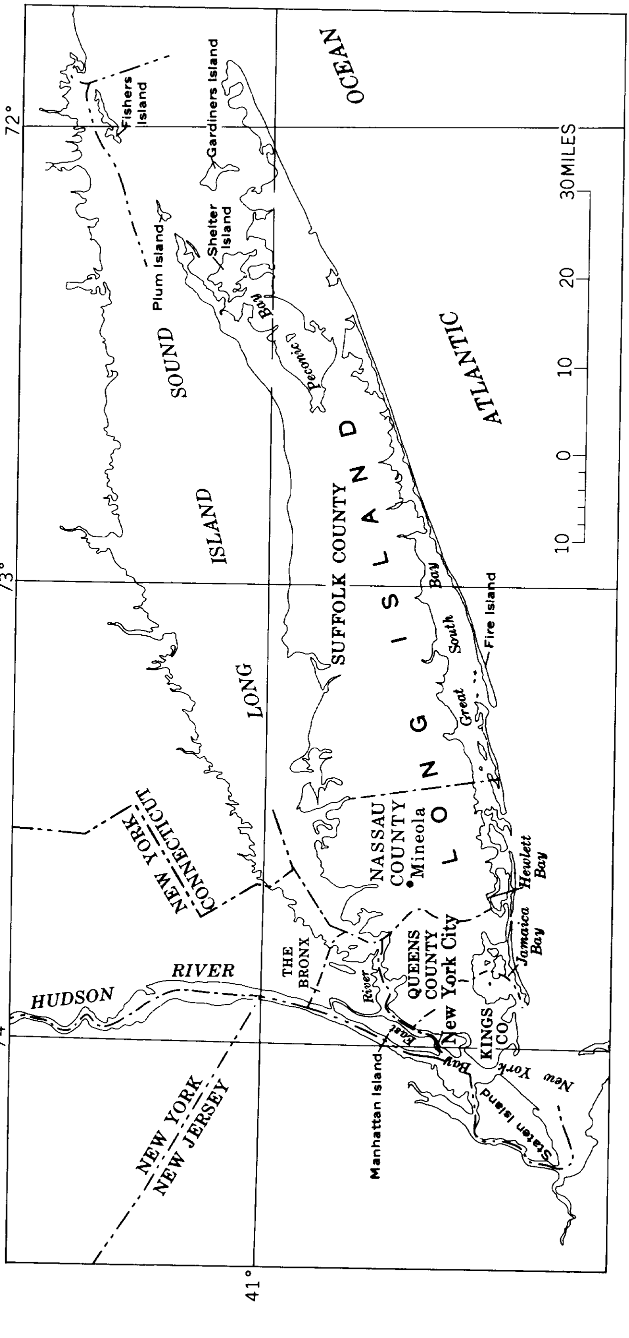

FIGURE 1.—Location and general geographic features of Long Island, N.Y.

POPULATION AND INDUSTRY

Since World War II the population of Nassau and Suffolk Counties has increased significantly (table 1). During 1971, the population growth rate was greater in Suffolk County than in Nassau County, mainly because open land in Nassau County for new housing and industrial developments is nearly depleted. The population influx to Suffolk County has been accompanied by large suburban housing developments consisting mainly of single-family units.

Industry, mainly light manufacturing in many diversified fields, is concentrated in the heavily populated areas of Nassau and western Suffolk Counties. Agriculture, mostly truck farms, is concentrated in the rural areas in eastern Suffolk County.

TABLE 1.—*Population, in thousands, of Nassau and Suffolk Counties (1920–1970)*

[U.S. Bureau of Census (1941, 1961, 1970)]

County	1920	1930	1940	1950	1960	1970
Nassau	126	303	407	673	1,300	1,460
Suffolk	110	161	197	276	667	1,060
Total	236	464	604	949	1,967	2,520

CLIMATE

The mild, humid climate on Long Island is influenced largely by westerly winds that cause most weather systems to move from the continental landmass to the island. However, during the summer, some of the tropical storms originating in and near the Caribbean bring intense precipitation. Temperature extremes are moderated by the ocean and Long Island Sound. The mean annual temperature at Mineola, N.Y., (fig. 1) from 1938 to 1970 was about 11°C (Celsius) or 52°F (Fahrenheit). The minimum mean monthly temperature is —1°C (31°F) in January; the maximum mean monthly temperature is 23°C (74°F) in July.

Average annual precipitation on Long Island from 1951 to 1965 was about 43 inches; it ranged from 40 inches in the nearshore areas to 50 inches in the central part of the island (Miller and Frederick, 1969, p. A13). Average monthly precipitation at Mineola generally ranged from 3 to 4 inches. Monthly precipitation is greatest during March and August and least during January, June, and October.

ACKNOWLEDGMENTS

The authors appreciate the help of the many individuals who contributed data, active interest, and cooperation in the compila-

tion and the analysis of the data presented in this report.

Aerial photographs were obtained from Lockwood, Kessler, and Bartlett, consulting engineers. Soil interpretations and data were provided by J. E. Arledge, District Conservationist, Suffolk County, N.Y., and J. W. Warner, Jr., soil scientist, of the U.S. Department of Agriculture, Soil Conservation Service. B. H. Lowell, U.S. Geological Survey, assisted in the compilation and the analysis of data. J. J. Bachmore, A. S. Candela, and A. L. Iorio, New York State Department of Environmental Conservation, and J. C. Walsh, U.S. Geological Survey helped collect, compile, and analyze the data; their help is gratefully acknowledged.

PREVIOUS STUDIES

Several hydrologists (Brashears, 1941; Welsch, 1949; Brice and others, 1959; Parker and others, 1967; and Holzmacher and others, 1970) have discussed recharge basins and made quantitative estimates of ground-water recharge through basins on Long Island. Seaburn (1970) described the results of a detailed hydrologic study at two recharge basins in Nassau County and Seaburn and Aronson (1971) compiled a catalog of recharge basins in use on Long Island in 1969. More recently Seaburn and Aronson (1973) discussed the results of hydrologic studies at three recharge basins on Long Island and the overall influence of recharge basins on the hydrology of Long Island.

No reports have been published on water-containing recharge basins on Long Island. However, studies have been made of several possible causes of water containment at recharge basins in other parts of the country. Examples of such studies are those by Suter and Harmeson (1960), who described progressive deterioration of the infitration rates of a recharge basin used to recharge untreated river water in Illinois, and Muckel (1959) and McMichael (1966), who discussed the relation between specific causes of water containment by basins and physical characteristics of materials on the basin floors.

GENERAL HYDROGEOLOGY

The major geologic units on Long Island and their pertinent characteristics are listed in table 2.

The land surface of Long Island is composed mainly of outwash deposits and ground- and terminal-moraine deposits laid down during the Wisconsin Glaciation in the Pleistocene epoch. Stream terrace deposits of Tertiary (?) age are exposed in the central part

TABLE 2.—*Description and areal extent of geologic units on Long Island, N.Y.*

[After Fuller, 1914; Crandell, 1962; Perlmutter and Geraghty, 1963; Swarzenski, 1963; Lubke, 1964; Pluhowski and Kantrowitz, 1964; Isbister, 1966; Soren, 1971]

Geologic unit	Area (sq mi)	Percentage of total land area	General description
Holocene deposits: shore and marsh deposits, alluvium, artificial landfill.	40	3	Beach and dune sand and gravel; marshy areas contain sand, silt, and clay mixed with decaying plant debris; beach deposits generally are of moderate to high hydraulic conductivity.
Harbor Hill ground-moraine deposits.	190	14	Till composed of unsorted mixtures of clay, sand, and boulders, forms a veneer over area north of Harbor Hill terminal moraine; generally of moderate to low hydraulic conductivity.
Harbor Hill terminal-moraine deposits.	70	5	Till and stratified sand and gravel; generally of moderate to low hydraulic conductivity.
Kame-delta deposits	5	<1	Roughly horizontally bedded deposits of sand and gravel overlying steeply inclined strata of well-sorted sand and gravel; generally of high hydraulic conductivity.
Ronkonkoma ground-moraine deposits.	6	<1	Till composed of unsorted mixtures of clay, sand, and boulders locally grading into stratified sand and gravel; generally of moderate to low hydraulic conductivity.
Ronkonkoma terminal-moraine deposits.	120	9	Till and stratified sand and gravel; generally of moderate to low hydraulic conductivity.
Outwash deposits (undifferentiated).	850	62	Predominantly Harbor Hill drift generally consisting of well sorted and stratified brown sand and gravel; locally includes Ronkonkoma drift of similar composition; generally of high hydraulic conductivity.
Till deposits (undifferentiated).	70	5	Till and stratified sand and gravel; hydraulic conductivity varies from low to high depending on lithology.
Mannetto Gravel	20	<1	Fine to coarse, white and brown stratified gravel containing lenses of clay and medium to coarse, yellow to brown sand; hydraulic conductivity varies from low to high depending on lithology.
Matawan Group–Magothy Formation(?) (undifferentiated).	1	<1	Interbedded sand, gravel, silt, and clay of various colors; some lignite, pyrite, and ferruginous concretions; hydraulic conductivity varies from low to high depending on lithology.
Bedrock	<1	<1	Crystalline metamorphic and igneous rocks, including muscovite-biotite schist, gneiss, and granite; virtually impermeable.

of the island, and small areas of Precambrian bedrock and unconsolidated deposits of Cretaceous age crop out in the northern part. The areal extent of the deposits is shown on plate 1.

Under natural conditions, the ground-water reservoir of Long Island was replenished by precipitation that percolated through the soil downward to the water table. About 50 percent of the average-annual precipitation on Long Island recharged the ground-water reservoir, evapotranspiration was 45–50 percent of the annual precipitation, and direct runoff to streams was 2–3 percent of annual precipitation (Pluhowski and Kantrowitz, 1964, p. 35–38).

Since the end of World War II, urbanization has advanced rapidly from west to east on Long Island. Construction of streets, sidewalks, parking lots, buildings and other impervious surfaces resulted in a decrease in the land area available for natural recharge of precipitation and in an increase of direct runoff to some streams (Seaburn, 1969).

In 1971, ground-water recharge resulted mainly from infiltration of precipitation through pervious areas, such as lawns and other open spaces, and by infiltration of storm runoff through recharge basins. Additional recharge resulted from the recycling of water used for domestic and industrial purposes through cesspools, septic tanks, leaching basins, and recharge wells and by the infiltration of some of the water used to irrigate lawns.

The authors estimate that in areas drained by recharge basins on Long Island in 1969, a total of about 115 square miles, the amount of ground-water recharge from precipitation equaled or slightly exceeded ground-water recharge under natural conditions. Recharge of domestic and industrial wastes, which in Nassau and Suffolk Counties represents a return of pumped water to the ground-water reservoir, was 250 mgd (million gallons per day) or about 75 percent of the annual pumpage (Franke and McClymonds, 1970, p. 152 and 172). Pumpage in 1969 in Nassau and Suffolk Counties was about 330 mgd (New York State Water Resources Commission, written commun., 1970).

GENERAL DESCRIPTION OF RECHARGE BASINS

Disposal of storm runoff from urban and suburban areas through basins on Long Island was begun in 1935 by the Nassau County Sanitation Commission, as part of a comprehensive drainage plan (Welsh, 1935). More than 2,100 recharge basins were in operation on Long Island in 1971. These basins drain residential, industrial, and commercial areas, as well as highways. Most of the basins are in the central part of the island where the water table is sufficiently deep to remain below the floor of the basin most of the time. Figure 2 is a photograph of a typical recharge basin.

Recharge basins on Long Island are unlined pits of various shapes and sizes that have been excavated in surficial deposits of mainly glacial origin. A few basins (less than 1 percent), however, are excavated in fine-grained Cretaceous deposits. Size of recharge

FIGURE 2.—Typical recharge basin on Long Island, N.Y. (from Seaburn, 1970).

basins generally ranges from 0.1 to 30 acres and averages 1 acre. Depth of basins averages 10 feet, but some are as deep as 40 feet.

Because of the generally highly permeable character of Long Island's surficial deposits, most of the water entering recharge basins rapidly infiltrates the ground. In 1971 the average infiltration rates at three recharge basins on Long Island were 0.9 fph (feet per hour), 0.8 fph, and 0.2 fph. Infiltration rates of the same magnitude were determined by Welsch (1949), Brice, Whitaker, and Sawyer (1959), and Seaburn (1970). The infiltration rates for some of Long Island's basins are probably considerably greater than these values, and rates for other basins are zero or nearly so.

Most basins on Long Island are owned and maintained by local government agencies; some are privately owned. Maintenance of recharge basins, consisting mainly of collecting and removing bulk debris and cutting and removing grass on the floor of the basin, is done regularly by some owners and sporadically or not at all by other owners.

WATER-CONTAINING RECHARGE BASINS

The time required to dispose of water impounded in recharge basins after a storm ranges from a few hours to many months, and some basins hold water perennially. However, most are commonly dry within a day or so after a storm. For this report, a criterion was established to classify recharge basins on Long Island into two categories: water-containing basins and efficiently operating basins. The authors have defined water-containing basins as those that contain water 5 or more days after a 1-inch rainfall on the contributing drainage area. Basins that become dry within 5 days are considered to be efficiently operating basins.

Most of the water-containing basins dispose of storm runoff slowly and, therefore, may be considered to be inefficiently operating basins. However, in some water-containing basins, water levels in the basins recede rapidly (within a few hours) to the pre-storm levels after storm runoff ceases. Therefore, it would be inappropriate to categorize all water-containing basins on Long Island as being inefficiently operating basins. Figure 3 is a photograph of a typical water-containing basin.

Aerial photographs taken in the springs of 1966 and 1969 were used to locate basins that contained water, and each location was subsequently visited to determine if the basin contained water for more than 5 days after a 1-inch rainfall. By this procedure, 194 recharge basins, about 9 percent of all basins on Long Island in 1969, were found to be water-containing basins in terms of the previously mentioned criterion. Plate 1 shows the location of these water-containing basins.

FIGURE 3.—Typical water-containing recharge basin on Long Island, N.Y.

CAUSES OF WATER CONTAINMENT

Containment of water in recharge basins for prolonged periods may be caused by one or a combination of the following conditions: (1) the bottom of the basin intersects the regional water table or a perched water table, (2) the bottom of the basin intersects natural deposits of low hydraulic conductivity, or (3) sediment and other debris of low hydraulic conductivity carried into the basin by storm runoff accumulates on the basin floor.

For this report, water-containing basins on Long Island have been divided into two groups—flooded basins and clogged basins. Flooded basins are defined as those that contain water because they intersect a water table or because the bottoms of the basins were excavated in natural materials of low hydraulic conductivity. Most of the flooded basins intersect a water table, and accordingly, those basins would empty if the water table were to drop below the basin floors. Clogged basins are defined as those basins that contain water because infiltration is retarded by materials of low hydraulic conductivity deposited or formed at or below the bottom of the basin after the basin was put into operation.

Most flooded basins that intersect the regional water table are readily identifiable by the difference in altitude between the water table and the basin floor; the basin holds water where the water table is higher than its floor. In contrast, the identification of flooded basins that intersect a perched water table or that are constructed in material of low hydraulic conductivity was difficult because detailed information on the lithology of the deposits underlying the floors of many basins was unavailable. Similarly, it was difficult to determine the specific causes of water containment in many apparently clogged basins because of scant information on thickness, composition, and hydraulic conductivity of materials on or beneath the floors of those basins.

To help evaluate the various causes of water containment, each basin would have had to be investigated in detail. Such studies, however, were beyond the scope of the present study. Instead, the causes of water containment in basins that do not intersect the regional water table were evaluated indirectly. Determinations were made of trends in the accumulated data that seemed to suggest cause and effect relations among the various parameters affecting basin operation and water containment. Preliminary results of these determinations are presented in the following sections.

FLOODED BASINS

BASINS THAT INTERSECT THE REGIONAL WATER TABLE

Unconsolidated deposits of Cretaceous and Pleistocene age form the bulk of the ground-water reservoir of Long Island. The intergranular spaces of these deposits are saturated from the weathered bedrock upward. The upper surface of the saturated zone forms the regional water table.

On Long Island, most of the recharge basins are constructed in areas where the regional water table is below the floors of the basins. Some basins on Long Island, however, have been constructed where the water table lies close to the land surface at least part of the year. Of the 194 water-containing basins on Long Island in 1969, 22 basins intersected the regional water table all or part of the year. Included in this total are four basins that were constructed during the 1962–66 drought (Cohen and others, 1969) and that subsequently became flooded as ground-water levels recovered after the drought.

BASINS THAT INTERSECT PERCHED WATER TABLES

On parts of Long Island, bodies of ground water are perched above the regional water table and are separated from it by an intervening unsaturated zone which contains one or more layers of low hydraulic conductivity (fig. 4). Such deposits generally consist of clayey material that occurs primarily in the areas underlain by ground and terminal moraines. At least 10 flooded basins of this type were identified with moderate certainty by the use of driller's logs of nearby wells and other hydrogeologic data.

In many places, sufficient subsurface hydrogeologic data were not available to distinguish between basins that intersect perched water tables and basins that were excavated into natural deposits of low hydraulic conductivity. Both types are flooded because of subsurface geologic conditions; therefore the number and the percentage of water-containing basins in each of the major types of surficial geologic deposits of Long Island were studied. (See pl. 1.) Excluding basins known to contain water for reasons other than unfavorable geology—that is, basins known to be clogged and basins known to intersect the regional water table—approximately 6 percent of the 1,732 basins excavated in outwash deposits contain water, and approximately 13 percent of the 333 basins excavated in the Harbor Hill and Ronkonkoma ground and terminal

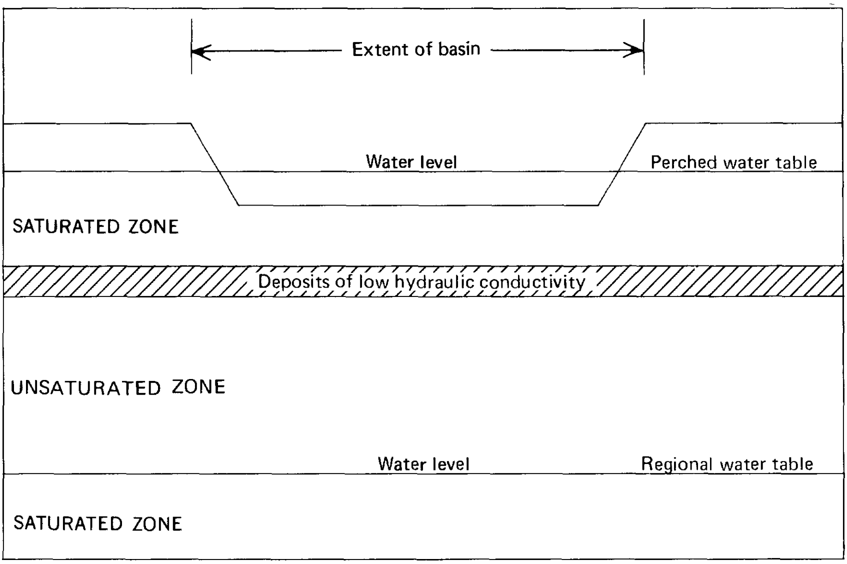

FIGURE 4.—A flooded recharge basin that intersects a perched water table formed by natural deposits of low hydraulic conductivity that underlie the basin.

moraines contain water. Although some of these water-containing basins undoubtedly hold water because they are clogged rather than flooded, the more than 2:1 ratio between the percentage of water-containing basins excavated in morainal deposits of generally low hydraulic conductivity and those excavated in outwash deposits of generally high hydraulic conductivity suggests that a relation exists between local geologic environment and basin flooding. This relation is probably attributable largely to differences in the hydraulic conductivity of the deposits at and beneath the basin floors.

Because of the highly variable lithology of the Mannetto Gravel and because of the small number of basins in kame-delta deposits and the Matawan Group–Magothy Formation(?) (6 basins), an apparent cause and effect relationship between the lithology of these deposits and water containment could not be determined with a reasonable degree of certainty.

CLOGGED BASINS

Accumulations of sediment and debris on the floor of a basin, washed in by storm runoff from the contributing drainage area, reduce infiltration rates. The fine-grained materials fill the interstices of the natural deposits or form impervious layers of materials over the natural deposits. Inspection of material from the floors of selected clogged basins show that the sediment and debris commonly are composed of three general types, including (1) natural litter, such as grass cuttings, leaves, and twigs from lawns and other unpaved areas, (2) organic matter, such as asphalt, grease, oil, tar, rubber particles, and similar substances from roads and parking lots, and (3) poorly sorted mixtures of fine sand, silt, and clay. Other complex factors, such as chemical or biological activity in the layer of accumulated materials, may also promote clogging (Muckel, 1959, p. 25; Parr and Bertrand, 1960, p. 312–321).

The composition and the quantity of sediment and debris washed into a basin is governed largely by surficial characteristics of the basin's drainage area, including the type and the proportion of paved and unpaved areas and the composition of the soil cover. The following sections present the results of a study of the influence of these factors on basin clogging.

RELATION BETWEEN DRAINAGE-AREA USE AND CLOGGING

A determination was made of the number and the percentage of water-containing recharge basins receiving runoff from the three types of drainage areas—residential areas, commercial and industrial areas, and highways. Basins known to be flooded were excluded from consideration. However, because of difficulties in distinguishing some flooded basins from clogged basins in the field, some flooded basins were probably inadvertently included in the calculation of percentages of water-containing basins receiving runoff from the various types of drainage areas.

Recharge basins that drain residential areas compose the largest category of basins on Long Island. In 1969, water from residential areas drained into 1,704 basins; however, the number of water-containing residential basins is only about 7 percent of the total number of residential basins. The low percentage of water-containing residential basins is probably at least partly related to the porous, friable nature of the natural organic detritus deposited on the basin floor, which facilitates infiltration. Such detritus is characteristic of most of material washed into basins in residential areas on Long Island.

Recharge basins that drain commercial and industrial areas compose the smallest category of basins on Long Island—about 54 basins in 1969. Of this total, about 28 percent were classified as water-containing basins. The high percentage of water-containing commercial and industrial basins is probably largely related to the large influxes of asphalt, grease, oil, tar, and rubber particles in storm runoff from adjacent parking fields.

Recharge basins that drain highways might be expected to receive high concentrations of similar material and so to become clogged as readily as commercial and industrial basins. There were 366 highway basins in 1969, but only about 9 percent of these contained water. The small percentage of highway basins that contain water probably largely reflects a combination of the more regular maintenance of these basins and the use of special structures incorporated into the basin floors. (Maintenance and design features of the basins are discussed in the section, "Means of Enhancing Infiltration Rates of Recharge Basins.")

RELATION BETWEEN DRAINAGE-AREA SOIL COVER AND CLOGGING

Part of the material deposited on the floor of a recharge basin by storm runoff is derived from erosion of the soil cover of the basin's drainage area. As part of this study, an analysis was made of the effect of differences in composition of drainage-area soils on promoting clogging in basins.

Most of the soils of Long Island are classified as either loamy soils or sandy soils (Lounsbury and others, 1928; Warner, 1969). Loamy soils contain a mixture of clay, silt, and sand in approximately equal amounts. Sandy soils contain mostly sand and only small percentages of clay and silt. Because of the higher concentration of clay and silt in loamy soils, basins draining these soils are more likely to become clogged than those draining sandy soils.

The number and the percentage of water-containing basins draining the major soil units on Long Island were determined. Basins known to intersect the regional or a perched water table were excluded from this analysis. About 8 percent of basins draining loamy soils contain water, and about 6 percent of basins draining sandy soils contain water. The similarity of these percentages suggests that differences in soils in the drainage area of a recharge basin may not be a major factor contributing to clogging.

LOSS OF WATER FROM WATER-CONTAINING BASINS

During a storm, inflow to a flooded basin causes the water level in the basin to rise rapidly. After inflow ends (commonly within a few days), the water levels in most flooded basins decline to about the pre-storm levels. (See fig. 5*A* for an example of a basin that intersects a perched water table.) Most basins that intersect perched water tables eventually drain by (1) the slow vertical movement of water through the layer of material of low hydrau-

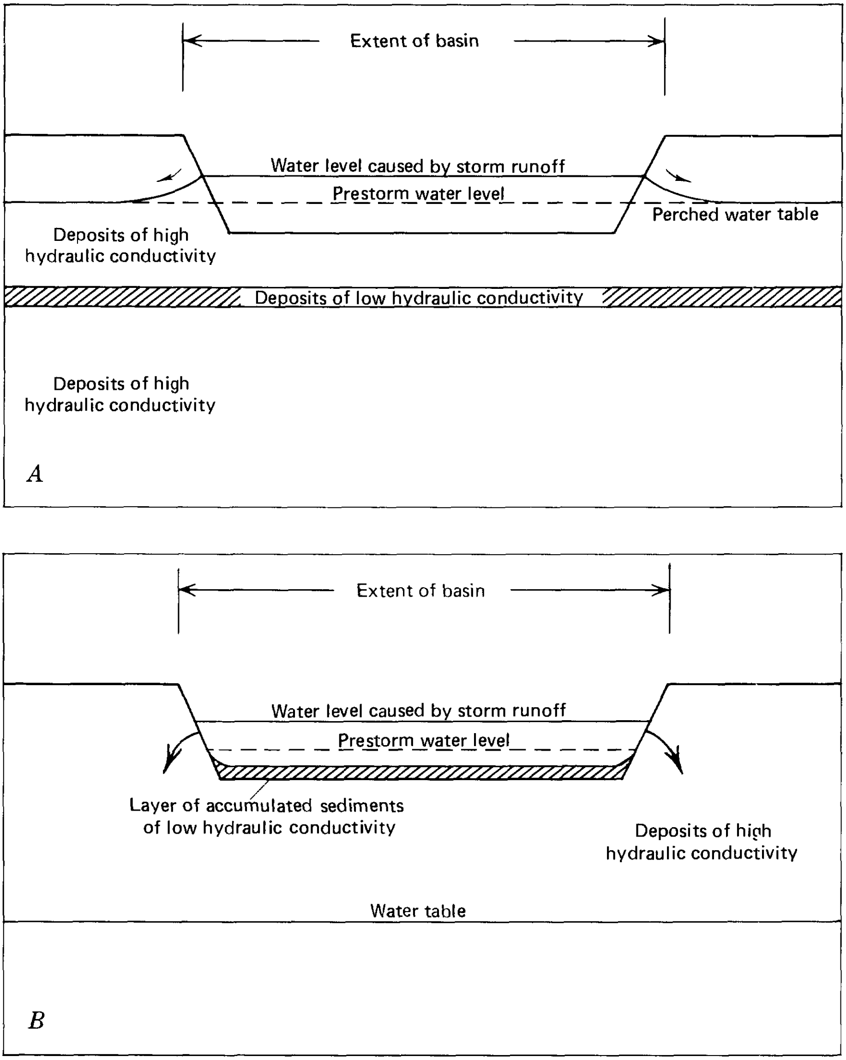

FIGURE 5.—Water-containing recharge basins illustrating storm-water disposal (*A*) by recession of a mound on a perched water table and (*B*) through the sides of the basin above the level of accumulated material of low hydraulic conductivity.

lic conductivity, (2) the horizontal movement of water to the lateral margins of that layer and from there downward to the regional water table, or (3) by a combination of these mechanisms.

Much of the inflow to clogged basins probably also reaches the water table on Long Island. Water levels in many clogged basins were observed to increase during storm runoff and then to recede slowly to their pre-storm levels within several days afterward. Within this short period, negligible water evaporates, and the decline in water levels in most such basins probably results from the infiltration of storm runoff through the sides of the basin above the accumulated impermeable layer. (See fig. 5*B*.)

An undetermined amount of water evaporates from water-containing basins. Specific conductance of water in 123 water-containing basins ranged from 26 to 200 micromhos per centimeter and averaged 95 micromhos per centimeter. Specific conductance of precipitation on Long Island averages about 40 micromhos per centimeter (U.S. Geological Survey, 1970, p. 132) and that of water in the shallow aquifer underlying urbanized areas averages about 200 micromhos per centimeter (N. M. Perlmutter, oral commun., 1971). The specific conductance of inflow to three basins that were intensively studied ranged from 1.1 to 1.4 times the specific conductance of precipitation. This increase was attributed almost entirely to solution of material on the land surface during runoff. Inasmuch as the average specific conductance of water in the 123 basins was only 95 micromhos per centimeter, the loss of water from these basins by evaporation (and consequent increase in specific conductance) does not seem to be large.

The specific conductance of water in 11 additional basins ranged from 210 to 465 micromhos per centimeter. These high specific conductances probably largely reflected a combination of large concentrations of dissolved solids washed in from the drainage area of the basins and concentration resulting from evaporation. In general, the effects of concentration resulting from evaporation were most apparent in those basins that contained water perennially.

MEANS OF ENHANCING INFILTRATION RATES OF RECHARGE BASINS

Several means are used to rehabilitate, maintain, or increase the infiltration rates of recharge basins on Long Island. These include settling areas, retention basins, diffusion wells, and scarification. All these have been applied with varying degrees of success; however, some basins are known to contain water despite the use of one or more of these devices. The rates of deterioration of basin performance after attempted rehabilitation vary widely. Moreover, numerous complexly related factors are involved, but a detailed analysis of these factors is beyond the scope of this report.

A brief description of several of the more common means of improving the infiltration capacity of recharge basins is presented in the following paragraphs.

SETTLING AREAS

The floors of many recharge basins are constructed on two or more levels. (See fig. 6.) The lower level is called a settling area and is designed to collect trash and sediment washed into the basin by storm runoff. The upper level, 1–2 feet above the lower level, is an auxiliary infiltrating area that receives overflow water from the commonly flooded lower level.

RETENTION BASINS

A dozen or so basins are known to be clogged permanently because of inordinately large accumulations of sediment and debris on the basin floor. These basins generally drain parking fields and heavily traveled roadways that contribute high concentrations of asphalt, grease, oil, tar, and rubber particles. The effort necessary for continual rehabilitation of retention basins would be costly, so they are used as settling basins for sediment and debris carried by storm runoff (fig. 7). The nearly sediment-free overflow water from the retention basin is then discharged, by way of pipes and flumes, to an adjacent nearby recharge basin for disposal.

DIFFUSION WELLS

Wells are dug below the floors of some water-containing basins to enable ponded water to percolate downward to the water table. These wells, locally called diffusion wells, are constructed primar-

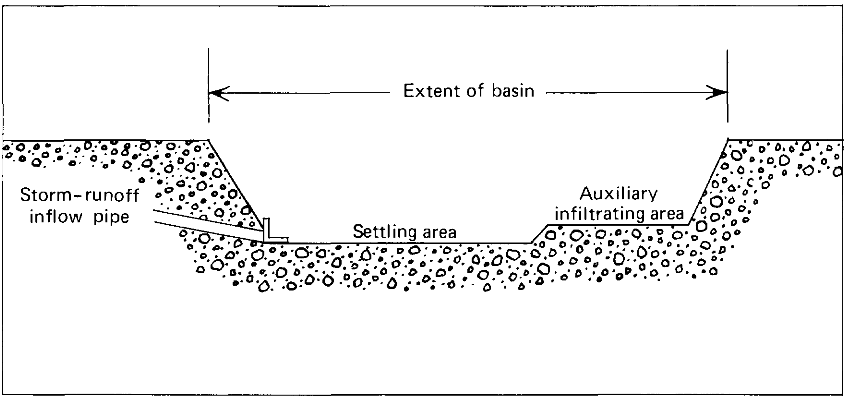

FIGURE 6.—Two-level recharge basin.

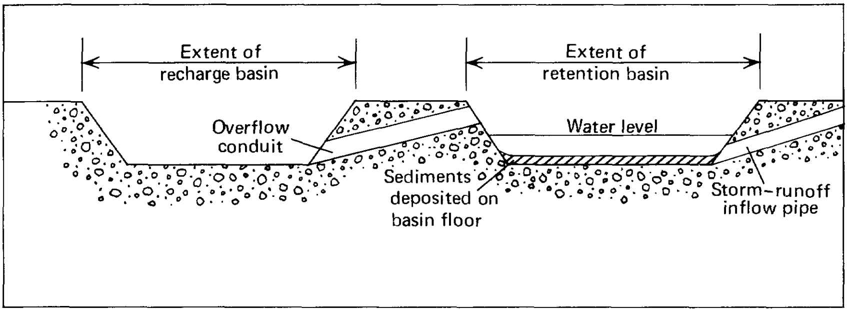

FIGURE 7.—Retention basin and the adjoining recharge basin.

ily in basins that are flooded because of underlying strata of low hydraulic conductivity, but they also are used in some basins that are clogged by accumulations of sediment and debris.

Diffusion wells (fig. 8) commonly are constructed of 10-foot diameter precast perforated concrete cylinders backfilled with coarse sand and gravel and installed at a sufficient depth to penetrate the restricting layer.

Diffusion wells are used mostly in basins draining highways and industrial and commercial areas where no adjacent land is available for construction of an adjoining recharge basin. Probably less than 20 percent of the water-containing basins and 5 to 10 percent of all the recharge basins in operation on Long Island in 1969 are equipped with diffusion wells.

SCARIFICATION

Those responsible for operating and maintaining recharge basins on Long Island use the word scarification to denote either the procedure by which the material on the floor of the basin is broken up or loosened or by which a thin layer of the material is removed. Basins that are commonly scarified are those that originally operated well but, because of the inflow of large amounts of sediment and debris, have deteriorated over a period of time.

Many basins draining residential areas are scarified to remove the large sediment loads deposited on the basin floor during and soon after the period of housing construction. Scarification is generally done after construction has been completed and sediment loads have stabilized. As lawns become established and the sediment loads in the runoff decrease, additional scarification generally is not required for many years.

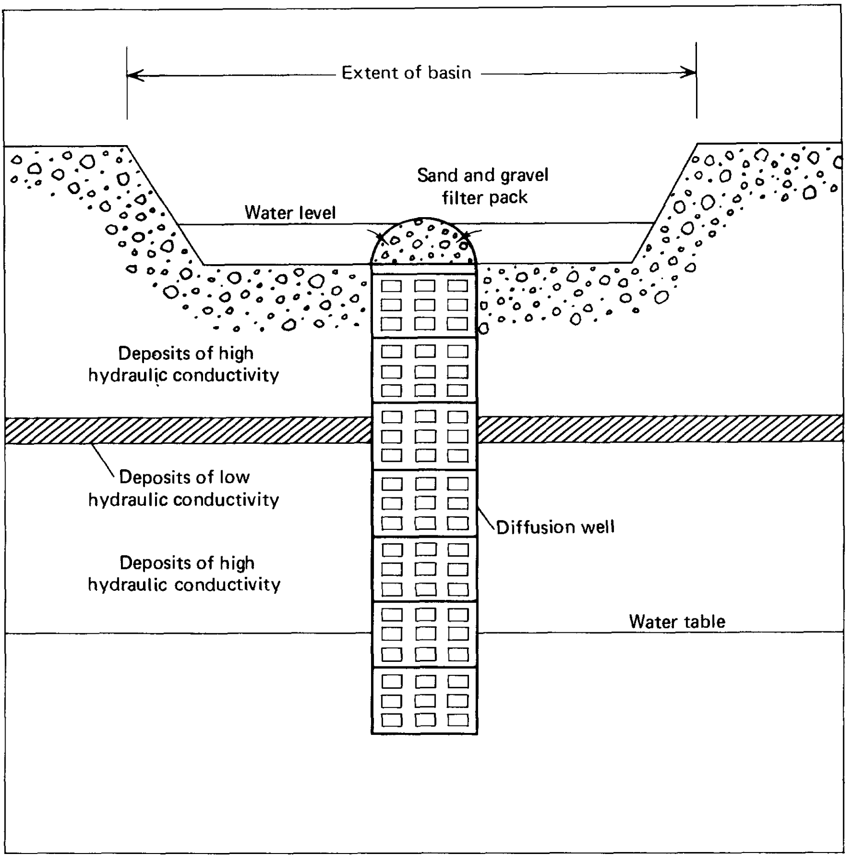

FIGURE 8.—Water-containing recharge basin equipped with a diffusion well.

SUMMARY

Of the approximately 2,124 recharge basins in operation on Long Island in 1969, approximately 9 percent or 194 contain water for 5 or more days after a 1-inch rainfall over the contributing drainage area. Basins on Long Island contain water because (1) they intersect the regional water table or a perched water table, (2) they are excavated in materials of low hydraulic conductivity, (3) layers of sediment and debris of low hydraulic conductivity accumulate on the basin floor, or (4) because of a combination of these factors.

In 1969, the bottoms of approximately 22 basins intersected the regional water table. Several of these basins, constructed during the 1962–66 drought on Long Island, became flooded as water levels recovered after the drought. An unknown number of water-containing basins intersected perched water tables.

A greater percentage of basins excavated in the Harbor Hill and the Ronkonkoma ground- and terminal-moraine deposits hold water than basins excavated in outwash deposits.

Storm runoff from industrial and commercial areas and highways generally contains high concentrations of asphalt, grease, oil, tar, and rubber particles. These materials markedly reduce the infiltration capacity of a basin. In contrast, storm runoff from residential areas mainly contains natural vegetal matter. A low percentage of these basins contain water. A greater percentage of basins that drain industrial and commercial areas contain water than basins that drain highways.

The proportion of water-containing basins that drain loamy soils with high silt and clay contents is slightly greater than the proportion of water-containing basins that drain sandy soils having considerably lower clay and silt content. However, the difference in soil types is not considered to be a significant factor in basin efficiency.

Water-containing basins dispose of an undetermined amount of storm runoff by the slow infiltration of water through the bottoms and the sides of the basins. Evaporation does not seem to be a major method of water disposal from most water-containing basins.

Several means are currently used to improve or maintain basin operation; these include the construction of settling areas, retention basins, and diffusion wells and scarification of basin floors.

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GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
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NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
SUFFOLK COUNTY DEPARTMENT OF ENVIRONMENTAL CONTROL
SUFFOLK COUNTY WATER AUTHORITY

WATER-SUPPLY PAPER 2001-D
PLATE 1

Base from U.S. Geological Survey New York, 1960; Hartford, 1962; Providence, 1947; and Newark, 1947

SCALE 1:250 000

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVALS 50 AND 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 25 AND 50 FOOT INTERVALS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER

Geology adapted from Fuller (1914), Crandell (1962); Perlmutter and Geraghty (1963); Swarzenski (1963); Lubke (1964); Pluhowski and Kantrowitz (1964); Isbister (1966); Soren (1971)

MAP SHOWING THE LOCATIONS OF WATER-CONTAINING RECHARGE BASINS IN 1969 AND GENERAL GEOLOGY, LONG ISLAND, NEW YORK

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